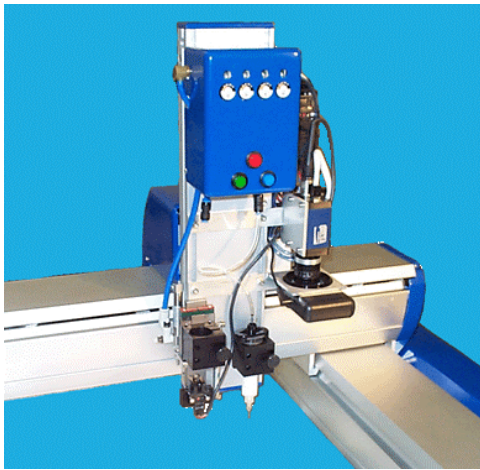




The Guidance Dispense System



Introduction and Reference Manual

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Warning Labels

The following warning and caution labels are utilized throughout this manual to convey critical information required for the safe and proper operation of the hardware and software. It is extremely important that all such labels are carefully read and complied with in full to prevent personal injury and damage to the equipment.

There are four levels of special alert notation used in this manual. In descending order of importance, they are:



DANGER: This indicates an imminently hazardous situation, which, if not avoided, will result in death or serious injury.



WARNING: This indicates a potentially hazardous situation, which, if not avoided, could result in serious injury or major damage to the equipment.



CAUTION: This indicates a situation, which, if not avoided, could result in minor injury or damage to the equipment.

NOTE: This provides supplementary information, emphasizes a point or procedure, or gives a tip for easier operation

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Guidance Dispense

System Introduction

Guidance Dispense (GD) is a set of hardware and software components that can be utilized to implement a complete automated dispensing system. When these components are integrated with a robot and combined with syringes and needles, they can automatically dispense adhesives, sealants and other fluids along both simple and arbitrarily complex paths. Path programming is performed using simple teach-and-repeat methods that can be augmented by machine vision to automatically correct for deviations in part position and orientation.

Since dispensing encompasses an extremely wide range of requirements, Guidance Dispense has been designed as a very open system that permits hardware and software components to be tailored for the application. While GD has been designed for use with the PrecisePlace Cartesian robots, GD can be employed with any robot that is controlled by a Precise Guidance Controller. As appropriate, the GD software can be coupled with 3rd party hardware or the GD hardware could be employed without the GD software. For simple dispensing applications, a user might purchase just the PrecisePlace robot with the simple GD fixed syringe holder and the GD software and supply their own air dispenser, syringes, needles and air plumbing.

In this manual, we assume that the full set of Guidance Dispense hardware and software components are being utilized, but this is only done to simplify the manual. Please skip those sections of the manual that do not apply to your system configuration.

The Guidance Dispense hardware consists of: a dual control air dispenser that can drive two syringes; a simple fixed position syringe clamp; a second syringe clamp that moves on a vertical slide under pneumatic control and includes a contact sensor; and an arm mounted camera that includes a variable intensity ring light. The dual air dispenser includes two regulators for controlling the air pressure that forces out the fluid in the syringes as well as two additional regulators for controlling vacuum for quickly releasing the pressure on the syringes. The air dispenser housing includes buttons with lights as a teaching aid and to indicate system status. The air dispenser solenoids, buttons and lights, pneumatic clamp piston and contact sensor are all interfaced to the robot's controller to permit automatic operation.

The Guidance Dispense software is an open source package that executes on any Precise Guidance Controller. In the case of the PrecisePlace robot, this software executes in a controller that is integrated into the back of the robot's X-axis. The operator interface is implemented as a series of web pages that can be viewed locally or remotely via a web browser. This software permits dispensing paths and processes to be taught and executed without the need for programming. The graphical user interface provides all of the tools for teaching straight and curved three-dimensional paths and controlling the operation of the two syringes. The system includes an operator control panel and runtime that permits paths to be played back while maintaining excellent speed control to enable consistent results.

GD also supports PreciseVision for performing vision-guided path dispensing. This permits a camera mounted above the work area or on the end of robot to locate objects or fiducial marks and to utilize the detected positions and orientations to automatically update dispensing paths. This reduces the need for complex fixtures and allows for a more flexible approach to dispensing.

Setup, Installation and Execution

Interfacing Your Robot to a PC

All of the software and data necessary to teach and execute a dispensing process (with the exception of machine vision) resides on the robot's controller. However, a PC is utilized as the graphical user interface (GUI) for the Guidance Dispense software. Except for one-time system setup procedures, the only application software required on the PC is a standard web browser. For the best results, it is suggested that you use the following PC equipment for a non-vision system:

- A 500 MHz or faster PC running Windows 2000 or Windows XP
- Microsoft Internet Explorer version 6.x or later
- A 10/100 Ethernet card
- A standard Cat-5 Ethernet cable

If your system includes PreciseVision, the vision software will be executed on the PC. In this case, the recommended equipment is the following (please see the PreciseVision manual for addition information on cameras and installation of the PreciseVision software):

- A 2.3Ghz or faster Pentium 4 PC running Windows XP
- Microsoft Internet Explorer version 6.x or later
- Gigabit Ethernet (recommended and required for certain cameras), otherwise 100Mb Ethernet interface
- A standard Cat-5 Ethernet cable
- 512 MB of RAM
- At least 1 GB of space on the PC's disk
- A 2x CD-ROM drive interfaced to the PC

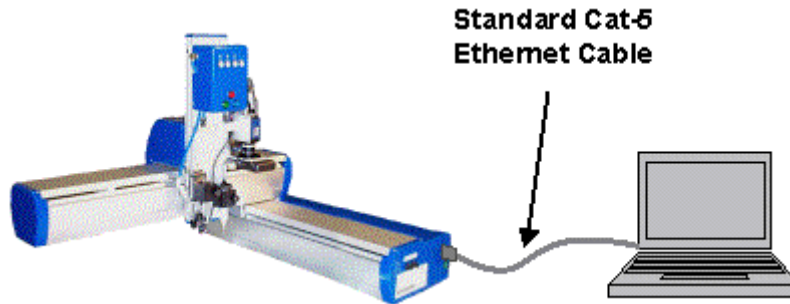
To connect the robot's controller to a PC, perform the following steps:

» Connect the robot's controller to the PC directly or via a hub or switch using the appropriate cable as described above.



DANGER: Before operating your robot, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *"PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual"*.

If you are utilizing a PrecisePlace robot, the Ethernet cable is plugged into either of the sockets on the right end-cap of the robot as illustrated in the following:



» Set the IP address and subnet mask on the PC to be compatible with the controller. By default the controller's IP address is 192.168.0.1 and the subnet mask is 255.255.255.0. If you are not familiar with the procedure for changing the IP address and subnet mask on the PC, please see the next section. Alternately, you can utilize the Guidance Discovery application to set the controller's IP information to be compatible with the PC.

For instructions on the use of the free Guidance Discovery utility, see the "Guidance Discovery" chapter of the "Guidance Development Suite" section of the *Precise Documentation Library*.

Setting the IP Address in Windows XP

This section provides detailed instructions if you require assistance in configuring your PC's IP address and subnet mask to be compatible with the robot's controller. If you have already changed the IP address and subnet mask on your PC, you can skip this section.

By default the Guidance Controller is factory configured with the IP address/subnet mask of 192.168.0.1 and 255.255.255.0. The PC must be compatible with this IP specification. For Windows XP users:

- » Open the PC control panel by clicking **Start > Settings > Network Connections** .
- » Right click on the icon for the Ethernet card that is connected to the controller and select "**Properties**".

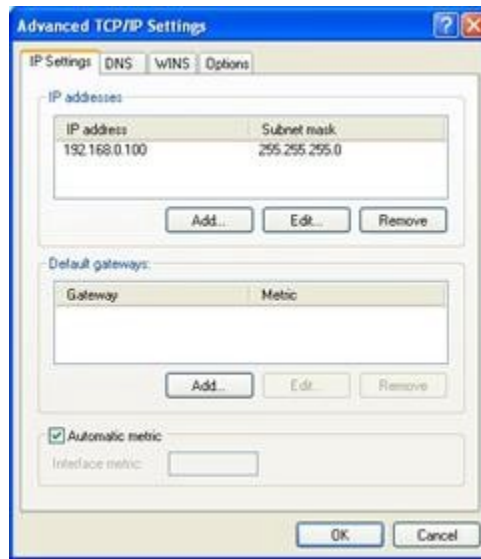


» Highlight "**Internet Protocol (TCP/IP)**" and click on the "**Properties**" button.



» If your PC is using DHCP and is not compatible with the controller, you will need to specify a compatible IP address and subnet mask. Click on the "**Use the following IP address**" radio button and enter IP information that is compatible. Once you have connected to the controller, you can change the IP address and subnet mask of the controller to be compatible with your network.

» If your PC is using a static IP address you do NOT need to change the IP address and subnet mask. Instead, click on the "**Advanced**" button.



» Click on the "**Add**" button and enter in a compatible IP address and subnet mask. For example you could use '192.168.0.200' and '255.255.255.0'.

» Click the **OK** to activate the changes.

Guidance Dispense Software Installation

If you wish to use the Guidance Dispense software package and it has not been pre-installed on your robot's controller or if you wish to upgrade your GD software to a new version, this section describes the software installation and upgrade process.

The GD software is an open source application that consists of a GPL "project" and a set of custom web pages. This information is contained in a collection of disk files that must be loaded into the robot controller's flash disk in the "/flash" directory. For simplicity, all of the required files are distributed in a single compressed ".ZIP" file.

To successfully install a new version of GD, the following is required:

- A distribution copy of the GD software. This file is typically named "GD_Version_xxx.zip".
- A copy of the Guidance Develop Suite (GDS) version 1.4 or later installed on your PC. For this procedure, it is not necessary to purchase a licensed copy of GDS since the installation utility will operate without a license.
- A PC with a suitable browser interfaced to the robot's controller via Ethernet.
- At least 1.5MB of free space available on the robot controller's flash disk.
- A copy of GPL version 1.3 or later executing on the robot's controller. GPL is the motion control system software that is provided with each Precise Guidance Controller.

To install the new Guidance Dispense software, perform the following steps.

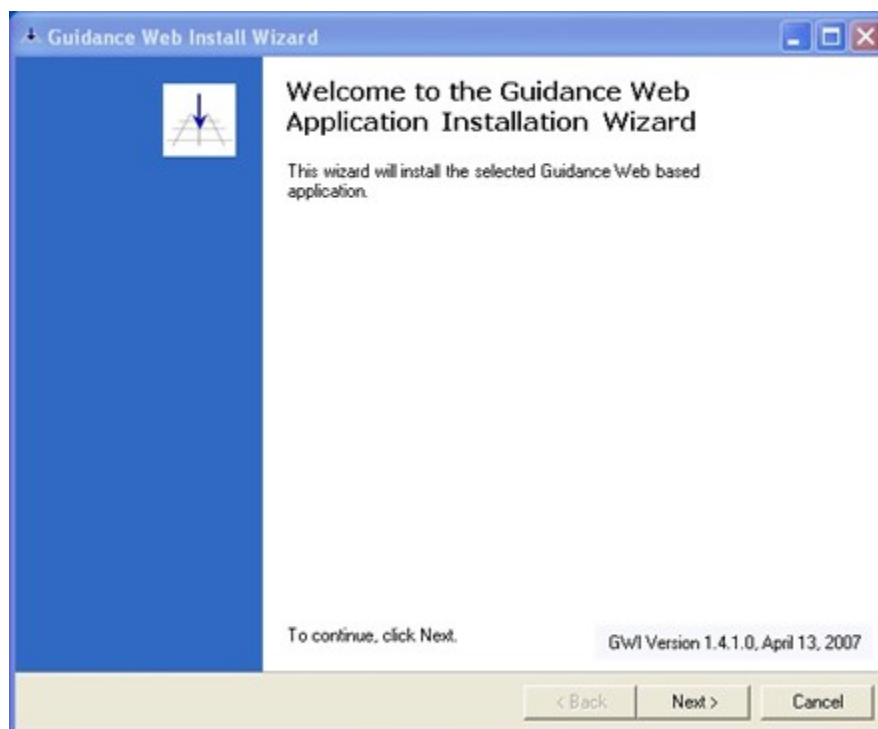
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» Copy the Guidance Dispense distribution file to your PC's hard drive and uncompress the Zip file.

Recent versions of the Windows operating system provide built-in utilities for uncompressing Zip disk files. Typically, if you right click on a Zip file, you will see a "Extract all" option. If your version of Windows does not include this feature, you can obtain a free version of an UnZip utility from multiple sites on the Internet.

Once the GD distribution is uncompressed, you can execute the "Guidance Web Install Wizard" to copy all of the files to the robot controller. This utility is part of the Guidance Development Suite. During the installation of the application, if an existing installation of a web-based application is detected, the wizard will prompt you to replace this with the new application.

» Launch the installation application by clicking **Start > Programs > Precise Automation > GDS x.x > Guidance Web Install Wizard**.



» Follow the instructions of this wizard to install the Guidance Dispense application.

» Provide the directory path and name of the file that contains the load instructions for the installer. For GD, this file is named "GuidanceDispense.gwa" and will be located in the top-level directory of the unZip'ed files.

Guidance Web Install Wizard

Select Application To Install
Browse to a PC folder that contains the application information file.

Locate the Guidance Web Application '.GWA' file. This file will be in the root folder where the web application files are located.

Guidance web application

Web Application Information
Guidance Dispense, Version .025, Build March 28, 2007

< Back Next > Cancel

Guidance Web Install Wizard

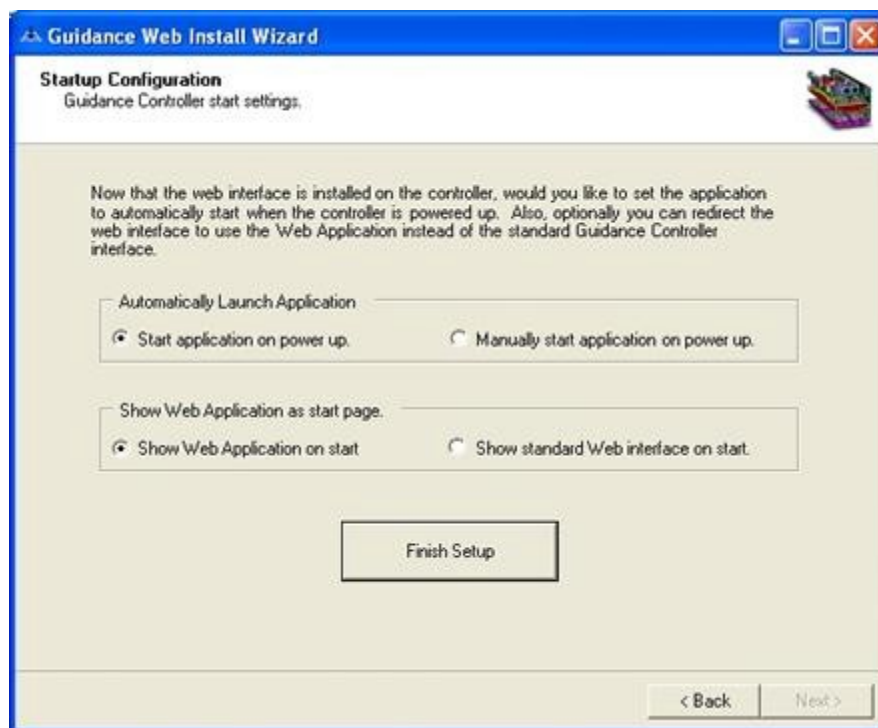
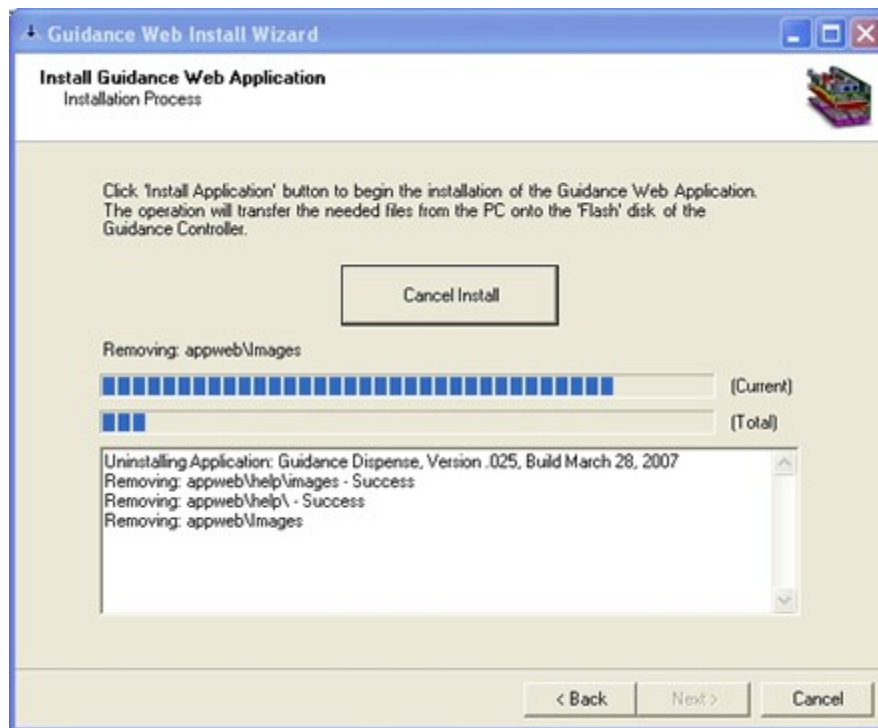
Enter IP address of controller
Enter the Guidance Controller IP address.

Enter the IP address of the controller that you wish to install the Guidance Web Application.

Controller IP
(i.e. 192.168.0.1)

< Back Next > Cancel

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» Once the wizard is completed, restart the robot's controller to begin execution of the Guidance Dispense application.

Starting the Guidance Dispense Application

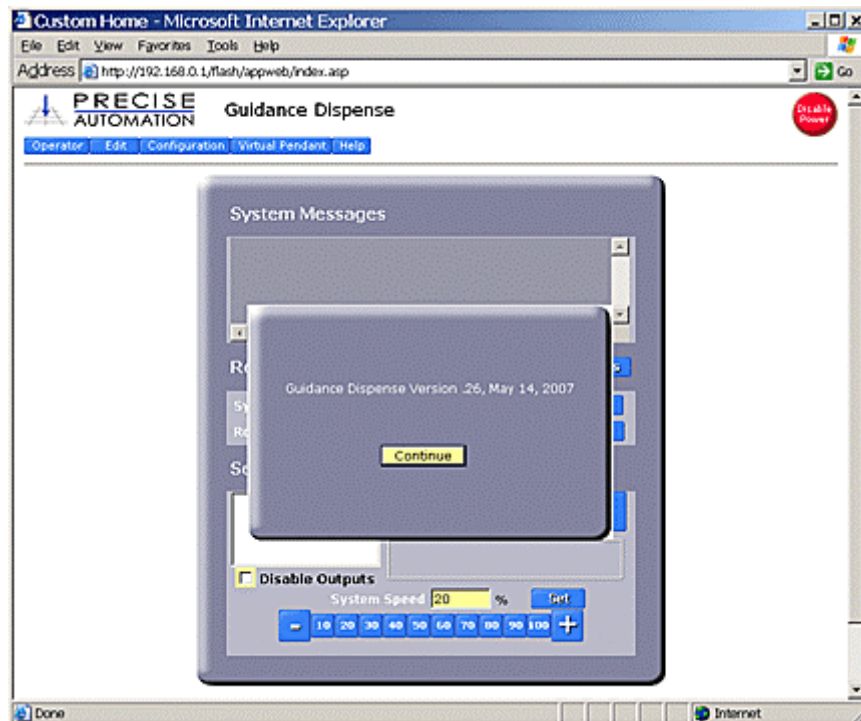
As a configuration option for the robot's controller, each time the controller is restarted, the Guidance Dispense Application can be automatically executed and the web pages redirected to the GD application pages.



DANGER: Before operating your robot, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *"PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual"*.

- » To access the Guidance Dispense Application user interface, start the robot's controller by turning on the robot's AC power.
- » On the PC interfaced to the controller via Ethernet, launch Internet Explorer and enter the IP address of the robot's controller. By default, the controller's IP address is set to 192.168.0.1.

If Guidance Dispense and its web pages have been automatically started, the following web page will be displayed within the browser. The background image is the GD Operator Control Panel. In the foreground is a pop-up window that identifies the version of the GD software.



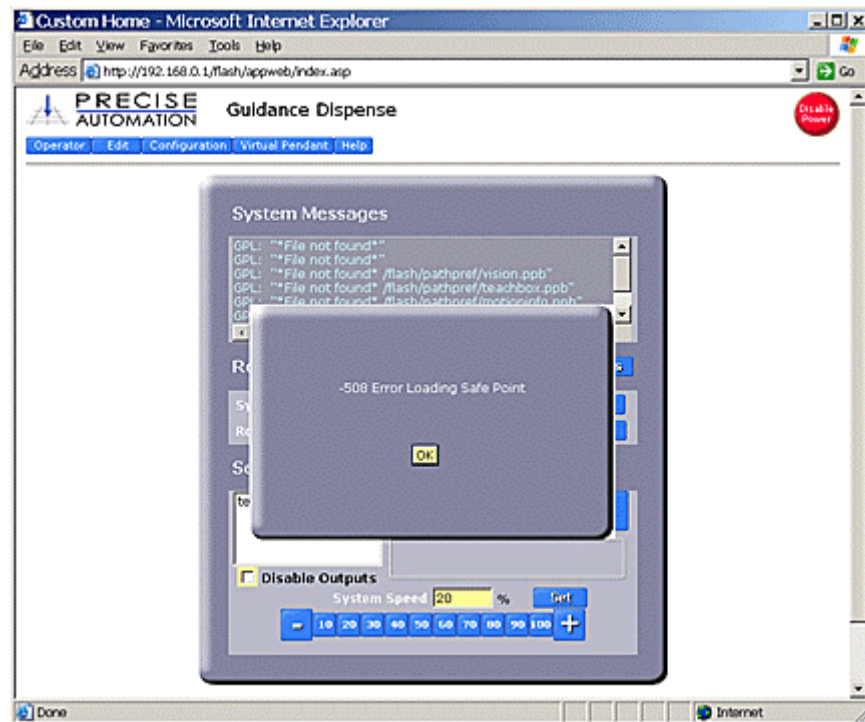
If you do not see this web page, please refer to the *Guidance Controller Setup and Operation, Quick Start Guide* for instructions for loading and executing a GPL project. The project to be loaded and executed should be on the controller's flash disk and be named "Gdispense". If you cannot locate the software or

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if you would like GD to automatically start, execute the Software Installation process described in the previous section and select the auto start options on the final screen. Once you are able to view the startup pages for GD, continue with the remainder of this section.

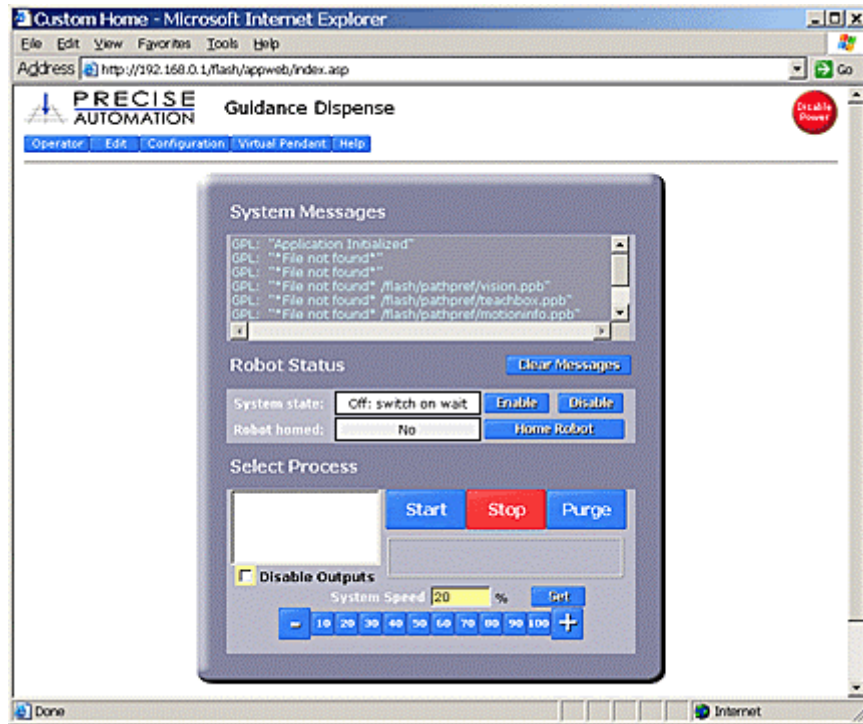
» Click the **"Continue"** button to dismiss the Guidance Dispense version identification pop-up window.

If this is the first time that the GD application is being executed, you will see the following error pop-up that indicates that the "Safe Point" has not been taught. You will also see a number of errors listed in the "Systems Messages" area that indicate that other data has not yet been defined.



» Click the **"OK"** to ignore this error for now and select **"No"** when you are asked to teach this position. The "Safe Point" will be discussed in later sections of this manual.

You should now see the following Operator Control Panel screen that indicates that the Guidance Dispense application has been successfully started and is now operational.

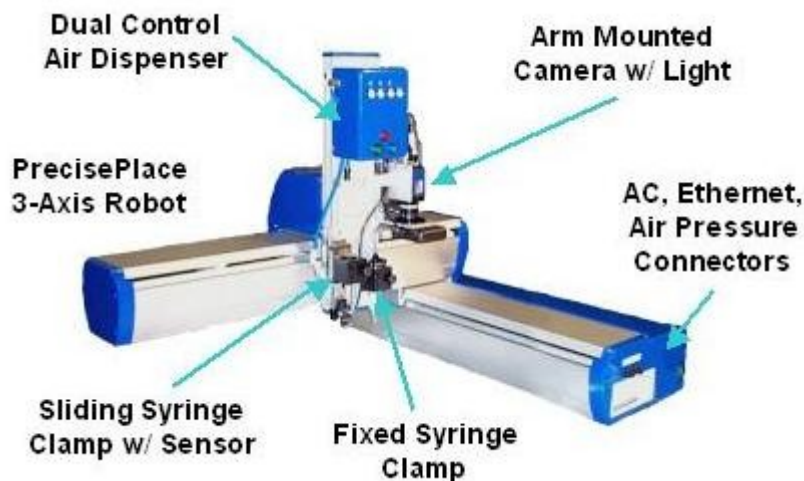


Hardware Introduction

Guidance Dispense Hardware Overview

This chapter describes how to operate and adjust the Guidance Dispense hardware components after they have been mounted and interfaced to a robot and the Guidance Dispense software has been installed on the robot's controller. For individuals who require an in-depth understanding of the this hardware and for those who wish to configure a robot system with these components, detailed descriptions of the GD hardware are provided in the Reference Information chapter.

The following picture illustrates a full-featured PrecisePlace 1300 (3-Axis XYZ) robot that includes all of the Guidance Dispense hardware components. With the addition of loaded syringes with needles and a PC interfaced via Ethernet, this equipment would be ready to apply to a vision-guided dispensing application.



DANGER: The robot's controller and power supplies are located beneath the X-axis cover. These units are open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 320VDC volts to the motors and takes about 2 minutes to bleed down after power is disconnected. AC power to the robot must be disconnected prior to removal of the X-axis cover for any reason.

Mounted on the Z-axis of the robot are: the dual control air dispenser; a sliding syringe clamp with a Z-Contact sensor; a fixed position syringe clamp; and an arm-mounted downward looking camera with a variable intensity ring light.

This system dispenses fluids by apply air pressure to a plunger within a syringe. This air pressure must be provided by an external source that is connected to an air intake fitting mounted on the robot's right end-cap. The air line is routed through the interior of the robot and the Z-axis E-chain and terminates at a fitting in the right side of the air dispenser. The dual control air dispenser regulates and manages the airflow and provides two output air lines, one for each of two possible syringes held by the two syringe clamps.

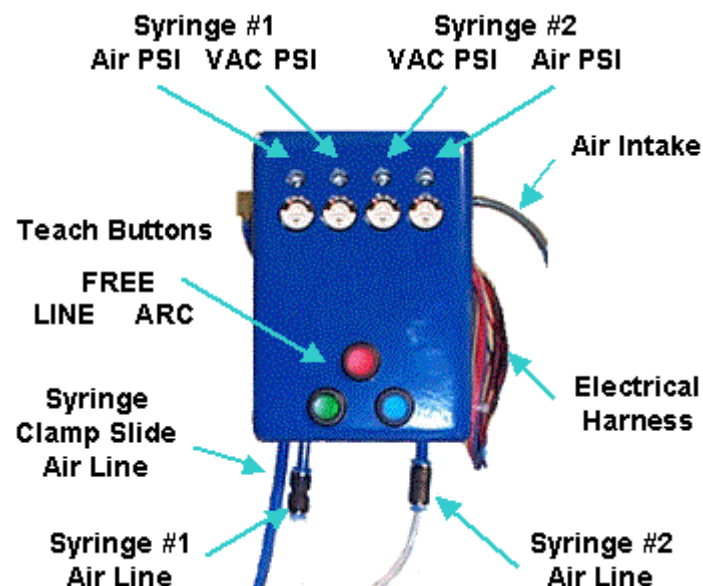
If the system is equipped with the machine vision option, the camera can either be attached to a stationary mount above the robot or can be mounted to the Z-axis of the robot as pictured above. The benefit of a stationary mount is that a picture can be taken while the robot has moved away. The benefit of an arm-mounted camera is that a higher resolution, smaller field of view lens can be selected and the camera can be repositioned in the workspace as required.

If an arm-mounted camera is utilized, the DC power for the camera and the light are provided at the Z-axis. The Ethernet cable that is connected to the camera is routed through the interior of the robot and its signals are available on the robot's right end-cap.

In the next sections of this chapter, instructions on operating and adjusting the hardware components are presented.

Dual Control Air Dispenser

The Dual Control Air Dispenser drives the air lines for the two syringes and the pneumatic actuator for the sliding syringe clamp. In addition, this device has backlit buttons that greatly simplify teaching path "nodes" and that display the system execution state when a path is being executed. The following picture illustrates the key elements of this device.



For each syringe, this device provides two pressure regulators: one to control the positive pressure that forces the syringe plunger to dispense fluid and a second regulator that supplies air to a venturi device that creates a vacuum in the syringe air line when the positive pressure is turned off. The vacuum assists in backing off the syringe plunger to minimizing dribbling of the dispensed fluid.

Guidance_Dispense





Each of these regulators can be adjusted from 7 PSI up to 100 PSI. An adjustment screw is available through a hole that is above each of the miniature pressure regulator meters.

NOTE: To avoid accidental changes in the pressure settings, the air pressure screw adjustments normally have a locking nut engaged. To release the lock nut, remove the cover of the air dispenser and loosen the nut.

The positive pressure for each syringe should be adjusted to provide the desired flow rate of dispensed material. If the pressure is too high, the fluid will be too thick. If the pressure is too low, a continuous bead will have unexpected breaks in the bead.

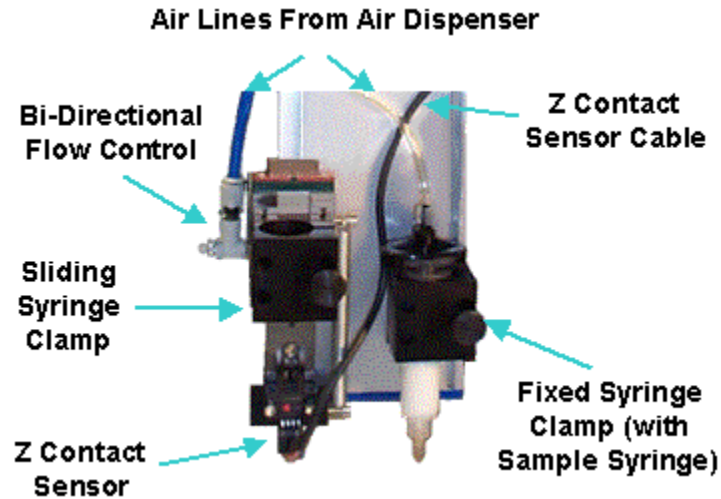
The three-backlit buttons on this unit provide a very convenient means for teaching a path. When the top button is pressed, the robot is "free'd" to permit it to be manually moved to any desired position. For robots like the PrecisePlace that have direct drive motors on the X & Y axes and very little friction, it is quick and easy to manually push the robot and accurately position the syringe tip in free mode. When the robot has been properly positioned, pressing one of the two lower buttons records either a node on a straight line or arc path. These three buttons provide a very intuitive and rapid means for training even complex paths.

The following table describes the use of the buttons and the interpretation of the button lights during both path teaching and normal execution.

Backlit Button		During Teaching	During Process Execution
Red (Free)		Press to "Free" or "UnFree" all axes of the robot. Backlight is on when in Free mode.	In dispense simulation mode, backlight is on when fluid should be dispensing.
Green (Line)		Press to create and teach a Line node. Backlight blinks momentarily to indicate node created.	Backlight is on when a Line node being executed.
Blue (Arc)		Press to create and teach an Arc node. Backlight blinks momentarily to indicate node created.	Backlight is on when an Arc node being executed.
Blue & Green		N.A.	Backlights both on when executing a Dot or Pause node.

Dual Syringe Clamps

The Air Dispenser can control the air pressure for two syringes. Two syringes permit quick change over when dispensing two types of fluids or when using two needle sizes. To accommodate two syringes, two syringe clamps are provided. To avoid physical interference, one syringe clamp is mounted in a fixed position on the robot's Z-axis and the second clamp is mounted on a pneumatically operated vertical slide so its tip can be positioned below the fixed syringe when in use and moved up when not needed. Another feature of the Sliding Syringe Clamp is that it is equipped with a sensor that can detect when the syringe needle touches the work surface.



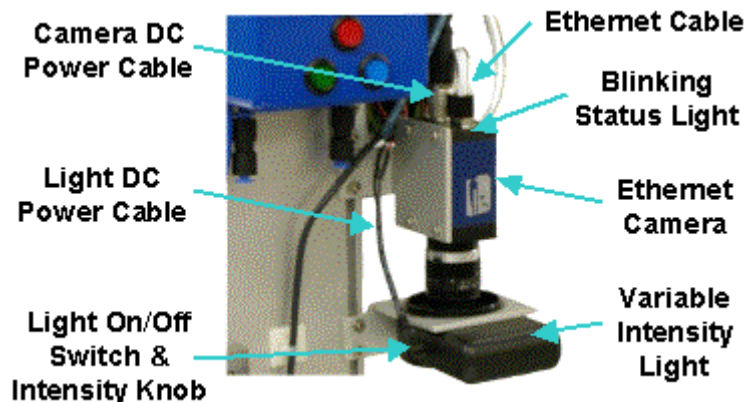
As pictured above, the vertical positions of both the Fixed and Sliding Syringe Clamps can be adjusted by sliding them up or down within the Z-axis T-slots before being tightened down. Both clamps have thumbscrews for retaining a syringe and can accommodate syringes up to 25 mm in diameter. For smaller diameter syringes, a standard plastic insert can be obtained.

The Sliding Syringe Clamp has a total travel of 30 mm. When there is no air pressure, the clamp is pulled into the down position by a spring. If the tip of the syringe mounted in this clamp touches a surface, the clamp will rise up in the slide with a resistance generated by the spring. The Z-Contact Sensor will detect this relative motion and this event will be captured by the robot's controller. Typically, the Z-Contact Sensor is utilized for accurately setting the Z height at which to dispense a fluid. This can compensate for manufacturing variations from part to part and can aid in ensuring that the dispense process yields high quality results.

To ensure that the Sliding Syringe Clamp moves up and down quickly but without excessive impact, a Bi-Directional Flow Control is mounted between the air supply line and the pneumatic actuator. Two knobs are provided that control the air flow rate when the air pressure is applied or eliminated.

Arm-Mounted Camera and Light

If your system includes an arm-mounted camera and variable intensity light, the following picture illustrates how these units can be attached to the Z-axis of the PrecisePlace 2300 robot.



Please note that both the camera and the light mounting brackets can slide up and down in the T-Slot of the Z-axis to permit these units to be positioned at the correct heights for an optimal camera field-of-view.

In order to operate, the camera requires that an Ethernet and DC Power Cable be plugged into the side opposite from the lens. The DC Power Cable furnishes 12VDC. The Ethernet cable is used to receive commands from the PreciseVision software and to transmit back digitized camera images.

Typically a manually operated lens that provides an f-stop and focus ring is mounted to the camera. To avoid having these settings change during operation, the lens often has setscrews for fixing the positions of the rings. These setscrews must be loosened in order to adjust either the f-stop or focus.

The Ethernet camera includes a Status LED on the same surface as the Ethernet connector. This status indicator is interpreted as follows:

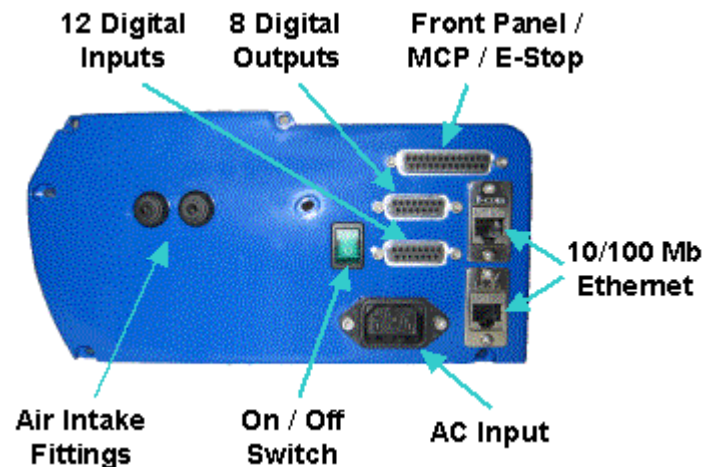
LED State	Camera Status
Off	Camera is not receiving power
Steady Red	Camera is not initialized
Slow Flashing Red	Camera initialization problem. Most likely indicates a camera hardware failure.
Fast Flashing Red	Camera is too hot
Slow Flashing Blue	Waiting for an IP address
Fast Flashing Blue	Ethernet cable disconnected (no link)
Steady Blue	IP address assigned, PreciseVision not connected to camera
Steady Green	PreciseVision connected to camera, standard operational state
Slow Flashing Green	Camera waiting for hardware trigger to take picture
Fast Flashing Green	Continuous acquisitions in progress, standard live video state

Since the light normally remains on at all times, it is not operated by the robot's controller. There is a switch (labeled in the picture above) that can be used to turn off the light even when the controller is powered on. In addition, there is a small knob by the on/off switch that controls the intensity of the light. Normally, the light intensity should be set bright enough to overcome variations in the ambient light but not so bright as to create a reflected glare back into the camera lens.

For detailed information on programming the machine vision system, please see the *PreciseVision Machine Vision System, Introduction and Reference Manual*.

PrecisePlace Robot Facilities End-Cap

If the Guidance Dispense hardware components are mounted on a PrecisePlace Cartesian robot, the robot's Facilities End-Cap on the right side of the X-axis contains the plugs and connectors for AC power, pneumatic air lines, Ethernet, and Digital IO signals.



To provide air pressure to the Dual Control Air Dispenser, clean, dry external air should be connected to the LEFT air fitting. This air line is routed through the interior of the robot and exits at the Z-axis E-Chain where it plugs into the Air Dispenser.



CAUTION: The maximum air pressure that can be conveyed by the air lines through the robot is **75 PSI**. Applying a pressure exceeding this level may disconnect interior connections or damage fittings or hoses. If a higher pressure is required, an external air line should be utilized.

If your system is equipped with an arm-mounted camera, the camera communicates with PreciseVision via Ethernet. The Ethernet cable that plugs into the camera is routed through the interior of the robot and is connected to the robot controller's integrated Ethernet switch. The two 10/100Mb Ethernet ports on the End-Cap are also connected to the same switch. Therefore, either Ethernet plug can be used to interface to the camera and the robot's controller. The second Ethernet port is provided as a wiring convenience.

If your system is equipped with a Precise Manual Control Pendant or an E-Stop box, these units can be directly plugged into the "Front Panel / MCP / E-Stop" connector. The E-Stop button on these units will be directly tied to the controller's hardware E-Stop inputs to ensure that the robot's motor power can be quickly and reliably disabled.

The electric power required by the robot, its control electronics, the arm-mounted camera and its light, and the Guidance Dispense hardware is all derived from the AC input line. The robot is equipped with power supplies that can be utilized worldwide since they can accept voltages from 90 to 132 VAC and

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180 to 264 VAC, 50-60 Hz. Turning off the green backlit On/Off switch on the end-cap will turn off power to the robot and all of the mounted hardware.



DANGER: The robot's controller and high voltage power supplies are located beneath the X-axis cover. These units are all open frame electrical devices that have exposed unshielded high voltage pins, components and surfaces. In addition, the motor power supply provides 320VDC volts to the motors and takes about 2 minutes to bleed down after power is disconnected. AC power to the robot must be disconnected prior to removal of the X-axis cover for any reason.

Should you wish to obtain detailed pin-out information for the Digital Input, Digital Output or Front Panel connectors, please see the *PrecisePlace 1300/1400 Robot, Hardware Introduction and Reference Manual*.

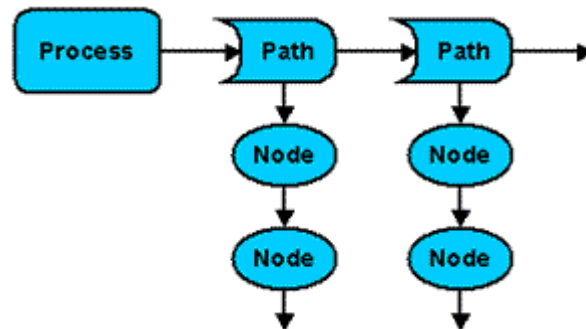
Software Introduction

Guidance Dispense Software Overview

The Guidance Dispense product includes an open source application program with a web-based graphical user interface. The purpose of this software package is to permit the user to teach and execute a sequence of operations that will move a syringe tip along a taught path while simultaneously sending commands to the dual control air dispenser to force out fluid as required. This chapter introduces this software's principal concepts, terminology and features. In addition, each of the web pages and the function of their buttons and fields are described.

In the next chapter, this information is put to use in a series of step-by-step tutorials that illustrate all of the basic operations of the system.

Within the Guidance Dispense software package, a complete dispensing operation is organized into a dispensing "**Process**" that consists of one or more dispensing "**Paths**" that in turn consist of one or more dispensing "**Nodes**".



Using a simple web-based control panel, an operator can select and execute a taught dispensing **Process**. A **Process** consists of a list of **Paths** that are performed in the sequence in which they are defined within the **Process**. A **Path** defines a series of motions that control the position of a syringe tip. The **Path** includes the specification for how fast the tool tip is to move when dispensing fluid and how high above the start and end of the path the tool tip should be moved to start and end the motion sequence.

A **Path** can be automatically repeated with its positions offset in X, Y, and Z. For example, a **Path** can be automatically repeated at every position within a two dimensional array of parts.

Each syringe tip position within a **Path** is defined by a **Node**. A **Node** contains both the syringe tip position as well as data specifying whether fluid should be dispensed while moving to this position. A **Path** can contain thousands of **Nodes** if needed.

The names of **Processes**, **Paths** and **Nodes** can consist of 1 to 43 characters. Names must start with an alphabetic character or "_" and cannot be a single "_". The first character can be followed by any

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combination of alphanumeric characters (a-z,A-Z,0-9) and "_". Names cannot contain space characters (" "). Upper and lower case letters are considered different so names are case sensitive.

When a **Process** is being executed, the data for the **Process**, its **Paths** and its **Nodes** are contained in the robot controller's memory. To permanently retain this information, a copy of this data is stored in files in the flash disk. The Guidance Dispense application automatically loads the required data files into the controller's memory when a **Process** or **Path** is accessed for editing or execution.

*To create and run a complete dispensing operation, you must first teach a series of **Nodes** to generate a **Path**. Then you define the sequence in which the **Paths** are to be performed by specifying their order within a **Process**. Finally, you execute the **Process**.*

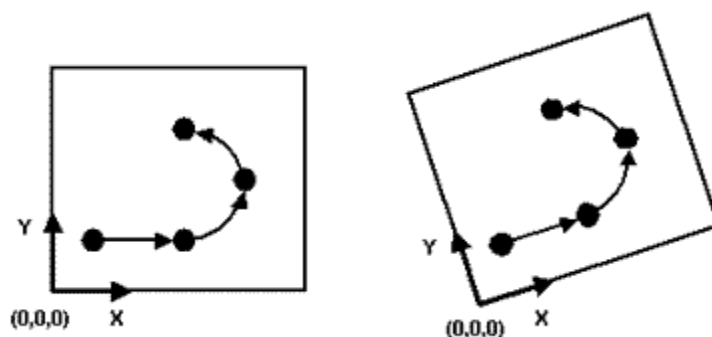
Dispensing Nodes, Node Types and Reference Frames

A dispensing "**Node**" is the most fundamental data element within the Guidance Dispense software. It defines a single syringe tip position and includes information about whether dispensing is turned on or off relative to this position. In order to specify the robot motion or action associated with a position, **Nodes** are organized into **Node Types**. For instance, there is a **Node Type** that indicates that the syringe tip is to move along a straight line to the position and a different **Type** to specify that a circular arc path is to be followed.

The following example illustrates a **Path** that contains four **Nodes**. Step 1 moves the syringe tip to a starting location. When this location is reached, dispensing is turned on. Next (Step 2), the tip is moved along a straight-line path to a location that serves as the end of the line and the start of an arc. Finally, the syringe is moved along an arc path (Steps 3 & 4), after which dispensing is turned off.

```
1. LineStrt  -ON
2. LineEnd
3. ArcMid
4. ArcEnd    -OFF
```

While GD could have been designed to define **Node** positions with respect to the base of the robot, instead, **Node** positions are always defined relative to a "reference frame". A reference frame specifies an important XYZ position and orientation that is significant to the dispensing application. For example, if you wish to dispense fluid on to a plate, the position and orientation of a corner of the plate could be defined by a reference frame. Then, instead of teaching positions relative to the base of the robot, each **Node** point would automatically be taught with respect to the corner of the plate. If the plate were later re-positioned or re-oriented, the positions of all of the taught points could be compensated by simply updating the position and orientation of the reference frame. This is illustrated in the following picture that depicts the four **Node Path** previously discussed.

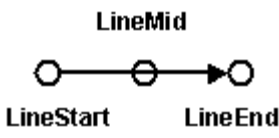
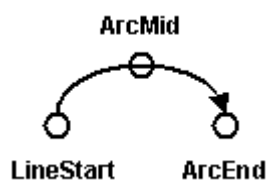


To simplify the use of a reference frame, by default, all **Node** positions are relative to the **Global Frame**. A utility for quickly defining the position and orientation of this reference frame is included in the GD software. If the value of the **Global Frame** is not taught, it will have a NULL value and all **Node** positions will be with respect to the base of the robot.

If your system is equipped with PreciseVision, vision can dynamically compute and return a reference frame that replaces all of the coordinates of the **Global Frame** except for its Z height. In the example above, a camera could be used to locate the position and orientation of the corner of the plate. Then all of the taught **Node** positions would be automatically adjusted to reflect the plate position and orientation as determined by PreciseVision.

Since application requirements or fluid properties may require that dispensing be turned on at the start of a motion or at the end of a motion or somewhere in between, GD supports a number of means for specifying when dispensing signals should be turned on or off. Each **Node** can specify that a signal must be changed a fixed distance or time from either end of its motion or as a percentage of travel. By default, signals are changed at the end of each motion.

In the following table, each of the **Node Types** is described. For some types, like the **Line Node**, you simply specify that you want a **Line Node**. However, when the **Node** is subsequently displayed, the software automatically distinguishes whether a **Line Node** starts a sequence of straight-line motions, ends a sequence or is in the middle of a sequence. This extra qualification is provided as a visual aid in understanding what motions are to be performed.

Node Type	Description	
Line	<p>Line Nodes define points between which the syringe tip will be moved along a straight-line path. A minimum of two Line Nodes are required to defined a line path, the "LineStart" and the "LineEnd". In addition, an arbitrary number of Line Nodes can be placed between these points and will be labeled "LineMid".</p> <p>A Line Node can be the first Node in a Path and can be used to start an arc motion.</p>	
Arc	<p>Arc Nodes define a circular arc motion. An arc motion must start with a Line or Pause Node followed by an arbitrary number of <u>pairs</u> of Arc Nodes. The minimum arc motion consists of a Line Node followed by two Arc Nodes. Arc Nodes cannot be placed after a Path Break or Dot. The last Arc Node in a sequence is labeled the "ArcEnd" and all of the intermediate points are labeled "ArcMid".</p> <p>The following rules apply:</p> <ul style="list-style-type: none"> • Arc Nodes must be defined in pairs. • The first Arc Node must be preceded by a Line or Pause Node. • Arc Nodes cannot be placed after a Path Break or Dot Node. • Arc Nodes cannot be the first Node of a 	

	Path.	
Path Break	<p>If you wish to stop dispensing fluid and start another dispensing sequence within a single Path, as a programming convenience, you can insert a Path Break Node. This Node will turn off dispensing, automatically move above the previous Node position by an amount "mm Above Path", and then move to a position "mm Above Path" above the next Node position.</p> <p>The following rules apply:</p> <ul style="list-style-type: none"> • There must be a Node before and after a Path Break. • Cannot be the first or last Node in a Path. • Cannot be two of these Nodes in a row. • Cannot be moved to since it has no robot position. 	
Pause	<p>A Pause will stop the robot's motion at a Node for a specified period of time. This is useful to form a fill area that is along the Path. This Node can start or end a Path in order to delay before fluid is dispensed or to delay until after the dispensing completes.</p>	
Dot	<p>A Dot Node dispenses a single dab of fluid at the Node position. The dispense tip is moved above the Node position by the Path's "Approach" height, moves down to the Node position and turns on dispensing, delays for a specified time, turns off dispensing, and then retracts to the Path's "Depart" height. This Node can start or end a Path. In fact, a Path could consist of several Dot Nodes and nothing else if required.</p>	

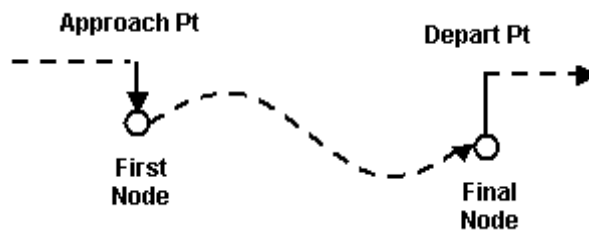
Dispensing Paths and Processes

A **Path** consists of a series of **Nodes** and can only operate a single syringe tip. A **Path** can contain as few as one **Node** or can have thousands of **Nodes** to represent an extremely complex dispensing pattern.

In addition to the list of **Nodes**, each **Path** includes specifications for the following functions and parameters that can be uniquely defined for each **Path**:

- [Z Height Search](#). At the first **Node**, GD can utilize the "Z-Contact" sensor or any similar device to detect the actual height of the work surface. The difference between the expected and actual height will then be automatically applied to correct the Z values of all **Nodes** in the **Path**.

- X, Y, Z Offsets. The positions of all **Nodes** in the **Path** can be shifted by a fixed offset in all three directions. This is useful for raising up the entire **Path** during debugging and for adjusting the **Path** height following a Z-Search.
- 1D, 2D, 3D Pallets. A **Path** can be automatically repeated and indexed in 1, 2 or 3 dimensions. This is convenient for repeating a pattern or for executing the pattern at each position in a 2D or 3D grid or pallet.
- Approach and Depart Points. At the start of a **Path**, the syringe tip can be moved to a position above the first **Node** before moving to the **Node** (the "**Approach**" point). Likewise, after moving to the final **Node** in a **Path**, the syringe tip can be moved to a position above the final **Node** (the "**Depart**" point). This is a convenient means for avoiding obstacles between dispensing patterns.



- Vision Process Reference Frame. At the start of the **Path**, a PreciseVision process can be executed and the resulting position and orientation used in place of all but the Z height of the **Global Frame** to dynamically compensate all of the **Path's Node** positions.
- Dual Syringe Speeds. Different syringe tip speeds can be specified for when fluid is and is not being dispensed to optimize the system cycle time.

Within a **Path**, there are some restrictions on when the various **Node Types** can be specified. The following are the rules that apply to all **Paths**:

- First Node. The first **Node** must be a **Line**, **Point** or **Pause Type**.
- Arc Nodes. **Arc Nodes** must always be specified in pairs and an arc path must start with a **Line** or **Pause Type**.
- Final Node. The final **Node** cannot be a **Break Path Type**.

To permit a complete dispensing operation to be specified, multiple **Path's** can be combined into a dispensing **Process**. A **Process** can be as simple as a single **Path** or can contain many different **Paths** and even multiple references to the same **Path**. **Paths** are executed in the order in which they are listed in a **Process**.

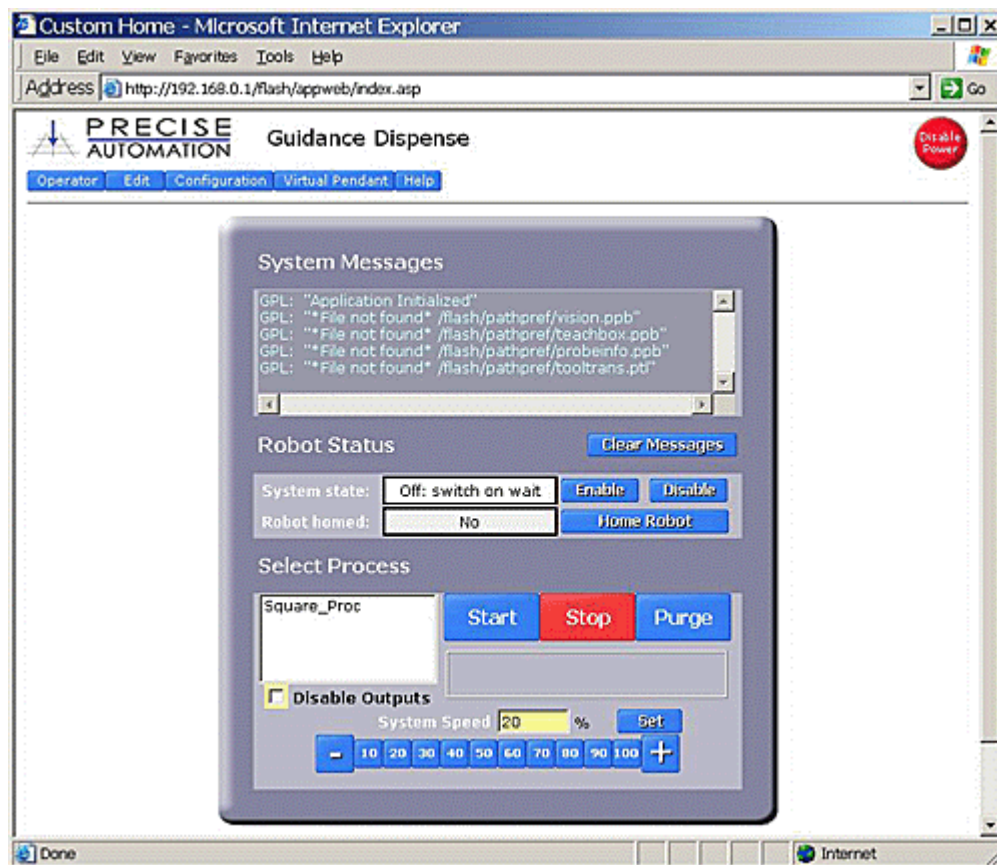
If your system includes two syringes and both syringes are utilized in the same operation, each syringe must be controlled by one or more different **Paths** and these **Paths** must be specified in a **Process** in the order in which they are to be executed.

To avoid driving the syringe into an obstacle as it moves to the **Approach** point for the first **Path**, a **Process** always begins execution by retracting the robot to the Z height of a pre-defined **Safe Location** and then moves horizontally to the **Safe Location**. Likewise, at the end of each **Process**, GD retracts the robot to the **Safe Location's** Z height and then moves horizontally to the **Safe Location** and terminates execution with the robot at this position.

Standard Web Page Format

The graphical user interface for the Guidance Dispense Application is composed of a series of web pages. These web pages are stored on the robot controller's flash memory along with the application software. They can be viewed either locally or remotely from a PC using Internet Explorer. Since both the web pages and the application software are stored in the controller, there is never a problem of inconsistencies between the user interface and the application software.

When GD begins execution in its normal mode of operation, the first web page displayed will appear as follows:



At the top of each web page, you will see the name of the software application, the top-level navigation bar and a red **"Disable Power"** button.




WARNING: The **"Disable Power"** button is provided as a convenience for turning off power to the robot's motors. However, this should not be confused with a hardwired E-Stop button. A hardwired E-Stop button directly connects to the controller hardware and guarantees that the motor power will be quickly disabled. The Disable Power button relies upon the proper operation of software to function.

The navigation bar allows you to quickly switch between main web pages and access their functions. In the case of the "Operator Control Panel" web page pictured above, all of the operations are available in a

single panel. For other pages, a list of sub-pages is displayed in a table on the left. Clicking on listed topics in the left table displays sub-panels that present additional information.

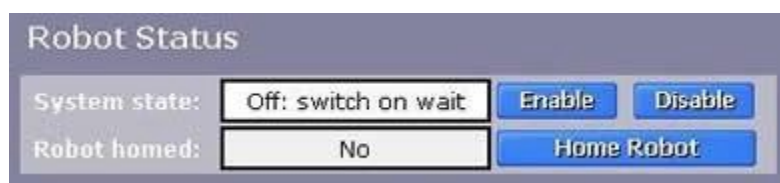
The following briefly describes the contents of the pages associated with each of the tabs on the main navigation bar. Each of these web pages and their sub-panels are described in greater detail later in this chapter.

Main Navigation Bar Summary	
Operator	Selects, starts and stops the execution of a dispensing Process . It also contains diagnostic and debugging aids such as: buttons for enabling and disabling motor power, buttons for reducing the speed of the entire Process , a checkbox for disabling output of dispensing signals, and a system messages display.
Edit	Accesses a series of panels for creating, editing and managing dispensing Processes , Paths and Nodes . Paths can be created and individual Nodes can be added or removed from a Path . Nodes can be edited including the specification of their Type , position and dispensing operation. Processes can be constructed by specifying the Paths that they contain.
Configuration	Presents a series of panels that define system configuration and parameter data. For example, this provides a step-by-step process for defining the Global Frame and a panel for configuring the digital IO signals that control the air dispenser and its teaching buttons.
Virtual Pendant	Displays the Virtual Manual Control Pendant (VMCP) in a separate web page window. The VMCP provides the same functionality available from a hardware Manual Control Pendant, i.e. the ability to manually move the robot in various modes and display the current robot position.
Help	Provides help information on the various web pages along with tutorial examples.

As an aid in learning how to use the Guidance Dispense application, a number of web pages and panels contain a help hot spot marked by . When you click on this icon, help information will be displayed in a new window.

Enabling Motor Power and Homing the Robot

As a convenience, a number of the web pages provide buttons and fields for enabling/disabling power to the robot's motors, displaying the current state of motor power, and for "homing" the robot. For example, the Operator Control Panel has a "Robot Status" section that appears as follows:



The screenshot shows a web interface titled "Robot Status". It contains two rows of controls. The first row is labeled "System state:" and shows a text field with the value "Off: switch on wait", followed by "Enable" and "Disable" buttons. The second row is labeled "Robot homed:" and shows a text field with the value "No", followed by a "Home Robot" button.

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When the **"Enable"** button is pressed, power to the robot's motors is enabled and any motor brakes are released. The robot will normally be left in a position control mode and the motors will be maintaining the current position of the robot until a command to move is generated. If the **"Disable"** button is pressed, the red **"Disable Power"** button in the top of the page is pressed, an E-Stop button is pressed or an error occurs, power to the motors will immediately be turned off.



DANGER: Before enabling power, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the *"PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual"*.

When power is enabled, the **"System state"** will transition from **"Off: switch on wait"** (which indicates that the system is waiting for a switch to be changed to enable power) to **"GPL Ready"** (which indicates that the robot is ready to operate in automatic mode) or **"GPL Executing"** (which indicates that a dispensing operation is being run). Several other informational messages are possible such as those that indicate that the robot is in manual control mode or that a hardware E-Stop button is being asserted.

Some systems are also equipped with a blinking power light. In the case of the PrecisePlace robots, a yellow LED is mounted on the top of the Z-axis motor. When the controller is first powered on, this LED will blink at a rate of about once per second. When motor power is enabled, the LED will blink at a rate of 4 times per second.

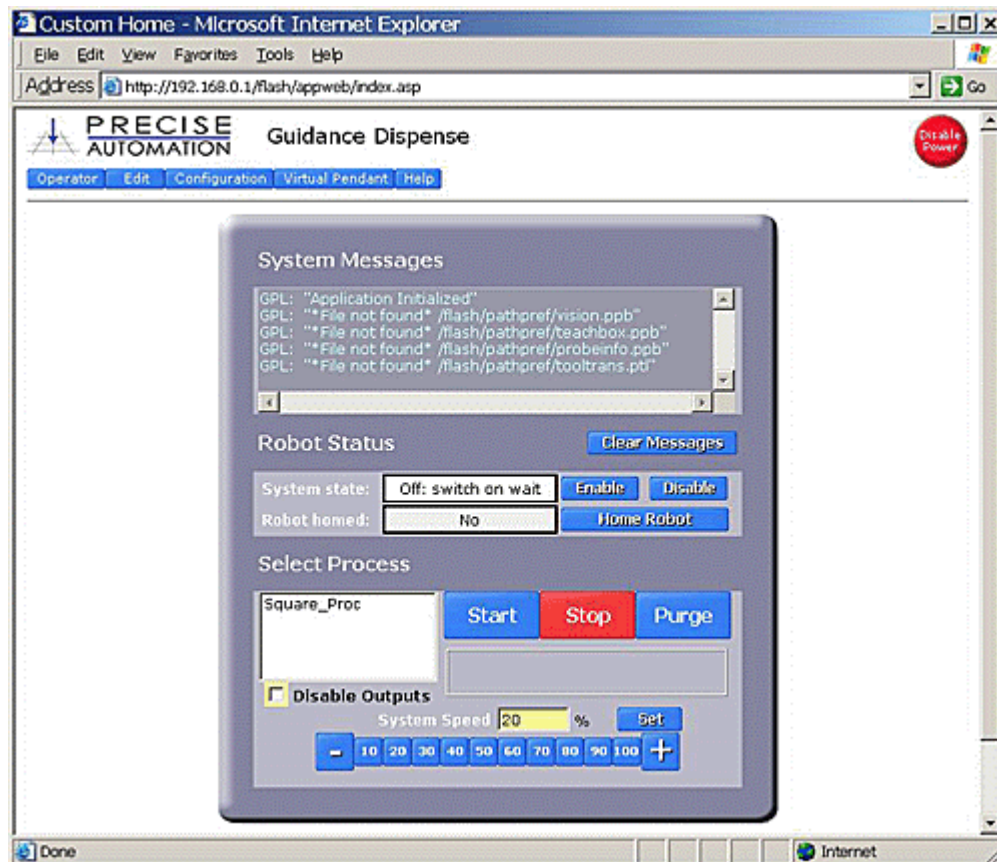
Before the robot can execute a dispensing **Process** or move in certain manual control modes, the robot must be "homed" in addition to having its motor power enabled. Homing is the process whereby each axis determines its position relative to an absolute 0 reference position. This permits the robot to accurately repeat a taught motion sequence after AC power has been cycled and the controller is restarted. Homing only needs to be performed once after controller power is restored no matter how many times motor power is enabled or disabled.

When motor power is enable for the first time after the controller is restarted, the **"Home Robot"** button should be pressed to home the robot. The homing method varies from robot-to-robot and from axis-to-axis. Some axes are equipped with special homing sensors. Others simply rely upon a travel limit signal or hard stop to re-establish the absolute position. In the case of the PrecisePlace robots, the X and Y-axes are equipped with special Precise Pseudo Absolute Encoders that allow the absolute position to be determined by making a very small 2-4 mm motion. For most robots, the homing process typically takes a minute or so to complete.

At the conclusion of the homing process, the **"Robot Homed"** field should indicate **"Yes"** and the robot will be ready to be moved under manual or automatic control.

Operator Control Panel -- Main Web Page

The Operator Control Panel is displayed when the **"Operator"** tab in the Navigation bar is clicked. This panel is used to select, start, stop and control the execution of a dispensing **Process**. It is normally the first web page that is displayed when this software package begins execution.



This panel is divided into three major sections (System Messages, Robot Status, Select Process).

The "System Messages" section at the top of the panel contains a scrolling list of informational and error messages that have been automatically generated. This section contains the following fields and buttons.

System Message	Description
Message box	A read only text box that displays all system and application messages. The most recent message is displayed on the top line. Please see the Trouble Shooting Chapter of this manual for a description of common error messages and output generated by Guidance Dispense. Please see the <i>Precise Documentation Library > Controller Software > Software Reference > System Error Codes</i> for a description of the complete list of error messages that can be generated by the robot control system.
Clear message	Clears all messages displayed in the "Message box". This is convenient for deleting old messages that can be confusing if attention is not paid to the message time stamp.

The "Robot Status" section in the middle of the panel contains items for controlling motor power and robot homing.

Robot Status	Description
System State	Please see the section on Enabling Motor Power and Homing the

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Robot Homed	Robot for a description of these buttons and fields.
Enable	
Disable	
Home Robot	

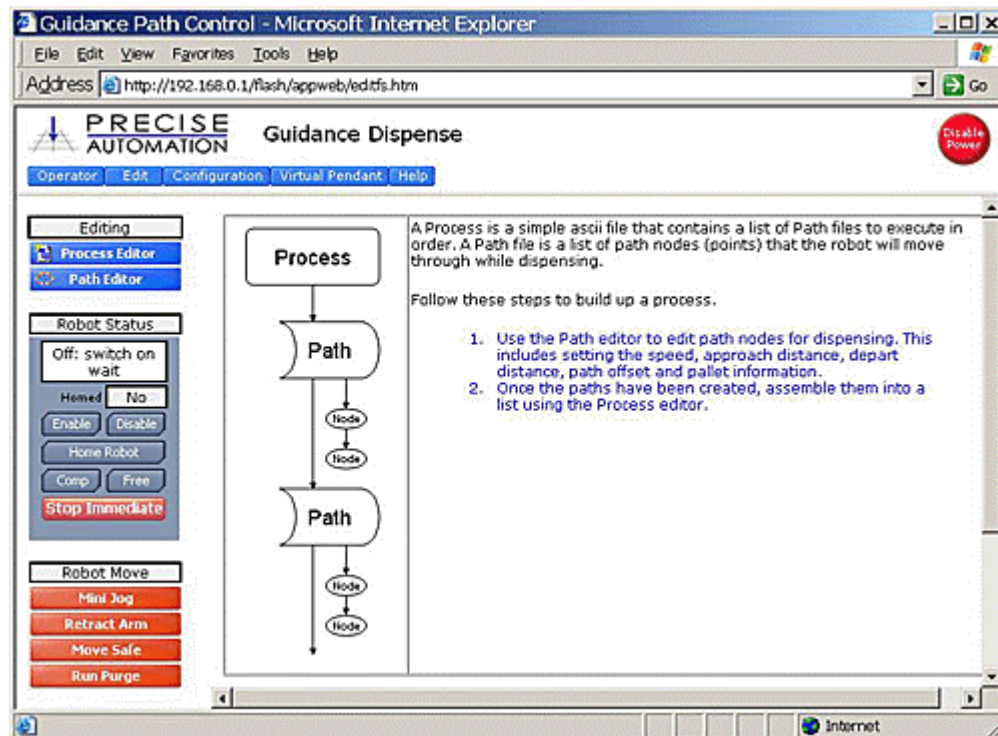
The "Select Process" section at the bottom of the panel permits the operator to select the dispensing **Process** that they wish to execute and to start and stop its execution. This panel also includes aids for debugging and testing a **Process**.

Select Process	Description
<Process list>	Displays a list of Processes that are currently defined. Before the "Start" button is pressed, a Process must be selected in this window.
Start	Begins execution of the Process selected in the <Process List>. Before execution can commence, robot motor power must be enabled and the robot must be homed.
Stop	Immediately stops any process currently being executed. The dispense output control signals will be turned off to prevent unintentional dispensing.
Purge	Displays a pop-up window that can move the robot to the designated "Purge" position and turn on the specified dispense head(s). This is used to verify that the heads are working or to clear the needles. Please see Purge Setup for additional information.
<input type="checkbox"/> Disable Outputs	If checked, disables the operation of the dispenser syringes when a Process is executed. The dispenser output signal is re-directed to the "Free" teach button light on the Air Dispenser . This mode is useful for test running an entire dispense Process without dispensing any fluid.
System Speed	Reduces the speed of all robot motions to allow a Process to be run slowly for diagnostic and debugging purposes. Normally, this speed should be set to 100% for normal operation.

Editing Web Page

Edit -- Main Web Page

The Edit page is displayed when the **"Edit"** tab in the Navigation bar is clicked. This page provides a series of panels for creating, editing and managing dispensing **Processes**, **Paths** and **Nodes**.



When this page is first displayed, the right panel presents a brief summary of the relationship between the dispensing elements and the steps for creating a complete operation. The three lists on the left select the data to be edited and provide convenient access to buttons for enabling motor power and moving the robot.

The contents of the Editing list is as follows:

Editing	Description
Process Editor	Displays in the section to the right, the panel for creating, modifying and deleting dispensing Processes . A detailed description of this panel is provided in the following section.
Path Editor	Displays in the section to the right, the panel for creating, modifying and deleting dispensing Paths and Nodes . A detailed description of this panel is provided in a following section.

The Robot Status list contains a variation of the motor power control and homing items available in the Operator Control Panel. In addition, it provides buttons for assisting in manually positioning the robot. This list and the following list are very useful for defining and touching up **Paths** and **Node** positions.

Robot Status	Description
<System State>	Please see the section on Enabling Motor Power and Homing the Robot for a description of these buttons and fields.
Homed	
Enable	
Disable	
Home Robot	Places the robot back into computer control mode (to permit automatic execution) if the robot is currently in manual control mode.
Comp	

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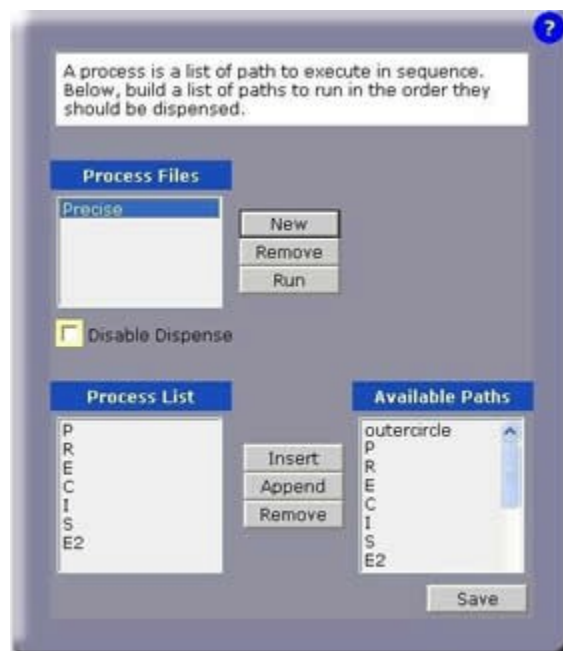
Free	Places the robot into manual control mode and "free's" all of the axes. Free'd axes can be positioned by pushing the robot and manually moving it into position.
Stop Immediate	Immediately decelerates and stops the robot if it is in motion and turns off all dispenser output signals. Then, the operator is prompted to determine if the robot should be retracted and moved to the Safe Location .

The Robot Move list provides a number of convenient means for repositioning the robot and purging the syringes.

Robot Move	Description
Mini Jog	Opens up a miniature version of the Virtual Manual Control Panel in a separate window. This panel can remain open while jogging and teaching points in the editor.
Retract Arm	If a Process is not executing, moves the robot in the world Z direction to the Z height of the Safe Location . This is convenient for clearing an error or debugging an operation.
Move Safe	If a Process is not executing, moves the robot in the world Z direction to the Z height of the Safe Location followed by a horizontal motion to the Safe Location .
Run Purge	Displays a pop-up window that can move the robot to the designated "Purge" position and turn on the specified dispense head(s). This is used to verify that the heads are working or to clear the needles. Please see Purge Setup for additional information.

Process Editor Sub-Panel

When the **"Edit"** tab is clicked and the **"Process Editor"** button is pressed, the panel pictured below is displayed in the bottom right of the Edit page. This editor allows multiple dispense **Paths** to be organized into a **Process**. A **Process** can contain any combination of **Paths** and multiples references to the same **Path**. Once a **Process** has been created, it will automatically be displayed in the process list of the Operator Control Panel.



The "Process Files" list displays the names of the **Processes** that have already been created. Each **Process** is preserved in its own file on the flash disk. Guidance Dispense automatically loads the data for a **Process** back into the controller's memory when it is required for editing or execution. However, modified **Process** data is only stored to a disk file when an explicit command is received to avoid replacing permanent settings with temporary trial data.

Process Files	Description
New	Creates a new Process both in memory and on the flash disk. Once created, Processes must have Paths assigned to them.
Remove	After confirmation, deletes the highlighted Process file from memory and the flash disk.
Run	Executes the highlighted Process . This is the same operation performed by the Operator Control Panel. *Note - this operation requires that the Process be saved prior to execution.
<input type="checkbox"/> Disable Dispense	If checked, disables the operation of the dispenser syringes when a Process is executed. This is useful for running an entire dispense Process without dispensing any fluid.

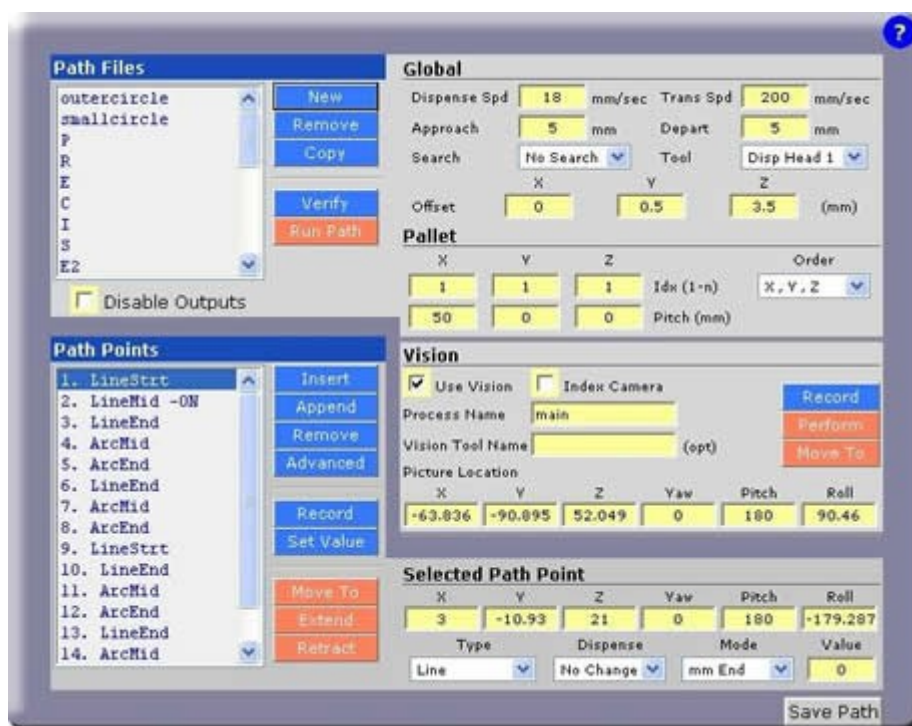
When a **Process** is selected in the "Process Files" list, the **Paths** assigned to the **Process** are displayed in the "Process Contents" display. New **Paths** can be added to the selected **Process** using the "Available Paths" list.

Process List & Available Paths	Description
Insert	Inserts the Path highlighted in the "Available Paths" list into the Process above the highlighted Path in the "Process Contents".
Append	Appends the Path highlighted in the "Available Paths" to the end of the "Process Contents" list.
Remove	Removes the Path highlighted in the "Process Contents" from the list. This does NOT remove the Path file from memory or the flash

	disk, it just removes a reference to it in the Process .
Save	Saves any changes made to the currently selected Process to its flash disk file. Once saved, you can use the "Run" operation or the Operator Control Panel to execute the Process .

Path and Node Editor Sub-Panel

When the **"Edit"** tab is clicked and the **"Path Editor"** button is pressed, the panel pictured below is displayed in the bottom right of the Edit page. The Path Editor provides the tools for creating, managing and modifying **Paths** and their **Nodes**.



The "Path Files" list displays the names of the **Paths** that have already been created. Each **Path** is preserved in its own file on the flash disk. Guidance Dispense automatically loads the data for a **Path** back into the controller's memory when it is required for editing or execution. However, modified **Path** data is only stored to a disk file when an explicit command is received to avoid replacing permanent settings with temporary trial data.

Path Files	Description
New	Creates a new Path both in memory and on the flash disk. Once created, Paths must have Nodes added to them. This function displays a pop-up that prompts whether a new Path is simply to be created (which is assigned a single Node) or whether a new Path should be created and a series of Nodes taught. In teach mode, the user can create and define the position for Nodes by clicking a pop-up button or using the teach buttons on the Air Dispense unit.

Remove	After confirmation, deletes the highlighted Path file from memory and the flash disk.
Copy	Makes a copy of the selected Path . The operator to enter a new Path name.
Verify	Performs a verification check on the selected Path . This test includes verifying that all of the Nodes in the Path satisfy the rules and that the Z height of all Nodes is sufficiently high. This function is provided to allow Paths to be pre-checked since this test is automatically performed when a Path is executed.
Run Path	Executes the highlighted Path . The operator is prompted to run the entire Path or one step at a time. The step-by-step mode allows individual line/arc operations to be executed along the Path and assists in debugging. In step-by-step mode, the dispenser output is automatically disabled.
[] Disable Dispense	If checked, disables the operation of the dispenser syringes when a Path is executed. The dispenser output signal is re-directed to the "Free" teach button light on the Air Dispenser . This is useful for dry running a Path and fine-tuning Nodes while receiving visual feedback on the dispensing commands.

The "Global" section of this panel specifies parameters that affect the entire **Path** and are not specific to a particular **Node**.

Global	Description
Dispense Spd	Specifies the speed (in mm/sec) of the syringe tip while it is dispensing fluid.
Trans Spd	Defines the transition speed (in mm/sec) of the syringe tip while it is moving between Nodes . Anytime that fluid is not being dispensed, this speed is applied to optimize the overall cycle time.
Approach/Depart	Defines distance (in mm) that the dispensing head will moved above the first and last Node positions when performing the dispensing Path .
Search	Enables the Z-Search mode. If "use probe" is selected, prior to performing the dispense path, the robot will move to the first Node in the path and search down. When the surface is detected, the "Z" height of the dispense Path is automatically adjusted (based on the "Z-Search" settings). This operation is only performed once per path cycle.
Tool	Specifies the dispense head that will be used. This is important as it determines the digital output that is operated to dispense fluid. In addition, the proper syringe dimension and mounting offset is applied based on the definition of the Dispense Head .
Offset X, Y, Z	Defines a fixed offset that is applied to the position of each Node in the Path when the Path is executed. It is also applied during teaching or editing of the Path points. This operation allows fine tweaking of a Path without having to edit individual path points.

The "Pallet" section permits a **Path** to be repeated in a 1, 2 or 3 dimensional rectangular grid that is relative to the **Path's** reference frame. This can be utilized to repeat a dispensing pattern at each position in a pallet.

Pallet	Description
--------	-------------

X, Y, Z Idx (1-n)	Defines which dimensions will be repeated and how many times they will be repeated. By default these values are all set to "1" to indicate that repeating is NOT enabled. If a Path is to be repeated on a standard pallet, these values represent the number of rows (X), columns (Y) and stacks (Z) in the pallet. In addition to setting these value, the "Pitch" must also be properly set.
X, Y, Z Pitch (mm)	Specifies the distance (in mm) between adjacent rows, columns or stacks.
Order	Selects the order in which the 3 dimensions will be indexed. When a pallet is enabled (indicated by having the 'Idx' values > 1) an order of operation is applied based on this setting.

The "Vision" section enables PreciseVision to dynamically compute a reference frame that replaces all of the components of the [Global Frame](#) except for its Z height. When enabled, a user defined PreciseVision Vision Process is automatically executed at the start of the **Path**. If PreciseVision cannot locate the reference frame or if a visual part inspection indicates that a part is not acceptable, **Path** execution will be terminated with an error.

Vision	Description
[] Use Vision	If checked, enables using PreciseVision to generate the Path's reference frame.
[] Index Camera	<p>If checked, automatically indexes the position of an arm-mounted camera based on the "Pallet" settings. This allows a grid of loosely fixtured parts to be addressed using a single Path pattern. Each time the pallet is indexed, the arm-mounted camera will be positioned to the next pallet location for the picture point and the vision system will be called again.</p> <p>If not checked and a pallet is enabled, PreciseVision will only be called at the first pallet location. All subsequent pallet Paths will use the original vision frame. This is useful for fixed mounted cameras or parts that are fixed accurately in a tray but where the tray is placed in the robot's work area in a coarse position.</p>
Process Name	Defines the required name of the PreciseVision Vision Process that is executed to determine and return the Path reference frame.
Vision Tool Name	Optionally defines the name of a vision tool that is part of the PreciseVision Vision Process. By default, the last tool executed by PreciseVision computes and returns the value of the required reference frame. However, if a tool name is specified in this parameter, its reference frame value is returned and utilized instead.
Picture Location (X,Y,Z,yaw,pitch,roll)	Defines the position where the robot should be moved to prior to calling PreciseVision to execute the Vision Process. If all of the components are set to "0" (the default), then the picture point stored in the Vision Configuration is used instead. This picture point is taught relative to the Global Frame . If this position is specified, its Z component is forced to match that of the original camera calibration point defined in the Vision configuration.
Record (button)	Records the Picture Location where the robot must be moved to prior to executing the Vision Process. This function automatically looks at the position stored in the Vision Configuration and sets the new point to the same Z height. For arm-mounted cameras, it

	is important that the Z height be constant to maintain the same field-of-view and scaling.
Perform (button)	Moves the robot to the Picture Location and performs the Vision Process. This assists in debugging the Picture Location and Vision Process. This must be executed prior to manually teaching Path points relative to the vision-generated frame of reference.
Move To (button)	Moves the robot back to the Picture Location. This is useful for debugging the Vision Process in PreciseVision.

The "Path Points" section displays and manages the list of **Nodes** defined in the currently selected **Path**. Specific data for the **Node** selected in this list is displayed in the "Selected Path Point" section.

Path Points	Description
Path Point List View	Provides a scroll list of all the Nodes defined in the selected Path . This list also displays any errors in the Path . If any error is detected, the list is displayed in Red . The Node causing the problem includes a "*" prior to its name. Use the "Verify" operation to get more descriptive details of the problem. When the Node list display is generated, Node Types are automatically assigned more descriptive names based upon the Node rules. For example, the first ARC Node will be labeled "ArcMid" and the second will be labeled "ArcEnd".
Insert/Append/Remove (buttons)	Allows Nodes to be easily added and removed to/from the selected Path .
Advanced	Allows advanced Node add/remove operations. These include "Copying" and "Removing" a range of Nodes and the ability to add more Nodes using the teach buttons on the Air Dispenser . These operations make is very easy to duplicate a section of a Path or remove unwanted areas of a complex Path .
Record (button)	Records the current position of the robot relative to the current reference frame and stores the value in the select Node .
Set Value	Simultaneously sets or increments a position component (X, Y, Z, Yaw, Pitch, Roll) for a range of Nodes . This is very useful for adjusting all or part of a Path to have the same "Z" value. Alternately, an offset can be added to a position component for a range of Nodes .
Move To (button)	Moves the robot directly to the selected Node position taking into account the current reference frame. If no special frame is in effect, the Global Frame will be utilized. If the Path is relative to vision results, the position will be relative to the last generated Vision Process reference frame. *Note - care should be taken when clicking this button. If the Global Frame has been re-taught improperly or Dispense Head dimensions or mounting have been changed, it could lead to needle damage.
Extend/Retract (buttons)	Extends or retracts the selected dispense head if it is equipped with a pneumatic slide. These buttons provide a convenient way to operate the head digital I/O.

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The "Selected Path Point" section displays the detailed information for the **Node** that is selected in the "Path Points" list.

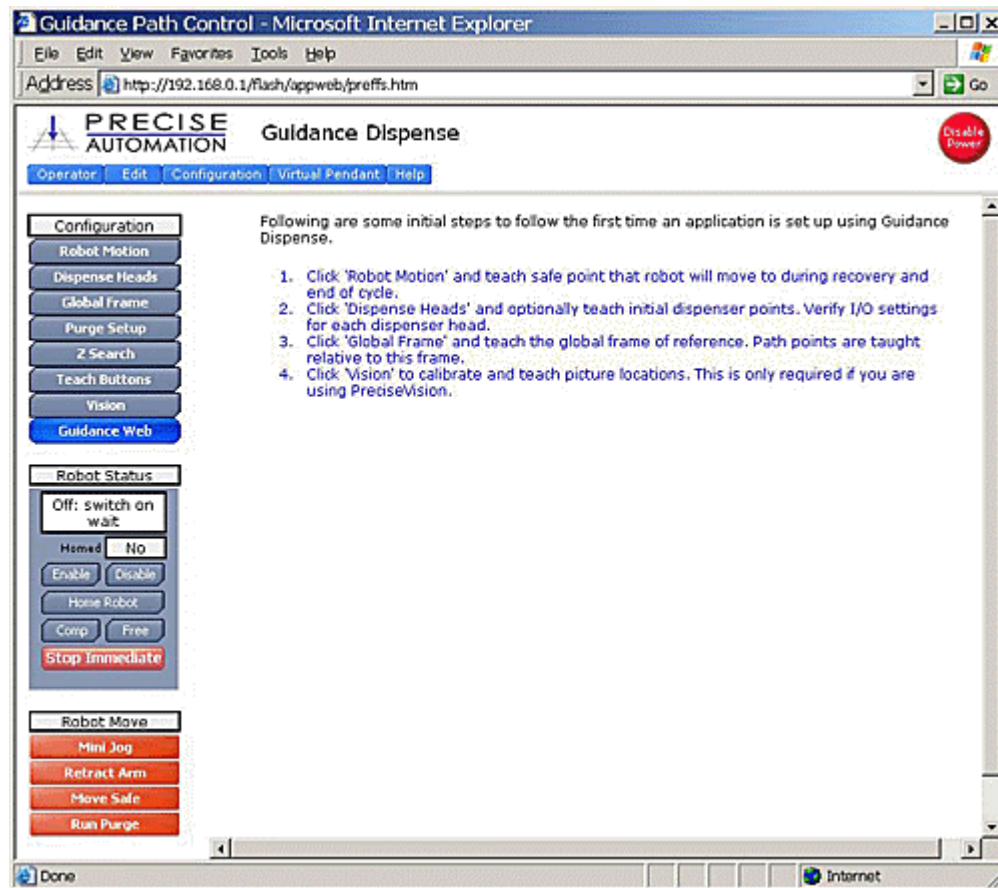
Selected Path Point	Description
X,Y,Z,yaw,pitch,roll	Displays the coordinates of the selected Node relative to the Path's reference frame. These values represent the relative position and orientation of the Node with respect to either the Global Frame or the frame generated by PreciseVision depending on the Path settings.
Type	Displays the Node Type for the current Path point.
Dispense	Selects if the dispense operation is turned on/off/nochange. Nochange will leave the current state of the output for the dispenser unchanged. On/Off will turn on or off the output of the dispense head.
Mode	<p>For Line and Arc Nodes, specifies when the dispense operation change defined by the "Dispense" parameter is put into effect.</p> <ul style="list-style-type: none"> • %Start/End - Change occurs at a percentage of the distance from the start or end of the motion to the Node. • mm Start/End - Change occurs at a distance in mm from the start or end of the motion to the Node. "mm End" is the default setting and the most common case. • Sec Start/End - Change occurs at a fixed time in seconds from the start or end of the motion to the Node. <p>For Pause and Dot Nodes, this parameter is ignored.</p> <p>For Path Break Nodes, this parameter indicates the "mm Above" height.</p>
Value	Defines the decimal number that is the numerical portion of the "Mode" specification. For example, if the Mode is "mm Start", this parameter defines the distance in mm from the start of the motion to the Node when the dispense operation change takes place.
Save Path (button)	Saves the currently selected Path to the flash disk. The user can make changes to a Path without saving. Once debugging is completed, use this button to permanently alter the Path .

NOTE: All changes to a **Path** will be lost if a different **Path** file is selected before the changes are saved to the flash disk. Anytime a **Path** is modified a "Path modified" box will be displayed next to the "Save Path" button to indicate the file on the flash is NOT up to date.

Configuration Web Page

Configuration -- Main Web Page

The Configuration page is displayed when the **"Configuration"** tab in the Navigation bar is clicked. This page provides a number of utilities for defining system configuration and setup parameters. For example, this page has a step-by-step process for defining the **Global Frame** and a panel for configuring the digital IO signals that control the air dispenser and its teaching buttons.



When this page is first displayed, the right panel presents a brief summary of important setup processes that should be executed. The three lists on the left select the configuration panel to be display and provide convenient access to buttons for enabling motor power and moving the robot.

When a button in the "Configuration" list is clicked, the corresponding panel is displayed to the right. In the following sections, the operation of each of these panels will be described in detail. The following table contains a brief summary of these panels.

Configuration	Description
Robot Motion	Defines the "Safe Location", robot speeds used during various motions and the minimum Z height for all automatic motions.
Dispense Heads	Defines the mounting position and dimensions of the two dispense heads (syringe tips) and the digital IO signals that control their

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	operation.
Global Frame	Defines the reference frame that all Node locations are defined with respect to by default.
Purge Setup	Defines the position to which the robot is moved to purge a syringe and the duration of the purging operation.
Z-Search	Defines the parameters for searching for the Z height of a surface using the "Z-Contact Sensor". The computed correction in the Z height will be applied to all Node locations in a Path .
Teach Buttons	Defines the digital IO signals assigned for the teach buttons on the Single/Dual Control Air Dispenser.
Vision	Defines the interface parameters necessary for using PreciseVision with GD. This includes the vision PC's IP address and the location to which the robot is moved to take a picture during the camera calibration process.
Guidance Web	Launches a new web window and displays the standard GUI for the Precise Guidance Controller. Access to this interface is provided for completeness and should not be required during normal operation of the system.

The Robot Status list contains a variation of the motor power control and homing items available in the Operator Control Panel. In addition, it provides buttons for assisting in manually positioning the robot. This list and the following list are very useful for manually moving the robot to define key locations necessary for the configuration operations.

Robot Status	Description
<System State>	Please see the section on Enabling Motor Power and Homing the Robot for a description of these buttons and fields.
Homed	
Enable	
Disable	
Home Robot	
Comp	Places the robot back into computer control mode (to permit automatic execution) if the robot is currently in manual control mode.
Free	Places the robot into manual control mode and "free's" all of the axes. Free'd axes can be positioned by grabbing the robot and manually moving them into position.
Stop Immediate	Immediately decelerates and stops the robot if it is in motion and turns off all dispenser output signals. Then, the operator is prompted to determine if the robot should be retracted and moved to the Safe Location .

The Robot Move list provides a number of convenient means for repositioning the robot and purging the syringes.

Robot Move	Description
Mini Jog	Opens up a miniature version of the Virtual Manual Control Panel in a separate window. This panel can remain open while jogging and teaching points in the editor.
Retract Arm	If a Process is not executing, moves the robot in the world Z direction to the Z height of the Safe Location . This is convenient for clearing an error or debugging an operation.
Move Safe	If a Process is not executing, moves the robot in the world Z

	direction to the Z height of the Safe Location followed by a horizontal motion to the Safe Location .
Run Purge	Displays a pop-up window that can move the robot to the designated "Purge" position and turn on the specified dispense head(s). This is used to verify that the heads are working or to clear the needles. Please see Purge Setup for additional information.

Robot Motion and Safe Location Sub-Panel

When the **"Configuration"** tab is clicked and the **"Robot Motion"** button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the "Safe Location", robot speeds used by various motions and the minimum Z height for all automatic motions.

Robot Motion

Safe Location
The safe point is where the robot will move to before and after performing a dispense process.

Teach Safe Point Move Safe Point

General Motion Settings
Settings that are used during moving between paths and back to the safe location.

Run Speed (% max) 30
Edit Speed (% max) 10
Accel/Decel (% max) 60
Accel Ramp (seconds) 0.1

Path Verify Test
Each path point should be taught above the global frame of reference (including any offset). This value is the value used to check against. Set to large negative to disable.

Z path node test 0 mm

Save

The Safe Location is a position where the robot can be moved to be clear of all obstacles in the work cell. When a **Process** begins execution, the robot is always moved to the Safe Location before going to the first **Node**. After the motion to the last **Node**, the robot is returned to the Safe Location before the **Process** terminates.

Motions to the Safe Location are always performed in two steps:

- Retracts the robot to the Z height specified by the Safe Location.
- Moves horizontally to the Safe Location.

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NOTE: The Z height of the Safe Location is particularly important since the robot moves to the Safe Location by first retracting to this Z height and then moving horizontally to the Safe Location. Also, other operations, like [Purging](#), also use this Z height for moving safely through the workspace.

Safe Location	Description
Teach Safe Point	Records the current location of the robot as the value of the Safe Location.
Move Safe Point	Moves the robot to the safe point. This is convenient for placing the robot into a known location.

The "General Motions Settings" contains speed and acceleration specifications that apply when the system is moved automatically during training (e.g. Purge and Move Safe operations) and when the robot is moving between **Paths**. While executing a **Path**, the transit and dispensing syringe tip speeds are explicitly specified as parameters to the **Path**.

General Motion Settings	Description
Run Speed (% max)	Defines the speed (as a percentage of the robot's maximum nominal speed) of motions when executing a Process but not following a Path .
Edit Speed (% max)	Defines the speed (as a percentage of the robot's maximum nominal speed) for automatic motions performed during training and debugging, e.g. Purge motions and moving to the Safe Location.
Accel/Decel (% max)	Defines the acceleration and deceleration (as a percentage of the robot's maximum nominal values) for all motions except when following a Path .
Accel Ramp (seconds)	Defines the acceleration/deceleration ramp times (s-curve profiling) for all motions except when following a Path .

Whenever the robot is moved automatically both during training and when executing a **Process**, the destination of each motion is tested to ensure that it is not too low relative to the Z height of the [Global Frame](#). This is a precaution to prevent a syringe tip from being inadvertently driven into the deck.

Path Verify Test	Description
Z path node test	Defines the minimum Z height relative to the Global Frame for the destination of all automatic motions. Any motion that attempts to go below this value will be terminated and flagged as an error. To disable this test, a large negative values should be entered.
Save	Updates the motion settings saved on the flash disk.

Dispense Heads Sub-Panel

When the "**Configuration**" tab is clicked and the "**Dispense Heads**" button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the mounting

position and dimensions of the two dispense heads (syringe tips) and the digital IO signals that control their operation.

Dispense Heads

Up to 2 dispenser heads can be mounted on the end of the arm. Each one can have a unique tool offset that is applied during teaching and playback.

Initial Setup Steps:

1. Teach initial reference point using dispense 'Head 1' and click 'Rec Reference'.
2. Move robot so Head 2 is at the reference point and click 'Rec Offset 2.'

After Changing Tip: Move dispenser head to initial reference point and click 'Rec Offset'

Reference	X	Y	Z	Yaw	Pitch	Roll	
Rec Reference	0	0	0	0	0	0	Move To

Head 1	X	Y	Z	Yaw	Pitch	Roll	
Rec Offset 1	0	0	0	0	0	0	Move To

Extend Signal: 36 Dispense Signal: 37

Extend Retract ON OFF

Head 2	X	Y	Z	Yaw	Pitch	Roll	
Rec Offset 2	0	0	0	0	0	0	Move To

Extend Signal: 0 Dispense Signal: 38

Extend Retract ON OFF

Mini Jog Save

It is permissible to teach a **Path** and repeat the **Path** without knowing the dimensions or mounting position of the syringe heads. But, if GD does know this information, if a syringe and needle size changes or if a syringe needle bends, GD can automatically adjust the robot motions so that the new syringe tip will follow the previously taught **Path**. In addition, if two syringes are used, the **Nodes** taught with one syringe can be easily repeated by the other syringe.

To simplify the training of the dimensions and mounting of the syringe tips, you must select a "Reference Point" in the work cell that does not move. Then, to teach the dimensions and mounting of a different syringe tip, you only need to move that tip to the same Reference Point and click a button. GD will compute the required information and will automatically put this data into effect each time the syringe tip is selected.

NOTE: Once the Reference Point value is taught, it should not be changed. If this value is re-taught with a syringe tip that is a different size or is mounted in a different position on the robot, it will alter the result of any syringe tips that are taught with respect to this new Reference Point and any formerly taught **Path's** will be incorrect.

Reference	Description
Rec Reference	Records the value of the Reference Point. <u>Dispense head #1 must be used to teach this location.</u>
X, Y, Z, Yaw, Pitch, Roll	Displays the coordinate values of Reference Point. <u>These should not be altered once they are taught.</u>
Move To	Displays a pop-up window that can move a syringe tip to the Reference Point or to a position above this location.

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Once the Reference Point is established, the dimensions and mounting of either dispense head can be taught or re-taught simply by moving the desired syringe tip to the Reference Point and pressing the Rec Offset button. The following data pertains to each of the dispense heads.

Head 1 or 2	Description
Rec Offset	Computes the dimension and mounting data for a dispense head when the syringe tip is positioned at the Reference Point.
X, Y, Z, Yaw, Pitch, Roll	Displays the computed coordinate values for the dispense head. Initially, the values for head #1 will all be close to 0.
Move To	Displays a pop-up window that can move a syringe tip to the Reference Point or to a position above this location.
Extend Signal	Defines the number of the Digital I/O signal that controls the extension and retraction of the sliding syringe clamp. When this signal is asserted, the slide is extended.
Dispense Signal	Defines the number of the Digital I/O signal that applies air pressure to the syringe. When this signal is asserted, fluid is dispensed.
Extend/Retract	Turns the Digital I/O signal that controls the syringe slide off or on. This allows for debugging the dispense head locally on this page.
On/Off	Actuates the dispense signal. This operation allows for debugging the dispense fluid.
Save	Saves all dispense head information to the flash disk.

Global Frame Sub-Panel

When the **"Configuration"** tab is clicked and the **"Global Frame"** button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel specifies the reference frame that all **Node** locations are defined "with respect to" by default.

The global frame is what path points are taught relative to. Click the "Teach Frame Wizard" button below to walk through teaching the frame.

When teaching the frame points, it is important to follow the right hand rule. These points describe a plane where the Cartesian "Z" axis is pointing up.

Teach Frame Wizard

	X	Y	Z	Yaw	Pitch	Roll	
Teach Origin	371.7414	229.3075	-91	0	180	180	Move To
Teach POX	372.8528	90.9304	-91	0	180	180	Move To
Teach POY	530.2799	230.2512	-91	0	180	180	Move To

Frame Values:

X	Y	Z	Yaw	Pitch	Roll
371.7414	229.3075	-91	0	0	-89.5399

Save

Node locations are always defined with respect to a reference frame. If vision is being used, the vision results dynamically supersede all of the coordinates of the **Global Frame** except for its Z height.. If no special reference frame is in effect, **Node** locations are automatically defined relative to the complete **Global Frame**.

NOTE: The **Global Frame** should be defined as soon possible to ensure that all **Node** locations are correctly recorded.

This panel displays the current value of the **Global Frame**. This value is automatically computed from the X, Y, Z coordinates of three locations that point at the following features of the reference frame:

- The origin (0,0,0) of the reference frame.
- Any position along the X-axis of the reference frame.
- Any position that is in the X-Y plane of the reference frame and generally along the Y-axis.

NOTE: As soon as the X, Y or Z coordinate of any of the three locations is altered, the **Global Frame** is immediately recomputed and the new value will be reflected in the location of all **Nodes** that are relative to this reference frame.

Global Frame	Description
Teach Frame Wizard	Launches the step-by-step wizard for teaching the three locations that define the Global Frame . As a convenience, the "Line" and "Free" buttons on the Air Dispenser can be used in place of the wizard's "Record" button and the Virtual Manual Control Pendant . At the end of this operation, the new frame value is automatically saved to the flash disk.
Teach Origin	Displays a pop-up that permits one of the three locations to be set equal to the current location of one of the syringe tips.
Teach POX	
Teach POY	
X, Y, Z, Yaw, Pitch, Roll	Displays the three sets of location coordinates and permits them to be edited.
Move To	Displays a pop-up window that can move the robot to the associated location or to a position above this location.
Save	Saves the frame value to the flash disk.

Purge Setup Sub-Panel

When the **"Configuration"** tab is clicked and the **"Purge Setup"** button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines where the robot is moved to purge the two dispense heads and the duration of the purge operation.

Purge Setup

During a purge operation, the robot will move to these two locations and enable the dispense head(s). A time value indicates the length of time the each dispense head will operate. This operation is executed with the dispense head(s) in the retracted position.

Run Purge

Teach Purge

	X	Y	Z	Yaw	Pitch	Roll	
Rec Head 1	636.2719	36.9378	-38.6663	0	180	180	Move To
	Time	1	seconds	Approach	10	mm	
Rec Head 2	636.2719	36.9378	-38.6663	0	180	180	Move To
	Time	1	seconds	Approach	10	mm	

Save

The purge operation is a pre-defined process that safely moves the robot to a designated position and dispenses fluids for a specified period of time. This function can be manually invoked from a number of pages and is used to test if a syringe is operating properly and to clear the needle. The purge operation performs the following steps:

- Retracts the robot to the Z height specified by the [Safe Location](#).
- Moves to the "Approach" position that is the specified number of mm above the purge position.
- Moves to the purge position with the syringe slide in the retracted position.
- Turns on the syringe air supply for the specified number of seconds.
- Retracts the robot to the Z height specified by the [Safe Location](#).
- Moves horizontally to the [Safe Location](#).

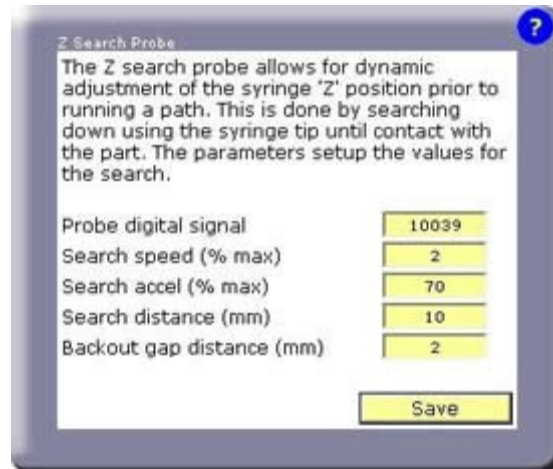
For this function, the speed and acceleration of the robot is defined by the [Robot Motion](#) parameters.

For each syringe head, the following fields and buttons are defined.

Purge Parameters	Description
Run Purge	Executes the purge operation as defined above. This is the same function that is available on a number of other panels.
Rec Head #	Records the current position of the robot (with no tool enabled) for the selected dispenser head.
X, Y, Z, Yaw, Pitch, Roll	Displays the purge location coordinates and permits them to be edited.
Move To	Displays a pop-up window that can move the robot to the purge position or to a position above this location.
Time	Specifies the duration that the syringe is purged in seconds.
Approach	Defines the "Approach" height above the purge location.
Save	Saves the purge settings to the flash disk.

Z-Search Sub-Panel

When the "**Configuration**" tab is clicked and the "**Z-Search**" button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the parameters for searching for the Z height of a surface using the "Z-Contact Sensor".



The Z-Search is an option that can be selected for any **Path**. When enabled, at the start of the **Path**, GD samples the Z-Contact Sensor to locate the height of the work surface at the first **Node** position. The correction between the actual height and the Z height of the first **Node** is dynamically applied to all **Nodes** in the Path.

If a **Path** has Z-Search enable, at the start of the **Path**, the syringe tip will be controlled as follows:

- Moves to the "Approach" position above the first **Node**.
- Moves down in Z at the "Search speed" and "Search accel" traveling a maximum "Search distance".
- Monitors the "Probe digital signal" and stops when the signal becomes TRUE.
- Retracts the syringe at 25% of the "Search speed" until the "Probe digital signal" is FALSE. This permits a faster "Search speed" while still obtaining an accurate height reading.
- Computes the difference between the first **Node's** Z position and the detected Z position minus the "Backout gap distance".
- Moves to the first **Node** position and all subsequent **Nodes** in the **Path** applying the Z correction and the X/Y/Z offset defined in the [Path Editing Page](#) to all **Nodes**.

Normally, the Z offset specified in the [Path Editing Page](#) is utilized to move the entire **Path** up to the proper height above the work surface to correctly dispense the fluid.

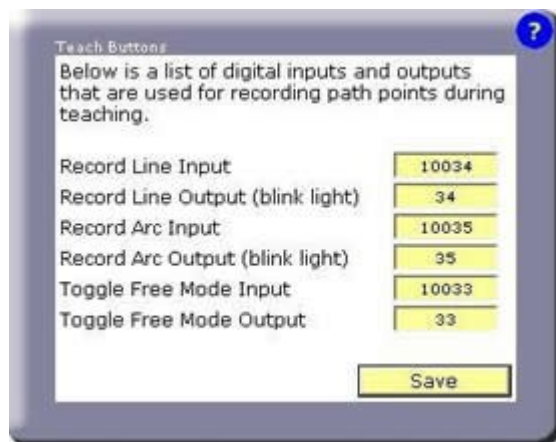
Z-Search Settings	Description
Probe digital signal	Defines the Digital I/O signal number for the contact probe. This signal becomes TRUE when the surface is detected. This defaults to 10039, which is the DIN signal normally connected to the Z-Contact Sensor.
Search speed (%)	Defines the speed (as a percentage of the robot's maximum nominal

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max)	speed) for the search motion.
Search accel (% max)	Defines the acceleration (as a percentage of the robot's maximum nominal acceleration) to be used during the search motion.
Search distance (mm)	Defines the maximum distance in mm that the robot is permitted to move during the search. If this distance is exceeded, the search will fail and will generate an error.
Backout gap	Defines the distance in mm between where the slide is fully extended and where the slide is retracted sufficiently to trigger the contact sensor.
Save	Saves the settings to the flash disk.

Teach Buttons Sub-Panel

When the **"Configuration"** tab is clicked and the **"Teach Buttons"** button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the system digital input and output signals that return the state of the three buttons on the Precise Single/Dual Control Air Dispenser and control their backlights. *These settings should not have to be changed once a system is wired and the hardware configuration has been debugged.*



If you are using a Precise Air Dispenser mounted on a PrecisePlace robot, the DIO signals should be set as shown in the picture above. These are signals that are provided by the robot's ZIO board that is mounted next to the Z-axis motor. If you do not have a Precise Air Dispenser you can configure these signals to connect to your own button box.

These buttons and lights are a programming convenience and are not needed for the proper operation of the GD application program. *If any of these signals are not present, their signal number should be set to 0 to avoid generating a runtime error.*

Teach Buttons	Description
Line Input/Output	Defines the DIO signals that are TRUE when the green create "Line" Node button is pressed during teaching and that is set TRUE to turn on this buttons backlight.
Arc Input/Output	Defines the DIO signals that are TRUE when the blue create "Arc" Node button is pressed during teaching and that is set TRUE to turn

	on this buttons backlight.
Toggle Free Mode Input/Output	Defines the DIO signals that are TRUE when the red "Free" button is pressed to place all of the axes into manual control "Free" mode and that is set TRUE to turn on this buttons backlight.
Save	Saves the DIO signal assignments to the flash disk.

Vision Sub-Panel

When the **"Configuration"** tab is clicked and the **"Vision"** button is pressed, the panel pictured below is displayed in the bottom right of the Configuration page. This panel defines the interface parameters necessary for using PreciseVision with GD.

Precise Vision Configuration

Specify the IP address of the PC that is running Precise Vision.

The 'Away Position' is the position the robot was during robot to camera calibration.

For ARM mounted camera, this point needs to be taught so the camera is in focus for the working surface of the robot. This point needs taught prior to using the 'Calibration Setup' wizard. The camera calibration is not valid if this point is changed after calibrating.

If this is a FIXED mounted camera, this point is used to move the robot out of the way of the camera prior to taking a picture.

IP address of vision server.

192.168.0.106 Set Vision test Process name Test Vision

(192.168.0.100)

Select where the camera is mounted.

☐ Fix Mounted ☒ Arm Mounted

Teach away robot position or camera calibration point.

Warning teaching this point will void the current arm mounted camera calibration. Perform this operation once prior to calibrating vision.

Robot	X	Y	Z	Yaw	Pitch	Roll
Teach Point	509.4748	263.9679	-38.9506	0	180	180

Calibration Setup Move To Save

Guidance Dispense contains built-in support for communicating with a PC that is executing PreciseVision. When GD requires vision to compute a frame of reference, it sends PreciseVision a command over Ethernet to execute a vision process. Typically, the vision process will consist of an Acquisition tool (for taking a picture) and just a few tools for determining the position and orientation of the object of interest. The results of the final tool are automatically returned to GD and dynamically replace all of the components of the **Global Frame** with the exception of its Z height.

In order for GD to communicate with PreciseVision, it requires the Ethernet IP address of the PC.

IP Address of Vision Server	Description
IP Address of vision server	Specifies the IP address of the PC executing PreciseVision. This address is used by GD to issue commands to PreciseVision and retrieve data. This address can normally be found on the PC by

	viewing "My Network Places > Network Connections > Local Area Connection > Status". By default, this is assumed to be 192.168.0.100. If you have executed the software installation procedure for PreciseVision, this value will already be properly set.
Vision Test Process Name	Defines the name of a PreciseVision process that can be executed to test that the communication connection is correct. Typically, you should create a test process that just consists of an Acquisition tool and a Fixed Frame tool positioned anywhere in the window. The value of this parameter is NOT SAVED to the flash disk.
Test Vision	When clicked, sends a message to PreciseVision to execute the "Vision Test Process". If the communication channel is operating, the PreciseVision display will show that the process has been executed and GD will display the X & Y position of the vision result (normally the position of the Fixed Frame). If the IP address is incorrect, GD might hang for 1-2 minutes before the system times out.

The following radio buttons select how the camera is mounted. Fix mounting the camera above the robot is advantageous if a large field of view is desired and you wish to take pictures when the robot is out of the work area. An arm-mounted camera is preferred if you require higher resolution since a smaller field of view can be used but you can still cover a large area by having the robot move the camera around the workspace.

Select Camera Mount	Description
Fix Mounted	Indicates that the camera is mounted in a fix location above the work surface of the robot. The camera does not move.
Arm Mounted	Indicates that the camera is mounted to the Z-axis of the robot. The camera must be moved back to the original picture position during camera calibration.

In order for PreciseVision to return position coordinates and orientation angles that can be used by the robot, the relationship between where the camera is looking (i.e. its field of view) and the coordinates of the robot must be determined. This relationship is computed by performing a "Robot Vision Area Calibration". The following parameters are used for this procedure.

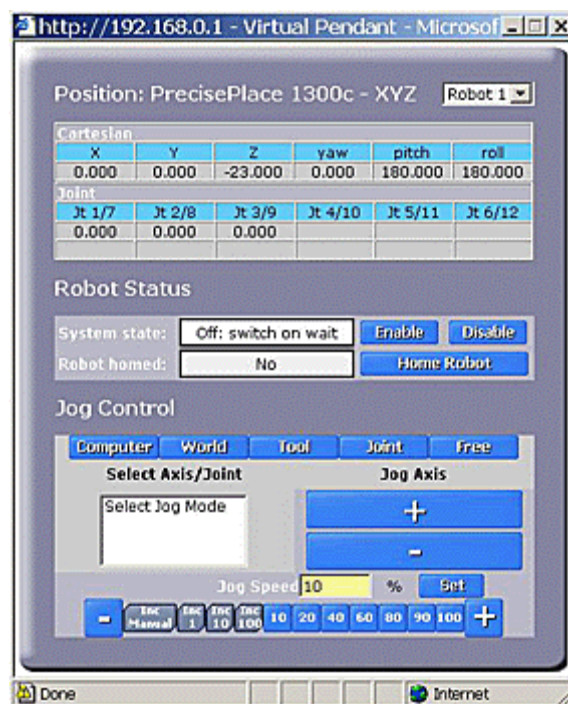
NOTE: For arm-mounted cameras, if the position defined in the following data is altered after the calibration is completed, the calibration will be invalid and must be computed again.

Camera Calibration Point	Description
Teach Point	Records the current robot position as the position that the robot will be moved to when a picture is taken during the calibration process.
X, Y, Z, Yaw, Pitch, Roll	Defines the position that the robot will be moved to when a picture is to be taken during the calibration process. For a fixed mounted camera, this position should move the robot out of the way so it does not block the camera field of view. For an arm-mounted camera, this should position the camera over the calibration target and at the proper Z height to produce the correct size for the field of view. This

	position should be defined before performing the calibration procedure and only altered if you wish to re-execute this procedure.
Move To	Displays a pop-up window that can move the robot to the picture taking position or to a position above this location.
Calibration Setup	Opens a small dialog that assists in performing the calibration procedure. This window should be kept on the desktop while performing the procedure. During an arm mounted camera calibration, this dialog is used to move the camera back to the picture taking position.
Save	Saves the vision settings to the flash disk.

Virtual Pendant -- Main Web Page

The Virtual Manual Control Pendant (VMCP) page is displayed in its own browser window when the **"Virtual Pendant"** tab in the Navigation bar is clicked. The VMCP provides the same functionality available from a hardware Manual Control Pendant, i.e. the ability to manually move the robot in various modes and display the current robot position.



The "Positions" section at the top of the panel displays the location of the currently selected syringe tip and the position of each of the robot's axes.

Position Display	Description
X, Y, Z, Yaw, Pitch, Roll	Displays the position and orientation of the currently selected syringe tip in Cartesian coordinates. The X, Y and Z are in millimeters. The three angles are in degrees and are a set of Euler angles. These angles correspond to a Yaw rotation about world Z-axis (rotating to the left and right along the horizon), followed by a Pitch rotation

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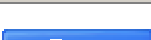
	about the new Y-axis (tilting to look up into the sky or down into the ground), followed by a Roll rotation about the new Z-axis (rotating to the left and right about the new vertical axis).
Jt 1/7 ... Jt 6/12	Displays the current position of each of the axes of the robot in millimeters or degrees as appropriate.

The "Robot Status" section in the middle of the panel contains items for controlling motor power and robot homing.

Robot Status	Description
System State	Please see the section on Enabling Motor Power and Homing the Robot for a description of these buttons and fields.
Robot Homed	
Enable	
Disable	
Home Robot	

The "Jog Control" section at the bottom of the panel is used to move the robot in various manual control modes. Prior to jogging the robot, motor power must be enabled and the robot must be "homed".

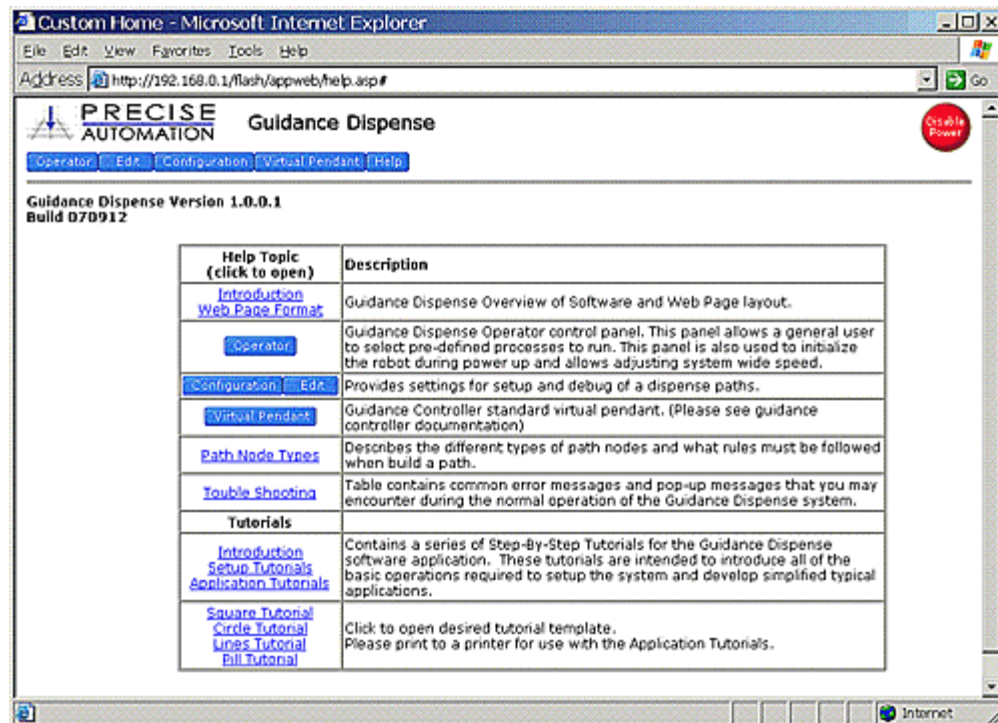
To move, you first select a mode, then an axis or coordinate, then a speed and finally press the "+" or "-" key to move the axis in the positive or negative direction. Releasing the "+" or "-" key or changing modes terminates the motion.

Jog Control	Description
	Disables Jog Control and permits GD to take control of the robot and automatically move its axes. This mode should always be selected when you have finished moving the robot in jog mode.
	Moves all of the axes of the robot in a coordinated fashion such that the selected syringe tip travels in a straight-line path along or rotates about the X, Y, or Z axes of the robot's world reference frame.
	Similar to World mode except that the reference frame is determined by the selected syringe's orientation. For example, since the Z-axis of the syringe normally points down, a positive motion in tool Z will move the syringe down.
	Moves individual axes one at a time. Even if an axis is beyond its limit stops, this mode can be used to drive the axis back into the working range.
	Allows one or more axes to be taken out of position control mode to permit the axis to move freely. For lightweight robots, this allows the operator to grip an axis and manually repositioned it.
<Select Axis/Joint>	Displays the axes that can be moved for the active jog control mode. An axis must be clicked in order to select it to be moved.
Jog Speed %	Specifies the speed that the axis will move, specified as a percentage of the maximum manual control speed. The speed can be entered numerically, incrementally changed with the speed "+" and "-" keys or by clicking one of the numbered speed keys. The "Inc" keys move the axis by a small step and then stop rather than moving continuously. This is convenient for making fine position adjustments.
Jog Axis ("+", "-")	Moves the selected axis in the positive or negative direction at the selected speed. For Free mode, multiple axes can be

simultaneously free'd by selecting the axis number and pressing the "+" key. Pressing the "-" key or selecting a different jog mode unfreezes an axis.

Help -- Main Web Page

The Help Panel is displayed when the **"Help"** tab in the Navigation bar is clicked. This page provides links to abbreviated online versions of much of the help information that is available in this chapter plus the tutorial examples.



Step-By-Step Tutorials

Tutorials Introduction

This chapter contains a series of Step-By-Step Tutorials for the Guidance Dispense software application. These tutorials are intended to introduce all of the basic operations required to setup the system and develop simplified typical applications.

These tutorials are organized into two groups:

- Setup Tutorials. These introduce all of the steps necessary to operate the system and initialize parameters that define the dispensing tools and workspace. *These tutorials should always be executed in the order they are presented* since they initialize data that is inter-dependent. In general, these tutorials only have to be executed once until the tooling or some element of the work cell is modified.
- Application Tutorials. The first tutorial is a complete, basic example. This is followed by a series of modifications of the basic example. These variations can be executed in any order.

Before performing these tutorials, please ensure that the following has already been completed.

- A PC has been interfaced to the robot and a suitable web browser can display the graphical user interface of the robot controller. If this has not been completed, see the [Setup and Installation](#) chapter of this manual.
- The Guidance Dispense software has been installed on the controller and has been started. This information can also be found in [Setup and Installation](#).
- You have reviewed the Hardware and Software Introduction chapters of this manual. A thorough understanding of the content of these sections is not required since much of what you read will become clearer as you perform the tutorials. However, a understanding of the basic operation of the hardware and the concepts and nomenclature of the software will be very helpful.



DANGER: Before operating your robot, ensure that the following steps have been performed: (1) the robot has been properly mounted; (2) all required safety interlocks have been installed and tested; and (3) power has been connected. For the PrecisePlace robots, this information is provided in the “*PrecisePlace 2300/2400 Robot, Hardware Introduction and Reference Manual*”.

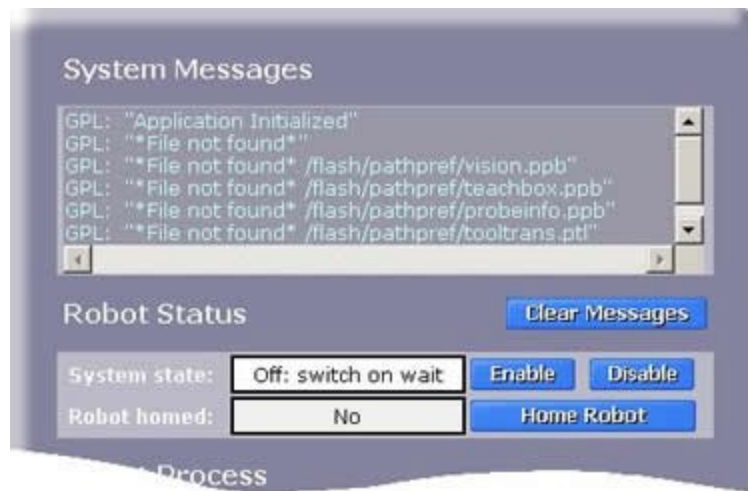
It's now time to get started with the tutorials! Please begin with the Setup Tutorials and execute them in order.

Setup Tutorial 1: Enabling Power and Homing

The first step in operating the system is to ["enable power" and "home"](#) the robot. Enabling power provides power to the motors. Homing establishes the absolute 0 position of each axis so that previously taught motions can be exactly repeated. Many robots lose track of their axes 0 positions when power to the controller is turned off. Homing re-establishes the 0 references using whatever technique is appropriate for the axes, e.g. pressing into a hard stop, engaging a limit switch, reading special encoder tracks, etc.

As a convenience, power enable/disable and homing buttons are provided on a number of different web panels (e.g. the Operator Control Panel, the Virtual Manual Control Pendant (VMCP), the Robot Status section of Edit and Configuration Pages). All of these buttons perform the same functions. For this example, we will use the [Operator Control Panel](#).

» Open the Operator Control Panel by clicking **Operator >**.



If you have started a newly loaded system that has not had all of the configuration data defined, there will be a number of benign error messages displayed in the "System Messages" window.

» Press **Clear Messages** to eliminate the clutter of the old messages. (This step is not required to enable power.) Then press **Enable** to turn on power to the motors.

The "System state" will transition from "Off: switch on wait" to "GPL Ready" to indicate that motor power has been successfully enabled.

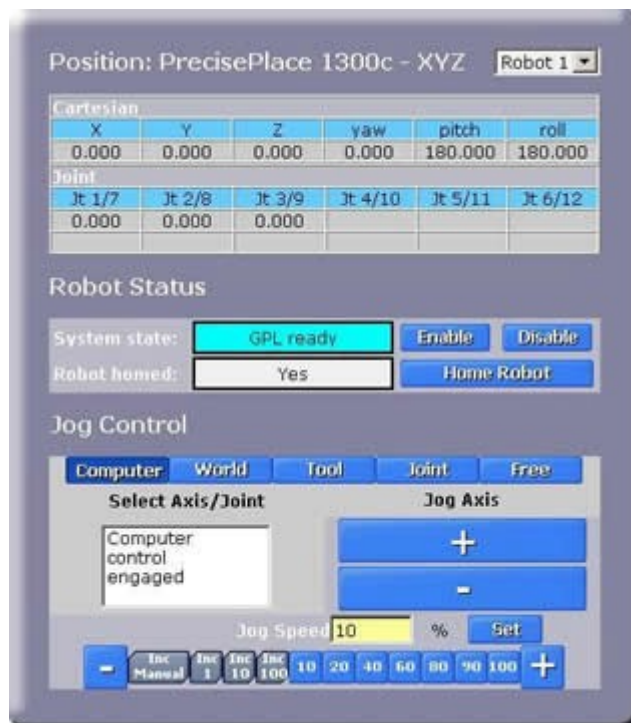
» Press **Home Robot** to establish the zero position for each of the axes. This operation will move the robot and may take a minute or two to complete.

When the homing successfully completes, the "Robot homed" field will change to "Yes". Once completed, homing does not have to be repeated until the robot controller is powered down, no matter how many times motor power is enabled and disabled.

Setup Tutorial 2: Manually Moving the Robot


In many of the following tutorials, you will be required to manually position the robot. GD provides several ways of accomplish this (e.g. the Red "Free" button on the [Air Dispenser](#), the [Virtual Manual Control Pendant \(VMCP\)](#), the optional hardware Manual Control Pendant, and the Robot Status and Mini Jog panel on the [Edit](#) and [Configuration](#) Pages). All of these methods. provide an equivalent or subset of the capabilities of the VMCP that will be discussed in this section.

» Open the Virtual Manual Control Pendant by clicking **Virtual Pendant >**.



The VMCP will appear in its own browser window. The upper section of the VMCP provides a dynamic display of the robot's current location. The lower area contains the "Jog Control" section whose modes are summarized in the following table. Prior to jogging the robot, motor power must be enabled and the robot must be "homed".

Jog Control	Description
Computer	Disables Jog Control and permits GD to take control of the robot and automatically move its axes. This mode should always be selected when you have finished moving the robot in jog mode.
World	Moves all of the axes of the robot in a coordinated fashion such that the selected syringe tip travels in a straight-line path along or rotates about the X, Y, or Z axes of the robot's world reference frame.
Tool	Similar to World mode except that the reference frame is determined by the selected syringe's orientation. For example, since the Z-axis of the syringe normally points down, a positive motion in tool Z will move the syringe down.
Joint	Moves individual axes one at a time. Even if an axis is beyond its

	limit stops, this mode can be used to drive the axis back into the working range.
	Allows one or more axes to be taken out of position control mode to permit the axis to move freely. For lightweight robots, this allows the operator to grip an axis and manually repositioned it.

To move a single axis in manual mode, do the following:

- » Press **Jog Control > Joint.**
- » Select a joint to move, e.g. **Joint 1**
- » Select a slow speed initially, e.g. **"10"**
- » Move the axis in the positive or negative direction by holding down the "+" or "-" keys.

The World and Tool modes operate in the same fashion. The Free mode is a bit different in that multiple joints can be freed at once and the speed setting is not used. For this mode, each time you select an axis and press the "+" the axis is freed until you press the "-" key to place the axis back into position control mode.

In Joint, World and Tool modes, if any of the "INC" speeds are selected, the robot will move a discrete increment and then stop instead of moving continuously. If you release the "+" or "-" key and press it again, the robot will move another increment. This is very convenient for fine positioning the robot.

Try to move the robot in each of the manual modes and at various speeds to get a feel for the virtual pendant.

- » When you are done practicing manual control, press **Jog Control > Computer.** This disables Jog Control and permits GD to automatically move the robot when required.

For additional experience, you should try to move the robot using the alternate interfaces, i.e. the optional hardware Manual Control Pendant, and the Robot Status and Mini Jog panels on the [Edit](#) and [Configuration](#) Pages.

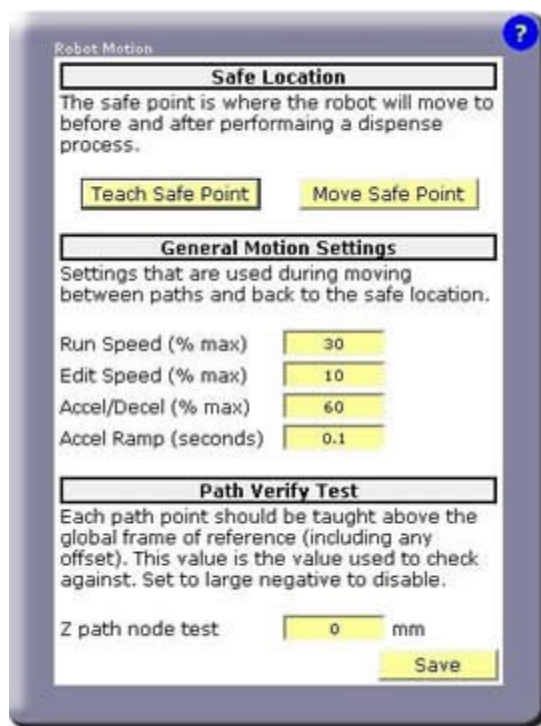
Setup Tutorial 3: Teaching the Safe Location

When a **Process** begins execution and after it is completed, the robot is automatically moved to a fixed [Safe Location](#). This safeguard helps to avoid inadvertent crashes with obstacles in the workspace. In addition, some standard operations, such as [Purging](#) syringes also move to this location for the same reason.

The Safe Location should be set to a position that is always clear of obstacles and that generally positions the robot out of the way.

NOTE: The Z height of the Safe Location is particularly important since the robot moves to the Safe Location by first retracting to this Z height and then moving horizontally to the Safe Location. So, the Z height should be above the highest obstacles in the workspace.

» To define the Safe Location, open **Configurations > Robot Motion**.



» Manually position the robot at the location that you have selected for the Safe Location taking special care in selecting the proper Z height.

» Press the **Teach Safe Point** button.

» When asked to "Record Safe Position", press **Yes**.

» If you are asked "File Exists: Okay to Delete", press **Yes**.

You have now successfully taught the Safe Location. This position will automatically be used whenever the system needs to move the robot to a height or position that is clear of obstacles and out of the way.

If you wish to verify the Safe Location, you can manually move the robot to another position and then press the "Move Safe Point" button.

Setup Tutorial 4: Teaching the Dispense Heads

While it is permissible to teach a **Path** and repeat the **Path** without knowing the dimensions or mounting position of the syringe heads, this is not the recommended procedure. If GD is taught this information, if a syringe and needle size changes or if a syringe needle bends, GD can automatically adjust the robot motions so that the new syringe tip will follow the previously taught **Path**. In addition, if two syringes are used, the **Nodes** taught with one syringe can be easily repeated by the other syringe.

» To define the [Dispense Heads](#), open **Configurations > Dispense Heads**.

Dispense Heads

Up to 2 dispenser heads can be mounted on the end of the arm. Each one can have a unique tool offset that is applied during teaching and playback.

Initial Setup Steps:

1. Teach initial reference point using dispense 'Head 1' and click 'Rec Reference'.
2. Move robot so Head 2 is at the reference point and click 'Rec Offset 2.'

After Changing Tip: Move dispenser head to initial reference point and click 'Rec Offset'

	X	Y	Z	Yaw	Pitch	Roll	
Reference							
Rec Reference	0	0	0	0	0	0	Move To
Head 1							
Rec Offset 1	0	0	0	0	0	0	Move To
Extend Signal				36	Dispense Signal		37
Extend				Retract	ON		OFF
Head 2							
Rec Offset 2	0	0	0	0	0	0	Move To
Extend Signal				0	Dispense Signal		38
Extend				Retract	ON		OFF

Mini Jog

Save

To simplify training the dimensions and mounting of syringes, you must select a "Reference Point" in the work cell that does not move. Then, to teach the dimensions and mounting of a different syringe tip, you only need to position that tip at the same Reference Point and click a button. GD will compute the required information and will automatically put this data into effect each time the syringe is selected.

NOTE: Once the Reference Point value is taught, it should not be changed. If this value is re-taught with a syringe tip that is a different size or is mounted in a different position on the robot, it will alter the result of any syringe tips that are taught with respect to this new Reference Point and any formerly taught **Path's** will be incorrect.

» Manually move syringe tip #1 to the position you have selected as the "Reference Point".

» Press **Record Ref** and **Yes** to confirm.

» To compute the initial offset for head #1, without moving the robot, press **Rec Offset 1** and **Yes** to confirm.

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- » If you have a second syringe head, manually position it at the Reference Point.
- » To compute the initial offset for head #2, press **Rec Offset 2** and **Yes** to confirm.
- » Press **Save** to store the results on the flash disk.

You have now successfully taught the dimensions and mounting information for the dispensing heads. Whenever you select to use a head, this information will automatically be put into effect by GD.

If at anytime you either change one of the syringes, adjust the mounting of a syringe clamp or bend a syringe tip, perform the following procedure to re-train the new dimensions and mounting information.

- » Manually move the syringe tip to the position you have selected as the "Reference Point".
- » To compute the new offset, press **Rec Offset** for the desired head and press **Yes** to confirm.
- » Press **Save** to store the results on the flash disk.

Setup Tutorial 5: (Optional) Teaching the Purge Locations

If you wish to execute the manual [Purging](#) sequence later to either test the operation of the syringes or to clear the needles, the locations where the robot is to purge the syringes must be taught. The purging operation can be manually initiated from the [Operator Control Panel](#), the left panel of the [Edit](#) or [Configuration](#) pages or from the [Purge Setup](#) panel. If you do not wish to execute purging, this exercise can be skipped.

- » To define the Purge Locations, open **Configurations > Purge Setup**.

Purge Setup

During a purge operation, the robot will move to these two locations and enable the dispense head(s). A time value indicates the length of time the each dispense head will operate. This operation is executed with the dispense head(s) in the retracted position.

Run Purge

Teach Purge	X	Y	Z	Yaw	Pitch	Roll	
Rec Head 1	636.2719	36.9378	-38.6663	0	180	180	Move To
	Time	1	seconds	Approach	10	mm	
Rec Head 2	636.2719	36.9378	-38.6663	0	180	180	Move To
	Time	1	seconds	Approach	10	mm	

Save

- » Manually position the robot at the location that you have selected to purge the first syringe.
- » Press **Rec Head 1**.
- » If you are asked to "Overwrite current position", press **Yes**.
- » Fill in the purging **Time** and the height that the robot should **Approach** the purge location.
- » Repeat for the second syringe head if it is being used.
- » Press **Save** to store the results on the flash disk.

You have successfully taught the syringe Purge Locations. They will automatically be used whenever the Purge operation is invoked. If you wish to verify the locations, you can manually move the robot to another position and then press "Move To". If you wish to test purging, press "Run Purge".

Setup Tutorial 6: (Optional) Vision Interfacing and Calibration

If your system includes PreciseVision, the following procedure must be performed to interface GD to [Vision](#) and to compute the calibration data that translates vision results into coordinates useable by GD.

- » To access the PreciseVision setup panel, open **Configurations > Vision**.

Precise Vision Configuration

Specify the IP address of the PC that is running Precise Vision.

The 'Away Position' is the position the robot was during robot to camera calibration.

For ARM mounted camera, this point needs to be taught so the camera is in focus for the working surface of the robot. This point needs taught prior to using the 'Calibration Setup' wizard. The camera calibration is not valid if this point is changed after calibrating.

If this is a FIXED mounted camera, this point is used to move the robot out of the way of the camera prior to taking a picture.

IP address of vision server.

192.168.0.106 Set Vision test Process name Test Vision

(192.168.0.100)

Select where the camera is mounted.

☐ Fix Mounted ☒ Arm Mounted

Teach away robot position or camera calibration point.

Warning teaching this point will void the current arm mounted camera calibration. Perform this operation once prior to calibrating vision.

Robot	X	Y	Z	Yaw	Pitch	Roll
Teach Point	509.4748	263.9679	-38.9506	0	180	180

Move To

Calibration Setup

Save

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This procedure assumes that you have already installed PreciseVision on a PC, connected the camera, and established the Ethernet link between PreciseVision and your robot controller. If not, please refer to the "Supported Hardware and Software Installation" chapter of the *Precise Vision Machine Vision System Introduction and Reference Manual* before continuing this tutorial.

- » To verify that the communications link is properly working, within PreciseVision, create a Vision Process named "**Gd_test**" that only contains a camera Acquisition tool.
- » In the "Vision test Process name field", enter "**Gd_test**" (without quotation marks)
- » Press **Test Vision**.

If the communication link is operating properly, you will see a new picture in PreciseVision's camera window. If this does not occur, re-execute the Software Installation processes in the PreciseVision manual.

If your camera is **fixed mounted** (i.e. not attached to the robot), perform the following:

- » Check the **Fixed Mounted** radio button.
- » Manually move the robot to the position that you would like it to move to when GD automatically takes a picture during a dispensing **Process**. This should be selected so that the robot and its shadow do not interfere with the picture.
- » To record this position, press **Teach Point** and press **Save** to store the results on the flash disk.
- » Execute the **Robot Vision Area Camera Calibration** procedure described in the PreciseVision manual.

If your camera is **arm-mounted** (i.e. it is attached to the robot), perform the following:

- » Check the **Arm Mounted** radio button.
- » Manually move the robot so the camera is over the area where you wish to perform the calibration process. *It is very important that the Z height be correct so that the camera's field of view is properly focused.* This Z height will be used when GD automatically takes a picture during a dispensing **Process**.
- » To record this position, press **Teach Point** and press **Save** to store the results on the flash disk.
- » To obtain step-by-step information on performing an arm-mounted camera calibration, press **Calibration Setup** and follow its instructions.

NOTE: For arm-mounted cameras, if the taught robot position is altered after the calibration is completed, the calibration will be invalid and must be re-computed.

This completes the PreciseVision setup and camera calibration procedure.

Application Tutorial 1: Basic Application Example

After having completed the Setup Tutorials, we are now ready to develop our first dispensing application. In general, the Setup Tutorials will not have to be re-executed unless the tooling or some element of the work cell is modified.

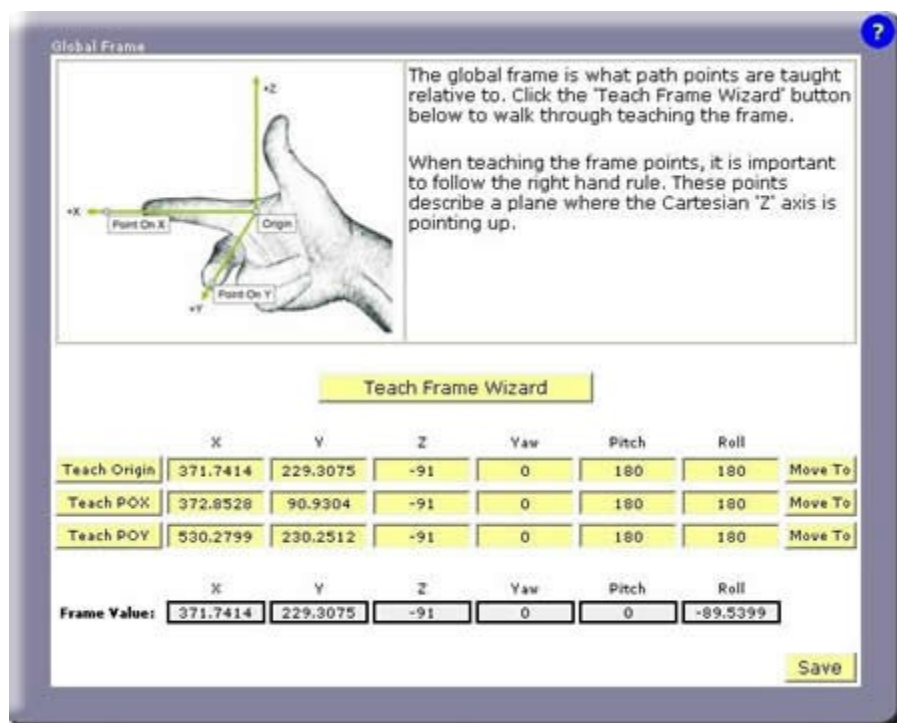
In the last section of this chapter, the [Sample Applications Templates](#) contain four example dispensing patterns.

» Print the **"Template #1: Sample Square Path"** and secure it to the robot's work surface. This template contains the square dispensing pattern that we will train in this tutorial.

STEP 1: TEACH THE GLOBAL FRAME

All **Node** locations are defined relative to a reference frame. In the absence of a special frame, **Node** locations are defined relative to the [Global Frame](#). The value of this frame can be left unchanged, but it is good form to always start an application by setting this frame to a meaningful value. For this tutorial, we will align the **Global Frame** with the X & Y axes drawn on the template.

» Open the **Global Frame** definition panel **Configuration > Global Frame**.



Within GD, frames are defined by specifying three points: the origin of the frame, a point on the X-axis and a point roughly on the Y-axis.

» Execute the frame teaching aid by pressing **Teach Frame Wizard** and confirm that you wish to continue by clicking **Yes**.

- » When asked, select the head that you will use during this Wizard by clicking **Head_x**.
- » When asked to record the Origin, Point On X and Point On Y, manually position the selected syringe tip at the points on the template marked "Origin", "POX" and "POY" and click the **Record** button at each position. (As a convenience, the "Line" button on the [Air Dispenser](#) can be used in place of **Record** and its "Free" button can be used to manually position the robot.)
- » Press the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.

This completes the training of the reference frame.

STEP 2: CREATE A NEW "PATH" AND TEACH ITS "NODES"

A **Path** contains a sequence of positions ("**Nodes**") that defines the motion of the syringe tip and specifies when dispensing is turned on and off. A single **Path** can only define the actions for a single syringe head. Normally, **Paths** are kept relatively short since multiple **Paths** can be combined into the final dispensing "**Process**" that is executed.

Given the simplicity of this example, we only need to create a single **Path** to define the desired dispensing operation.

- » Open the Path Editor panel, **Edit > Path Editor**.

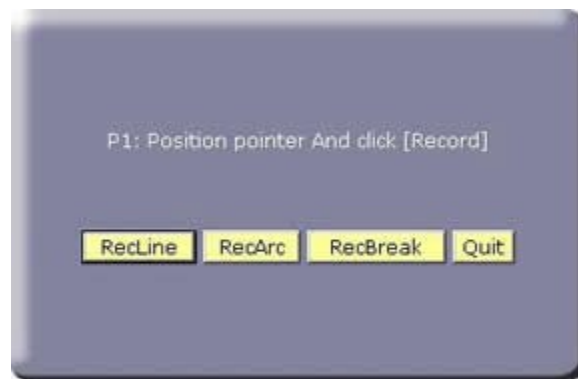
The screenshot shows the Path Editor software interface. It features a sidebar on the left with 'Path Files' and 'Path Points' sections. The main area is divided into several functional blocks: 'Global' settings for dispensing speed and approach; 'Pallet' settings for X, Y, Z coordinates and order; 'Vision' settings for camera use and tool selection; and a 'Selected Path Point' section for defining specific path nodes with coordinates and dispensing parameters. A 'Save Path' button is located at the bottom right.

The top of the panel is for managing and defining **Paths**. The middle right section is utilized when a **Path** is defined relative to the results from PreciseVision. The bottom is for managing and defining **Nodes** (positions) in the currently selected **Path**.

We will use a wizard to create the new **Path** and to create and record the positions of its **Nodes**.

- » To create the Path, under "Path Files", click **New**.
- » A pop-up will be displayed that asks "Create new path file or Teach new path file?". Pressing "CreateNew" will create a new **Path** but will not define any **Nodes**. To create the **Path** and to create and teach the **Node** positions, press **TeachNew**.
- » When requested, enter the name of the new **Path** as "**Square**" (with no quotes).
- » When prompted, specify the dispense head you will use for training and to dispense by clicking either **Head_1** or **Head_2**.

The pop-up panel from the teach wizard will now ask you to teach the position for the first Node in the new Path.



From this wizard, you can teach the positions of **Line**, **Arc**, and **Break Path Nodes**. Other **Node Types** can be inserted later. Also, the **Types** of the taught **Nodes** can be subsequently modified.

- » Using any of the manual control methods, position the syringe tip at **P1** on the template. It is normally easiest to have the syringe tip lightly touch the template. The Z heights of the positions can be adjusted individually or as a group later.
- » Create the first **Node** as a **Line Type** and record its position by either clicking the **RecLine** button in the pop-up or pressing the green **Line Button** on the [Air Dispenser](#).
- » Repeat the process for the other positions, **P2**, **P3**, **P4**, **P5** and **P6**
- » Terminate position teaching by pressing **Quit**.

The editor panel should now resemble the following:

The screenshot shows the Path Editor software interface with the following sections:

- Path Files:** A list containing "Square" with buttons for New, Remove, Copy, Verify, and Run Path. A checkbox for "Disable Outputs" is present.
- Global:** Dispense Spd (10 mm/sec), Trans Spd (10 mm/sec), Approach (30 mm), Depart (30 mm), Search (No Search), Tool (Disp Head 1), and Offset (X: 0, Y: 0, Z: 0 mm).
- Pallet:** A table with columns X, Y, Z, Idx (1-n), and Pitch (mm).

X	Y	Z	Idx (1-n)	Pitch (mm)
1	1	1		
0	0	0		
- Vision:** Checkboxes for Use Vision and Index Camera, fields for Process Name and Vision Tool Name, and a table for Picture Location.

X	Y	Z	Yaw	Pitch	Roll
0	0	0	0	0	0
- Path Points:** A list of 6 points: 1. LineStrt, 2. LineMid, 3. LineMid, 4. LineMid, 5. LineMid, 6. LineEnd. Buttons for Insert, Append, Remove, Advanced, Record, Set Value, Move To, Extend, and Retract are available.
- Selected Path Point:** A table showing details for the selected point (1. LineStrt).

X	Y	Z	Yaw	Pitch	Roll
89.099	22.14	-21.24	0	180	180

 Below this table are fields for Type (Line), Dispense (No Change), Mode (mm End), and Value (0).

A "Save Path" button is located at the bottom right.

Note that although you taught 6 **Line Nodes**, when displayed, the first **Node** is a series of straight-line motions is labeled "LineStrt" and the final **Node** is labeled "LineEnd". This is automatically done by GD to make the list of points more understandable.

STEP 3: EDIT NODE AND PATH PROPERTIES

If you click on a line in "Path Points", the **Node's** position relative to the **Global Frame** is displayed at the bottom right together with other information about the **Node**. Currently each **Node** is a **Line Type** and has dispensing turned off.

Using the buttons next to the **Node** display, you can edit the **Path** by adding or deleting **Nodes**, recording new position values, etc. The "Set Value" button permits a coordinate value to be changed in a group of **Nodes**. The "Advanced" button permits a group of **Nodes** to be copied or deleted or for new **Nodes** to be inserted using the teaching method.

Before we execute this Path, we wish to edit a few properties.

- » To turn on dispensing at the first **Node**, in "Path Points", click on "**1. LineStrt**" and in "Selected Path Point" data, pull-down the list of options below "Dispense" and select **Turn On**.
- » To turn off dispensing at the final **Node**, in "Path Points", click on "**6. LineEnd**" and in "Selected Path Point" data, pull-down the list of options below "Dispense" and select **Turn Off**.

To the right of the "Dispense" pull-down list, you will see the "Mode" and "Value" fields. These fields have different interpretations for the different **Node Types**. For the **Line** and **Arc Nodes**, these values control when dispensing is turned on or off relative to the start or end of the motion. In this example,

since the motions for P1 and P6 overlap slightly, these field can be used to delay turning on dispensing or to turn it off early.

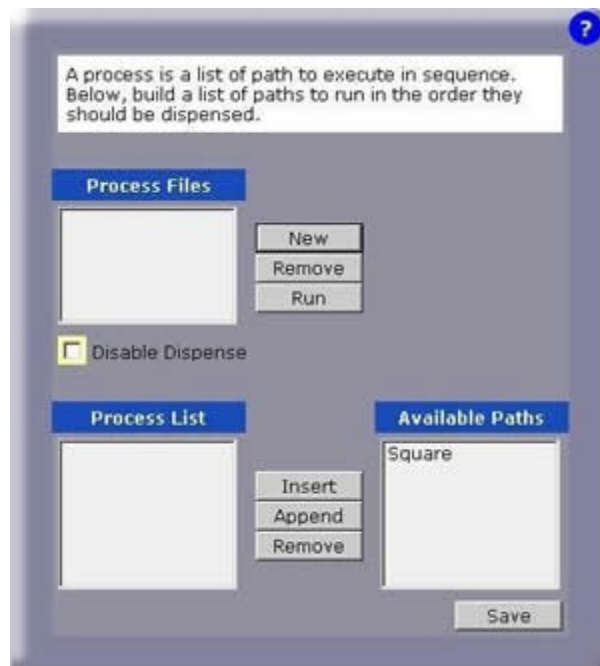
We now wish to modify the parameters that apply to the Path overall.

- » In the **Path** "Global" data, change the "Dispense Spd" and the "Trans Spd" to **"5"** mm/sec. This reduces the nominal speeds when fluid is and is not dispensed.
- » Set the "Approach" and "Depart" heights to **"50"** mm. This increases that height that the robot will move above the first and last **Nodes** when starting and ending the **Path**.
- » Set the "Z" value of the "Offset" to **"10"**. This will lift all of the **Node** positions by 10 mm. Once the **Path** has been verified, this value can be reduced to obtain the correct distance between the syringe tip and the surface to properly dispense the fluid.
- » Click the **Save Path** button to save the changes and respond **Yes** to the confirmation.

STEP 4: CREATE THE PROCESS

To assist in debugging, it is possible to execute a single **Path** directly from the Path Editing panel. But, since our entire **Process** will consist of one **Path**, we will directly move to creating and executing the full application.

- » Open the Process Editor panel, **Edit > Path Editor** .



- » To create the Process, click **New**.
- » When requested, enter the new process name as **"Square_Proc"** (without quotation marks) and click **OK** to confirm.

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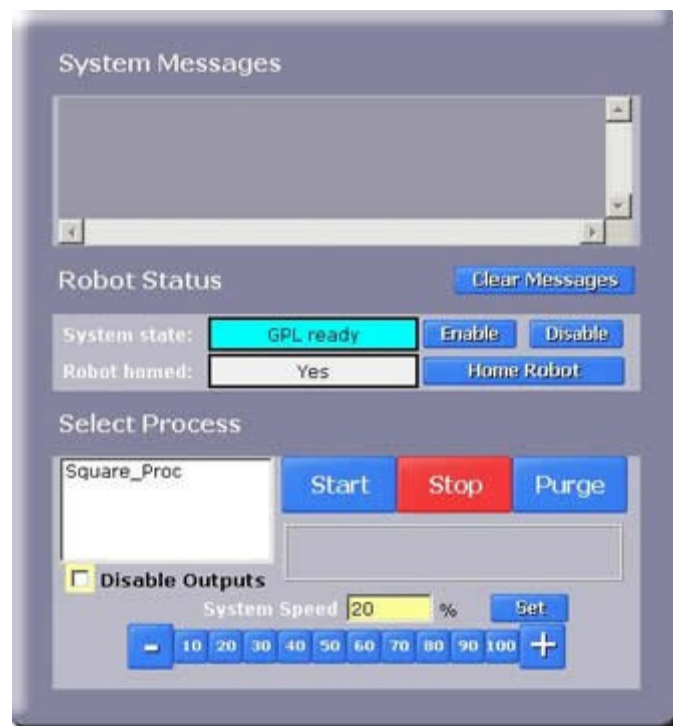
- » In "Process Files", click on **Square_Proc**. In "Available Paths", click on **Square**.
- » To add the Square **Path** to the Square_Proc **Process**, press **Append**.
- » Click the **Save** button to save the changes to the flash disk, and click **OK** to confirm.

This completes the creation of the **Process**. If we had more **Paths** to add, they would appear in the "Available Paths" list and could be appended as well.

STEP 5: EXECUTE THE PROCESS

We are now ready to execute this **Process**.

- » Open the Operator Control panel, **Operator >** .



In order to execute the Process, motor power must be enabled and the robot must already be homed as indicated in the "Robot Status". In the Select Process area, the overall speed of the robot can be reduced for testing.

- » Reduce the speed of all robot motions by clicking the **10 %** speed button.
- » To inhibit dispensing fluid during testing, check the **Disable Outputs** box.
- » Select the application to run by clicking on **Square_Proc** and press the **Start** to begin execution.

Congratulations! You have just developed and executed your first dispensing application with Guidance Dispense.

At this time, we suggest that you try running the application at various speeds and adjusting the Z height of the **Path** offset with the dispense outputs enabled until you achieve a good, consistent dispensed fluid pattern.

For additional practice, you should print out the remaining three examples in the [Sample Applications Templates](#) and program these test patterns as well. Each sheet has the list of **Nodes** that should be trained to produce the test pattern.

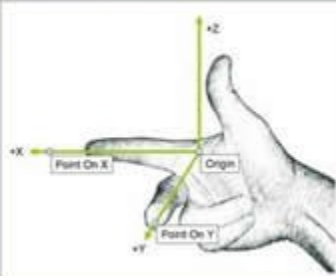
Application Tutorial 2: Adjusting for Base Shifts and Rotations

This tutorial demonstrates that if the base of a dispensing **Path** has been shifted and/or rotated, the [Global Frame](#) can be adjusted to compensate all of the **Path's Node** positions.

This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

- » For any of the sample templates, execute the **Process** again to verify that the dispensing path is accurately being followed.
- » Shift and rotate the sample template on the work surface and secure it again.
- » Open the **Global Frame** definition panel, **Configuration > Global Frame**.

Global Frame
?



The global frame is what path points are taught relative to. Click the "Teach Frame Wizard" button below to walk through teaching the frame.

When teaching the frame points, it is important to follow the right hand rule. These points describe a plane where the Cartesian "Z" axis is pointing up.

Teach Frame Wizard

	X	Y	Z	Yaw	Pitch	Roll	
Teach Origin	371.7414	229.3075	-91	0	180	180	Move To
Teach POX	372.8528	90.9304	-91	0	180	180	Move To
Teach POY	530.2799	230.2512	-91	0	180	180	Move To

Frame Values:

371.7414

229.3075

-91

0

0

-89.5399

Save

We now need to re-teach the **Global Frame** and realigning it with the X & Y axes drawn on the template. Since all of the **Node** locations have been defined with respect to this reference frame, once the **Global Frame** is updated, all of the **Node** locations will be automatically compensated.

- » Execute the frame teaching aid by pressing **Teach Frame Wizard** and confirm that you wish to continue by clicking **Yes**.
- » When asked, select the head that you will use during this Wizard by clicking **Head_x**.
- » When asked to record the Origin, Point On X and Point On Y, manually position the selected syringe tip at the points on the template marked "Origin", "POX" and "POY" and click the **Record** button at each position.
- » Press the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.
- » Execute the **Process** again and verify that the dispensing path is once again following the pattern on the shifted and rotated template.

Application Tutorial 3: Automatic Z Height Adjustment

If your system is equipped with a Z-Contact sensor or similar device that can detect the Z height of a surface, this tutorial illustrates how this sensor can be used to adjust the Z heights of all of the **Nodes** in a **Path**. When enabled, GD will perform a [Z-Search](#) as follows:

- Moves to the "Approach" position above the first **Node** of a **Path**.
- Moves down in Z until the sensor is tripped.
- Computes the difference between the first **Node's** Z position and the detected Z height.
- Moves to the first **Node** position and all subsequent **Nodes** in the **Path** applying the Z correction and the X/Y/Z offset defined for the **Path**.

When a Z-Search is performed, the **Path** Z Offset value is utilized to adjust the height of the **Path** after the correction is applied. For example, if the Z Offset is set to 0, after the surface is detected, the Z height of the first **Node** would be set to the height of the surface and all subsequent **Nodes** would be corrected accordingly. Typically, the Z Offset is set to be equal to the gap desired between the surface and the syringe tip.

This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

- » For any of the sample templates, execute the **Process** again to verify that the dispensing path is accurately being followed.
- » Open the Path Editing panel: **Edit > Path Editor**.



- » Select the **Path** for the template that you are using for this tutorial.
- » Enable the Z-Search for this path by setting the Search pull-down to **Use Probe**.
- » For testing purposes, increase the height of the Path so it is well off the surface by setting the Z Offset value to **"10"** mm.
- » Press the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.
- » Execute the **Process** again and confirm that the syringe tip contacts the surface and then backs off 10 mm.
- » In the Path Editor, reduce the value of the Z Offset and re-execute the **Process** until the **Path** height is correct and the fluid is being correctly dispensed.
- » To verify that the Z-Search is operating correctly, manually adjust the height of the template and execute the **Process** again.

Application Tutorial 4: Repeating a Path in a Grid Pattern

Once a **Path** has been created, it is very easy to have the **Path** repeated in a 1, 2 or 3 dimensional grid pattern. This is useful for dispensing fluid on parts that are stored in a pallet or for repeatedly stepping a fixed distance and duplicating a dispensing pattern.

This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

- » For any of the sample templates, execute the **Process** again to verify that the dispensing path is accurately being followed.
- » Open the Path Editing panel: **Edit > Path Editor**.



A **Path** is always indexed along the major axes of its reference frame. For example, if a **Path** is relative to the [Global Frame](#), you can step in the positive or negative direction of its X, Y or Z axes. You cannot step diagonally. However, since you are free to select the orientation of the reference frame for a Path, this does not impose a significant limitation.

By default, the number of "Pallet" indices (Idx) is 1, which means do it once and don't step.

- » Select the **Path** for the template that you are using for this tutorial.
- » Change the number of Pallet indices (Idx) in **X** to "**2**". This will repeat the pattern once by stepping once in the X direction.
- » To specify an index step size of 25.4mm, change the **X Pitch** to "**25.4**".
- » Press the **Save** button to store the results on the flash disk. Respond **Yes** when asked if it is okay to delete the existing file.
- » Execute the **Process** to view the results.

Since we are only indexing in one dimension, the order in which we index the X, Y and Z values is immaterial. However, if we did specify more than one indexing direction, the "Order" pull-down could be change to re-order which axis we indexed along first.

This completes the modifications for repeating a **Path**.

Application Tutorial 5: Using Machine Vision

If your system is equipped with PreciseVision, the application of machine vision in GD is very straightforward. PreciseVision dynamically computes the reference frame for a **Path** and this reference frame is used in place of all of the components of the [Global Frame](#) except for its Z height. If PreciseVision cannot locate the reference frame or if it performs an inspection operation that indicates that a part is not acceptable, it will return an error that will stop execution of the GD **Process**.

After the [Vision Interfacing and Calibration](#) tutorial is performed, all communication with PreciseVision and the translation of all results into coordinates that can be applied to **Paths** is automatically handled by GD.

The procedure for developing a vision based dispensing application can be summarized as follows:

- As with the [Basic Application Tutorial](#), start by teaching a **Global Frame**. This reference frame should be selected keeping in mind that vision will need to generate the same frame.
- Follow the same procedures as before and create and define dispensing **Nodes**, **Paths** and a **Process**.
- After your **Process** has been debugged, create a Vision Process in PreciseVision that can dynamically locate and return the same reference frame as the **Global Frame**.
- Flag any desired **Path's** to indicate that they are relative to the vision reference frame instead of the **Global Frame**.
- Execute your new vision-based dispensing application.

The new steps in this procedure will be described in this tutorial. Prior to reading this material, you should familiarize yourself with the basics of applying PreciseVision.

This training example requires that Application Tutorial 1 has already been completed and builds upon its results.

» For any of the sample templates, execute the **Process** again to verify that the dispensing path is accurately being followed.

In this tutorial, pictures of the Square template will be presented for illustrative purposes, but any of the other templates can be used as well. To mimic the manual training of the **Global Frame**, we will be training vision to locate the positions of the lines drawn on the template for the X and Y axes. In a real application, coordinate axes are rarely present. Instead, features such as distinct edges with an included corner or fiducial marks can be selected for both the manual **Global Frame** definition and the automated vision identification.

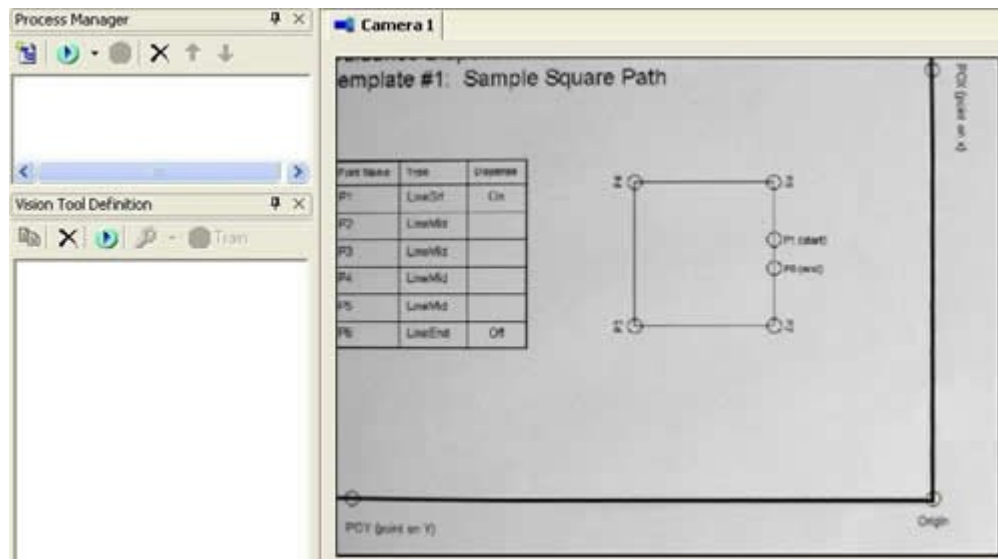
We start by illustrating how PreciseVision is trained to locate the X and Y axis lines.

» Position the dispensing template below the camera. It is not necessary to accurately position the template in the camera's field of view. All that is required is that a portion of the X & Y axes are visible.

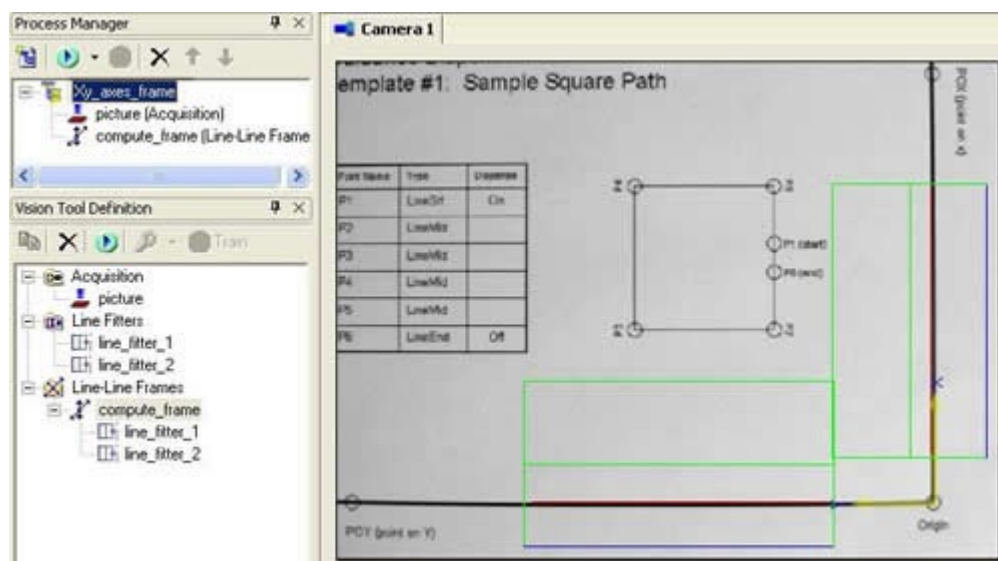
» If the camera is mounted on the robot, ensure that its Z height is the same as the calibration point in the GD [Vision](#) panel. You can use **Move To** on the Vision panel to correctly set the Z height.

» Using PreciseVision, take a picture by selecting **File > Acquire New Image**.

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- » In PreciseVision, create a new Vision Process named **"Xy_axes_frame"**.
- » Create and add to this Vision Process an Acquisition Tool followed by a Line-Line Frame Tool.
- » Create two Line Fitter Tools and provides these as the inputs to the Line-Line Frame Tool.
- » Position the first Line Fitter to locate the X-axis and the second Line Fitter to locate the Y-axis of the template.

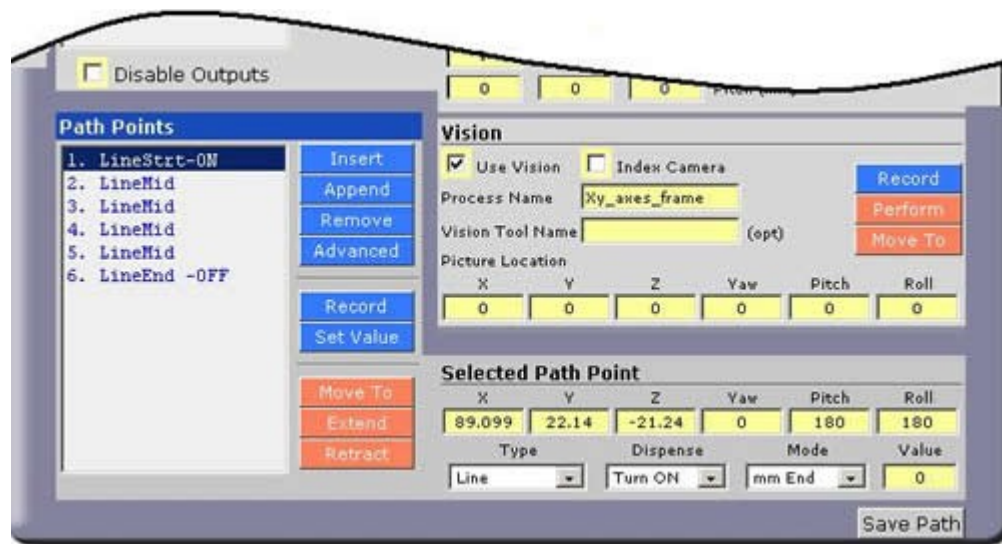


This Vision Process will take a picture and determine the two lines that best fit the X and Y axes of the template. Then, a reference frame is computed whose origin is the intersection of the two line fitters and whose X-axis is aligned with the results of the first Line Fitter.

This completes the vision training. The Xy_axes_frame Vision Process can now be executed by Guidance Dispense whenever the template reference frame needs to be located.

Returning to Guidance Dispense, we must now mark the dispense **Path** as being relative to the vision results in place of all of the components of the **Global Frame** except for its Z height.

- » Open the Path Editor by clicking **Edit > Path Editor**.
- » Select the **Path** for the template that you are using for this tutorial.
- » Flag this **Path** as being relative to a vision result by checking **Use Vision**.
- » Specify the Vision Process to be executed to locate the reference frame by entering "**Xy_axes_frame**" (without quotation marks) into the **Process Name** field.



- » The Vision Tool Name can be left blank since we just want the results from the last vision tool that is executed, the Line-Line Frame tool.
- » If the camera is mounted on the robot and you want to move the camera to a position other than the point where the camera was calibrated, manually move the camera to the correct position and Z height and press **Record**.
- » Press **Save** to store the results on the flash disk.

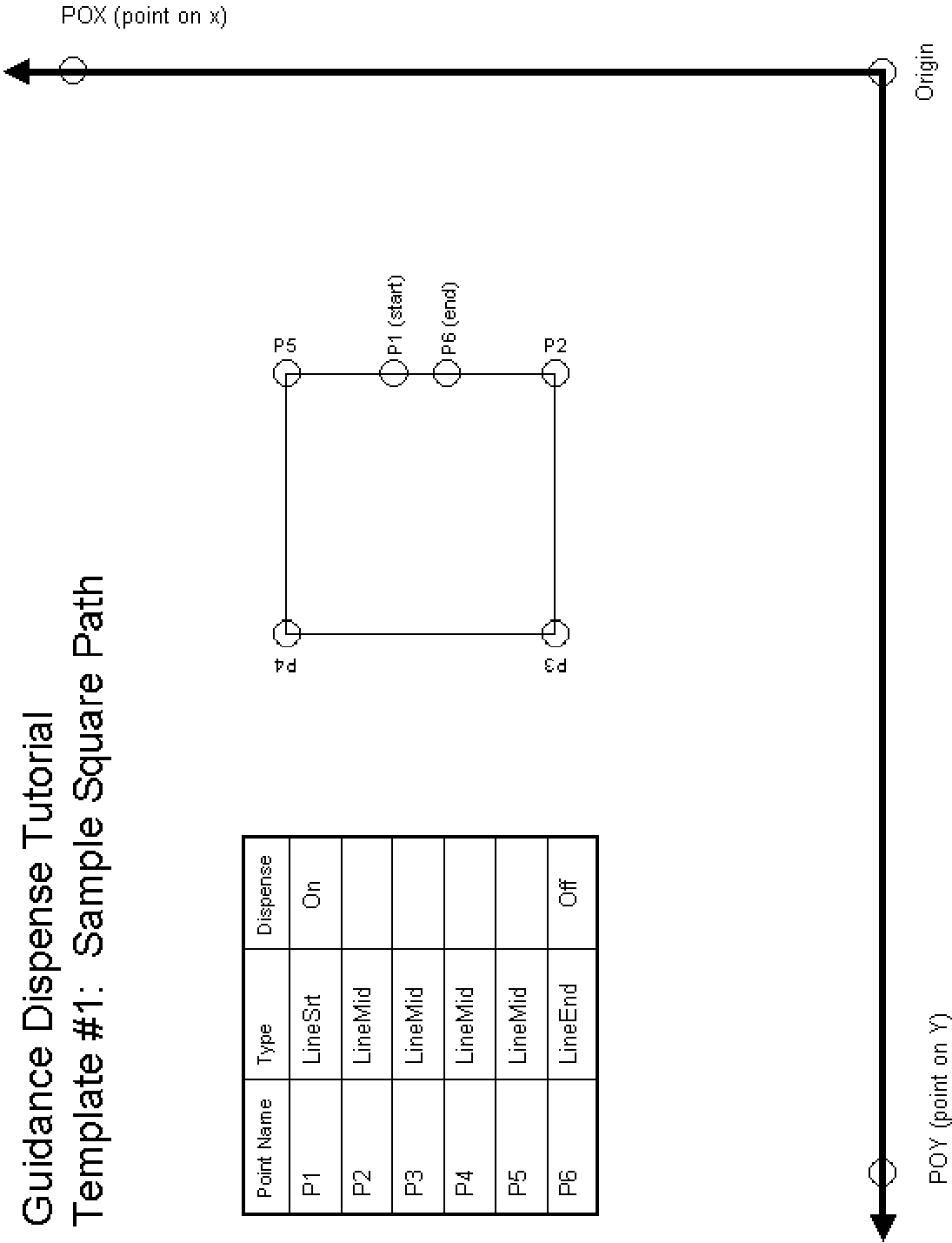
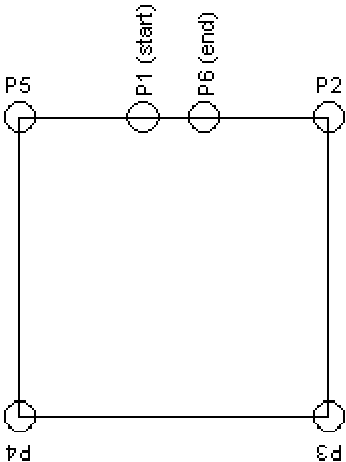
This completes the extra steps necessary to develop a vision based dispensing application! Your previously created **Process** can be executed as before. As a test, try displacing and slightly rotating the template to verify that the **Path** is being dynamically updated.

Sample Application Templates

The following are a series of sample Paths. These should be printed out and used in connection with the Tutorials presented earlier in this Chapter.

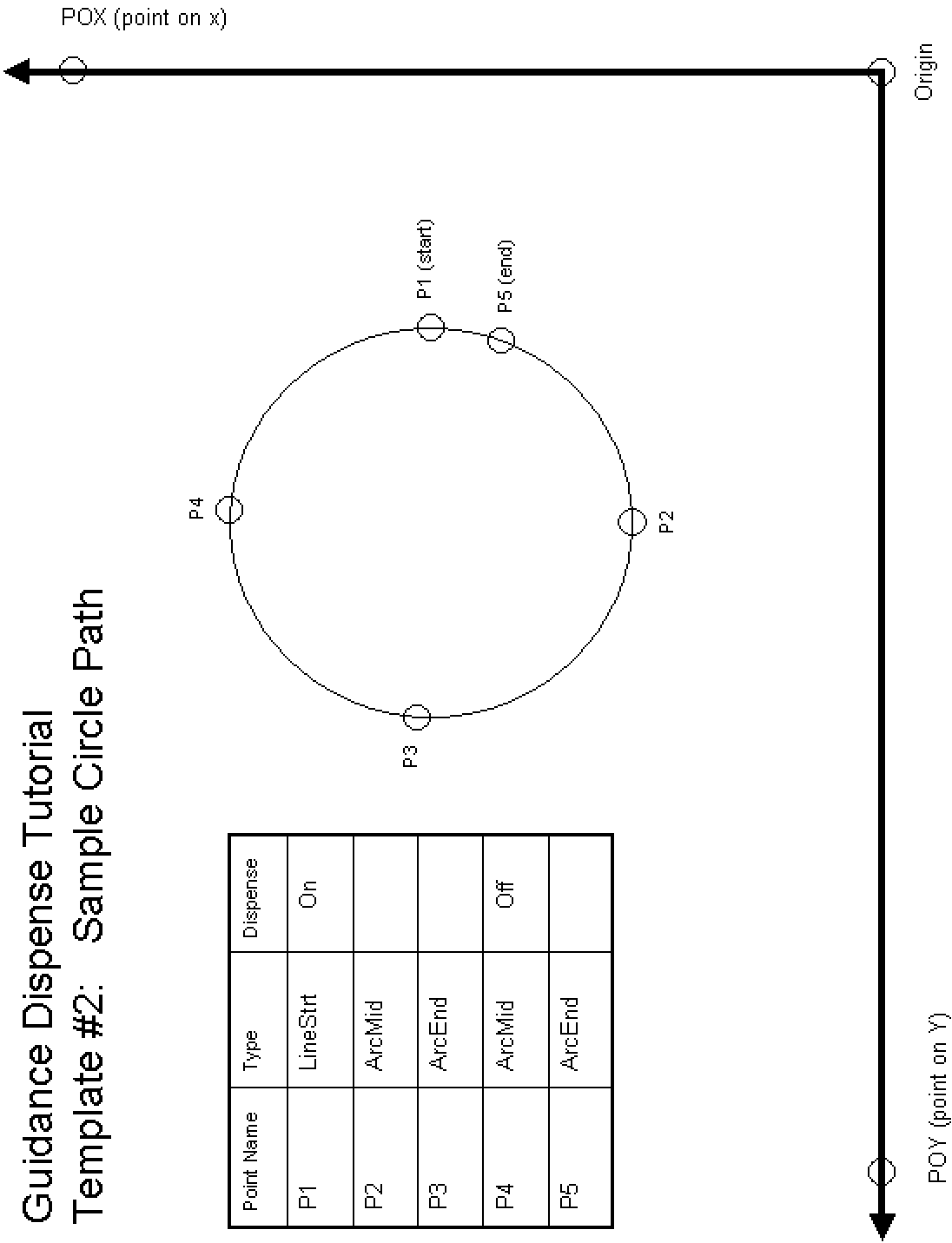
Guidance Dispense Tutorial
Template #1: Sample Square Path

Point Name	Type	Dispense
P1	LineSrt	On
P2	LineMid	
P3	LineMid	
P4	LineMid	
P5	LineMid	
P6	LineEnd	Off



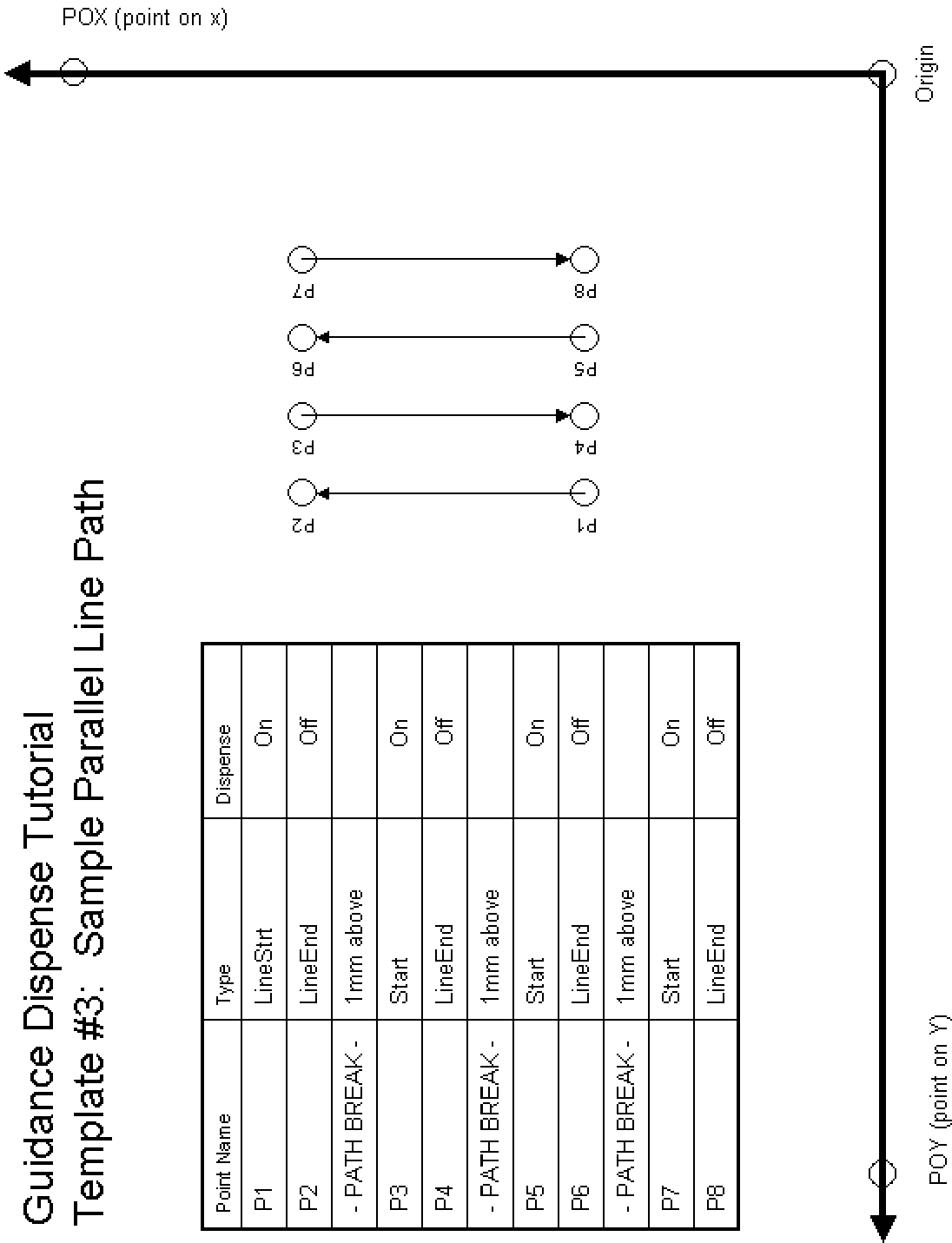
Guidance Dispense Tutorial
Template #2: Sample Circle Path

Point Name	Type	Dispense
P1	LineStart	On
P2	ArcMid	
P3	ArcEnd	
P4	ArcMid	Off
P5	ArcEnd	



Guidance Dispense Tutorial
Template #3: Sample Parallel Line Path

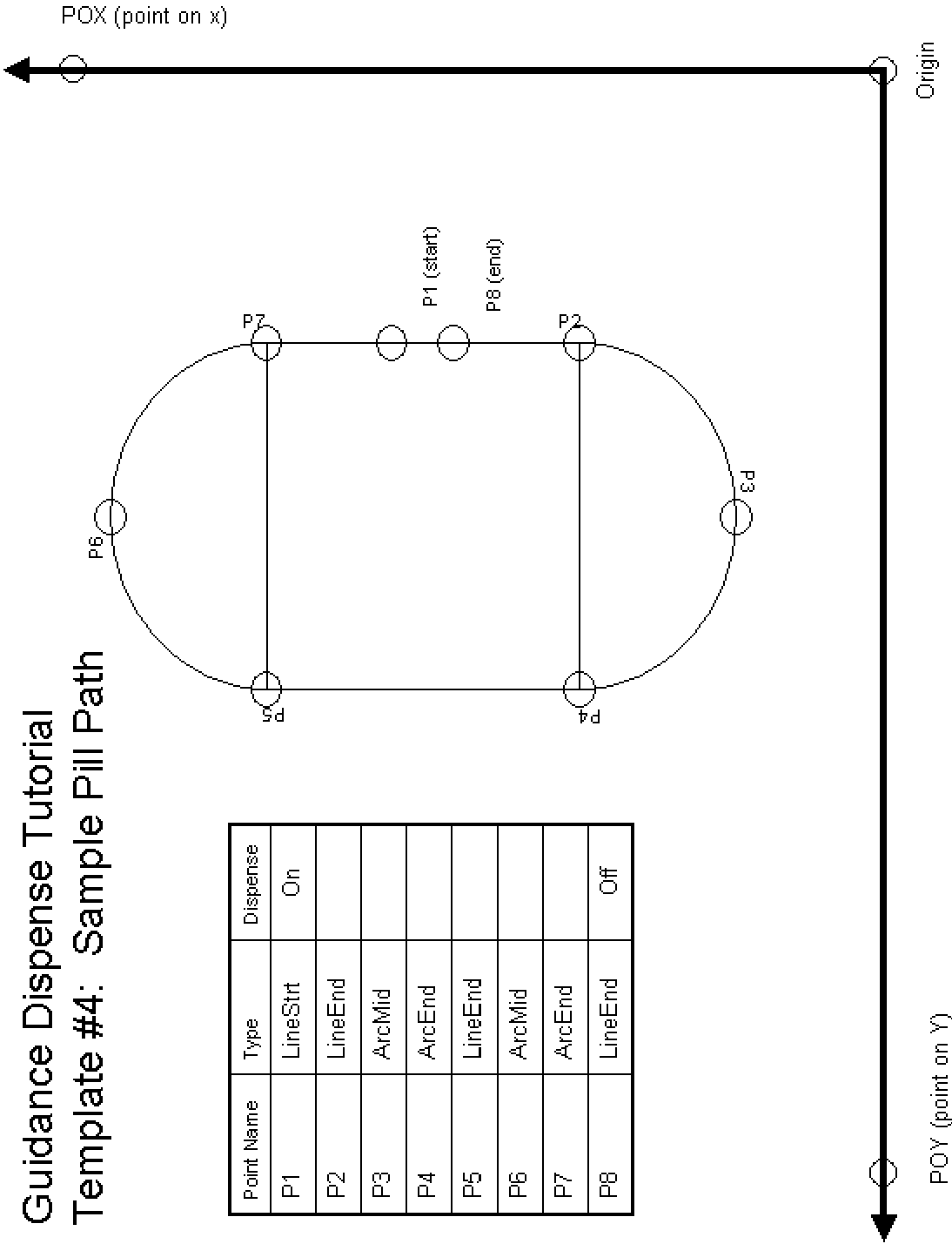
Point Name	Type	Dispense
P1	LineStart	On
P2	LineEnd	Off
- PATH BREAK -	1mm above	
P3	Start	On
P4	LineEnd	Off
- PATH BREAK -	1mm above	
P5	Start	On
P6	LineEnd	Off
- PATH BREAK -	1mm above	
P7	Start	On
P8	LineEnd	Off



Guidance Dispense Tutorial

Template #4: Sample Pill Path

Point Name	Type	Dispense
P1	LineStart	On
P2	LineEnd	
P3	ArcMid	
P4	ArcEnd	
P5	LineEnd	
P6	ArcMid	
P7	ArcEnd	
P8	LineEnd	Off

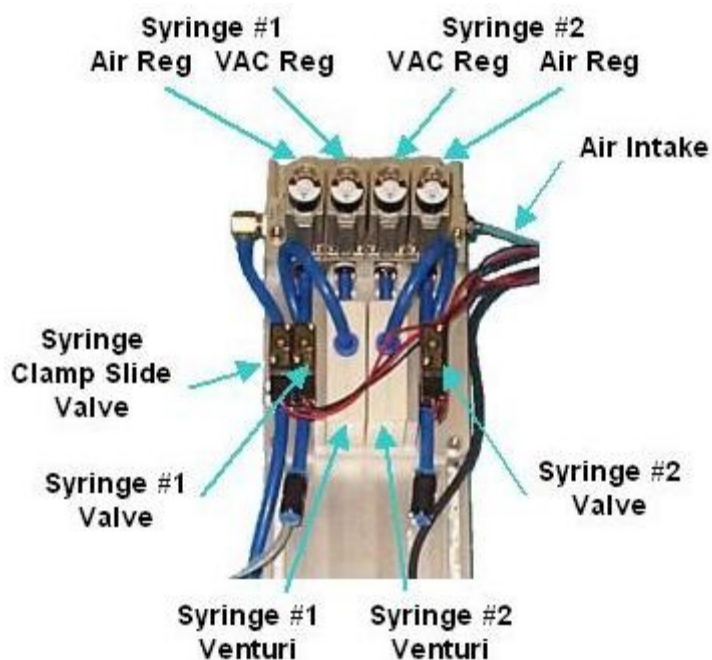


Reference Information

Dual Control Air Dispenser Pneumatic Connections

The Dual Control Air Dispenser controls the air lines for the two syringes and the pneumatic actuator for the vertical slide for the first syringe clamp. For each syringe, this device provides two pressure regulators: one to control the positive pressure utilized to dispense the fluid from the syringe and a second regulator that supplies air to a venturi device that creates a vacuum in the syringe air line when the positive pressure is turned off. The vacuum assists in withdrawing the syringe plunger to minimizing dribbling of the dispensed fluid.

The picture below illustrates the pneumatic inter-connections between the components of the Dual Control Air Dispenser.



The external air pressure input line is on the right of the unit. This air is provided to the four regulators and flows to the left to the hose for the Syringe Clamp Slide Solenoid Valve. The Syringe #1 & #2 regulators provide reduced air pressure to the Syringe #1 & #2 Solenoid Valves. The Syringe #1 & #2 VAC regulators provided reduced air pressure to the Syringe #1 & #2 Venturi components. The Venturi units convert the positive air pressure into a vacuum that is provided to the negative side of the Syringe #1 & #2 Solenoid Valves.

Dual Control Air Dispenser Electrical Connections

The Dual Control Air Dispenser requires a number of electrical connections for the proper operation of this unit. These interfaces include the following:

- Three 24VDC input signals into the Air Dispenser that operate the three solenoid valves (Syringe #1 & #2 Valves and the Syringe Clamp Slide Valve).
- Three dry contacts in the Air Dispenser that indicate if any of the buttons is being pressed (Red Free, Green Line and Blue Arc momentary contact buttons).
- Three 24VDC input signals into the Air Dispenser that turn on the back lights of the three buttons.
- One sensor output signal from the Air Dispenser that is generated by the Z-Contact sensor on the Sliding Syringe Clamp.

All of these signals are connected to 4-pin 3M 37104 series Mini-Clamp Plugs.



The following tables describe how each of the signals are wired to their respective plugs.

Pin	Push Button with Back Light	Wire Color
1	GND	Black
2	24VDC supplied to turn on back light. Returned through pin 1.	Gray
3	24VDC returned by dry contact switch when button pressed.	Green
4	24VDC power supplied to dry contact switch.	Red

Pin	Solenoid Valve Control	Wire Color
1	GND	Black
2	24VDC supplied to open valve. Returned through pin 1.	Red
3	N.A.	Not connected
4	N.A.	Not connected

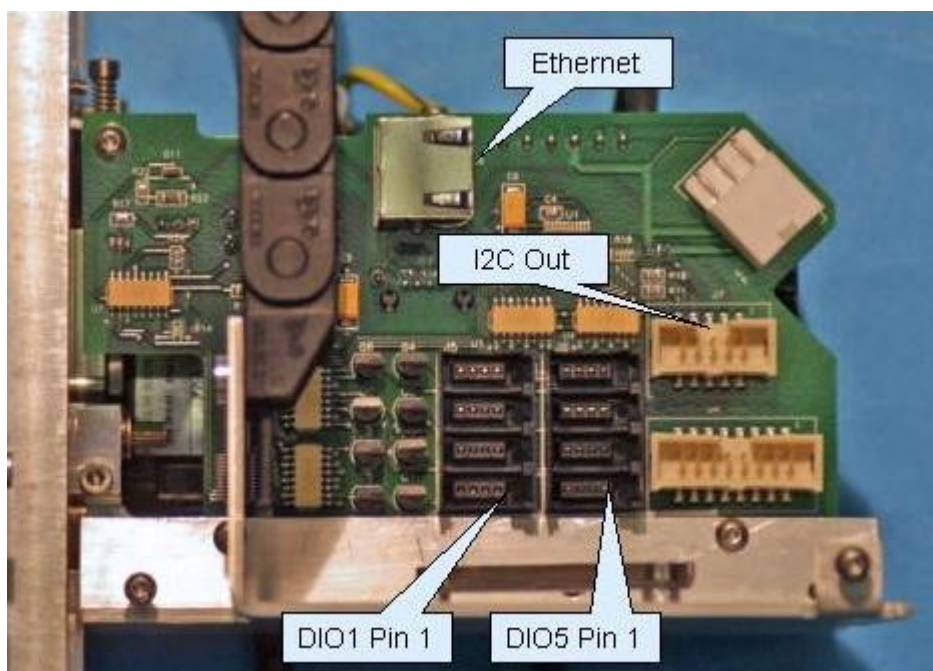
Pin	Z-Contact Sensor	Wire Color
1	GND	Blue
2	N.A.	Not connected
3	24VDC returned by sensor when contact detected.	Black
4	24VDC power supplied to sensor.	Brown

Interfacing to PrecisePlace Robots

If the Dual Control Air Dispenser is interfaced to a PrecisePlace robot, the electrical connections from the Dispenser should be plugged into the Digital I/O signals provided in the Z-Axis IO board. This board is mounted beneath the cover for the Z-axis motor. The following is a picture of the Z=Axis IO board.



DANGER: The Z-Axis IO board contains an optional motor connector that provides a bus voltage of 320 VDC. As such, this board represents a high-risk and should only be accessed when the main AC power to the robot is disconnected.



The following table defines where each of the Air Dispenser plugs should be connected to the Z-Axis IO board.

DIO Connector	GPL Signal Number	Air Dispenser Plug
1	33 / 10033	Red Free button
2	34 / 10034	Green Line Button
3	35 / 10035	Blue Arc Button
4	36	Syringe Clamp Slide Solenoid Valve
5	37	Syringe #1 Valve
6	38	Syringe #2 Valve
7	10039	Z-Contact Sensor
8		No used

Trouble Shooting Guide

Guidance Dispense Common Error Messages

The following table contains common error messages and pop-up messages that you may encounter during the normal operation of the Guidance Dispense system. Please see the *Precise Documentation Library > Controller Software > Software Reference > System Error Codes* for a description of the complete list of error messages that can be generated by the robot control system.

Error	Description	Corrective Action
Error Messages		
-1006, *Robot already attached*	Can occur when trying to record a position that requires that the dispensing head dimensions be set but another task has control of the robot.	The most common problem is that the virtual MCP is not in Computer mode and is controlling the robot. Be sure to set the virtual MCP to computer mode.
-1046, *Power not enabled*	Can occur any time in response to a request to execute a dispensing Process, Path , Move Safe, Retract Arm or other robot motion.	Before the robot can be moved, motor power must be enabled. Check that the "System state:" displays "GPL ready" before attempting to move the robot.
-1047, *Virtual MCP in Jog mode*	Can occur any time in response to a request to execute a dispensing Process, Path , Move Safe, Retract Arm or other automatic robot motion.	The system cannot be in jog mode when attempting to move the robot automatically. Take the system out of jog mode by clicking on the "Comp" button in the "Robot Status" under "Edit" or the "Computer" button in the Virtual Pendant.
-4000, *Cannot connect to vision server*	Can occur in response to a request to execute a dispensing Process or Path that uses PreciseVision to locate an object.	Before a vision process can be executed, PreciseVision must be running on a PC. The PC IP address must be set in the "Vision Configuration" page.
Vision Operation Failed	During execution of a dispensing Process that contains a request to locate an object using PreciseVision, the PreciseVision process has failed due to one of its vision tools not obtaining the expected results.	Check the PreciseVision camera window to see if the proper object is inside the field of view. Check to see if the proper PreciseVision project is loaded for the dispensing Path being executed. Check to make sure the proper lighting is set and on.
Pop up messages		
Last Command Still Busy ...	Message occurs when clicking on a button or selecting an item in a list in the graphical user interface.	This indicates that the web interface is still processing the last request while a new one is being requested. Only a single request can be performed at a time in the web interface.

		<p>Try performing the operation again.</p> <p>If this continues to happen for all requests and the robot is idle, make sure the GPL project is loaded and running. See the <i>Precise Documentation Library</i> for details on the Guidance Web Interface. Use the Guidance Web interface operator control panel to determine if the "GDispense" project is loaded and running.</p>
Changing points too quickly.	Message occurs when selecting points in the path editor.	<p>When a Path node is selected, the web page retrieves the information from the controller and updates the data fields. This operation cannot be interrupted and must be completed.</p> <p>If this message continues to be displayed, try slowing down between selection of points. If the web pages seem to be updating very slowly, check with your network administrator as there could be a problem with the network traffic.</p>
Busy ...	Message never goes away at bottom of web panels.	<p>While the robot is executing a Process or Path, the "Busy ..." indicator will be displayed.</p> <p>If the indicator never goes away, it could indicate that the GPL project "GDispense" is not executing. See the <i>Precise Documentation Library</i> for details on the Guidance Web Interface. Use the Guidance Operator Control panel to determine if the "GDispense" GPL project is executing.</p>