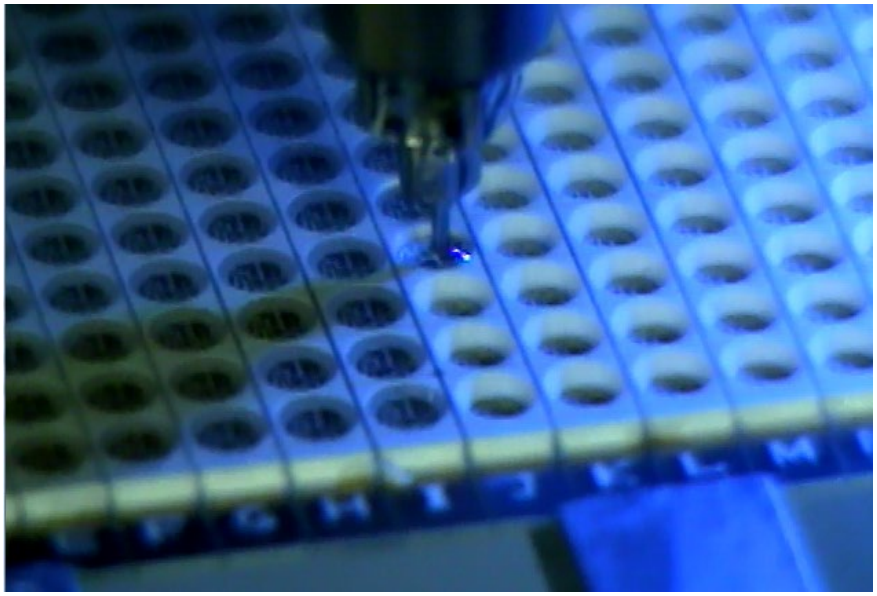
WHERE

PRECISION

DRIVES

PRODUCTION



PathMaster®

Owner's Manual

Revision L

Precision Valve & Automation
Six Corporate Drive
Halfmoon, NY 12065
www.pva.net

This document is based on information available at the time of its publication. While efforts have been made to ensure the contents of this manual are accurate, the information contained herein does not purport to cover all specific details or variations in hardware, or to provide for every possible contingency in connection with installation, operation, or maintenance. Features may be described herein which are not present in all hardware and software systems. Precision Valve and Automation, Inc. assumes no obligation of notice to holders of this document with respect to changes subsequently made.

Precision Valve and Automation, Inc. makes no representation or warranty, expressed, implied, or statutory with respect to, and assumes no responsibility for the accuracy, completeness, sufficiency, or usefulness of the information contained herein. No warranties of merchantability or fitness for purpose shall apply.

Table of Contents

1. Introduction

Before you operate this system, read the operation and setup manual. This will help you to become familiar with the product and ensure successful operation.

If any questions or problems arise, contact PVA's Technical Support department.

PVA Contact Information

Main Office **PVA**

One Mustang Drive

Cohoes, NY 12047

Tel +1-518-371-2684

Fax +1-518-371-2688

Website: http://www.pva.net

Email: info@pva.net

Technical Support

Tel +1-844-734-0209

Email: cs@pva.net

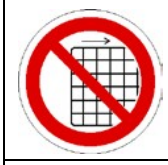
1.1 Document History

Revision	Revision Date	Reason for Changes
REV L	February 2020	Passwords updated, New Template
REV K	January 2019	4.5 PathMaster Release
REV J	May 2018	IP Addresses Added
REV I	May 2018	4.4 PathMaster Release
REV H	February 2018	Additional 4.3 Release Updates
REV G	February 2018	4.3 PathMaster Release
REV F	April 2017	Update of INI Content
REV E	March 2017	PathMaster 4.2 Release
REV D	October 2016	Added Notice on PathMaster.ini File
REV C	April 2016	Save for Part Manager and Motion Smoothing
REV B	January 2015	4.1 PathMaster Release
REV A	October 2013	Initial Release

Note: All photographs and CAD model representations in this document are a "general representation" of the system and its components. The actual appearance of the system and its components can differ based upon customer specific configuration.

1.2 Safety

Certain warning symbols are affixed to the machine and correspond to notations in this manual. Before operating the system, identify these warning labels and read the notices described below. Not all labels may be used on any specific system.

	Always wear approved safety glasses when you operate or work near the workcell.
	Before you operate the system, read and understand the manuals provided with the unit.
	Never put hands or tools in areas with this symbol when the machine is in operation. A dangerous condition may exist.
	Read and understand the manuals provided with the unit before any repairs or maintenance is done. Only a qualified individual should do service.
	Use caution when there are pressurized vessels. Find and repair any leaks immediately. Always wear appropriate safety equipment when you work with pressurized vessels or vessels that contain chemicals
	Shear hazard from moving parts. Avoid contact.
	Do not remove protective guarding.
	In situations where inattention could cause either personal injury or damage to equipment, a warning notice is used.

	Do not smoke near the PVA UV cure machine. Always have a fire extinguisher available for emergency use.
	Before performing any repairs or maintenance to the system, turn off power and lock out the power disconnect switch.
	Warning notices are used to emphasize that hazardous voltages, current, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use. Only qualified personnel should enter areas designated with this symbol.
	Laser light source present. Do not stare directly into the beam. Do not use in the presence of highly reflective surfaces
	Pinch hazard from moving parts. Avoid contact.
	Hot surface. Avoid contact.
	Warning, Ultraviolet (UV) light hazard. Do not look directly at the UV light source.

1.3 Theory of Operation

This manual applies to the following Precision Valve & Automation, Inc. workcells:

PVA350™	PVA6000™
PVA650™	Delta 6
PVA2000™	Delta 8
PVA3000™	

Some features may not apply due to specific hardware and the version of PVA Portal installed on the workcell. Please contact PVA for more information. All machines are referenced in the manual as workcells. This manual gives information on common options and configurations for a workcell. The machine related to this manual may not contain all items or may have additions. If the manual refers to an option that was not purchased, ignore that section. If there are options on the workcell not included in this manual, refer to the workcell manual for more information.

NOTE: Always wear gloves when handling materials and solvents. Refer to MSDS sheets on the material dispensed for other precautions.

1.4 Waste Disposal

Dispose of all used parts and materials in accordance with local laws and regulations.

1.5 Hardware and Software Requirements

PathMaster® requires an Intel® Core i5 processor or equivalent processor with 4 Gigabytes of RAM, 2 Gigabytes free hard drive space and Windows® 10 Operating System or newer. Your computer must also have:

- (2) Ethernet ports
- (1) RS232 serial communications port
- 17" monitor with 1280 x 1024 resolution
- Mouse (USB) and 6' extension cable
- Keyboard (USB) with a touch pad if used with a PVA monitor mount
- Keyboard extension cable, 6'
- Monitor cable, 15' (Display port or DVI)
- Display port or DVI video support (VGA cannot be used)
- CDROM drive
- PMInterface Version 1.05, if Portal is used
- Support for Windows 10 LTSB or Enterprise (Windows 10 Pro is not supported)

NOTE: Portal may not work correctly with systems that do not meet these minimum requirements.

1.5.1 Galil Controller Requirements

- Galil controller, DMC 4000/4200 with firmware revision D400s08n/DMC4200s05h or newer. Controllers must be purchased from PVA.
  - A DMC2000 controller may be used, but the software may only be configured for DMC2000 or Legacy modes.

1.5.2 Security Software

Some security software packages and firewalls can interfere with PVA system software. PVA software uses Ethernet ports 23, 60007, and 502 by default. Security software and firewalls must be configured to allow traffic on these ports.

2. Setup and Communication

Before you operate a tool, workcell, or program a path, it is necessary to understand the workcell and the software.

2.1 Operator Skills

The operator must have basic computer skills and be familiar with the Windows® 7 (or Windows® 10) operating system.

2.2 Install PathMaster®

NOTE: Make sure that the Windows® User Account Control (UAC) is disabled and the user account has Administrator rights before you install PathMaster®.

1. Insert the CD into the CD drive.
2. Run 'PathMaster_Install.exe' on the CD drive and follow the instructions shown.

NOTE: If the user does not have administrator rights or if UAC is not disabled, the following prompts will be shown.

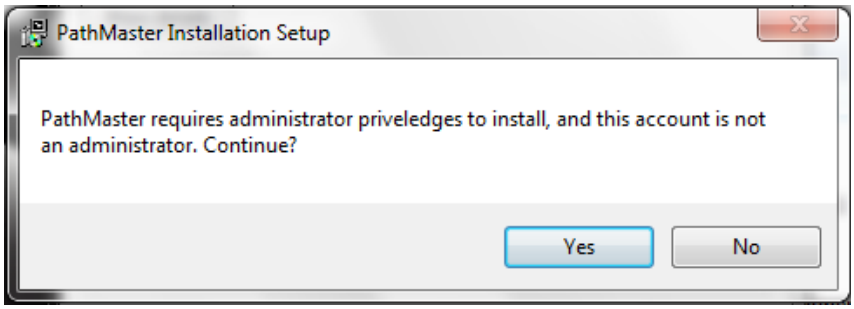


Figure 1: PathMaster® Installation Administrator Privileges Window

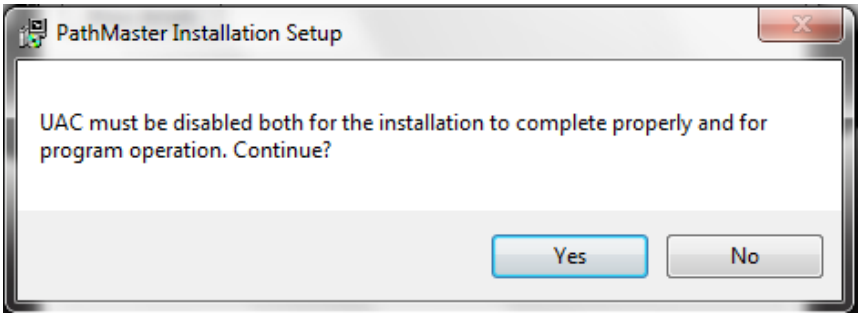


Figure 2: PathMaster® Installation UAC Window

NOTE: Install the software in its default directory (c:\Program Files\PVA for 32 bit systems, c:\Program Files (x86)\PVA for 64 bit systems).

Software Startup

If you receive a warning at startup, please contact PVA. It is possible that the main program needs to be updated. If you select "OK" and continue to use the software, some of the features may not work.

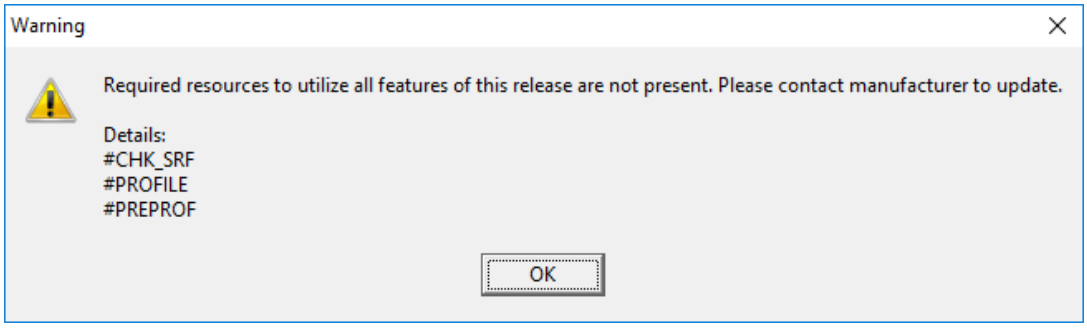


Figure 3: Example Startup Validation Warning

2.3 Upgrade Procedure

PathMaster upgrades are available free of charge, however, to upgrade the software, hardware upgrades may be necessary. For a successful upgrade, you must have the requirements shown in Section 1.5. Also, it may be necessary for workcells with some custom options to have additional edits to work correctly. Please contact PVA's Customer Service Department for information on upgrading your PathMaster software.

2.4 Multi-Machine Support

In PathMaster® version 4.3, multi machine support has been deprecated, but backward compatibility is maintained.

When a database is imported in PathMaster® 4.3, the database is checked to see if it is pre-4.2. If the database is pre-4.2, PathMaster® checks to see if the database has multiple machines in it. If there are multiple machines in the database, the database will be split into multiple databases (.bck files) with the data for a single machine in a single database. The new database filenames will be the machine name (<MachineName>.bck) and are stored in the \PathMaster\DB\Machines folder. When the database split is complete, PathMaster® will load the database with the same machine name as the last loaded database. If that machine name was not present in the multi-machine database, PathMaster® will load the default machine (Default.bck). Every database has a default machine. Any of the new database files (single machine databases) can be loaded at any time. Use the machine name to access data from each machine in the old database.

2.5 Computer and Workcell Communication

The workcell communicates with the PC through RS-232 or Ethernet. All PVA Portal systems communicate through Ethernet. Standalone systems communicate through RS-232 but Ethernet can be used if the workcell has a Galil DMC2200, DMC4000, or DMC4200 series motion controller.

WARNING! The computer must be at the same ground potential as the workcell.

2.5.1 Ethernet Communication

The PC can communicate with the workcell over Ethernet directly, with an Ethernet cross-over cable, or through a switch (Galil Series DMC2000, DMC4000, DMC4200 required.) The Galil controller must remain on a localized subnet that does not see traffic from external networks or devices. The only devices that can be on the Galil subnet are the PC and remote I/O controllers. Connect all other devices through a separate NIC on the PC.

Switch	Position	Description
MRST	OFF	Master Reset Switch
10B	OFF	Ethernet Connection Speed
Ethernet	OFF	Unsolicited MG's (Default)

Table 1: DMC-2200 Dip Switch Settings for Ethernet

Device	Address	Subnet Mask
Computer	100.100.100.100	255.255.255.0
Galil Controller	100.100.100.101	Default
Remote I/O	100.100.100.102	Default

Table 2: Typical Ethernet Addressing

2.6 Save Settings and Database Folders

Before the Program Offsets can be applied, a backup of the machine database is created. The backup file will save with the date and time. Where the file is saved depends on the operation. Refer to the Database Folders chart below for details. When the offsets are applied, the database is saved and programs are exported to a DMC format for use with PartManager (this is the equivalent of *Save For Part Manager* option in PathMaster®, version 4.1).

NOTE: Some auto backup and save features can be changed in the PathMaster.ini. Contact PVA for details.

Table 3: Database Folders

Folder	Description
\PathMaster\DB	Active System Database
\PathMaster\DB\Daily	Daily Auto Backups • Created once per day on program launch • File name AB_<Date>_<Time>.bck
\PathMaster\DB\Machines	Machine Backups • Created on import of machine database • File name <Machine name>.bck • Multiple Backups are created if Multi Machine database is imported
\PathMaster\DB\NeedleCalibration	Needle Calibration Backups • Created prior to running needle calibration • File Name <Date>_<Time>_TOOL_<TL_ID>.bck • If multiple tools, file name will contain multiple Tool IDs.
\PathMaster\DB\ToolOffset	Tool Offset Backup • Created prior to Tool Offset Setup or Tool Change function • File Name <Date>_<Time>_TOOL_<TL_ID>.bck
\PathMaster\DB\WorkspaceReference	WorkSpace Reference Backup • Created prior to Teaching a Workspace Reference • File Name <Date>_<Time>.bck
\PathMaster\DB\Transfer	Machine Transfer Backup • Created prior to Export -> Machine -> Transfers • Filename <Date>_<Time>.tfr

2.7 Calibration Plate

Every system should have a recognizable workspace reference position. Standard systems, with conveyors or flex fixtures, use a calibration plate (see below). Custom systems and systems with non-standard part fixtures will have a defined workspace reference position, but may or may not use the standard calibration plate.

- To use the standard calibration plate, put the plate on the conveyor or flex fixture so it is against the fixed rail and the hard stop or board stop.
- The purpose of the calibration plate, as it relates to PathMaster® 4.2 and 4.3, is to define a consistent workspace reference position. This is very important to the efficacy of machine transportability.

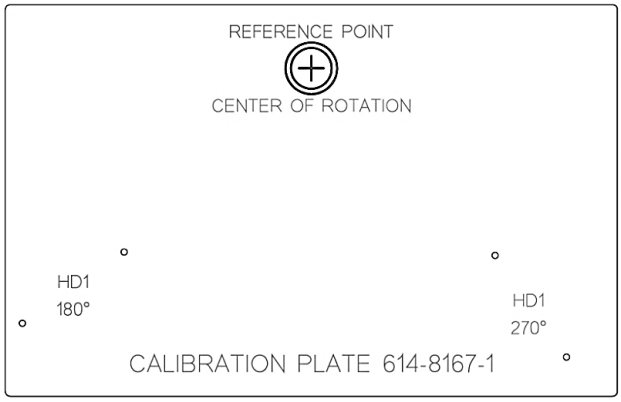


Figure 4: Calibration Plate

2.8 Path Program Planning Tips

- Look at the workpiece to be programmed and find a place to start the path.
- Plan the path program on paper with a diagram or plotted points.
- Select the tool (dispense valve, spray valve, jet) for each path.

NOTE: The first point and direction may not be best and it may be necessary to program the path again.

- Include the active tool operations for each path, ex: Rotate A/B, Tool Up/Down.
- Put the workpiece in the workcell in a repeatable location and make sure it is parallel with the gantry.
- Insert comments into the program for future editing or other users. Comments are shown in red text.

NOTE: If a stop or dwell must be added at one of the points after a path is completed, the path must be broken into two paths or be programmed again.

2.9 Tool Commands in Programs

Pneumatic positions (tool up, tool down, rotary selection, etc.) are not automatically programmed by PathMaster® and there is no communication between the workcell and PathMaster® related to the active tool and its pneumatic position. The operator must select the correct tool in PathMaster® and put the necessary pneumatic commands in the program. The pneumatics can be operated from the Tools Tab in Portal, or from the OIT Interface on the workcell in Manual mode. It is important these commands are in the correct locations. In general, follow these rules:

- Move the X and Y (and W) axes into position before a tool slide or tool rotary is actuated.
- Actuate a tool slide before a tool rotary, if necessary. Make sure there is nothing in the motion radius of the tool rotary.
- Program each segment with the related tool slide in the down position.
- Add tool slide down and tool rotary B commands into the path program, before any segment(s) where the tool is used.
- Move the gantry to a save Z-height before returning a tool to rotary A position, then actuate the tool slide. Input tool rotary A and tool slide up commands into the path program when finished with the tool.
- To change the tool being used safely, include a non-dispense move on the Z-axis to 0, so there is room for the new tool to lower (refer to Section 2.10).

2.10 Inter-Path Movement

After a path is complete, the workcell returns to the ‘standby’ position taught in Setup mode. It is necessary to plan out a path programs to make sure there are no obstructions between paths. To avoid any potential crashes, program a ‘Z only’ move, with the Z-axis target set to 0. The operator must make sure all path programs are safe to run on the workcell and dispense surface.

3.Overview

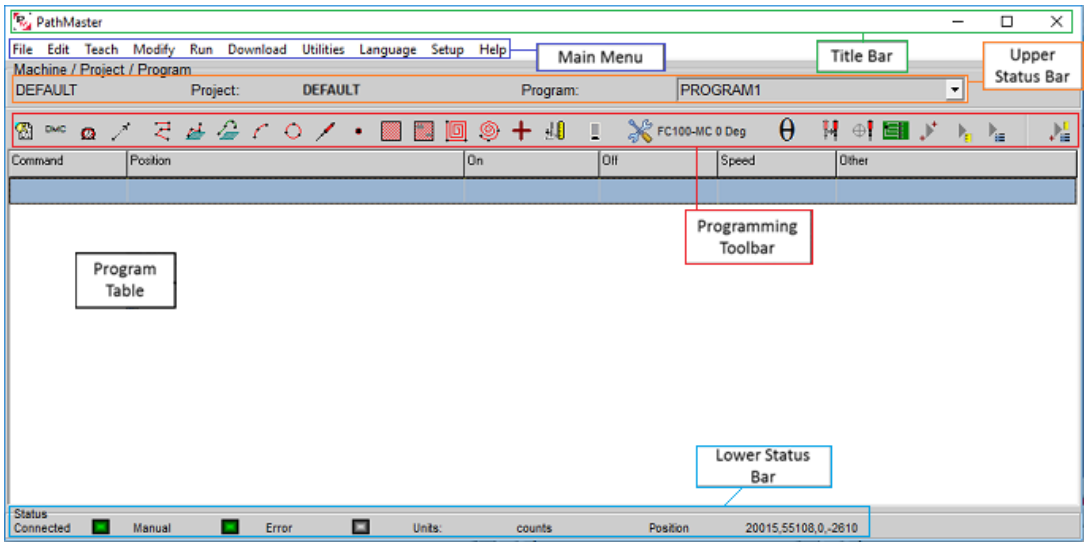


Figure 5: PathMaster® Window

If PathMaster® is opened while Portal is in use, the PathMaster® window will open as an attached split screen below the Portal window, which will hide the Title Bar.

3.1 Upper Status Bar

The upper status bar displays the active machine configuration, current project file and current path program, which can be changed with the Program drop-down menu.

Figure 6: Upper Status Bar

3.2 Lower Status Bar

The lower status bar shows the current status of the workcell. The communication status between the PC and the workcell is shown in the “Connected” display. The “Manual” display shows if the workcell is in Manual mode. The “Error” display shows if the workcell is in a state of error. The Units field gives the measurement system used when programming paths, and can be changed in the Setup section of PathMaster®.

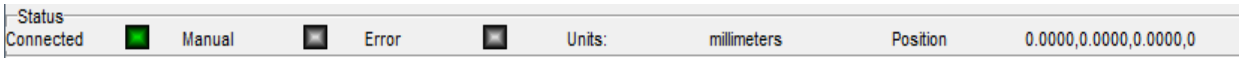


Figure 7: Lower Status Bar

NOTE: In order to teach path programs online, PathMaster® must be connected to a workcell that is in Manual mode, and not in a state of error.

3.3 Programming Functions

The programming toolbar shows the most frequently used programming functions. Functions that are green or outlined in green have the ability to reference surfaces. Functions that are red do not. With the exception of Polyline, Functions can only reference one surface. The toolbar you see depends on the workcell controller. The toolbar shown is for a DMC4000 or newer controller.

Figure 8: Programming Toolbar

Programming functions are used to create path segments, which make up a path program. PathMaster® contains a variety of useful programming functions which can be used to create 2 dimensional and 3 dimensional paths. The most common functions are on the toolbar, other functions can be accessed from the Teach menu.

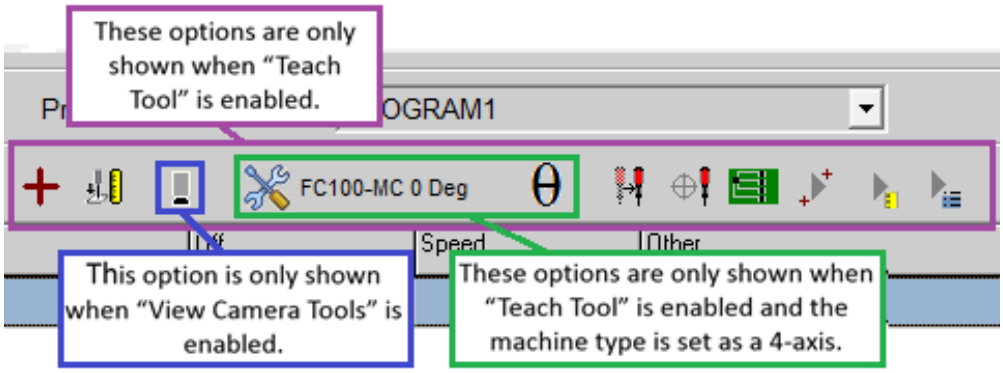


Figure 9: Explanation of Functions

Comment – Add comments into the program.

DMC – Teach a DMC command line in the program.

Plugin Select – Select a plugin from a preset list of options.

Dwell – Teach a delay in the program for a set period of time.

Move – Teach a move to a specific location.

2D Path – Teach a 2D path segment and program tool operation.

3D Path – Teach a 3D path segment and program tool operation.

Polyline – Teach 2D or 3D path segments and program tool operations that can make use of Height Profiling, if applicable.

Arc – Teach an arc path segment and program tool operation.

 **Circle** – Teach a circular path segment and program tool operation.

 **Tool** – Add a tool function (up/down, rotary, etc.).

 **Dot** – Dispense at a defined point for a length of time and program tool operation.

 **Dot Array –** Define a series of dots based on two adjacent points along with X and Y pitch.

 **Area** – Teach a path segment that covers a rectangular area.

 **FastMask** – Teach a FastMask™ path segment (specify keep out areas).

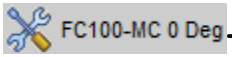
 **Rectangular Spiral** – Teach a rectangular spiral segment to cover an area.

 **Circular Spiral** – Teach a circular spiral segment to cover an area.

 **Fiducial** – Teach a fiducial A or B command in the path program. The Teach Tool (Camera) box must be selected in *Setup->Machine Parameters* to see this function.

 **Surface Height –** Teach a surface height command in the path program. The surface height reading is used to calculate the Profile Z Height for Run tools used during Polylines.

 **Camera Height** – Moves the Z axis to the set camera height from the Machine Parameters. In the Utilities menu, select "View Camera Tools" to see this function.



Tool State Selector –Open the Tool State Selector menu to select an option. This will move the selected tool to the correct programmed position. This is only shown if the Teach Tool box is selected under the Tools section in the Machine Parameters Window and PathMaster® is setup for a 4-axis machine.

 **FastPath** – Open the FastPath™ window for offline programming. The Teach Tool (Camera) box must be selected in *Setup->Machine Parameters* to see this function.

 **Theta**- Move the selected tool to the calibrated W-axis position (theta). The Theta button in all command forms and in the Main Grid now shows an indicator color

- Yellow means the Theta axis is not at the proper coordinate for the selected Teach Tool
- Green means the Theta axis is at the proper coordinate +- the value in the ThetaDeadband string of Pathmaster.ini

 **Tool Change-** Correct the position of a tool and apply offsets.

 **Tool Calibration –**Used to change tool offsets and set the profile calibration.

3.3.1 Legacy / DMC2000 Tool Operations

The controller can be selected in setup mode. When the controller is set as Legacy or a 2000 series controller, polyline and surface height commands are not available.

Figure 10: Legacy Mode, DMC2000 Toolbar

Polyline3D – Teach a path segment with 3D lines and arc commands.

PolyLine – Teach a path segment with of 2D, circle, and arc path segments.

3.3.2 Run Fiducials / Surfaces / Selection / Sequence

Figure 11: Run Commands

Run Fiducials – Plays back any fiducials at the top of the path program and enters "corrected" teaching space. See Section 9.4 for more details.

Run Surfaces – Plays back any taught surface height commands and enumerates the surfaces to be used in and polylines taught after these surfaces.

NOTE: Subroutines cannot access Surfaces outside of the subroutine, and any Surfaces in a subroutine are localized to that subroutine and are inaccessible outside of it.

Run Selection – Plays back the selected line(s) of path program.

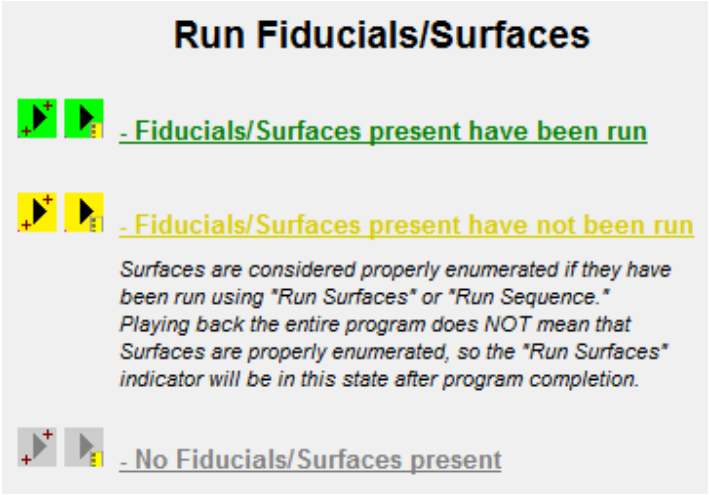


Figure 12: Run Fiducials / Surfaces Status Colors

Run Sequence – Plays the entire path program.

The highlighted color for Run Fiducials and Run Surfaces will change based on certain conditions. The buttons for Fiducials and Surfaces will be yellow if the related command is in the current path program but the command has not been run. This refers to teaching in "Corrected Space" for Fiducials, and Surface Order Enumeration for Surfaces. The playback button for Fiducials will be green when Fiducials have been run for the selected Path Program. The playback button for Surfaces will be green when Surfaces have been run and correctly enumerated.

NOTE: If a Fiducial is present in the path program and has not been run, the user cannot run, teach, or edit surface commands.

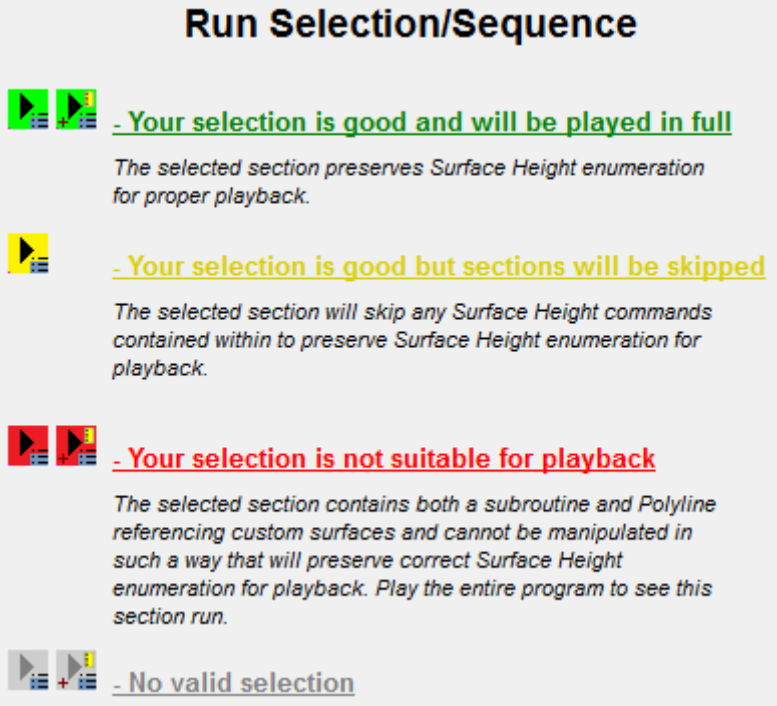


Figure 13:Run Selection / Sequence Status Colors

Once any multiple-line selection is made by the user, the Run Selection / Sequence buttons will change color based on several factors. If the selection is cannot be played, the button will be red. This shows that the enumeration for surface heights will not be correct at the time of playback. If the selection can be played but will skip some surface height commands in order to preserve the Surface Height enumeration, the selection will be highlighted yellow. If a valid selection is made that can be played in full, the play button will be highlighted green.

4.PathMaster® Database

PathMaster® uses a flexible database structure to store all parameter and program information and must be backed up correctly. The database can be backed up and restored. The full database must be manually backed up before and after any changes are made to projects or programs. PVA is not responsible for any lost data or production time because of incorrect database backup procedures.

4.1 Automatic Backup

PathMaster® will do an automatic backup of the full database the first time it is opened each day. PathMaster® uses a rolling ten-day automatic backup scheme. A backup file will be stored for the last ten days that PathMaster® was used.

All automatic backups are stored in the Db\Daily sub folder of the PathMaster® application folder. The default location of these files is "C:\Program Files\PVA\Pathmaster\DB\Daily".

4.2 Manual Backup

A manual database backup should be part of the programming procedure.

1. To do a manual database backup, select the *File* -> *Database* -> *Backup Option* from the main menu.
2. Save the project if prompted to do so.
3. Select the "**Backup**" button when the Backup Files window opens.

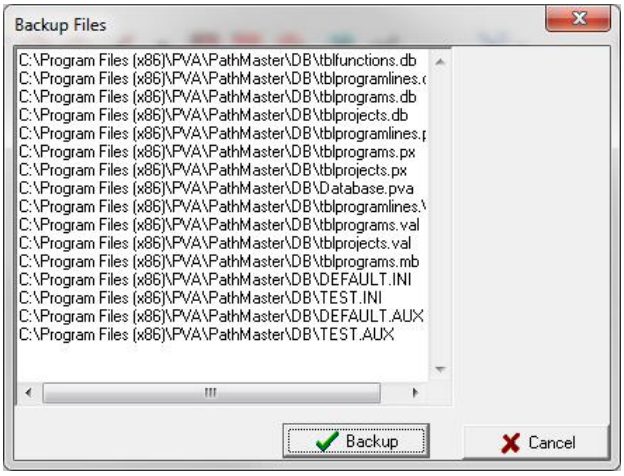


Figure 14: Backup Files

4. The Save As dialog box opens. Select a location and a filename for the backup file (the backup will only be 1 file). The backup file extension will be '.bck'.
5. Select the "**Save**" button. The PathMaster® database backup is complete.

4.2.1 Modify Database Location, Save the Database on a Network

1. Open the BDE Administrator, usually in C:\Program Files(X86)\Common Files\Borland Shared\BDE\bdeAdmin.exe.
2. Select pvadb from Databases.

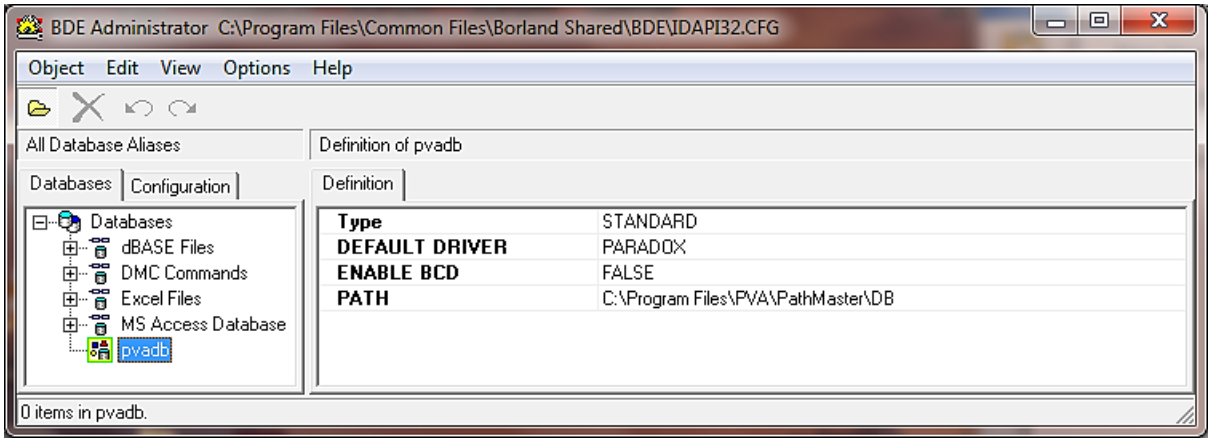


Figure 15: BDE Administrator

3. Change the Path so that the Database is saved as necessary.

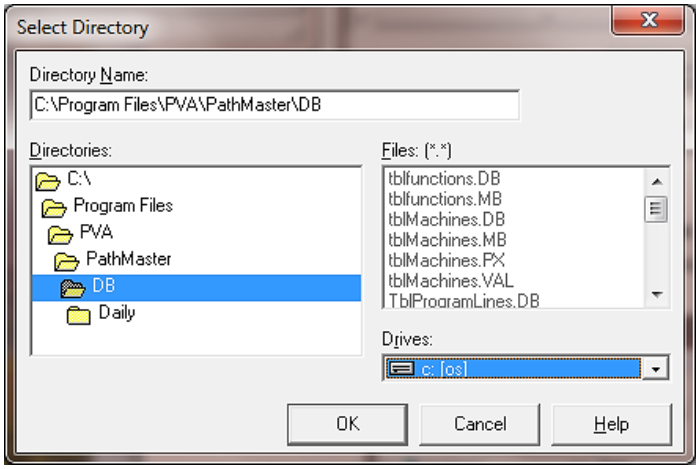


Figure 16: BDE Administrator Select Directory

4. Select "**OK**" when finished or select "**Cancel**" to exit and not save changes or "**Help**" for additional information.

4.3 Database Restoration

To restore the PathMaster® database:

1. Select the *File -> Database -> Restore* option from the main menu.
2. You can restore a *.bck (standard backup) or *.abck (automatic backup) file with this option.

WARNING! A restore PathMaster® database will completely overwrite all data prior to the restore. Do not restore partial data with a database restore procedure.

3. When the file dialog box opens, select the location and file you wish to restore.
4. Select the "**Open**" button.
5. When the "Restore Successful" message displays, select the "**OK**" button.
6. Restart PathMaster®.

4.3.1 Restoring a database from a PathMaster® 2.3, 3.0 and 4.0

1. Follow the steps outlined above. Upon restart, you will be prompted indicating that the database has been upgraded.
2. Use the above instructions to restore the database.

4.3.2 Restoring a database from prior to PathMaster® 2.3

It is not possible to restore a database to PathMaster® 4.1 from versions prior to PathMaster® 2.3. Any database from a version of PathMaster® before 2.3 does not meet the minimum requirements for the restore. Contact PVA if a restore is necessary.

4.4 Path Programs

A path program is a collection of individual path segments that make up a dispense program. Path programs are made up of any combination of programming functions. Each path program can have a unique name of 12 characters or less. The path program name is shown on the operator interface while the path runs.

4.5 Project Files

PathMaster® project files can contain up to 30 individual path programs. A downloaded project file has all 30 storage areas, even if some are empty. Empty areas will do nothing if selected to run.

4.6 Save for Part Manager

When you select **Save** or **Save As**, the current project is saved and exported to a folder hierarchy on the hard drive. The default location for the folder is in the 'PathMaster.ini' file. PathMaster® can be configured to prompt the user for the folder location.

Example Save (for part manager) folder hierarchy: Project name: MyProject

- Select **File -> Save** or **File-> Save As**

A folder called MyProject (Project name) is created in the default project file output location (C:\Program Files\PVA\PathMaster\Projects). In the MyProjects Folder, 30 individual files are created, one for each program in the project. The files names of the 30 program match the program name. If the program name contains characters that are not allowed in file names, the character is replaced with the character '@'.

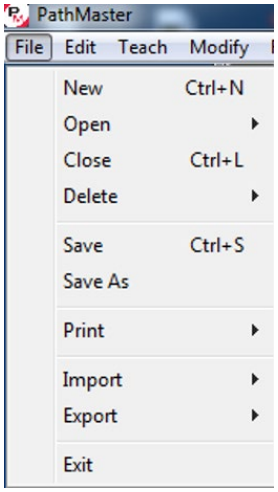


Figure 17: Save for Part Manager

4.6.1 INI Settings for 'Save For Part Manager'

- Default folder location for Save For Part Manager: ProjectFileOutput=C:\Program Files\PVA\PathMaster\Projects
- Set if the default location is used or if the user is prompted to select a location: UseDefaultProjectFileOutput=1

CAUTION: The Path specified in the '[General]' section of the 'PathMaster.ini' file with the 'ProjectFileOutput' key is for PathMaster® use only. This folder is an extension of the PathMaster® database, for use with PVAPortal's dependency, PartManager. Any external data written to this folder or its children will be overwritten by PathMaster®!

4.7 Machine Program Transport

PathMaster 4.4 can import data from previous versions of PathMaster, but previous versions of PathMaster cannot import data from PathMaster 4.4 or newer. This includes all types of data imports (Machine, Program, Project, Subroutine).

WARNING: Tool Offsets and Workspace Reference positions must be correctly configured on both the source and destination machine before a Machine Program Transport is done. Refer to sections 6.4.7 and 6.6.5 for more information.

A machine program transport requires a transfer file (.tfr) from the source machine to be imported onto the destination machine.

The Transfer file contains program data, Workspace Reference Position and the Z component of Tool Offsets. The Import Machine Transfer function compares the source machine Workspace Reference position (X,Y only) to the destination machine Workspace Reference position (X,Y) and finds an appropriate global offset for the destination machine programs. The Z component of tool offsets are also compared to find an appropriate Z offset for each tool on the destination machine.

NOTE: When the configuration of systems is planned for Machine Program Transport, the systems should be matched mechanically as much as possible. The Tool ID's should also be the same from one system to another. For example, if a dispense valve on the source machine is the first virtual tool (TL_ID 1) and a spray valve is the second virtual tool (TL_ID 2), the destination machine must have the same tool relationship (1st tool = TL_ID 1, 2nd tool = TL_ID 2), etc.

4.7.1 Exporting a Transfer File

1. To export a Transfer File, select **File -> Export -> Machine -> Transfer** from the main menu.

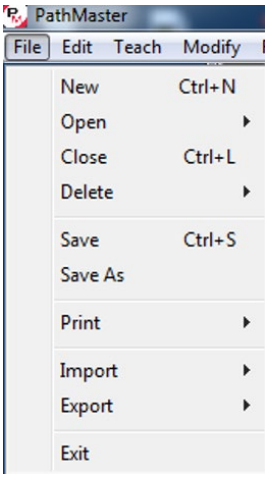


Figure 18: Export Machine Transfer

2. A prompt will ask for a file name and destination. Name the file. The Transfer File will have a '.tfr' extension. The transfer file can be imported onto a destination machine.

4.7.2 Importing a Transfer File

1. To import a Transfer File, select **File -> Import -> Machine -> Transfer** from the main menu.

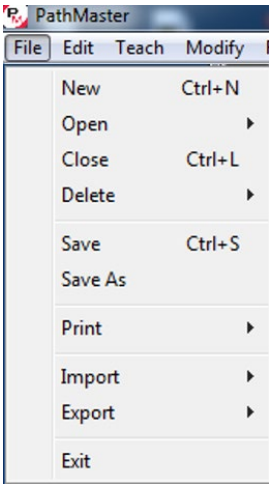


Figure 19: Import Machine Transfer

2. A prompt will ask for a transfer file name. Select the necessary file. The transfer file will have a '.tfr' extension.

4.7.3 Machine Transport Errors

When a machine transfer file is exported, PathMaster® makes sure that all tools that are referenced have an associated virtual tool configured. When a machine transfer file is imported, PathMaster® makes sure that all tools referenced by a path in the transfer file are configured on the destination machine, and that the destination machine has the same name as the source machine. If there is a machine name or tool configuration mismatch, PathMaster® will show an error and the import or export will be canceled, and a transfer error detail file ('TransferErrorDetails.txt') will be written to the \PathMaster\Logs folder.

The transfer error detail file will outline the machine, project, program #, line # and tool that had the issue. Having more tools configured than are used is allowed, but if a tool is referenced in the source machine, it must exist on the destination machine.

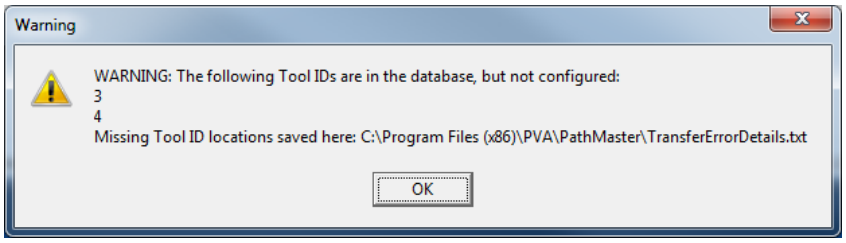


Figure 20: Example Export Error

Figure 21: Example Import Error

Example TransferErrorDetail.txt

```
Project,Program,Line#,ToolID
DEFAULT,PROGRAM1,7,3
FASTPATH_SAMPLE,PROGRAM1,25,3
FASTPATH_SAMPLE,PROGRAM1,28,3
FASTPATH_SAMPLE,PROGRAM1,31,3
FASTPATH_SAMPLE,PROGRAM1,34,3
FASTPATH_SAMPLE,PROGRAM1,37,3
FASTPATH_SAMPLE,PROGRAM1,40,3
```

5.Operation

5.1 Start PathMaster

It is necessary to configure PathMaster® to run correctly with the workcell when it is initially setup.

1. Double-click on the PathMaster® icon to start PathMaster®, or to start PathMaster® from Portal, select Manual mode. Select the PathMaster® tab and then select the PathMaster® button.

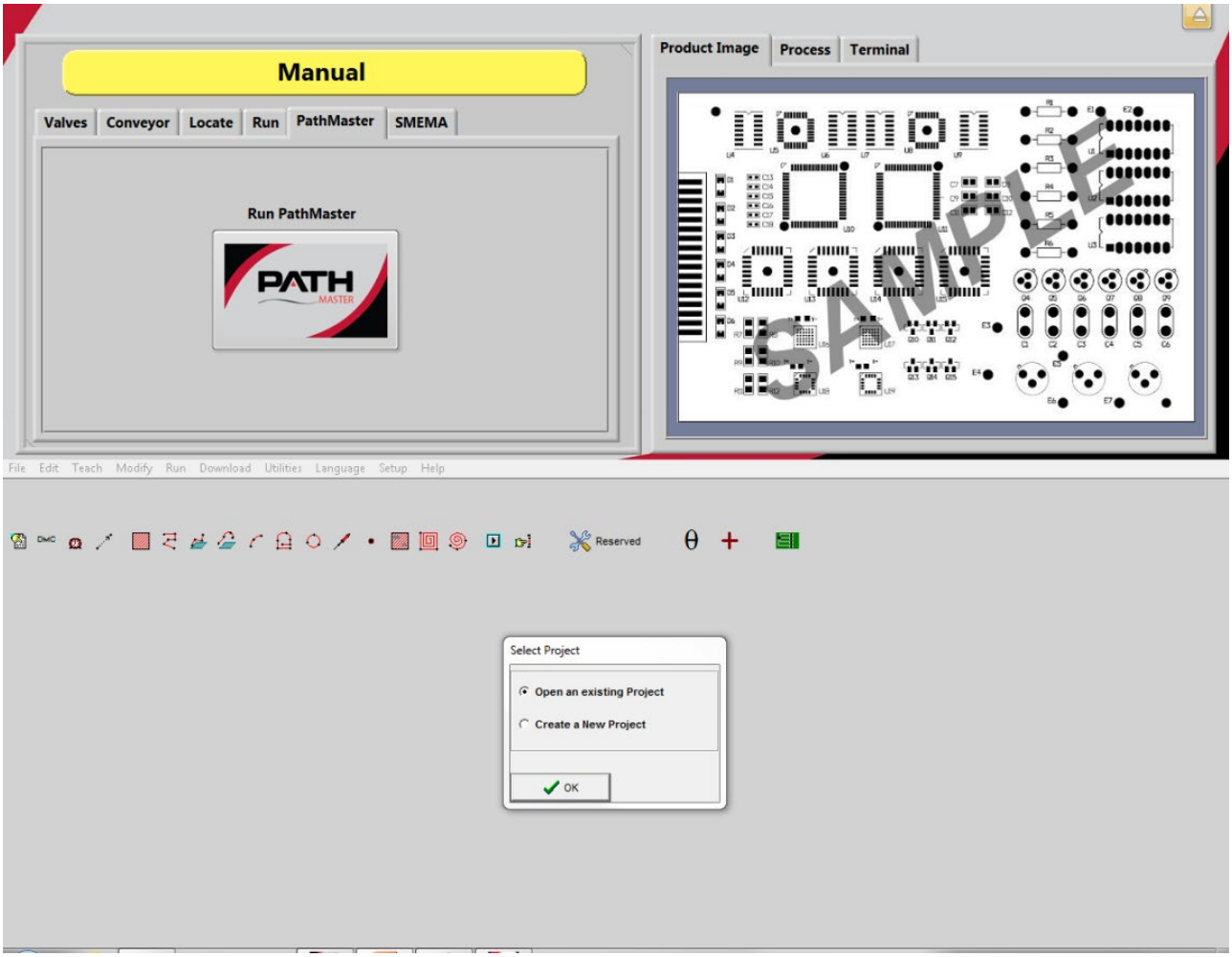


Figure 22: PathMaster® Opened through Portal

2. The **Select Project** dialog box will be shown.
3. Select **Create a New Project**.

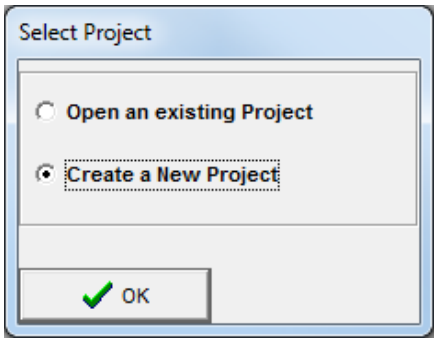


Figure 23: Select Project Window

4. Select "**OK**".

5.2 Project Selection

You must select the correct project before you start to program. You can open an existing project or create a new project. The Select Project window is shown at startup, when PathMaster® changes the current machine setting, or if you open a different project.

1. Select the correct choice from the Select Project window.
2. Select the "**OK**" button.
3. Highlight the correct project.
4. Select the "**OK**" button to open the project.

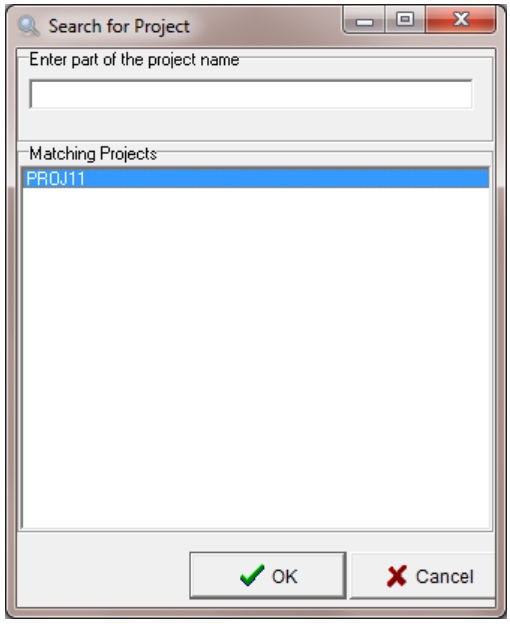


Figure 24: Select a Project

5. Select the "**Cancel**" button to exit and make no changes.

6.Machine Parameters

You must setup the Machine Parameters the first time you use PathMaster®. The Machine Parameter window is used to set software and hardware properties. The settings in the Machine Parameter window apply only to the current machine profile. The current machine profile is shown in the Upper Status Bar of the main PathMaster® window.

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.

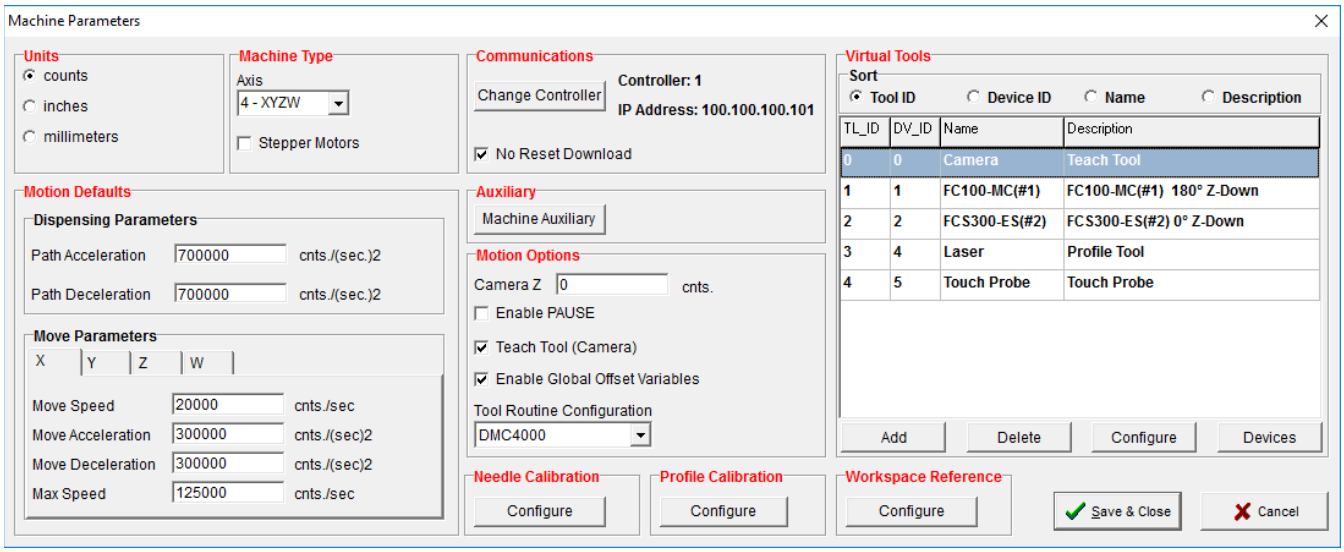


Figure 25: Setup Machine Parameters

NOTE: If you attempt to make changes that require a MAIN program change, a window will be shown to confirm the changes.

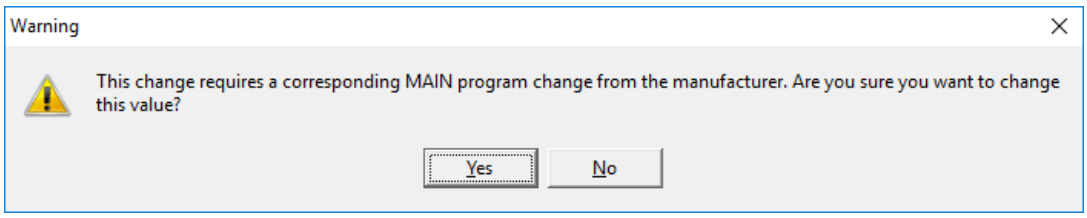


Figure 26: MAIN Program Change Conformation

2. To exit the Machine Parameters window, select "**Save & Close**" to save changes and exit or "**Cancel**" to exit and not save changes. The changes are not applied until you select "**Save & Close**".

6.1 Dispensing Parameters

The dispensing parameters are the default parameters for all coordinated path motion. These parameters can be modified in each programming function for each path segment. These settings are found in the Machine Parameters window.

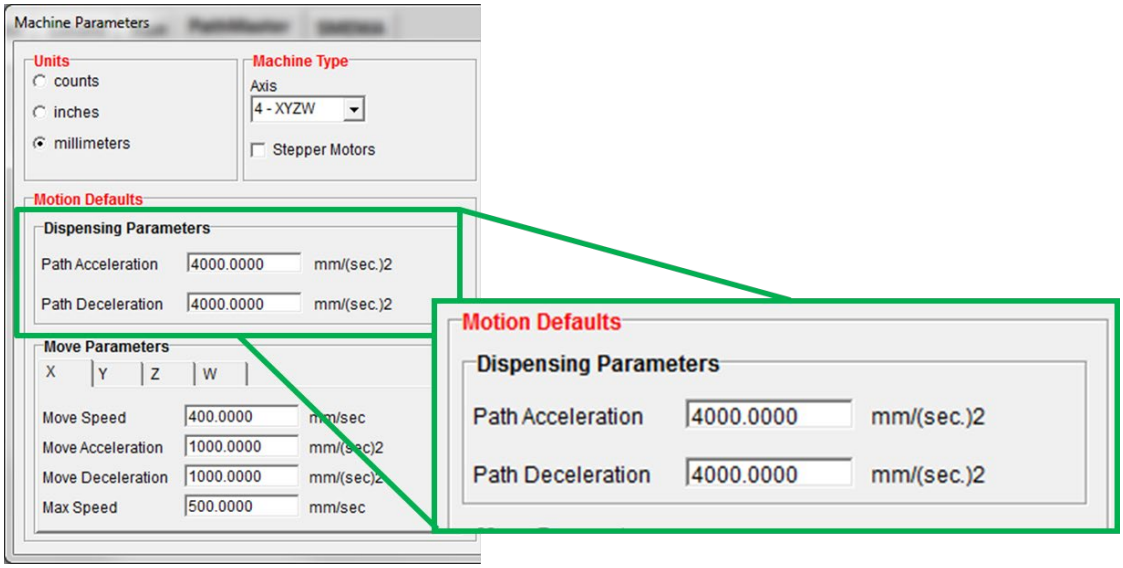


Figure 27: Dispensing Parameters

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. Set the **Path Acceleration** and the **Path Deceleration** speed. This will be the default acceleration and deceleration for all coordinated motion.

6.2 Move Parameters

The move parameters are the default parameters for all independent path motion for each axis of motion that does not include any dispensing. Select the necessary axis from the tabs available to view and change the move parameters. These settings are in the Machine Parameters window.

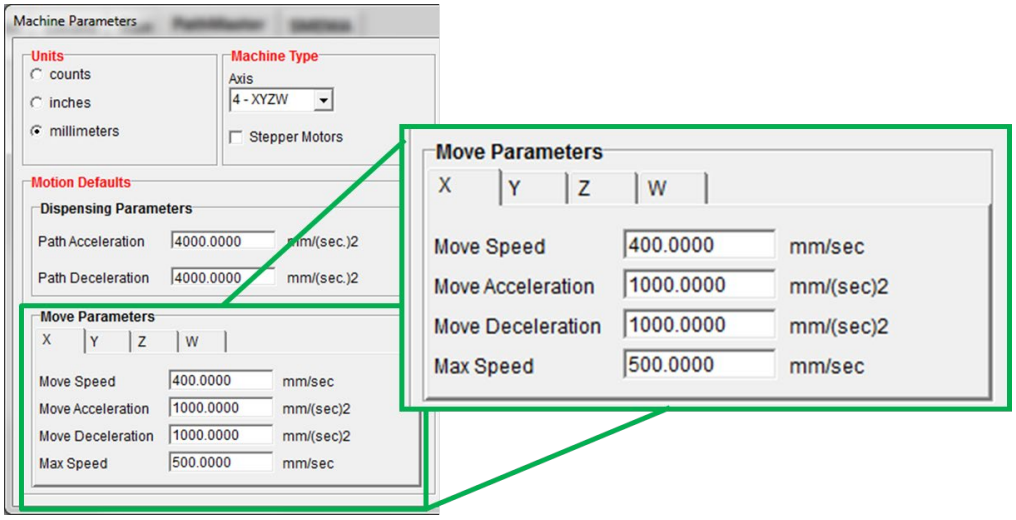


Figure 28: Move Parameters

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. Select the necessary Axis Tab (X, Y, Z, W).
3. Set the **Move Speed**. This is the default speed for all independent path motion.
4. Set the **Move Acceleration** and **Move Deceleration** in speed. This is the default acceleration and deceleration for all independent path motion.
5. Set the **Max Speed**. This is the greatest speed for an independent path motion.

6.3 Units and Machine Type

These settings are found in the Machine Parameters window.

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. Select the necessary measurement system from those shown (counts, inches, or millimeters).

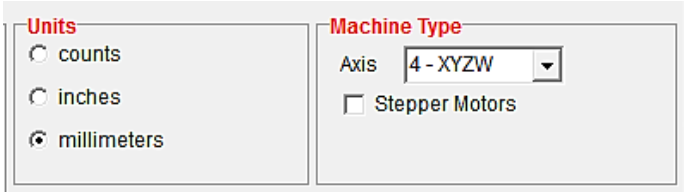


Figure 29: Units and Machine Type

3. Select the necessary **Axis** from the drop-down menu to configure PathMaster® for a two, three, or four axis gantry.

WARNING: If you change axis after a path has been created it may have unintended consequences. Tool offsets must be updated as necessary. If you remove an axis, the offset of that Axis will be permanently deleted.

4. Select the Stepper Motors box if your workcell has stepper motors instead of servo motors. Refer to Figure 29.

6.4 Motion Options

PathMaster® can have up to 14 devices configured. All Devices are physical tools in the system. Devices are used to relate a Virtual Tool to a physical tool. These settings are found in the Machine Parameters window.

- Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.

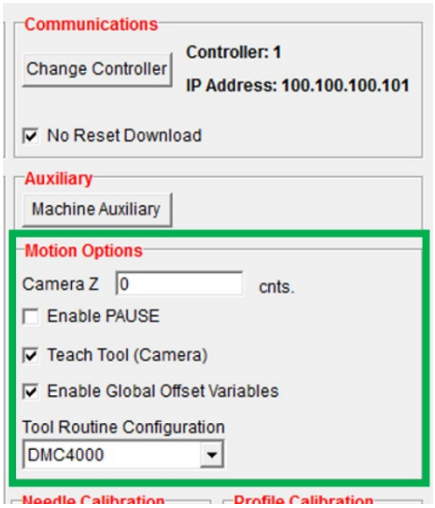


Figure 30: Changes in Options When the Teach Tool Box is Selected

- Some options shown in this manual are only available when the Teach Tool box is selected.

NOTE: You must a use a local copy of the software for the teach tool to work correctly.

6.4.1 Teach Tool

When the Teach Tool function in PathMaster® is enabled, the first virtual tool (Tool ID 0) will be the teach tool by default and will be related to the first Device (Device ID 0). If a workcell does not have a teach tool, the first tool spot will be reserved. If a teach tool is added on the workcell later, the reserved first tool will become the teach tool.

Also, when the Teach Tool is enabled, PathMaster® shows the options for the teach tool. The box should be checked if there is a teach tool installed.

- When the **Teach Tool** box is selected, Pathmaster® shows the options for the teach tool. The box should be checked if there is a teach tool installed.

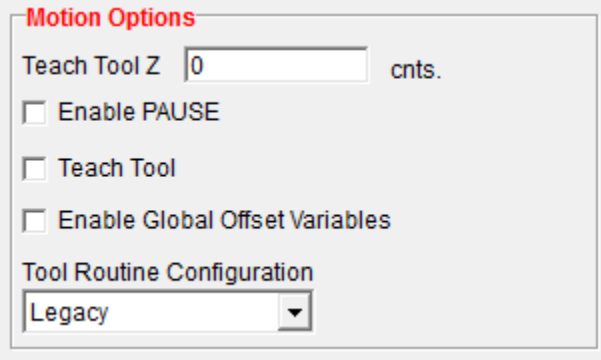


Figure 31: Changes in Options When the Teach Tool Box is Selected

Some options shown in this manual are only available when the Teach Tool box is selected.

6.4.2 Camera Z Position

The value in the **Camera Z Position** box is the Z height used when the "Move to Camera Height" function in the toolbar is selected. The machine must be in manual mode and this height should be where the camera is in focus with the product to be observed.

6.4.3 Enable Global Offset Variables

If you select this feature, offset variables can be used in a workcell so that the same program can be used in more than one workcell. The main program of the machine must be programmed for this feature. If the main program has not been changed, the workcell will show a Command Error (refer to the Troubleshooting manual).

6.4.4 Enable Pause

If you select this feature a program can be stopped and then restarted mid-cycle in automatic production. The main program of the machine must be programmed for this feature. If the main program has not been changed, the workcell will show a Command Error (refer to the Troubleshooting manual).

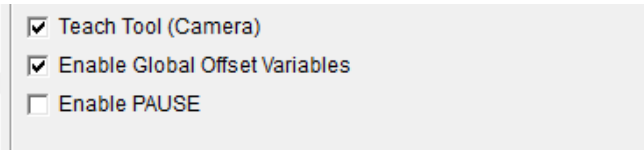


Figure 32: Machine Parameters, Tools Section Options

6.4.5 Tool Routine Configuration

The Tool Routine Configuration drop down menu will come set from the factory or will be selected as "Legacy" if PathMaster has been updated. If you change this setting, Main program changes will be necessary or you will have program errors.

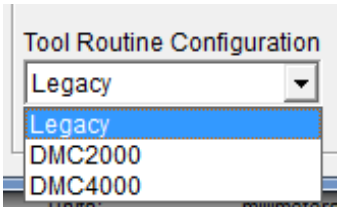


Figure 33: Tool Routine Configuration

6.4.6 Needle Calibration

The Needle Calibration Reference Position defines where the needle calibration unit is physically located in the system. The needle calibration setup is a two-part setup. First, the needle calibration reference position is set, then, the needle calibration sensor locate sequence runs.

WARNING: The tool offsets must be configured before the needle calibration is set up. If Tool Offsets are not configured correctly when the Sensor Locate Sequence is run, the system could be damaged.

1. Select the "**Configure"** button to set the Needle Calibration Reference position and run the sequence.

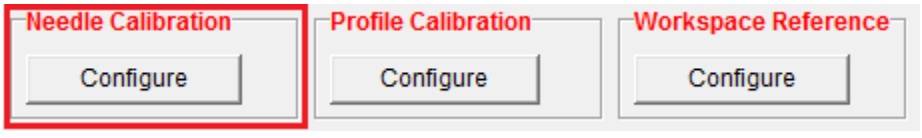


Figure 34: Needle Calibration

2. To set the Needle Calibration Reference Position, line the teach tool up with the cross hair on the needle calibration unit and select the "**Teach"** button.

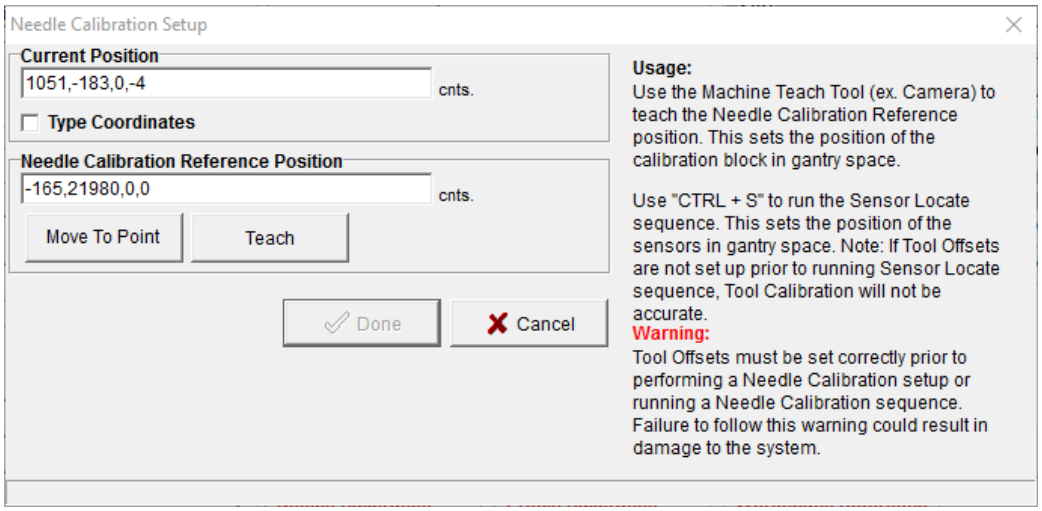


Figure 35: Needle Calibration Setup Window

3. Click the **"Move To Point"** button to move to the last programmed needle calibration reference position.
4. Next, push "**CTRL + S**" on the keyboard to run the needle calibration Sensor Locate sequence. It is not necessary to run this every time a needle calibration reference is set, but it must be done initially and if the sensor is damaged or replaced. This sequence establishes the X, Y, Z relationship of each sensor as it relates to the crosshair on the needle calibration unit. The tool offsets and needle calibration reference position are combined with relative sensor locations to find each tool in the needle calibration unit.
5. Push **"Ctrl + S"** on the keyboard to run needle calibration Sensor Locate sequence.
6. The first time the sensor locate sequence runs, the user will be shown a list of tools. Select the tool that will be used for the sensor locate sequence. The selection is saved and the prompt will not be shown again.

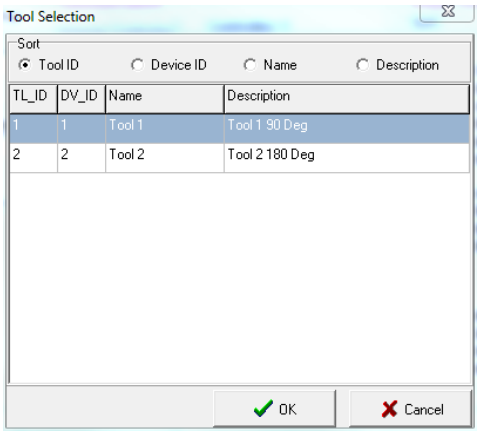


Figure 36: Tool Selection

NOTE: For a tool to show up in the tool selection list, the "Needle Calibration" checkbox needs to be checked in the Tool Configuration window, which is hidden if the tool type is either Teach Tool or Profile Tool.

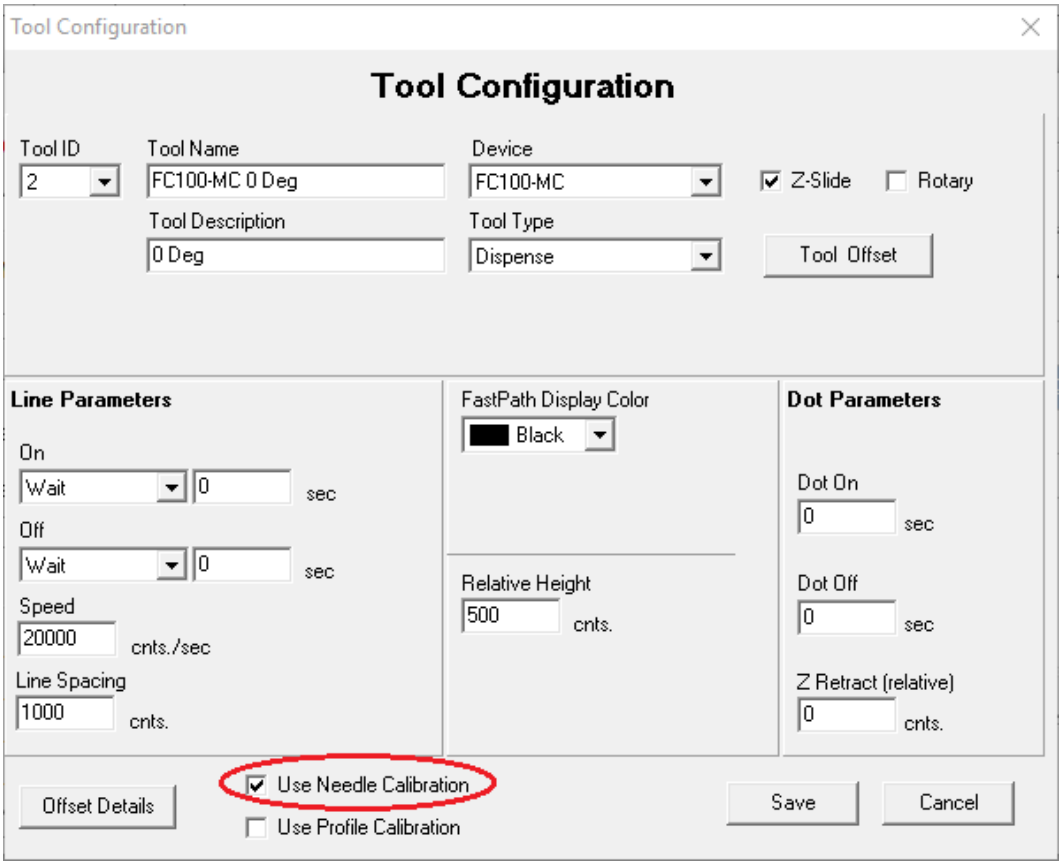


Figure 37: Use Needle Calibration Checkbox

NOTE: It is not necessary to run the Sensor Locate Sequence again unless the position of a sensor relative to the needle calibration cross hair changes, such as if the needle calibration circuit board is replaced or is damaged.

7. When the needle calibration reference position has been taught, select the "**Done**" button, or select **"Cancel"** to exit and not save changes.

6.4.7 Profile Calibration

Height profiling (new in PathMaster 4.3) uses two height-reading devices, with the polyline programming tool, to adjust the Z-height of dispenses on parts based on surface readings done at the start of the path program. One height reading device is mounted inside the machine at a fixed location, facing up, called the Profile Base, the second is mounted on the gantry and is either at a fixed Z-height or moves along the Z-axis, and is called the Profile Tool.

WARNING: The tool offsets must be configured before Profile Calibration is set up. If Tool Offsets are not configured correctly, the system could be damaged when the Profile Plunger Locate Sequence is run.

- To setup height profiling, it is necessary that all tool offsets are correctly set up, that Needle Calibration Setup is complete (if applicable), and that a tool is set up with the tool type of "Profile Tool" in Machine Parameters.
- When Setting up a Profile Tool Type, a second selection box is shown for the Profile Type: Non-Contact or Contact. A selection must be made for correct operation of the Profile Tool.

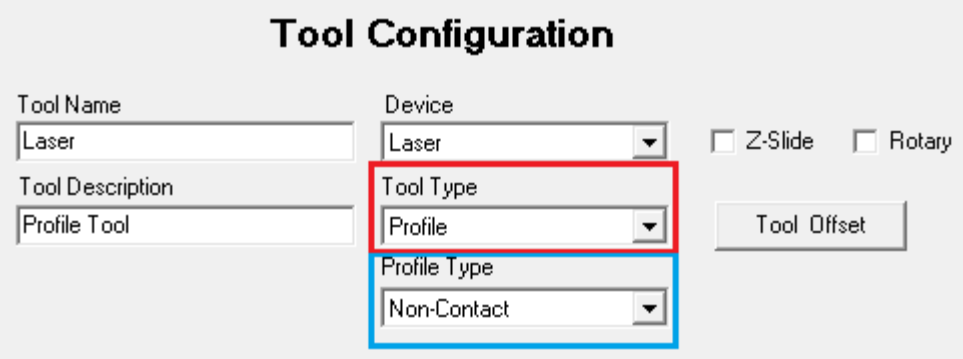


Figure 38: Profile Tool Type and Profile Type Selection

1. After the setup is complete, click "**Configure**" underneath Height Profiling in the Machine Parameters window to open Profile Calibration Setup.

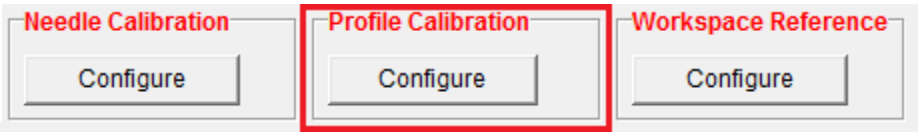


Figure 39: Height Profiling

2. To set the Profile XY Reference Position, line the teach tool up with a point on the **Profile Base** and select the **"Teach"** button. Click the **"Move To Point"** button to move to the last programmed Profile XY Reference position.

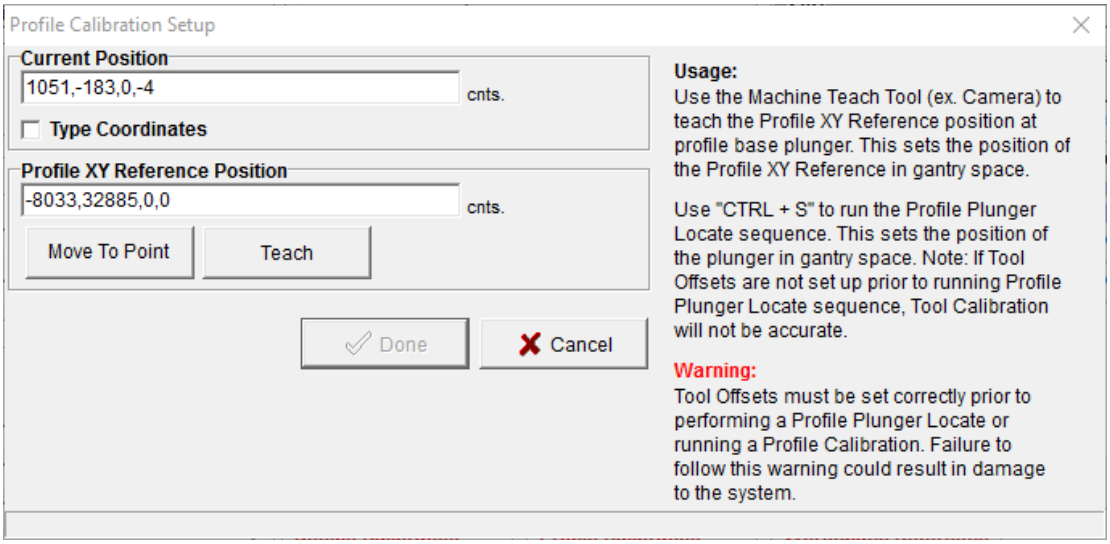


Figure 40: Profile Calibration Setup

3. Next, run the Profile Plunger Locate Sequence by pressing CTRL + S on the keyboard. It is not necessary to run this every time a Profile XY Reference position is set, but it must be done during initial setup, if the Profile Base is damaged or replaced, or if the Profile Tool is damaged or replaced. The Profile Plunger Locate sequence uses the Tooling Offset between the Teach and Profile Tools to read the Profile Base Plunger to determine a common profile surface for all tools, called the **Profile Z Reference**.
4. When the Profile XY reference position has been taught, and the **Profile Z Reference** is established, select the "**Done**" button, or select **"Cancel"** to exit and not save changes.

6.4.8 Workspace Reference

Workspace reference is a global reference position used to help make a machine program transport or a global offset to the local system.

To teach a workspace reference point, on a typical system, put the machine calibration plate against the board stops and put the teach tool at the cross hair on the machine calibration plate. The workspace reference point must reference the part workspace so that if the part fixture changes, due to board stop location, etc., the workspace reference point moves with it.

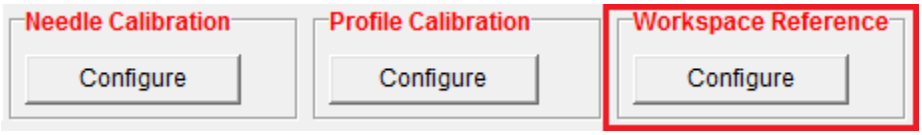


Figure 41: Workspace Reference

1. Select the **Workspace Reference "Configure"** button.

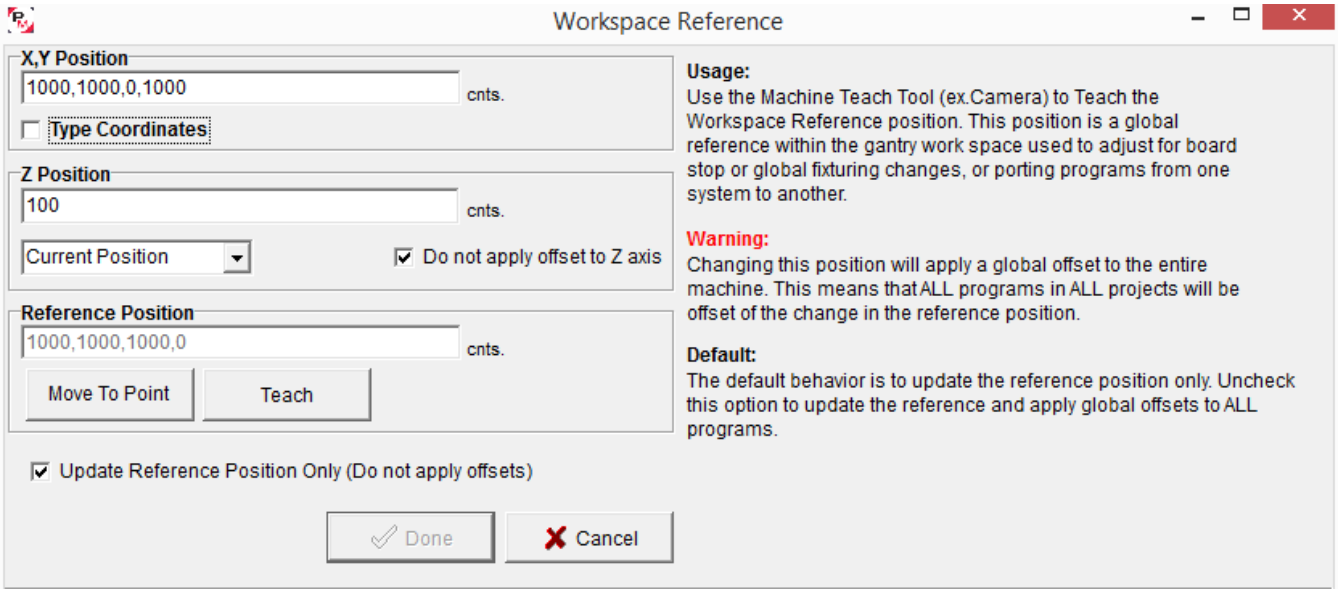


Figure 42: Workspace Reference Window

2. Click the "**Move To Point**" button to move to the workspace reference position.
3. If the Move to Point button is not in the correct location, use the teach tool to move to the necessary workspace reference position. Click the **"Teach"** button to teach the workspace reference position.
4. The **Update Reference Position Only** checkbox is checked by default. This will update the workspace reference position but not apply program offsets (The difference between the original workspace reference and the new workspace reference). Uncheck this box to apply global offsets to all programs.

5. Select the **Z Position** from the drop-down menu. The Z component of the workspace reference can be chosen from the current position, a position that is typed in, or from the tool position of the tool Z offset.

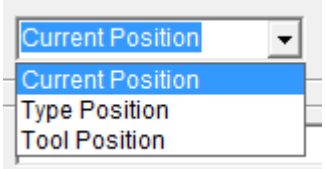


Figure 43: Select the Z Position

6. Select the **Do not apply offset to Z axis** checkbox, if the Z offset should not be included.
7. When the settings have been set, select the "**Done**" button, or select **"Cancel"** to exit and not save changes.

NOTE: The Teach Tool option must be enabled and the machine must be in Manual mode to teach the workspace reference position.

6.5 Devices

PathMaster® can have up to 15 devices configured if the teach tool is enabled. All Devices are physical tools in the system. Devices are used to relate a Virtual Tool to a physical tool. These settings are found in the Machine Parameters window.

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. To configure the devices in the system, click **'Devices'** in the **Virtual Tools** section of **Machine Parameters**.
3. From here you can name all the Devices in the system. Any name that is left blank will be unavailable to use to teach paths and during playback.

With the Teach Tool function in PathMaster, the first device will be the teach tool (device 0) by default. If a workcell does not have a teach tool, the first tool spot will be reserved. If a teach tool is added on the workcell later, the reserved first tool will become the teach tool and prevent many programming changes.

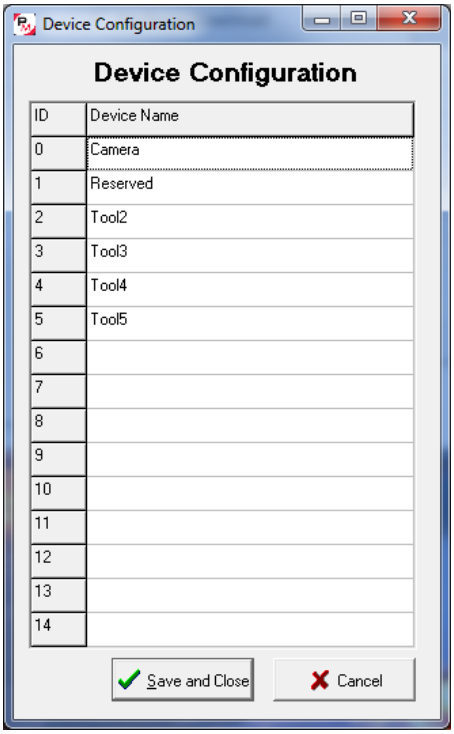


Figure 44: Tool Name and Configuration

NOTE: Devices must be listed in sequential order. For example, if Device 5 is left blank, all following Devices will be unavailable for playback and teaching. If a tool is deleted it will not be available.

6.6 Virtual Tools

PathMaster® can have an unlimited number of virtual tools configured. All virtual tools are related to a physical device in the system. A device can be saved with specific settings as several different virtual tools.

For example, in a 4-axis system, Tool 1 can be device A with a theta rotation of 0°. Tool 2 can be device A with a theta rotation of 90°. The same device is used for Tool 1 and 2 but the valve settings are different.

The different theta positions of the virtual tools changes how the physical device relates to the teach tool. The difference in position relationship is called the tool offset. Refer to Section 6.6.5 for more information.

If the teach tool is enabled, you must create Virtual Tool 0 first for Device 0 before you can create additional virtual tools.

6.6.1 Sort

With the **Sort** radio buttons, you can arrange how you view the Virtual Tools in the system. You can sort the virtual tools by **Tool ID**, **Device ID**, **Name**, or **Description**.

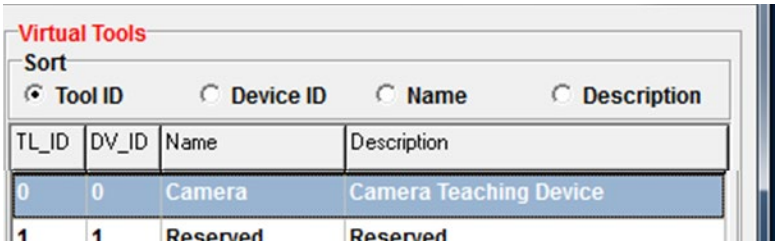


Figure 45: Sort Options

- Select the necessary label to sort the virtual tools.

6.6.2 Add a Tool

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. To add a new virtual tool, click the "**Add**" button in the Virtual Tools section of Machine Parameters.

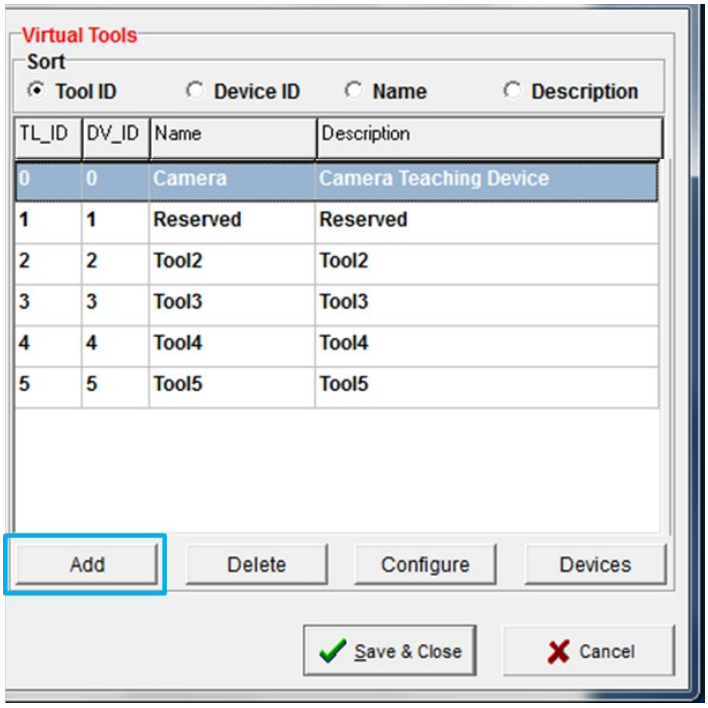


Figure 46: Add a Virtual Tool

3. The Tool Configuration menu will open; refer to Section 6.6.4 for more information about how to correctly configure a virtual tool.

6.6.3 Delete a Tool

Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.

WARNING: If a Virtual Tool was used in a path before it is deleted you will have to update that path with a different virtual tool. If you play a path that uses a deleted virtual tool there may be unintended consequences.

1. To delete a virtual tool, select the tool in the Virtual Tools section of Machine Parameters window.
2. Click the "**Delete**" button.

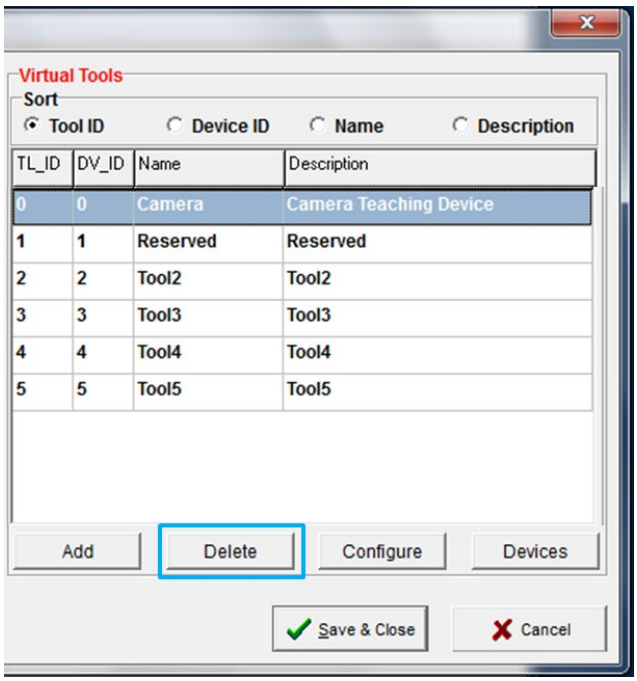


Figure 47: Select Virtual Tool and Delete

3. A warning window will be shown, click "**Yes**".

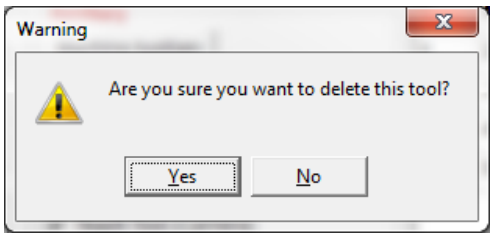


Figure 48: Delete Tool Window

A deleted tool ID will go to a reserved state. You will have the option to use the deleted tool ID when you create a new virtual tool.

6.6.4 Tool Configuration

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. To configure an existing virtual tool, highlight a virtual tool and click the "**Configure**" button in the **Virtual Tools** section of Machine Parameters. Or, double-click an existing tool to open the **Tool Configuration** window.

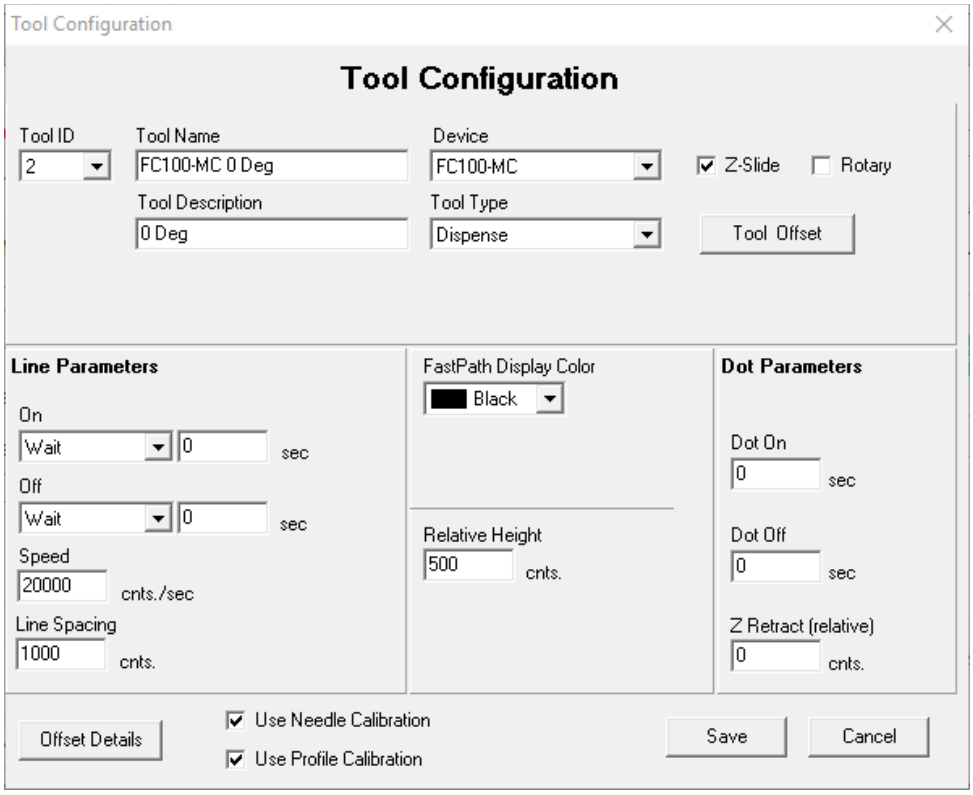


Figure 49: Tool Configuration

3. Set the **Tool ID** from the dropdown number list. This can only be changed when you add a new virtual tool.
4. Set the **Device** the virtual tool uses with the dropdown menu. The device is the physical tool that the virtual tool uses with specific programmed settings.
5. Set the **Type** of virtual tool with the dropdown menu. This is the type of device that will be used during operation.
6. Select the **Z-Slide** box if this tool has a slide installed.
7. Select the **Rotary** box if this tool has a rotary installed.
8. Set the tool **On** to **Wait** or **Distance** and set the time or distance. Wait is the pause after the tool turns on but before the path is started. Distance is the length of the path traveled before the tool turns on.

9. Set the tool **Off** to **Wait** or **Distance** and set the time or distance. Wait is the pause after the path is finished and the tool is off but before the tool goes to the next point. Distance is the length of the path traveled after the tool is off but before the path is done.
10. Set the default **Speed** for the virtual tool.
11. Set the **Line Spacing** for the distance between runs when an area path or rectangular spiral is used.
12. Set the **Display Color** for the color used for offline programming features.
13. Set the default **Relative Height**. This is the distance from the surface of the product to the lowest point of the tool above the product, as taught in the tool offset function (offline programming only).
14. Set the **Dot On Dwell** and the **Dot Off Dwell** time. This will be the default tool on and tool off time for the Dot function for this virtual tool.
15. Set the **Z-Retract (relative)** distance. This will be the default relative Z-retract for the Dot function for this virtual tool.
16. Select "**Save**" to save your changes and exit. Select "**Cancel**" to exit and not save changes.

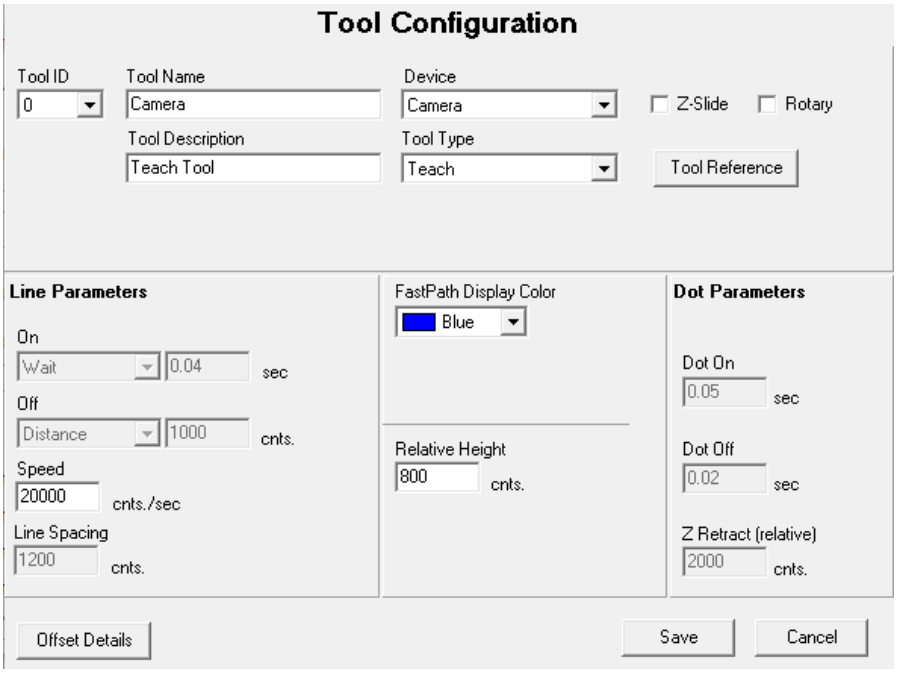


Figure 50: Teach Tool Configuration

NOTE: Some options in Tool Configuration are changed or disabled when a type of "Teach" or "Profile" is selected.

6.6.5 Tool Offsets

NOTE: Tool Offsets are only available if the Teach Tool box is checked.

Tool offsets define the X, Y, theta relationship (offset) between the teach tool (usually a camera) and every other physical tool installed on the workcell. Tool offsets let a teach tool be used to program paths in PathMaster® and use a different physical tool to playback the path. PathMaster® must measure the offset for each tool relative to the teach tool for this to work correctly. In PathMaster®, the tool offsets are defined (setup) with the Tool Offset option in the Tool Configuration window.

When you teach tool offsets, you must put the tool in the correct state before you teach the tool position. For example, on a 3-axis system with a dispense valve mounted on a pneumatic rotary, put the pneumatic rotary in the necessary state (A or B). On a 4-axis system, put the theta axis in the correct position before you teach the tool offset.

WARNING: If the Teach Tool function is enabled, the Tool Offsets must be set before the Workspace Reference, Needle Calibration Reference, or Profile Relative Surface positions are set. Tool Offsets also need to be set before a Tool Change, Needle Calibration, Surface Height, or a path program is taught.

6.6.6 To Teach Tool Offsets

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. Select the virtual tool you want to configure the offset for. Double click on the virtual tool or highlight it and select "**Configure**".

NOTE: Set up the teach tool, tool 0, first. Then set up any additional tools.

3. Select the "**Tool Offset**" button in the **Tool Configuration** window.

NOTE: If you do not have the Teach Tool (Camera) box selected in the Machine Parameters window you will not see the "Tool Offset" button.

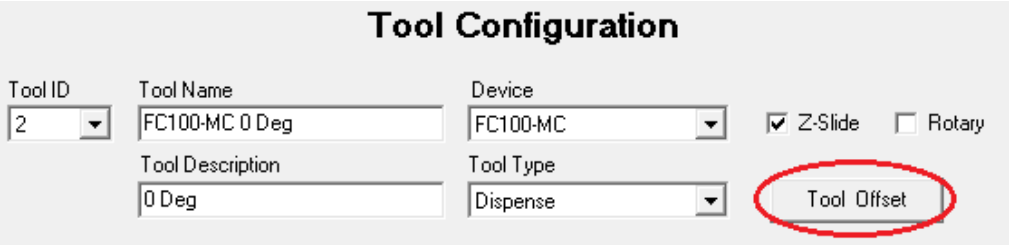


Figure 51: Tool Offset Button

NOTE: Tool 0 (the teach tool) has a "Tool Reference" button, not a "Tool Offset" button, and the Tool Type is set to 'Teach'.

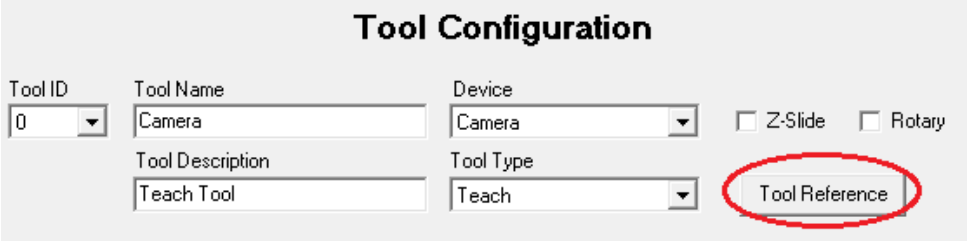


Figure 52: Teach Tool, Tool Reference

4. Move the theta axis (4-axis systems only) to the correct position with the Trackball or click the "**θ**" button to move to the last calibrated theta position.

PathMaster® must measure the offset for each tool relative to the teach tool. It is necessary to teach a tool at a reference or fiducial point.

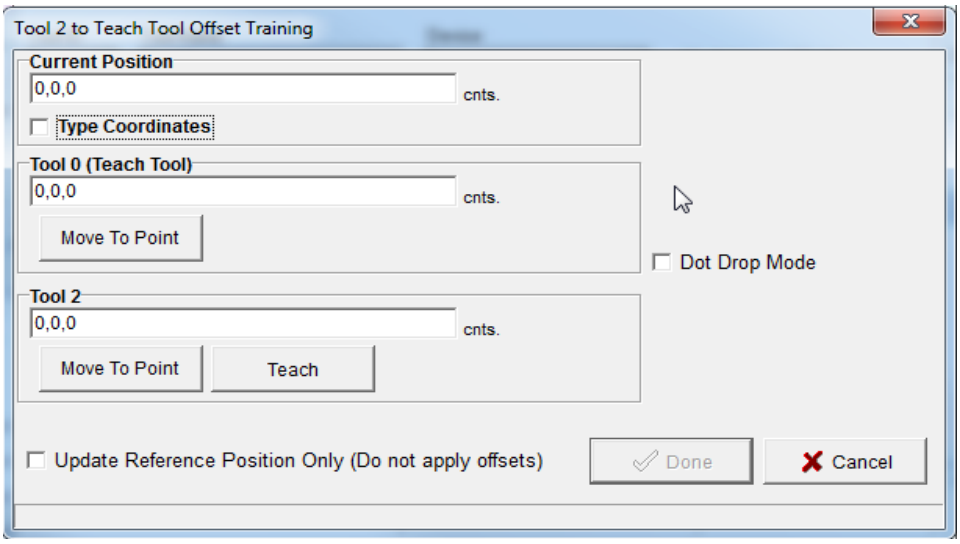


Figure 53: Run Tool Reference Training Window

5. Move the teach tool above the reference point, which both the teach tool and the selected tool can reach. Or, select the "**Move to Point**" button to move to the teach tool reference point, if previously taught.
6. When the teach tool is above the reference point, select the "**Teach**" button. Make sure Z height and W (optional axis) are correct in the taught position.
7. Move the run tool to the reference point and select the "**Teach**" button.
8. Select the **Update Reference Position Only (Do not apply Offsets)** checkbox to update the reference position only, tool offsets will not be applied. The default is unchecked, and tool offsets are applied to all corresponding path segments (all programs, all projects).

NOTE: If the Update Reference Position Only (Do not apply Offsets) box is unchecked, offsets will automatically be applied to any existing paths or programs that use the tool that was changed and will be applied to any new paths or all programs created.

NOTE: When the Teach Tool reference position is updated, Tool Offsets are updated to reflect the change in relationship between the Teach Tool and each Run Tool.

9. When tool offsets have been taught for each tool, select the "**Done**" button, or select **"Cancel"** to exit and not save changes.

The distance between the run tool and the teach tool has now been taught. Repeat steps 2-9 for all other tools.

NOTE: If the run tool is a valve, you can use a dot of material on a surface and teach the run tool over the dot. Refer to Section 6.6.7.

10. Select the "**Save & Close**" button to exit and save the changes.

6.6.7 Dot Drop Mode

Dot Drop Mode is used to align the run tool and teach tool when the run tool cannot be aligned with the reference point or fiducial because it does not have a protruding tip. It can also be used if the operator prefers it.

1. Select the **Dot Drop Mode** checkbox to enable this function. When you select the check box, the **Dispense Position** and **Run Parameters** will be shown in the Offset Training window. If you select and save the values for dot drop mode, the settings will be saved for future use with this tool.

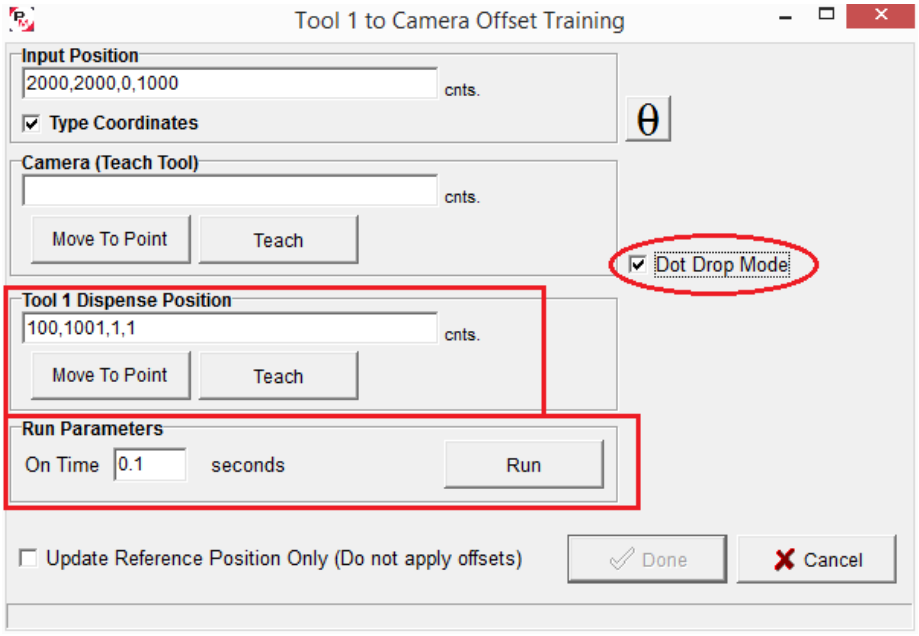


Figure 54: Dot Drop Mode

2. Teach the **Dispense Position** with the teach button, this is the location the dot will be dispensed. The dispense position is stored for this tool.
3. Set the **On Time** in seconds. This is how long the tool will operate to dispense the dot.
4. Select "**Run**" to dispense the dot for the set On Time.
5. Move the teach tool to the dispensed dot and teach the position.
6. When the tool offsets have been taught for each tool, select the "**Done**" button, or select **"Cancel"** to exit and not save changes.

NOTE: If Dot Drop Mode is enabled for a tool, that tool will reference Dot Drop mode when a Tool Change is done.

NOTE: If a Dispense Position is taught, the Run Tool reference position will be calculated automatically and can be used when you exit Dot Drop mode.

6.6.8 Tool Change

A Tool Change adjusts the tool offset and applies a program offset to correct the position of a tool. A tool change should be done after a needle is changed, or if a tool installed after maintenance has been done. A tool change should be done after any change in the physical location of a tool tip.

NOTE: The teach tool option must be enabled to use the tool change function.

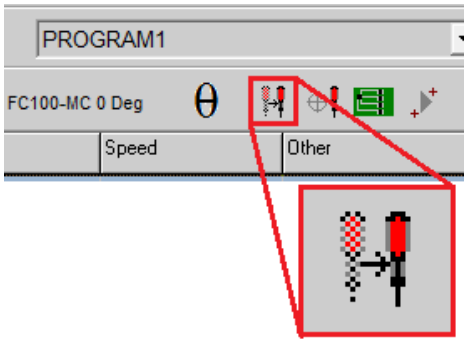


Figure 55: Tool Change Button

1. Select the Tool Change button on the main tool bar.
2. Select a tool from the Tool Selection window.

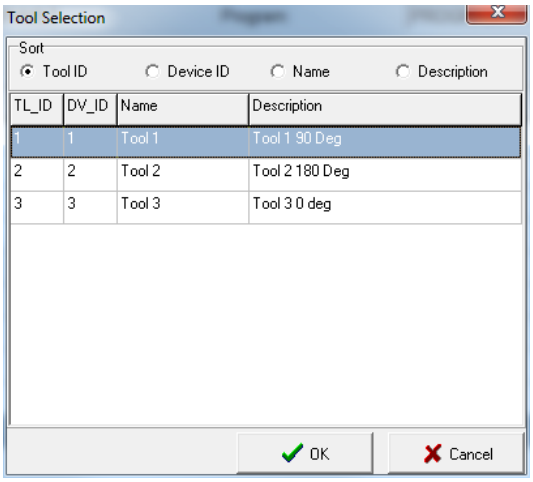


Figure 56: Tool Selection Window

3. Select the "**OK**" button.

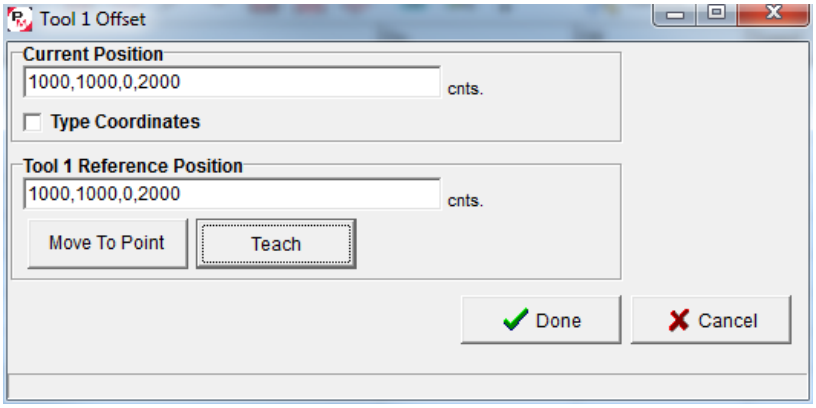


Figure 57: Tool Offset Window

4. Align the selected tool with the reference position (the same position referenced by the Teach Tool). You can use the "**Move To Point**" button to move to the run tool reference position.
5. Select the "**Teach**" button to teach the run tool reference position.
6. Select the "**Done**" button, or select **"Cancel"** to exit and not save changes.
7. If "Use Profile Calibration" is enabled on the current tool, the Tool Calibration for changing the **Profile Offset** will automatically run.

6.6.9 Tool Calibration

A tool calibration must be done after a needle is changed, if a tool is installed, or after any change in the physical location of a tool. The purpose of a tool calibration is twofold:

- If "Use Needle Calibration" is enabled on a virtual tool's Tool Configuration, the Tool Calibration Function adjusts the tool offset and applies a program offset to correct the position of the tool's tip.
- If "Use Profile Calibration" is enabled on a virtual tool's Tool Configuration, the Tool Calibration Function adjusts the **Profile Offset** for the tool.

NOTE: Enable the teach tool option to use the Tool Calibration function.

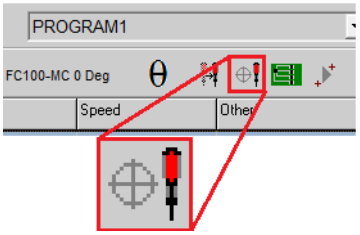


Figure 58: Tool Calibration

WARNING: The tool offsets, the Needle Calibration Sensor Locate Sequence (if applicable) AND the Profile Plunger Locate Sequence (if applicable) must be set up before a Tool Calibration is done, or the system could be damaged.

1. Select the **Tool Calibration** button on the main tool bar.
2. Select the necessary tool from the **Tool Selection** window. Multiple, consecutive tools can be selected. Use the **Sort** buttons to sort the tools so the necessary tools are listed consecutively. Hold the "**Shift**" key and click or click and drag to highlight the tools to calibrate.

NOTE: For a tool to show up in the tool selection list, the "Use Needle Calibration" checkbox or the "Use Profile Calibration" must be checked in the Tool Configuration window.

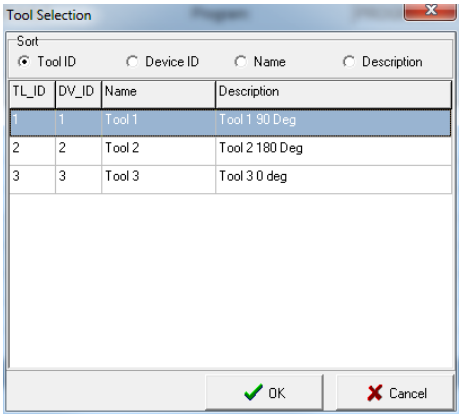


Figure 59: Tool Selection Window

3. Select the "**OK**" button.

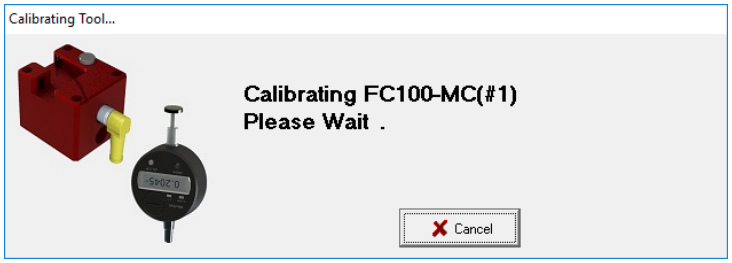


Figure 60: Calibration Wait Screen

4. When the Tool Calibration is done, changes are saved and offsets are applied to the path programs for the related tool(s), if Needle Calibration was run.
5. For multi-tool calibration, all applied calibration operations run for each tool, in any combination of Needle Calibration and Profile Calibration. Any changes to **Tool Offsets** or **Profile Offsets** are saved and offsets are applied to tools individually, if the calibration was successful.
6. If any of the selected tools fail, the sequence is stopped. Any tools that were completed before the failed tool will have **Tool Offsets** and/or **Profile Offsets** applied. If a multi-tool calibration fails, move the mouse over the failed message to show a pop up with the status of each tool. The popup window must have focus to show the popup hint.

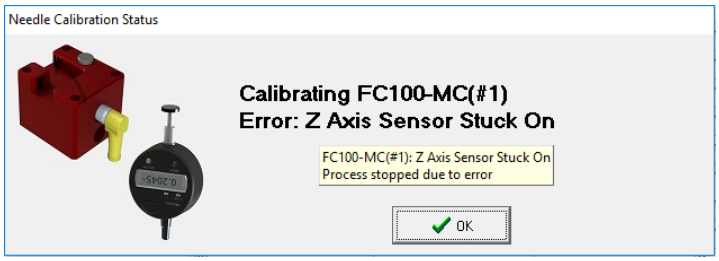


Figure 61: Calibration Status Screen

7. Use the "**Cancel**" button to stop the sequence. For multi-tool calibration, the current tool will finish calibrating and changes will be saved for all of the tools that complete calibration before the calibration was canceled.

6.7 Auxiliary

The machine auxiliary feature is used to hardcode custom software options into the machine software. This function is programmed by PVA and instructions on how to use it are supplied if necessary.

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. If necessary, select the "**Machine Auxiliary**" button.

Figure 62: Machine Auxiliary

3. Make the necessary changes in the Auxiliary Code window.

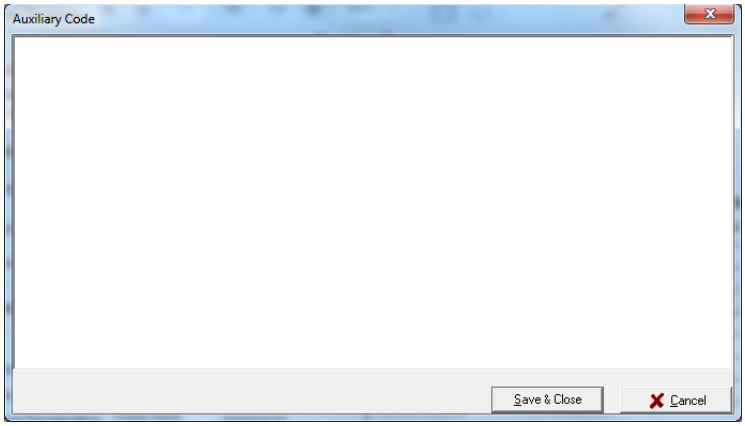


Figure 63: Auxiliary Code

4. Select "**Save & Close**" to keep the changes.
5. Select "**Cancel**" to exit and not save changes.

6.8 Communications

This feature is used to configure the RS-232 communication or Ethernet settings between the computer and the workcell. PathMaster® uses control handles to store all communication settings for a machine. The information in the control handles is stored in the Windows® registry. PathMaster® can have multiple control handles configured, but only one control handle can be selected at a time. When PathMaster is installed it creates controller 1 as an Ethernet controller with an IP address of 100.100.100.101 as a default. These settings are found in the Machine Parameters window.

Figure 64: Communications

The table below has the list of IP Addresses referenced directly by PathMaster® or its underlying architecture.

IP Address	Description
100.100.100.101	Motion Controller 1 (Default)
100.100.100.102	Motion Controller 2
100.100.100.103	Motion Controller 3
100.100.100.104	Motion Controller 4
100.100.100.105	Motion Controller 5
100.100.100.106	Motion Controller 6
*100.100.100.110**	*Remote I/O*

Table 4: PathMaster IP Addresses

6.8.1 Change Controller

Select "**Change Controller**" to select from any pre-configured controller handles stored in the Windows® registry.

6.8.2 No Reset Download

If you select this feature the workcell will not reset when the project is downloaded. The DMC Motion Controller must have the latest firmware revision (D220S36N or higher) to use this feature. The main program of the machine must be programmed for this feature. If the main program has not been changed, the workcell will show a command error. Refer to the Troubleshooting document for more information.

6.8.3 Saving Machine Parameters

When all machine parameters have been set, select the "**Save & Close**" button to save the parameters and return to the main PathMaster® window.

7. Program Details

7.1 Main Program Modifications

If it is sometimes necessary to make changes in the main program that runs the workcell. You must correctly download the corrected main file to prevent any problems. Use a text editor, such as Windows® Notepad or Winpad to open the *Main* program.

7.2 Common Main Program Changes

There are a few sets of points that regularly need to be changed, these include: standby position, purge position, solvent cup position, and calibration position. In the main program these settings are in the Machine Specific Information section (near the end of the file). An example is shown below:

```
REM !!!! Machine-Specific Information !!!!
#IMACH;MT 1,1,1,1
CE 0,0,0,0;FSTX=20000;SLWX=10000;FSTY=20000;SLWY=10000
FSTZ=10000;SLWZ=5000;FSTW=10000;SLWW=5000
KNTOOL=3;A_TOOL[1]="FCS100";R_TOOL[1]=0
A_TOOL[2]="FC100 ";R_TOOL[2]=1
A_TOOL[3]="DISPSE";R_TOOL[3]=1
PT_APG[0]=80000;PT_APG[1]=65000;PT_APG[2]=0;PT_APG[3]=3000
PT_SOL[0]=80000;PT_SOL[1]=65000;PT_SOL[2]=0;PT_SOL[3]=3000
PT_CAL[0]=15000;PT_CAL[1]=15000;PT_CAL[2]=500;PT_CAL[3]=2000
PT_SBY[0]=25000;PT_SBY[1]=25000;PT_SBY[2]=250;PT_SBY[3]=3500
AP_EN=0;AP_LEN=2000;AP_TIME=30000;PNTO=4000;LT_EN=1;AC_TMR=1
SLP_TM=30000;SO_EN=0;LLA_EN=0;LLB_EN=0
#TUNE;AC*=325000;DC*=300000;SP*=120000;VA*=70000;VD*=70000
BL -4000,-4000,-1000,-1000
FL 83000,85000,15000,30000;TL*=9.9999
KD 67.99,82.43,76.09,50.00
KP 5.66,6.75,8.38,5.00
KI 0.25,0.19,0.34,0.50;EN
```

The following tables display the command variables that it may be necessary to change.

Table 5 – Coordinate System Locations

	Axis			
Locations	*X*	*Y*	*Z*	*W*
Auto Purge Location	PT_APG[0]	PT_APG[1]	PT_APG[2]	PT_APG[3]
Solvent Cup Location	PT_SOL[0]	PT_SOL[1]	PT_SOL[2]	PT_SOL[3]
Calibration Location	PT_CAL[0]	PT_CAL[1]	PT_CAL[2]	PT_CAL[3]
Standby Location	PT_SBY[0]	PT_SBY[1]	PT_SBY[2]	PT_SBY[3]

When the main program has been changed, download the new program to the controller. Use the PathMaster® *Download -> Main function*.

7.3 How to Read a Program

The PathMaster® program display is arranged in a table format. Use the chart below to determine the purpose of the text that appears in each field.

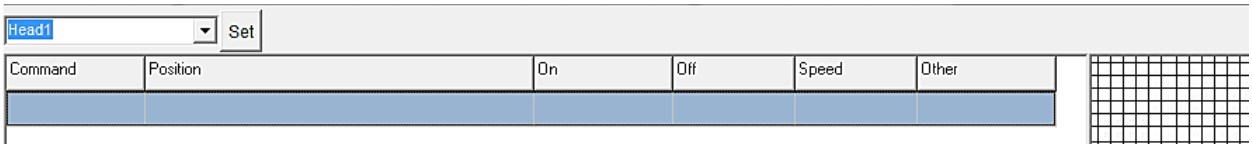


Figure 65: Program Table

COLUMN	USE	EXAMPLE	EXPLANATION
Command	Programmed Command	DOT	Dot Program
		LINE(3D)	3D Line
Position	Coordinates	4555,3000,760	Cartesian coordinates for current point
On	Tool or I/O on	(1)W.5	Activate tool 1, tool on time of .5 seconds
		(2)D300	Activate tool 2, tool on distance of 300 counts
		I49	Wait for input 49 to be on
		O32	Turn on output 32
Off	Tool or I/O off	W.75	Deactivate the path's tool 1, tool off time of .75 seconds
		D500	Deactivate the path's tool, tool off distance of 500 counts
		I51	Wait for input 51 to be off
		035	Turn off output 35
Speed	Path speed	2000	Path speed of 2000 counts per second
Other	Varies according to path	Z=250	Z-axis relative move of 250 counts after completing a dot path

NOTE: A command uses all the lines below it until another command reference appears in the Command column.

7.4 Playback

Paths can be played with PathMaster® or downloaded and run on the workcell.

7.4.1 To run an individual path

1. Highlight an individual path from the PathMaster® window.
2. Select *Run ->Selection* from the drop-down menu or the right-click menu.

7.4.2 To run an entire program

3. Select *Run ->Program* from the drop-down menu or the right-click menu.
4. Before the path runs, the user must select "**Wet**", "**Dry**" or "**Virtual Tool 0**". The name for the third option will be the name of Virtual Tool 0.

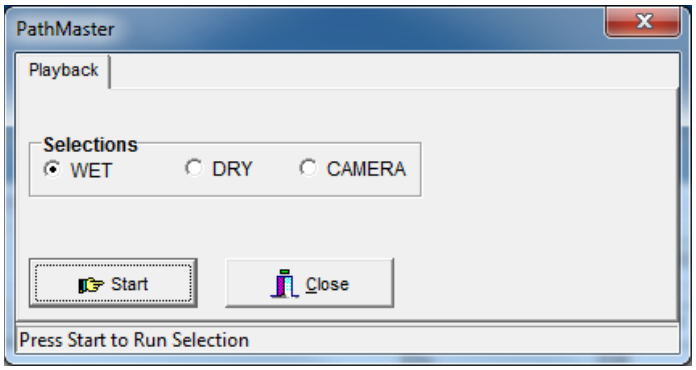


Figure 66: Playback

"**Wet**" playback activates the tool(s) and material will dispense. "**Dry**" playback does not activate the tool(s). "**Virtual Tool 0**" (replaced by the name of "**Virtual Tool 0**") will run the path with the teach tool at "**Virtual Tool 0**" Z, as defined in Machine Parameters instead of the run tool.

5. Select "**Start**" to run the path as selected or "**Close**" to exit without running the path.

7.5 Edit Windows

The operator can change a path segment after it has been created. Double click on the path segment to show the edit window. The Coordinates box is shown in the upper left-hand corner of the edit window. All the programmed coordinates are shown.

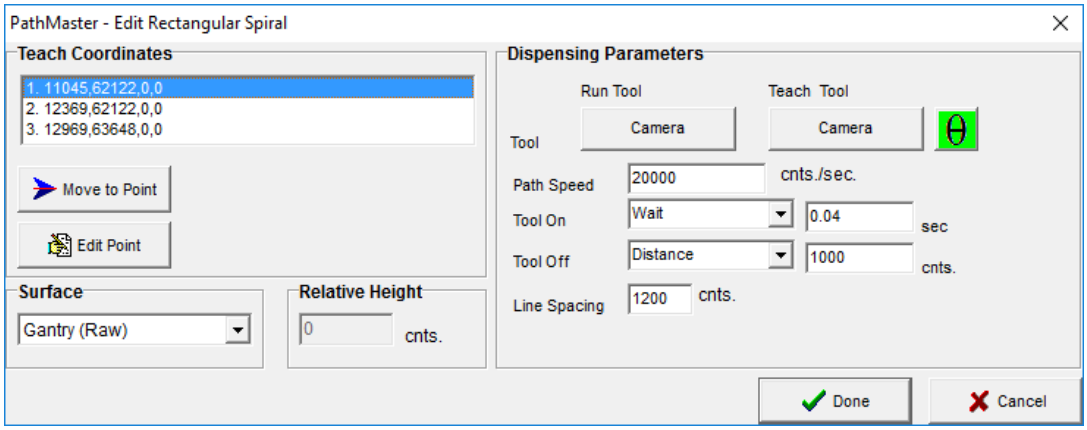


Figure 67: Example Edit Window

Use the options shown as necessary to edit the paths. Not all options will be shown in every edit window.

1. Select **Move to Point** to move to the point highlighted in the coordinates box.
2. Select **Edit Point** to open the point highlighted in the Coordinates box in the edit window.
3. Set the **Tool Height** to "**Use the Current Z Height**" or "**Use Calibrated Z Height,**" or, if the function has surfaces, select the **Surface** from the drop-down menu. If necessary, set the **Relative Height** in millimeters.
4. Select the **Run Tool**.
5. Select (double click) on the necessary tool.

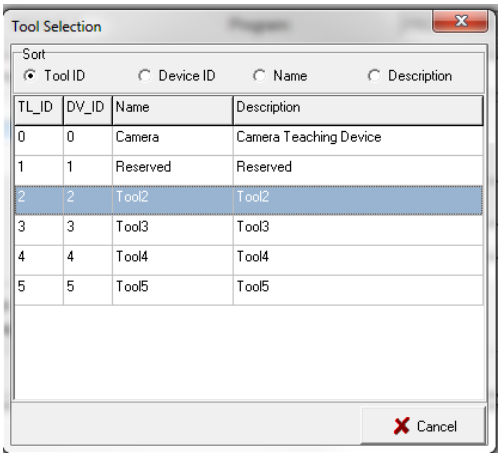


Figure 68: Tool Selection

6. Select the **Teach Tool**.
7. Select (double click) on the necessary tool.
8. Set the **Path Speed**.
9. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance.
10. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance.
11. Set the **Line Spacing**.
12. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.

7.5.1 Important Reminders

- To Insert Code – When PathMaster® programming functions are used to insert code, the code is inserted above the current highlighted location on the screen. The operator must make sure the new path is put in the correct position.
- To Insert Tool Functions – Commands to move the tools are NOT automatically inserted into the path programs. If a tool must change position (up/down, rotary) the correct function must be inserted manually with the Tool programming function. Refer Section 2.9.
- To Download Files – The operator must activate the EMERGENCY STOP button when downloading files to the controller.

8.Workcell Interaction

For PathMaster® to operate correctly it must work with the workcell. The workcell must be in Manual mode to teach a path program online with PathMaster®. Refer to the workcell manual for more information.

NOTE: Playback of a path is only possible if workcell is in Manual mode.

8.1 Teach Pendant

PVA workcells come with a teach pendant. Each teach pendant has a Trackball, Teach button, Purge button, Axis selection button, and LED indicators for selected axes and teach function.

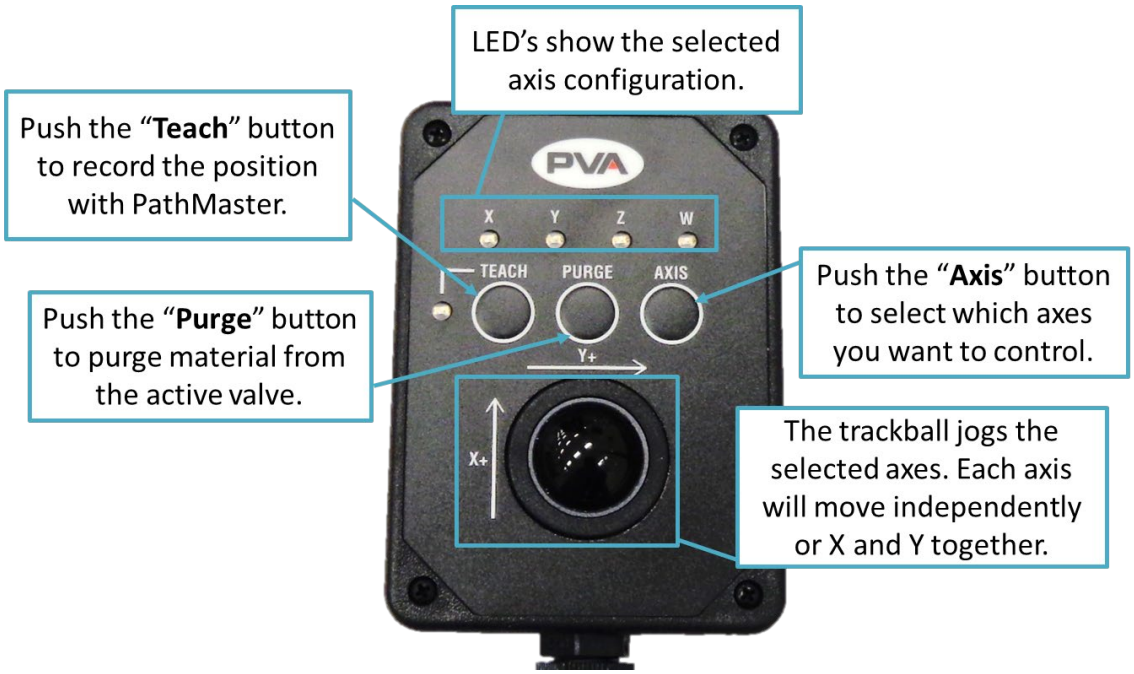


Figure 69: Teach Pendant

LED's – The X, Y, Z and W LED's show the selected axis configuration. The Teach LED shows a position was correctly recorded by PathMaster®. The light tower buzzer will "beep" when the Teach LED illuminates.

NOTE: W-axis trackball control is locked if the Teach Tool is enabled, unless the PathMaster Tool Offset window is open (Setup-> Machine Parameters-> "Tool Offsets"). This so the operator does not teach an accidental theta position with the teach tool.

9. Fiducial Function

NOTE: When you work with fiducials, the workpiece is usually a PCB and will be referred to as a PCB in this section and its sub sections (Section 9).

PathMaster® uses fiducials to make sure the part that is dispensed on is correctly installed in the work area. A fiducial is an object in the field of view of the imaging system used as a reference point. The shape and size of the fiducials must obey the SMEMA Fiducial Mark Standard (Standard 3.1). You must have PVA Portal Vision Module 1.04 or higher, and Firmware D220S36S or higher for the motion controller to use the fiducial functions in PathMaster®.

The fiducial function will do an inspection of fiducial A or B to correct for the translational (X and Y) and rotational offset (skew) of a product. To correct for skew, the product must have an A and B fiducial mark and the skew must be within an acceptable tolerance. The A and B fiducials should be located diagonally opposite one another.

The skew tolerance is set in the inspection program profile from the Portal Manual teach window. The tolerance is a radius in millimeters from the center of the expected fiducial location. The measured center of the fiducial must fall within this radius to pass the check. Refer to the Portal Manual.

Program and run fiducial A before fiducial B.

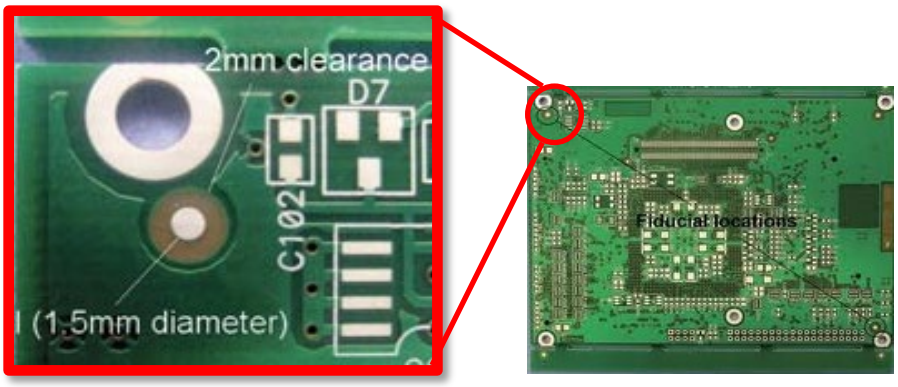


Figure 70: Example Fiducial

9.1 Fiducial A

When fiducial A runs, X and Y offsets are cleared, and the tool moves to the taught absolute gantry position. When the tool is in position, the programmed fiducial parameters are run. A pass / fail status is shown. If the result is a pass, an XY offset is reported to the controller.

NOTE: There is a box so the XY offsets are not cleared when fiducial A is run. Do not select this box unless there is a reason.

9.2 Fiducial B

Fiducial B uses the offset found by fiducial A to move the tool to the corrected fiducial B coordinates. When the tool is in position, the programmed fiducial parameters are run. The fiducial B function finds if the part is skewed and if the amount of skew is within tolerance. A pass/fail status is shown based on the skew tolerance. The calculated skew is applied to the machine.

9.3 Fiducials and Skew Correction

9.3.1 Translational Correction

PathMaster® uses translational correction in the fiducial function. The fiducial function will find the center of the fiducial on the PCB (Workpiece) and calculate the translational correction to be applied to the path program. Translational correction will be applied to all path segments that follow the fiducial function in the program table.

9.3.2 Rotational Correction

PathMaster® finds the necessary rotational correction with a Fiducial A function followed by a Fiducial B function. The Fiducial A function calculates and applies the translational correction to fiducial B to find fiducial B on the PCB. When fiducial B is found, the rotational correction is calculated by the angular difference between the actual fiducial B location ($Angle_1$) and the expected fiducial B location ($Angle_2$). You must run fiducial A before fiducial B because the translational correction from the Fiducial A function is necessary to find fiducial B.

9.3.3 Calculations

$DeltaX_1 = (FidB[X]_{Expected} - FidA[X]_{Actual})$

$DeltaY_1 = (FidB[Y]_{Expected} - FidA[Y]_{Actual})$

$DeltaX_2 = (FidB[X]_{Actual} - FidA[X]_{Actual})$

$DeltaY_2 = (FidB[Y]_{Actual} - FidA[Y]_{Actual})$

$Angle_1 = ArcTan(DeltaY_1 / DeltaX_1)$

$Angle_2 = ArcTan(DeltaY_2 / DeltaX_2)Angle_{Skew} = (Angle_1 - Angle_2)$

9.4 Corrected Space

Corrected space is a virtual coordinate system used by PathMaster® to adjust for rotational correction. The virtual coordinate system (or PCB coordinate system) rotates the XY gantry coordinate system by the skew angle. The coordinates are rotated around fiducial A, as related to the current PathMaster® tool. The virtual coordinate system is used to run, playback, or teach a path program that is skewed relative to the machine coordinate system. PathMaster® enters corrected space automatically when Fiducial A and B functions are run. The fiducial icon illuminates to show you are in corrected space.

PathMaster® shows the virtual coordinates (PCB coordinates) when in corrected space, not the gantry coordinates. You can teach and edit in PathMaster® while in corrected space. When you teach or edit a path in corrected space the coordinates recorded in the program table are different from the coordinates that you taught on the part. PathMaster® automatically teaches the path in normal, “uncorrected” space. If you move to a position in the path while in corrected space, the tool will be in the correct position on the part, but the coordinates may not match the coordinates that you moved to. This is because PathMaster® automatically adjusts for translational and rotational offset. With this adjustment you can run the path on a part that has been placed correctly in the system and does not need fiducial correction. If you open or change a program, edit a fiducial, select the Clear Fiducial function from the Main menu, or enter Tool Offset Setup menu you will exit corrected space.

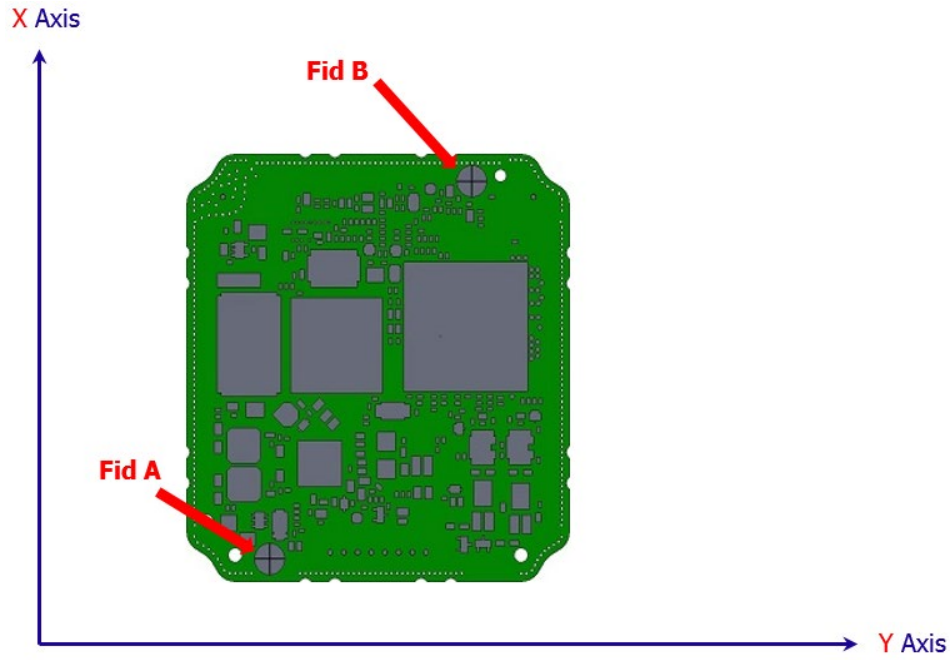


Figure 71: Normal Space

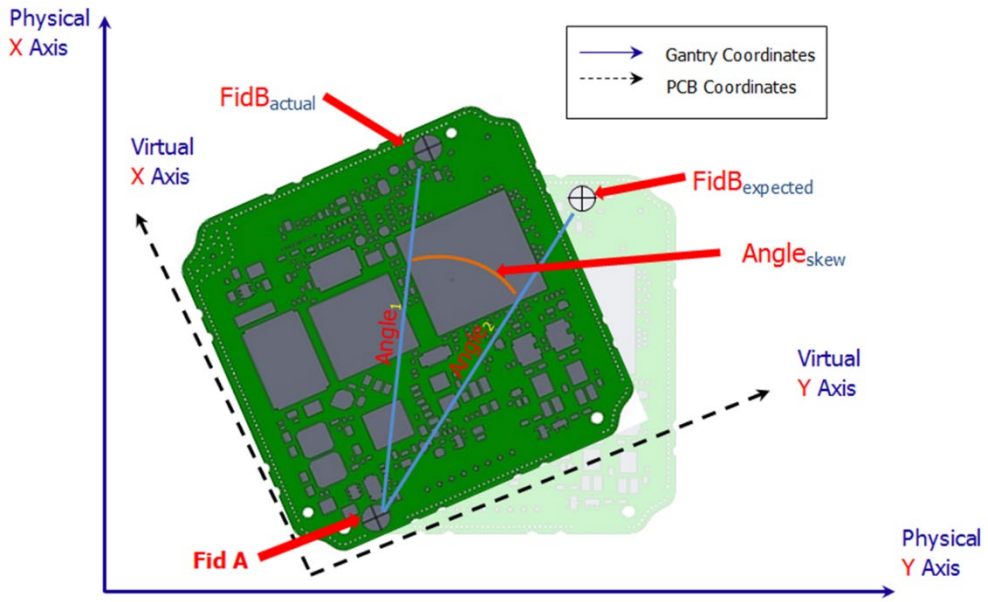


Figure 72: Corrected Space

9.5 Teaching Fiducials

1. Select the Fiducial function.
2. Select the necessary Inspection and Light.
3. Select the Fiducial. Fiducial A must be programmed first.
4. Teach Fiducial A.

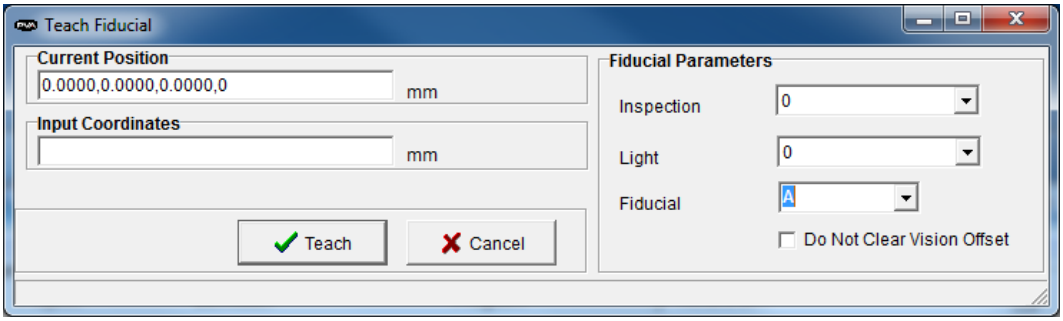


Figure 73: Teach Fiducials

The fiducials will show on the edit screen in blue.

5. Double click on the fiducial function to edit the fiducial.
6. Select "**Teach**" to save changes made under Fiducial Parameters.

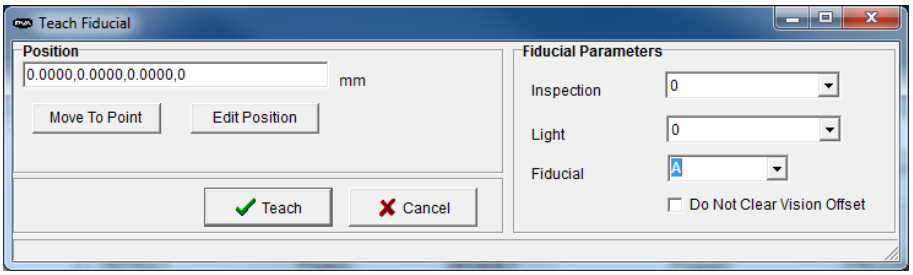


Figure 74: Fiducial Window

7. Select "**Edit Position**" to change the position of the fiducial.
8. Select "**Teach Position**" to teach the location of the end effector, or put the coordinates in the **Teach Coordinate** box and select "**Teach Coordinate**".

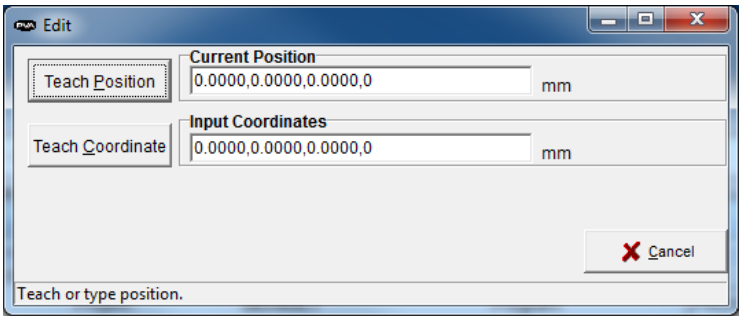


Figure 75: Edit Fiducial

9. Select "**Teach**" when you are done to exit and save the changes you have made, or select "**Cancel**" to exit and not save changes.

9.6 Run Fiducials

Run fiducials before any online programming.

1. Select Run Fiducials from the programming toolbar.
2. The status will show in a window, either pass or fail.

NOTE: If the fiducials have not been run and an online programming tool is selected, you will be asked if you want to continue without the fiducials run, paths that contain a fiducial that has not been run will not allow surface editing.

3. Double click on the Position section of the Lower Status Bar to see the current XY offset and skew angle.

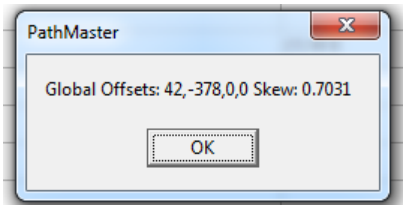


Figure 76: Global Offset and Skew

10. Programming Functions

10.1 General Function Parameters and Buttons

The following function definitions apply to 2D path, 3D path, Arc, Circle, and Area tools.

Current Position – If there is communication with the controller, the current position is shown in the text box. Use the teach pendant on the workcell to change the position.

Input Coordinates –Enter the target position manually.

Dispensing Parameters – Select parameters for the current dispense and the active tool.

Tool On Wait – The pause after the tool is turned on before the dispense path starts.

Tool Off Wait – The pause after the path is finished and the tool is off, but before the tool moves to the next point.

Tool On Distance – The distance of the path traveled before the tool turns on.

Tool Off Distance – The distance of the path traveled when the tool is turned off, but before the path is finished.

Z Retract (Relative) – Distance to raise the Z-axis after certain moves are completed.

Teach – Records the current point.

Surface- Drop down menu to select the end-effector height. Menu options depend on the function.

- **Gantry (Raw)** uses the Z coordinate exactly as it was taught.
- **Gantry (Relative)** uses the Z coordinate that was taught and subtracts the "**Relative Height**" numeric field's current value.
- **Calibrated Z** uses the Run Tool Reference Z for the current run tool and subtracts the global "**Relative Height**" set for that tool in Tool Configuration.
- **Use Last** uses the Z height of the previous Surface used in the Polyline.
- **Custom Surface** uses the XY coordinates of the Surface command that shares the same name and uses the Z height and the current run tool's "**Calibrated Z**" to set the dispense Z height.

Use Current Z Height – This will teach all coordinates at the current end-effector height.

Use Calibrated Z Height – This will teach all coordinates at the end-effector height taught during teaching offsets. The final calibrated height is the tool offset Z Height minus the "Relative Height" parameter set for the tool in Tool Configuration.

Done – Adds all edits to the program.

Cancel – Exit without changes to the program.

NOTE: Playback can only operate if the workcell is in Manual mode.

NOTE: When teaching a position on a 4-axis machine the last coordinate in the list (0.000, 0.000, 0.000, 0) is the theta value. Theta is measured in encoder counts and is always a whole number.

NOTE: Teach tool selections only apply when the teach tool is used.

10.2 Add Comment

1. Select the add comments icon from the tool bars.
2. Add a comment to each path program so anyone who views the path program can understand the program. All comments are removed from the program on compilation and do not use any controller memory.

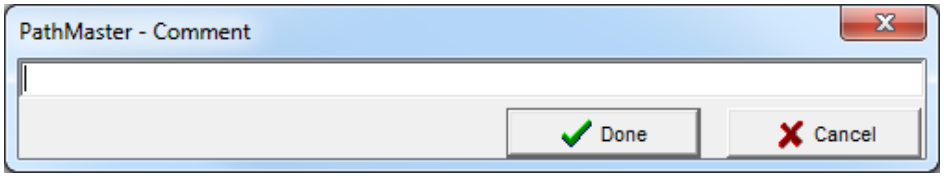


Figure 77: Comment

10.3 DMC

With this function the user can enter DMC code into the program. Only users who understand the DMC language should use this.

Command	Position	On	Off	Speed	Other
DMC	DEZ=0;AC_SETA=1.00;AC_DEVA=10				

Figure 78: DMC Command Programmed

1. Select the DMC function.
2. Enter the correct command into the Edit DMC window.
3. Select "**Done**" to save the changes.
4. Select "**Cancel**" to exit and not add a command.

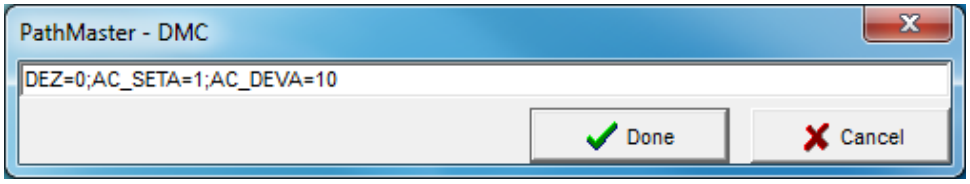


Figure 79: Edit DMC

10.4 Plugin Select

Plugin Select is where the user can select which plugins are used.

1. Select the Plugin Select icon or select *Plugins->Plugin Select* from the main menu bar.

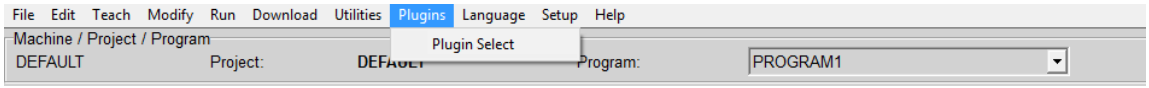


Figure 80: Plugin Select Menu

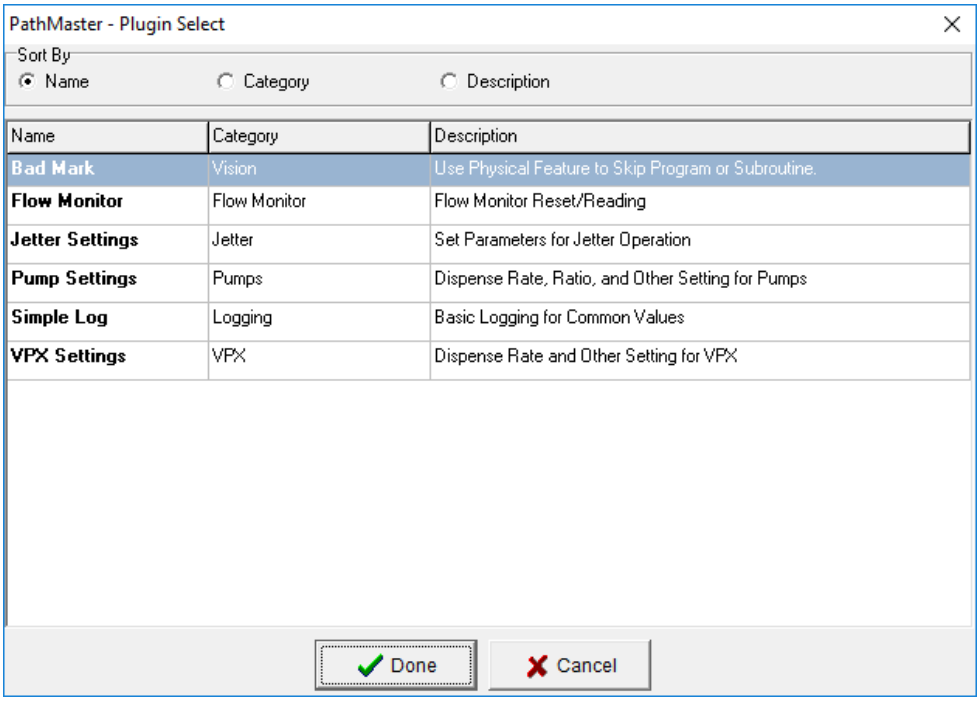


Figure 81: Plugin Select

2. Use the radial buttons to sort the plugins as necessary by Name, Category, or Description.
3. Select necessary plugin so it is highlighted.
4. Select "**Done**".

A plugin specific window will be shown. Refer to plugin specific documentation for more information.

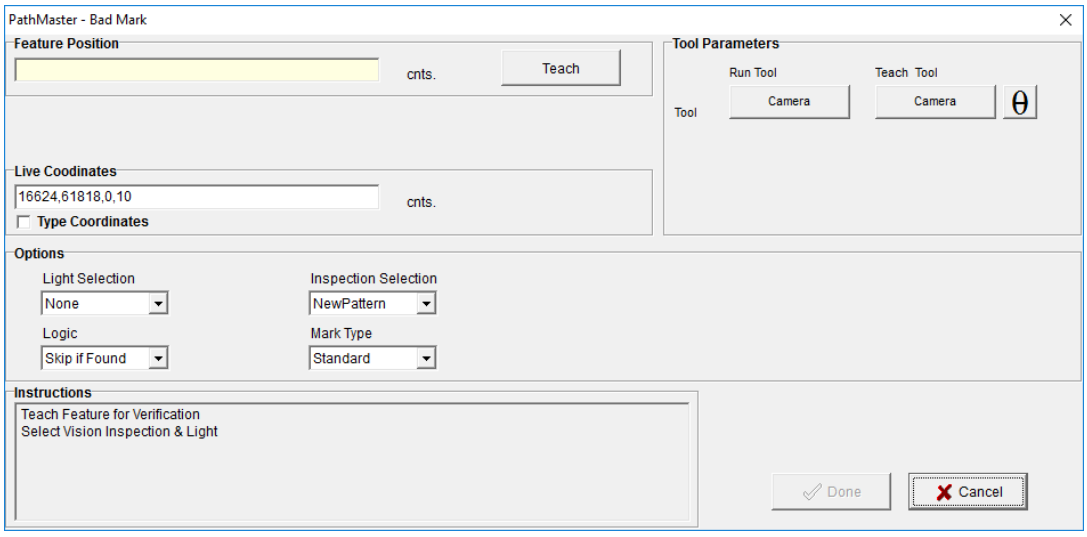


Figure 82: Example Plugin Window

Plugins will be shown on the program table with the **Command** as "PLUGIN" and the plugin specific name shown in the **Other** column.

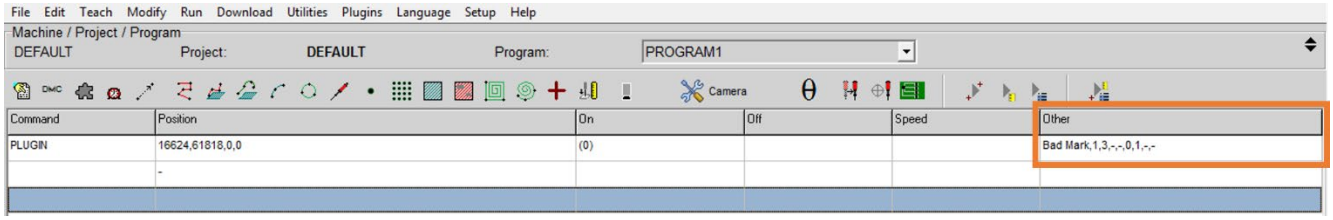


Figure 83: Example Programming

10.4.1 Plugin Download Error

Plugins are not available to projects that are downloaded to the controller. Portal PartManager must be used to select programs if plugins are used. If an attempt is made to download or export a Project that contains plugins, an error will be shown.

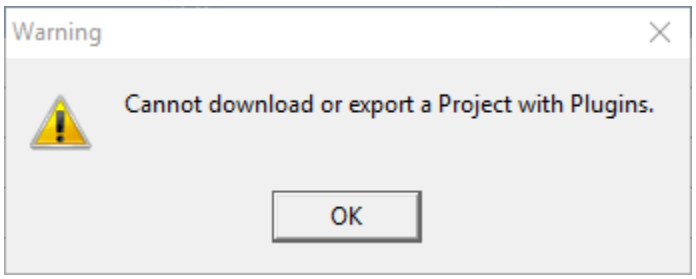


Figure 84: Plugin Warning

10.5 Dwell

Set a delay in program execution in between path segments with the Dwell function.

1. Select the Dwell function.
2. Put the correct value in the **Wait** box.

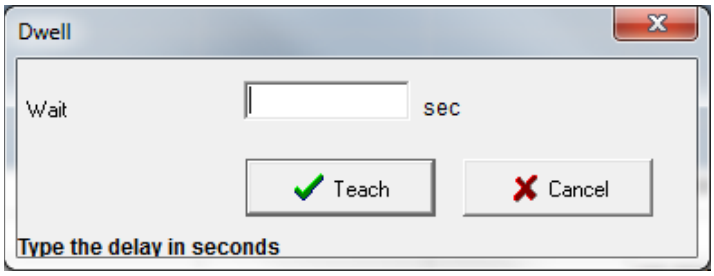


Figure 85: Teach Dwell

3. Select "**Teach**" to add the command to the edit screen.
4. Select "**Cancel**" to exit and not add a command.

10.6 Move

The Move command is a non-dispense move. The approach type is applied globally to all points taught within a single move command and determined by the selected approach type when the "**Done**" button is clicked. If more than one approach type is necessary, teach multiple move commands. Refer to Section 10.1 for definitions of the tool functions.

Command	Position	On	Off	Speed	Other
MOVE	20,20,10,10	(2)			Z only
MOVE	20,20,25,10	(2)			Z only

Figure 86: Move Command in the Edit Screen

1. Select the Move function.

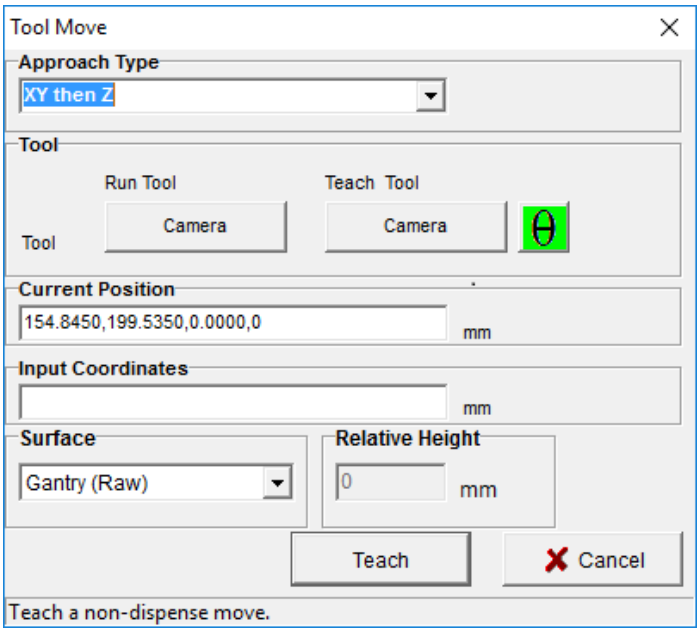


Figure 87: Tool Move

2. Select the Approach Type.
3. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window.
4. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window.
5. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

6. Select the **Surface** from the drop-down menu. Gantry (Raw) uses the current Z height, Calibrated Z uses the calibrated Z height, Gantry (Relative) the user to sets a move in Z axis relative to the taught position (mostly used for knit-line finishing).
7. Use the teach pendant or input the commands in the Input Coordinates box and select "**Teach**".
8. Click "**Teach**" at the next move point as necessary.
9. Select "**Done**" to close the window.
10. To edit a Move command, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.7 2D Path

This tool teaches 2D path segments. The Z-axis does not change its position in the path. Refer to Section 10.1 for definitions of the tool functions.

Command	Position	On	Off	Speed	Other
LINE(2D)	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	
	25,0,0,0				

Figure 88: Programmed 2D Line Command

13. Select the 2D Path function.

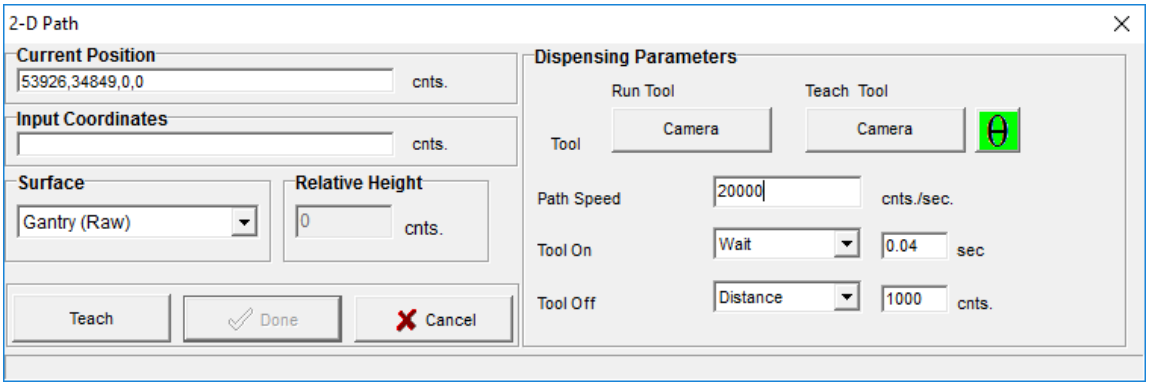


Figure 89: Teach 2D Line

14. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
15. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
16. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

17. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
18. Set the **Path Speed**.
19. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance in the box.
20. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
21. Select the "**Teach**" button or use the teach pendant to input the commands in the Input Coordinates box.
22. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.
23. To edit a 2-D path, double click on the path and edit in the window shown. Refer to Section 7.5.

10.8 3D Path

This function teaches 3D path segments. Refer to Section 10.1 for definitions of the tool functions.

Command	Position	On	Off	Speed	Other
LINE(3D)	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	
	10,0,2,0				

Figure 90: Programmed 3D Line Command

1. Select the 3D Path function.

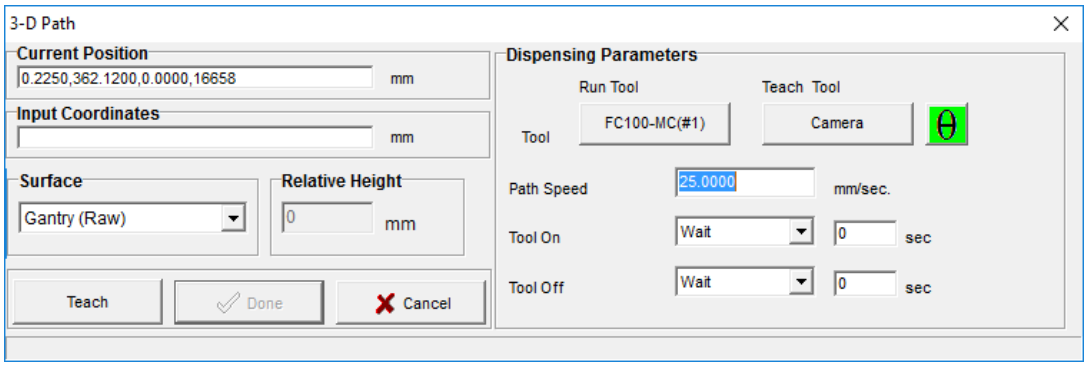


Figure 91: Teach 3D Line

2. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height.**
6. Set the **Path Speed**.
7. Set the **Tool On** to "**Wait**" or **Distance**" and set the time or distance in the box.
8. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
9. Select the "**Teach**" button or use the Teach pendant to input the commands in the Input Coordinates box.
10. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.
11. To edit a 3-D Path, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.9 PolyLine (DMC 4000)

A Polyline is a path made of lines and arcs. Polylines are used when it is necessary to change direction quickly, at high speeds, during a dispense. Polyline, in Pathmaster® 4.3, uses surface height readings (taught before a polyline is used). Surface Height readings and the Calibrated Z Height of a tool (Section **Error! Reference source not found.**), account for differences in individual part height and paths are adjusted to dispense correctly.

10.9.1 New Polyline

1. Click on the Polyline or select Teach > Polyline > Create New from the Main Menu to open the Polyline Teach Interface.

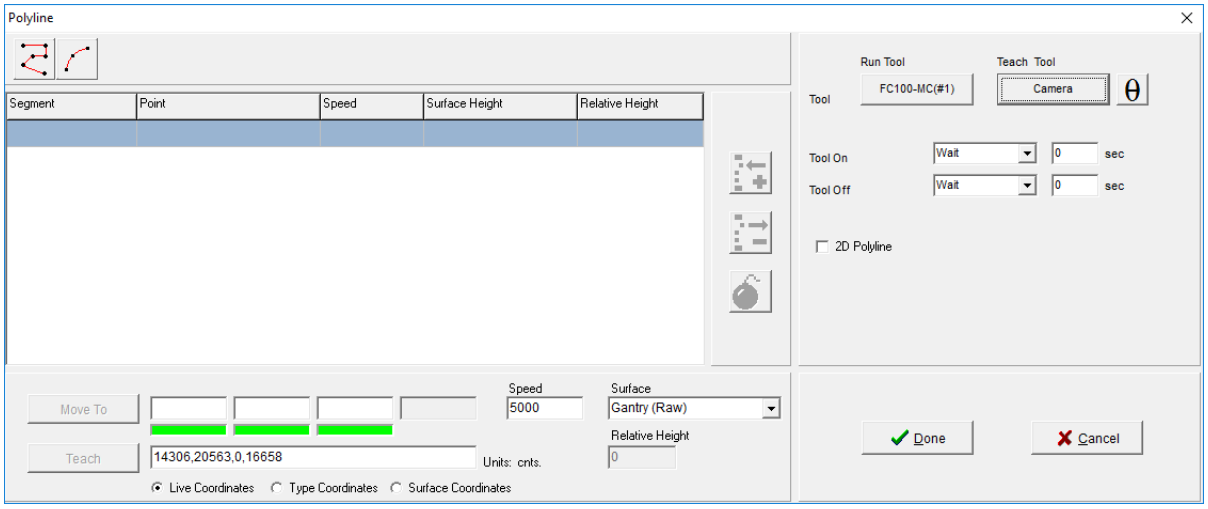
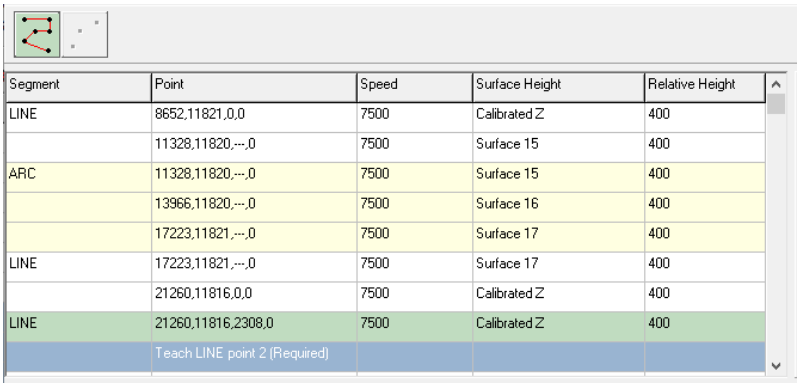


Figure 92:PolyLine Teach Window

2. The **Bomb** button 'explodes the polyline'. All the taught segments and arcs move into the main path program as separate segments. When a line is exploded, the height profiling feature cannot be used.
3. When 2D Polyline is enabled, a single Z height is taught for all the polyline segments. Select the "**2D Polyline**" checkbox to use this option.
4. Select either a Polyline or Arc from the top of the Polyline teach window. Follow the prompts to teach the points.



Segment	Point	Speed	Surface Height	Relative Height
LINE	8652,11821,0,0	7500	Calibrated Z	400
	11328,11820,---,0	7500	Surface 15	400
ARC	11328,11820,---,0	7500	Surface 15	400
	13966,11820,---,0	7500	Surface 16	400
	17223,11821,---,0	7500	Surface 17	400
LINE	17223,11821,---,0	7500	Surface 17	400
	21260,11816,0,0	7500	Calibrated Z	400
LINE	21260,11816,2308,0	7500	Calibrated Z	400
	Teach LINE point 2 (Required)			

Figure 93: Polyline Line Segment Teaching

5. Use the Coordinate Selection radio buttons and Surface dropdown selection to Z coordinate options. The radio buttons select between:
   Live Coordinates: The end effector's current gantry position.
   Type Coordinates: User types in the coordinates with the keyboard.
   Surface Coordinates: Where the **Surface Height** commands, that are valid for this polyline, were taught.

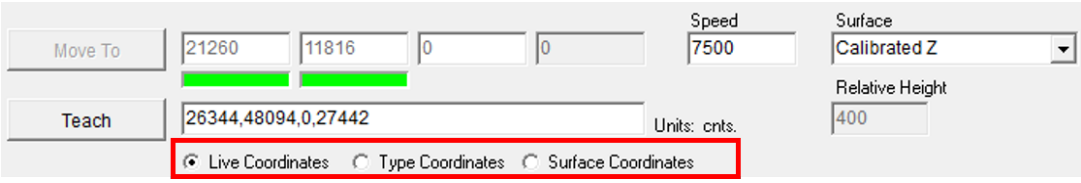


Figure 94: Teach Radio Buttons

NOTE: Only surfaces that are in the program grid and are in the path program before the point of insertion of the polyline will be in the dropdown.

6. Use the **Surface** drop-down menu to set the Z-plane for a selected Polyline point.

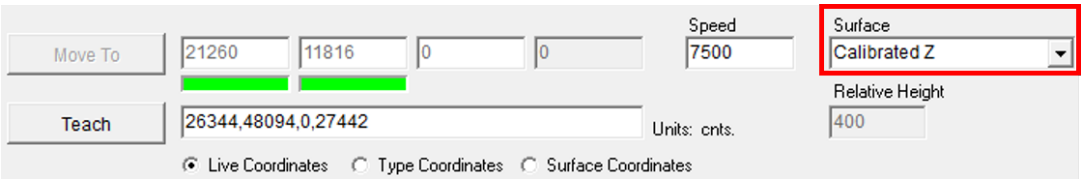


Figure 95: Teach Surface Dropdown

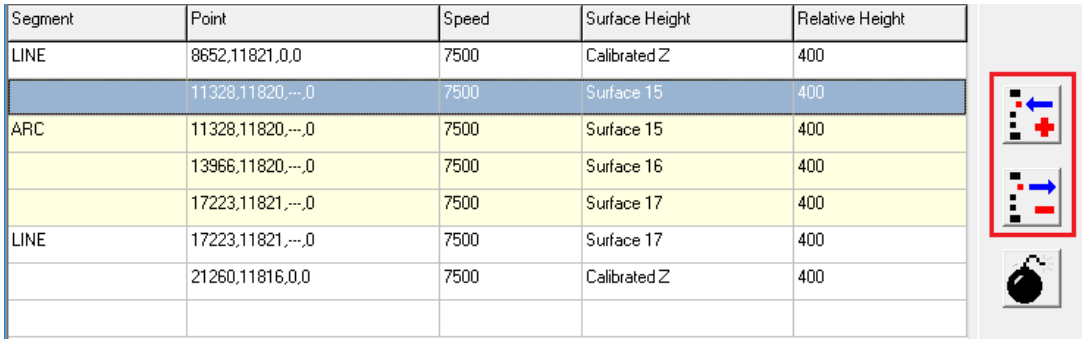
- **Gantry (Raw)** uses the Z coordinate exactly as it was taught.
- **Gantry (Relative)** uses the Z coordinate that was taught, and subtracts the "**Relative Height**" numeric field's current value.
- **Calibrated Z** uses the Run Tool Reference Z for the current run tool, and subtracts the global "**Relative Height**" set for that tool in Tool Configuration.

- **Use Last** uses the Z height of the previous Surface used in the Polyline. The first point of a new Polyline cannot use this selection.
- **Custom Surface** uses the XY coordinates of the Surface command that shares the same name and uses the Z height and the current run tool's "**Calibrated Z**" to set the dispense Z height.

NOTE: Surfaces are named in the Path Segment before the Polyline being taught.

7. Click the green highlighted button above the Polyline Segment table to end the line.
8. Select the "**Speed**" column for an individual segment and type the value to change it. Highlight multiple segments to change multiple values.
9. To edited line segments, use the buttons to the right of the Polyline Segment table. The top button is used to add a new point into a line, and the bottom button to remove a single point from a line, or remove an entire arc.

NOTE: After a new point is taught to a line, the segment is de-latched automatically.



Segment	Point	Speed	Surface Height	Relative Height
LINE	8652,11821,0,0	7500	Calibrated Z	400
	11328,11820,---,0	7500	Surface 15	400
ARC	11328,11820,---,0	7500	Surface 15	400
	13966,11820,---,0	7500	Surface 16	400
	17223,11821,---,0	7500	Surface 17	400
LINE	17223,11821,---,0	7500	Surface 17	400
	21260,11816,0,0	7500	Calibrated Z	400

Figure 96: Polyline Segment Table Edit Buttons

NOTE: If a line segment only has two points, the entire line will be removed if "Remove" is selected. If a segment does not have the necessary number of points, it is removed from the polyline list. Line segments must have at least two points, but can have more. Arcs must have exactly three points.

10. Highlight a point and click "**Move To**" to move to the selected point.

Figure 97: Move to Coordinate Enable/Disable

11. Click the bar under any active axis to disable movement and editing of that axis by turning the indicator yellow.
12. When all desired segments are taught, click "Done" to save the Polyline and add it to the Path Program, or "Cancel" to return to the main PathMaster® window without saving.

10.9.2 Create from Selected

1. To create a Polyline from individual path segments, select the path segments to include in the Polyline.
2. Select the **Teach** menu.
3. Select *Polyline -> From Selected Lines*.

If the endpoints of the path segments do not match up, PathMaster® will ask to match up the endpoints. If you do not to match up the endpoints the Polyline will not be made. If you select match up the endpoints, the polyline will use the best fit.

The newly created Polyline will default to using the Raw Gantry height of the integrated path segments. Entering the Polyline edit window allows the user to make use of Surface Height readings and Relative Heights. Circles are re-generated into two arcs.

WARNING! PathMaster® will use the tool used in the first segment for all the segments. Make sure all individual paths segments in a polyline use the same tool.

10.10 PolyLine (Legacy and DMC2000)

A PolyLine is a path made of 2 dimensional lines, arcs, and circles. PolyLines are used when it is necessary to change direction quickly at high speeds during a dispense. Paths with lines, arcs, and circles will have smoother movement and more uniform corners and circles if created as a polyline.

There are two ways to make a polyline. Individual path segments can be made and then changed to a polyline, or via the Polyline tool.

10.10.1 New PolyLine

When teaching a segment in a polyline, the last point of the previous segment will be used as the first point of the new segment. For example, only two points of a polyline arc need to be taught (if it is not the first segment of the polyline) because the first point will be the last point of the previous segment.

4. Open the Polyline function from the top menu *Teach > PolyLine.*
5. Select a programming tool from the toolbar on the left.

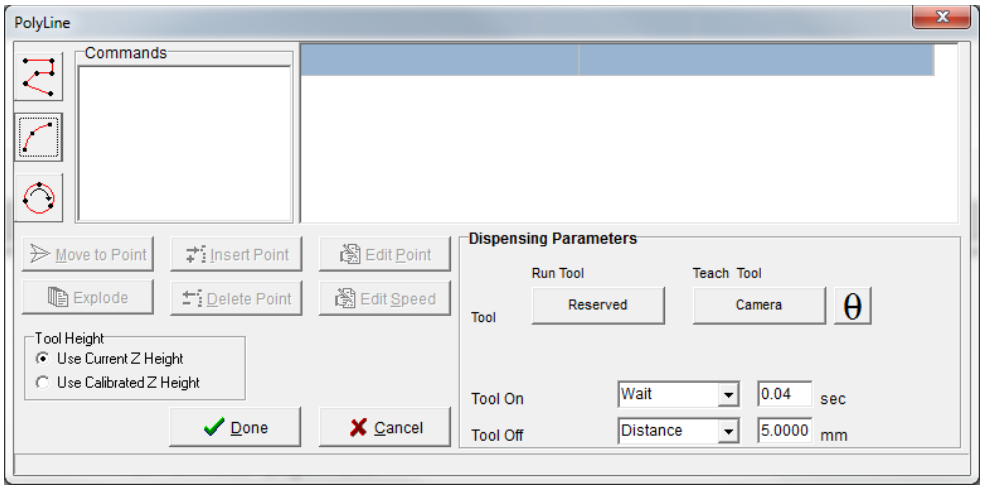


Figure 98: PolyLine Window

6. Teach the points required for the tool selected.
7. Set the **Path Speed**.

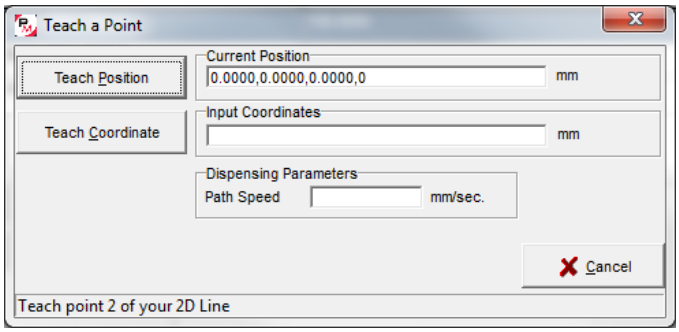


Figure 99: Teach a Point

As each segment is created, it is added to the command list on the left of the Polyline program table. The polyline is limited to 2047 points for all segments.

8. Select a command from the list of commands.
9. Set the **Dispensing Parameters**.
10. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When using the "Teach Tool" (virtual tool 0), it is not necessary to select this button.

11. Select a segment in the command list and select the "**Edit Point**" button or the "**Edit Speed**" button to edit the points and speed for each segment.
12. The Polyline can also be exploded into individual path segments and modified on the main PathMaster® program table.

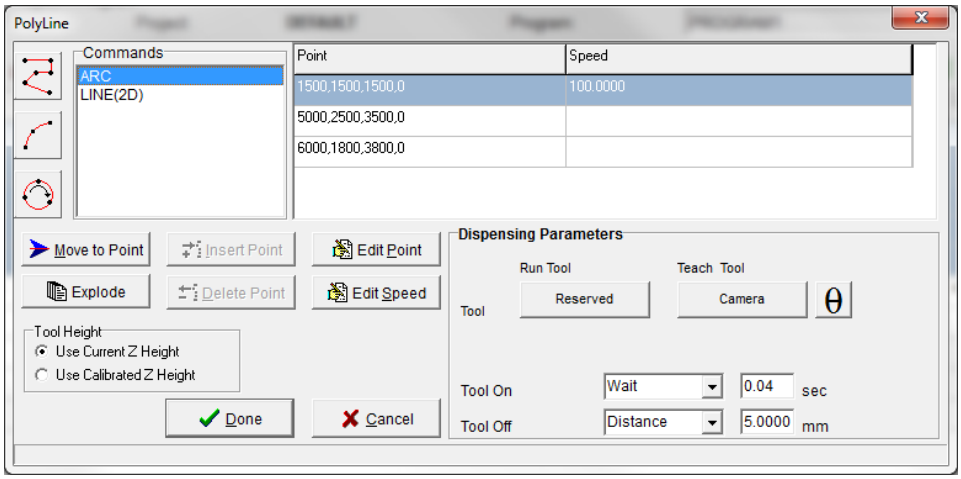


Figure 100: PolyLine

13. Select "**Done**" to save the completed polyline or select "**Cancel**" to exit and not save changes.
14. To edit, double click on the path segment and change the command in the edit window. Refer to Section 7.5.

10.10.2 From Selected Line

15. To create a polyline from individual path segments, select the path segments to include in the Polyline.
16. Select the **Teach** menu.
17. Select *Polyline -> From Selected Lines*.

If the endpoints of the path segments do not match up, PathMaster® will ask to match up the endpoints. If you do not to match up the endpoints the polyline will not be made. If you select match up the endpoints, the polyline will use the best fit.

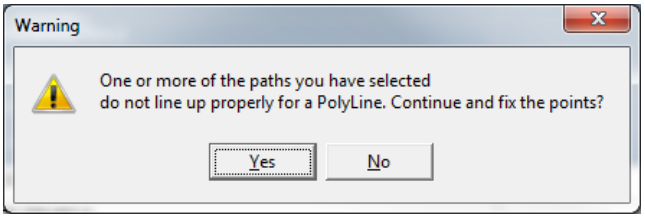


Figure 101: PolyLine Point Match Up

When a polyline is made from individual path segments, the tool parameters will be from the first path segment in the series. The speeds for each path segment will be kept.

WARNING! PathMaster® will use the tool used in the first segment for all the segments. Make sure all individual paths segments in a polyline use the same tool.

18. To edit a polyline, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.11 Polyline3D (Legacy and DMC2000)

A Polyline3D is a single continuous dispensing path that allows motion in the X, Y, and Z Axes. There are two ways to make a polyline. Individual path segments (2D/3D lines or Arcs) can be made and then changed to a polyline, or you can use the Polyline tool.

Command	Position	On	Off	Speed	Other
POLYLINE3D	0,0,0,0	(1) W 0	W 0	3.9370	LINE(3D)
	0,10,10,0				
	0,10,10,0			3.9370	ARC
	0,100,50,0				
	0,0,0,0				

Figure 102: Programmed 3D Polyline Command

10.11.1 New Polyline3D

When you teach a segment in a polyline, the last point of the previous segment is used as the first point of the new segment. For example, it is only necessary to teach two points of a polyline arc (that is not the first segment of the polyline) because the first point will be the last point of the previous segment.

1. Open the Polyline3D function.
2. Select a programming tool from the Polyline toolbar on the left.

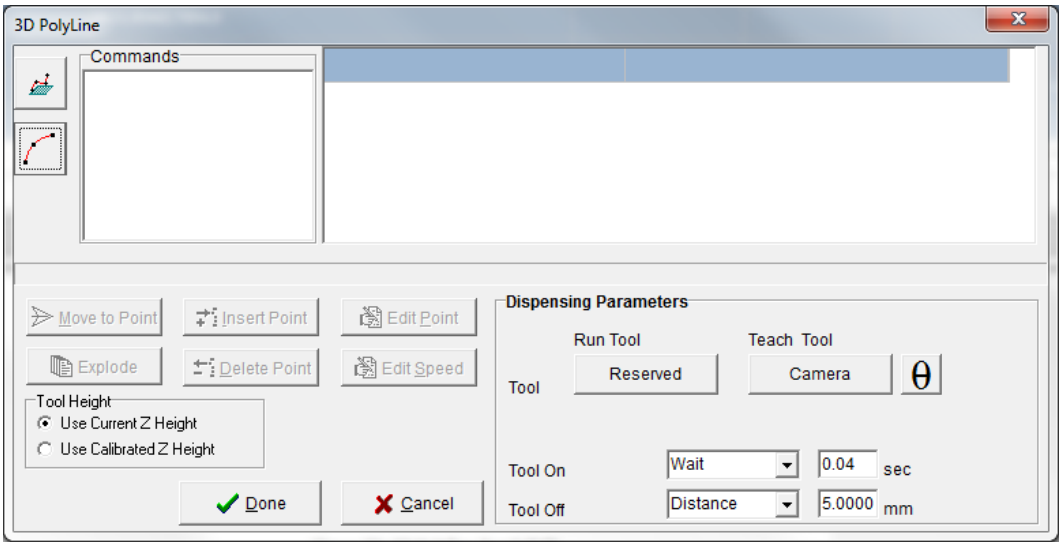


Figure 103: Polyline3D Teach/Edit

3. Teach the points necessary for the tool selected, input the coordinates or use the teach pendant.
4. Set the **Path Speed**.

As you make each segment, it is added to the command list on the left of the Polyline program table. The polyline is limited to 2047 points for all segments.

5. Select the command from the Command list and set the **Dispensing Parameters**.
6. To edit the points and speed for each segment, select a segment in the command list and select the "**Edit Point**" button or the "**Edit Speed**" button.

The Polyline can also be exploded into individual path segments and modified on the main PathMaster® program table.

7. Once the Polyline is complete select "**Done**" to save the changes or select "**Cancel**" to exit and not save changes.

10.11.2 From Selected Line

8. To create a polyline from individual path segments, select the path segments to include in the Polyline.
9. Select the **Teach** menu.
10. Select *Polyline -> From Selected Lines*.

If the endpoints of the path segments do not match up, PathMaster® will ask to match up the endpoints and the polyline will use the best fit. If you do not to match up the endpoints the polyline will not be made. Refer to Figure 101.

The tool used for the first segment and the θ (Theta) position, will be used for the 3D Polyline command. This function is helpful when dispensing gaskets and odd shaped adhesive patterns where it is necessary to change height but have a continuous flow of material.

11. To edit a polyline, double click on the path and change the commands in the edit window. Refer to Section 7.5.

10.12 Arc

This function teaches an arc. An arc must have three points. The Z-axis does not change its position in the path. Refer to Section 10.1 for definitions of the tool functions.

Command	Position	On	Off	Speed	Other
ARC	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	
	1,1,0,0				
	0,2,0,0				

Figure 104: Programmed Arc Command

1. Select the Arc function.

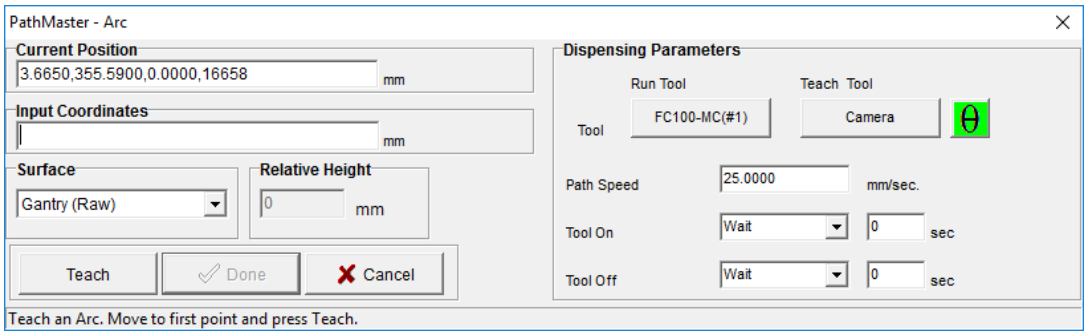


Figure 105: Teach Arc

2. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
6. Set the **Path Speed**.
7. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance in the box.
8. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
9. Teach the three points. Include the start point and move (clockwise or counter-clockwise) in the direction the axes must move. Use the teach pendant or input the coordinates.

NOTE: When you select points, space them evenly around the arc.

10. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.
11. To edit an Arc, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.13 Circle

This function teaches a circle. A circle must have three points. The Z-axis does not change position in this path. Refer to Section 10.1 for definitions of the tool functions.

NOTE: When you select points, space them evenly around the circle. Do not use the same point for the first and last point.

Command	Position	On	Off	Speed	Other
CIRCLE	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	
	2,2,0,0				
	0,2,0,0				

Figure 106: Programmed Circle Command

1. Select the **Circle** function.

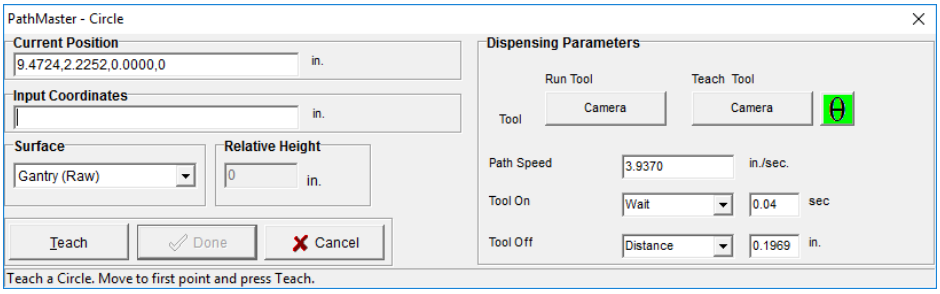


Figure 107: Teach Circle

2. Select the **Run Tool.** Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
6. Set the **Path Speed**.
7. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance in the box.
8. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
9. Select three points on the circumference of the circle. Include the start point and move (clockwise or counter-clockwise) in the direction the axes must move.
10. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.
11. To edit a circle, double click on the path and change the command in the edit window. Refer to Section 7.5.

NOTE: You can only operate Playback if the workcell is in Manual mode.

10.14 Tool

With this tool the user can enter a tool (tool) command into the edit window. Only tools that are configured in machine parameters are shown in this window.

Command	Position	On	Off	Speed	Other
TOOL	2 On				

Figure 108: Programmed Tool Command

1. Select the **Tool** function.
2. Select the **Run Tool**.
3. Select (double click) the necessary tool from the window. Refer to Figure 68.

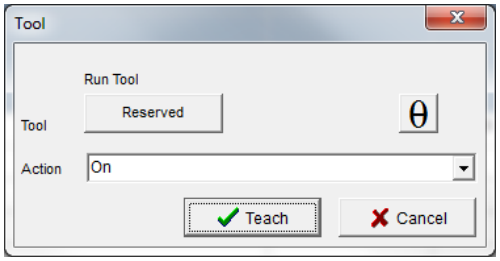


Figure 109: Tool Window

4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Action** from the dropdown menu.

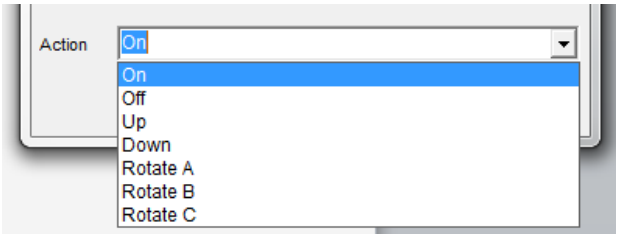


Figure 110: Tool Dropdown Menu

6. Select "**Teach**" to save the command, or "**Cancel**" to exit and not save the command.
7. To edit a tool command, double click on the tool command in the program table to open the Tool Command window.

Pneumatic positions (tool up/down, rotary selection) are not automatically programmed by PathMaster®. The operator must select the correct tool in PathMaster® and put the necessary pneumatic commands in the program after a path has been completed. Refer to Section 10.14 for more information.

10.15 Dot

This function teaches a timed dispense over a coordinate point.

Command	Position	On	Off	Speed	Other
DOT	1000,1500,0,10	(2) W 0.05	W 0.02		10.0000

Figure 111: Programmed Dot Command

1. Select the Dot function.
2. Teach the point with the teach pendent or input the coordinates.

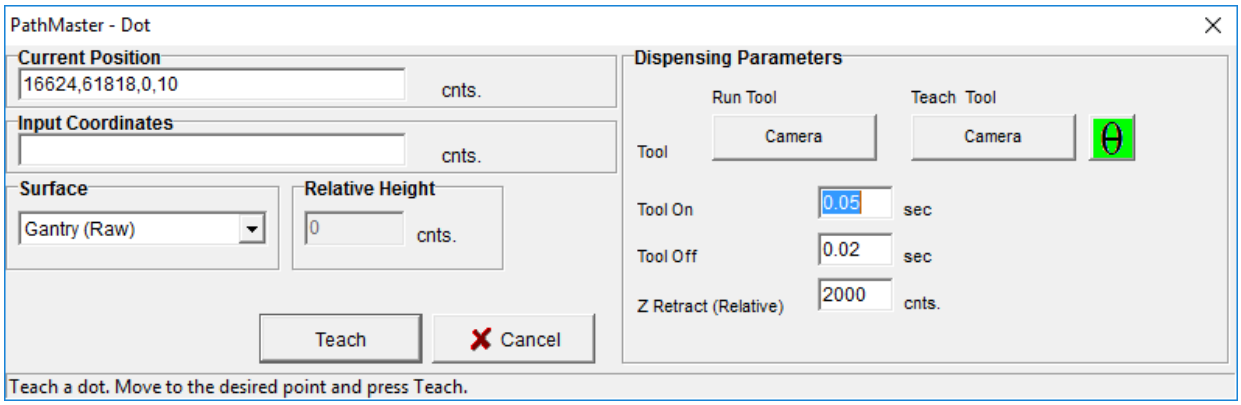


Figure 112: Teach Dot

3. Select the **Run Tool**. Select (double click) on the necessary tool from the window. Refer to Figure 68.
4. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
5. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

6. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
7. Make sure the **Z Retract** value is correct.
8. To edit the dot, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.16 Dot Array

Select any two corners of the array to create the array. The order the dots are taught determines the direction of the array. The program will automatically calculate the number of dots and the row spacing based on the set values.

1. Select the Dot Array function.
2. Select the **Run Tool**. Select (double click) on the necessary tool from the window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
6. Set the **Tool On** and **Tool Off** settings in seconds. Use the keyboard to type the values.
7. Set the **Z Retract (Relative)** setting in counts. Use the keyboard to type the value.

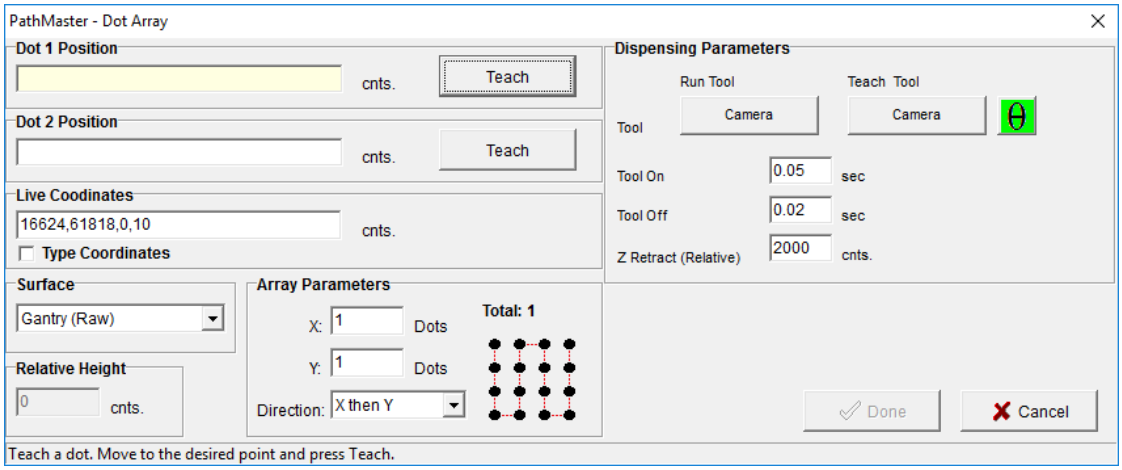


Figure 113: Create Dot Array

8. Set the number of dots for the X-axis.
9. Set the number of dots for the Y-axis.
10. Set the Direction for the dot array from the drop-down menu, either "X then Y" or "Y then X".
11. Teach the Dot 1 position. Move to the necessary position and select "**Teach**". In the example, this is the top left-hand corner of the array.

12. Teach the Dot 2 position. Move to the necessary position and select "**Teach**". In the example, this is the bottom right-hand corner of the array.

NOTE: The order you teach the dots in determines the direction of the array.

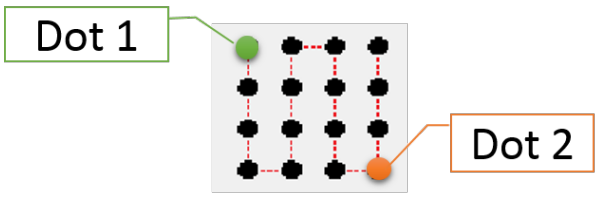


Figure 114: Dot 1 and 2

A window will show that the dots are generating.

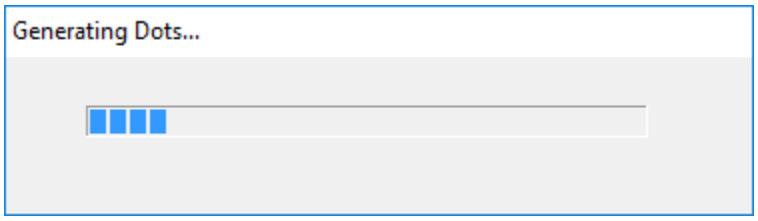


Figure 115: Generating Dots

13. Select "**Done**" when you are finished.

10.17Area

This function teaches rectangular paths. The Z-axis does not alter its position during the path. Refer to Section 10.1 for definitions of the tool functions.

Command	Position	On	Off	Speed	Other
AREA	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	12.0000,0
	4,0,0,0				
	4,4,0,0				

Figure 116: Programmed Area Command

1. Select the Area function.

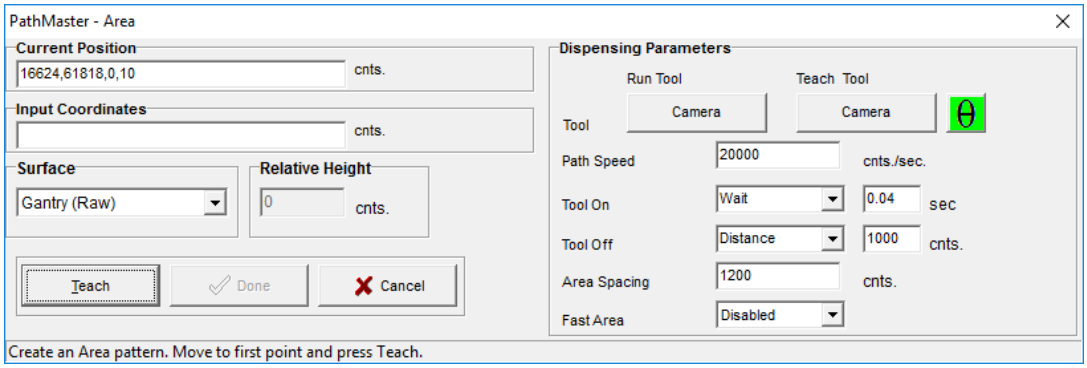


Figure 117: Teach Area

2. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
6. Set the **Path Speed**.
7. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance in the box.
8. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
9. Select the three points. Include the start point and move (clockwise or counter-clockwise) in the direction the axes must move.
10. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.
11. To edit an Area, double click on the path and change the command in the edit window. Refer to Section 7.5.

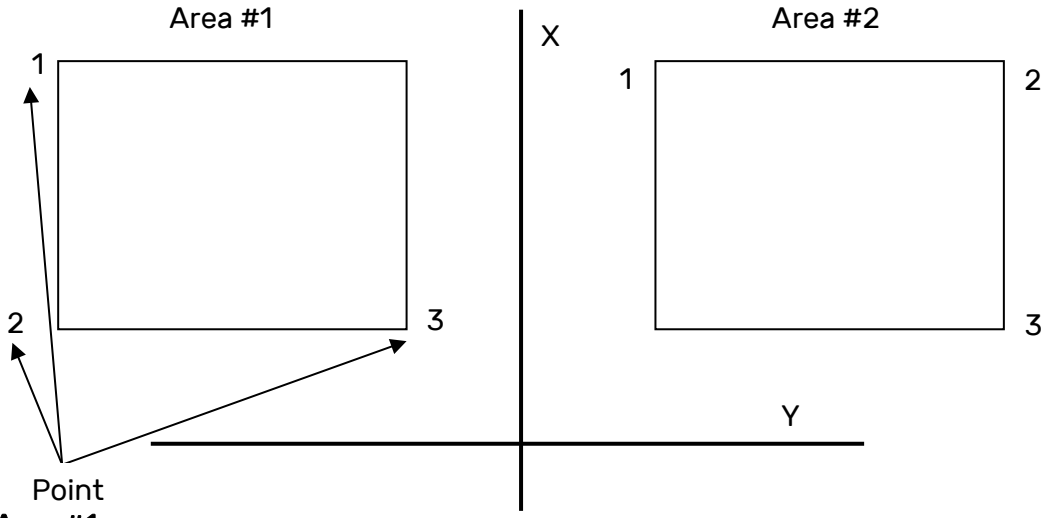
NOTE: Playback can only be operated if the workcell is currently in Manual mode. Only three points are required for the Area tool.

10.17.1 How the Area Function Works

Area path segments are calculated with three points as shown below:

Point 1 defines the start of the pattern. Point 2 defines the direction and length of the pattern. After the direction of the pattern is determined, the distance from point 1 to point 3 determines the width of the pattern.

The width is divided by the 'Area Spacing' (or 'Path Spacing') parameter on the Area function screen. The value given is the number of passes needed to fill the given area.



Area #1

- Point 1 defines the start.
- Point 2 is along the X-axis, so that is the direction of the path. The length of the path is the distance over the X-axis. Therefore, the width is along the Y-axis.
- Point 3 defines the width. The width is the difference in Y between points 1 and 3. This is divided by the 'Area Spacing' (or 'Path Spacing') parameter resulting in the number of paths the machine needs to run to fill the given area.

Area #2

- Point 1 defines the start.
- Point 2 is along the Y-axis, so that is the direction of the path. The length of the path is the distance over the Y-axis. Therefore, the width is along the Y-axis.
- Point 3 defines the width. The width is the difference in X between points 1 and 3. This is divided by the 'Area Spacing' (or 'Path Spacing') parameter resulting in the number of paths the machine needs to run to fill the given area.

10.17.2 FastArea™

FastArea™ is faster than the standard area because it prevents tool cycling between rows. This feature can greatly decrease cycle time. The way coordinates are taught with FastArea™ is different than a normal area. Each point defines the 3 corners of the rectangle, and the path will fit into area. Refer to the figure below.

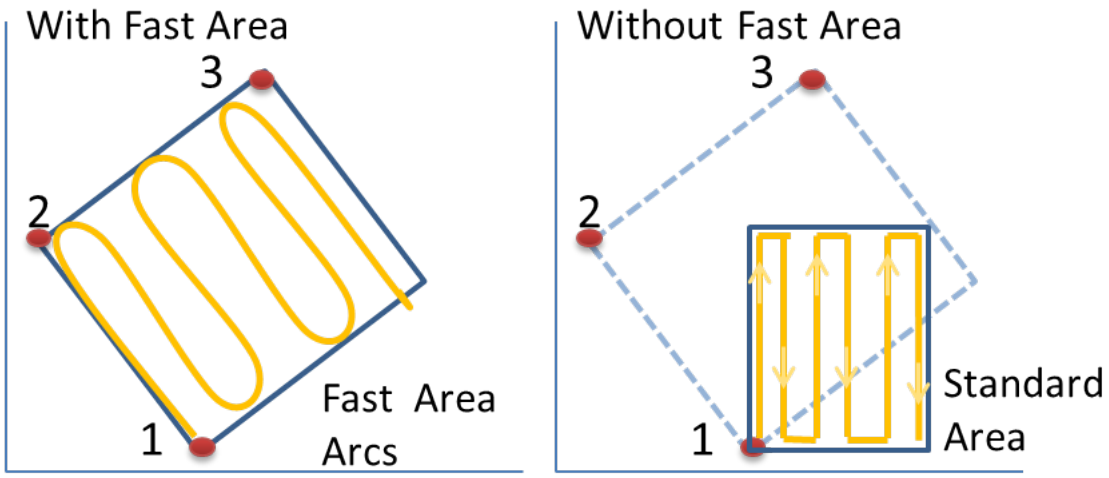


Figure 118: Fast Area

1. To use the FastArea™ feature teach a standard area. Refer to Section 10.17.
2. Select the type of fast area to be used (Disabled, Rectangular, Arcs).

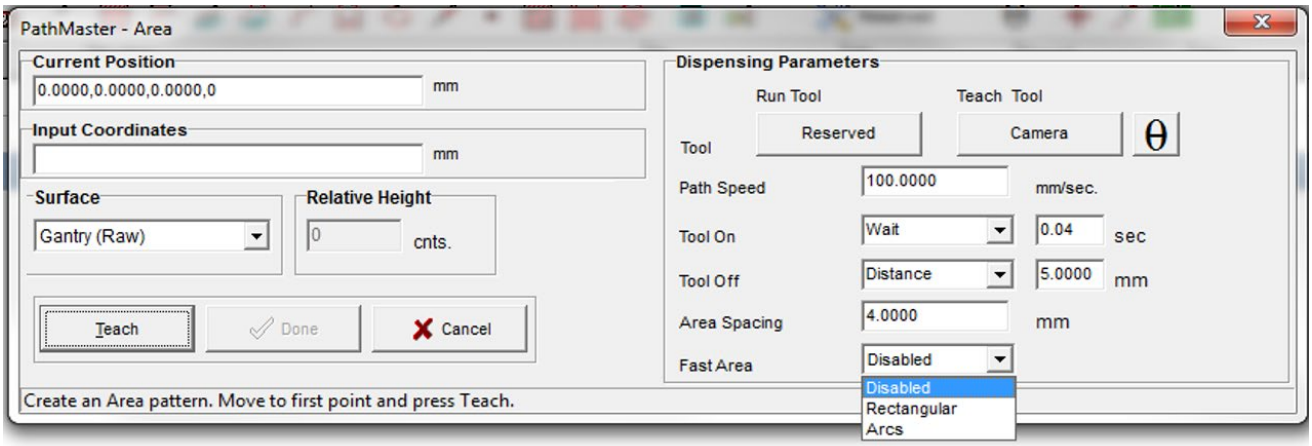


Figure 119: Fast Area

3. Select "**Done**" to save the changes, or "**Cancel**" to exit and not save changes.
4. To edit a FastArea, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.18 FastMask™

The FastMask™ function will create an area to be coated and keep outs within that area. There can be up to 99 keep out areas specified within the coating area.

Command	Position	On	Off	Speed	Other
FASTMASK	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	12.0000,0,0
	0.0000,0.0000,0.0000,0				
	0.0000,0.0000,0.0000,0				
	0.0000,0.0000,0.0000,0				

Figure 120: Programmed FastMask Command

Shown below is an example of a PCB (Printed Circuit Board) with keep out areas specified.

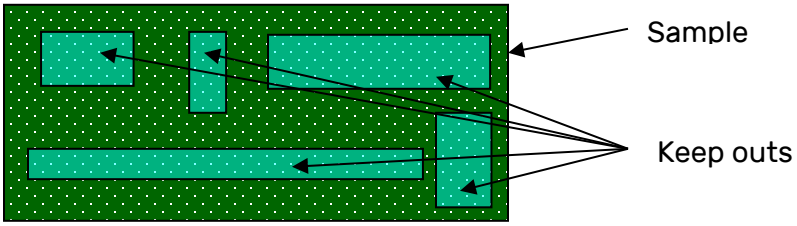


Figure 121: Sample Board with Keep out Areas

1. Select the FastMask™ function to open the wizard.
2. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Set the **Tool Height** to "**Use the Current Z Height**" or "**Use Calibrated Z Height**".
6. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance in the box.
7. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
8. Set the **Path Speed**.
9. Set the **Area Spacing.**
10. Select the appropriate tool parameters.
11. Teach two opposite corners of the area to be coated as point 1 and point 2.

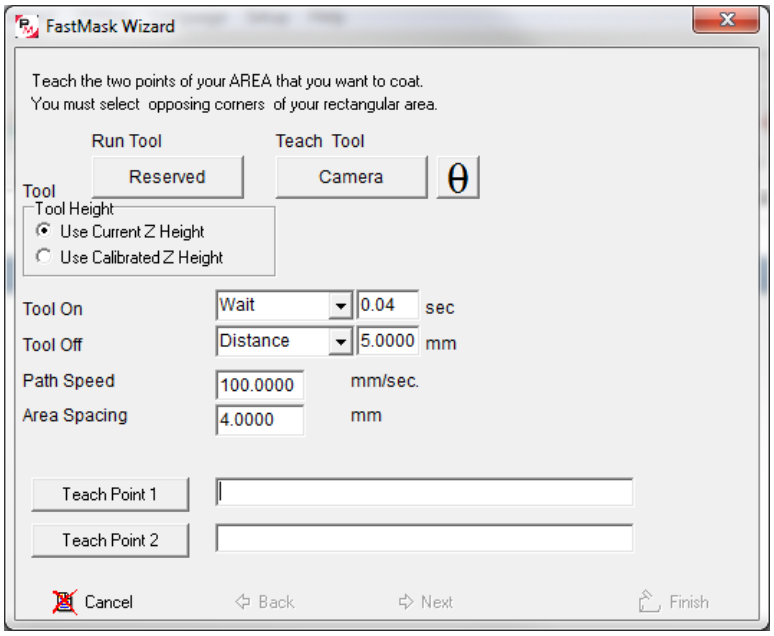


Figure 122: FastMask Area Teach

12. Select the "**Next**" button.
13. Teach the opposite corners of the first keep out area.
14. Select the "**Add**" button to add the keep out to the FastMask™ list.

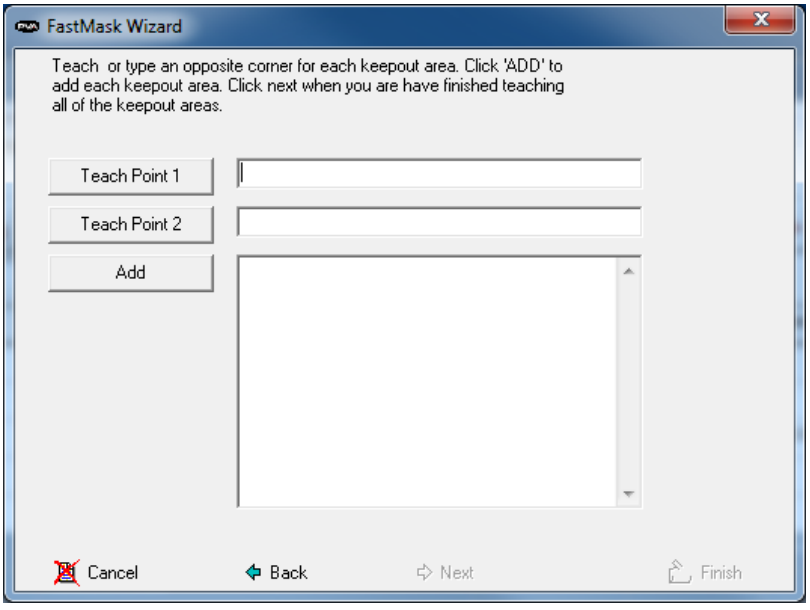


Figure 123: Keep Out Teach Menu

15. Continue to add keep out areas (up to 99 keep outs) until all non-coat areas have been included in the FastMask™ list.
16. Select the "**Next**" button.

17. Select the **Spray Pattern**. This is the direction the tool will go when this FastMask™ pattern is used.

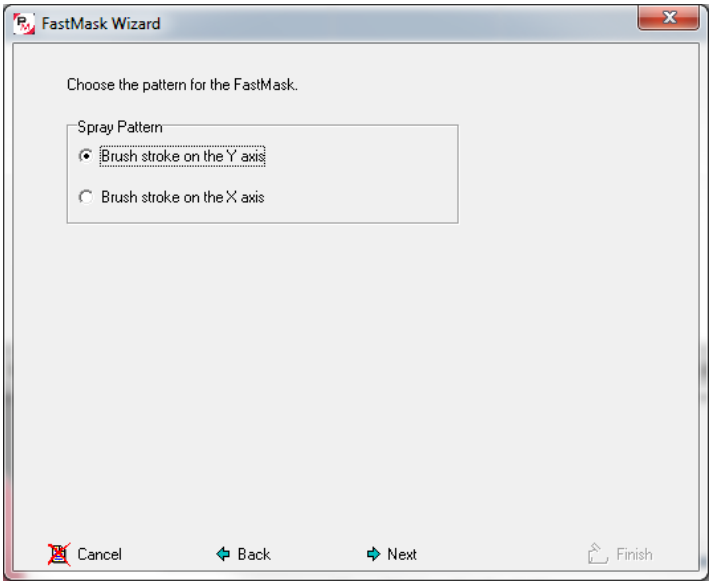


Figure 124: FastMask Brush Stroke Pattern

18. Select the "**Next**" button.

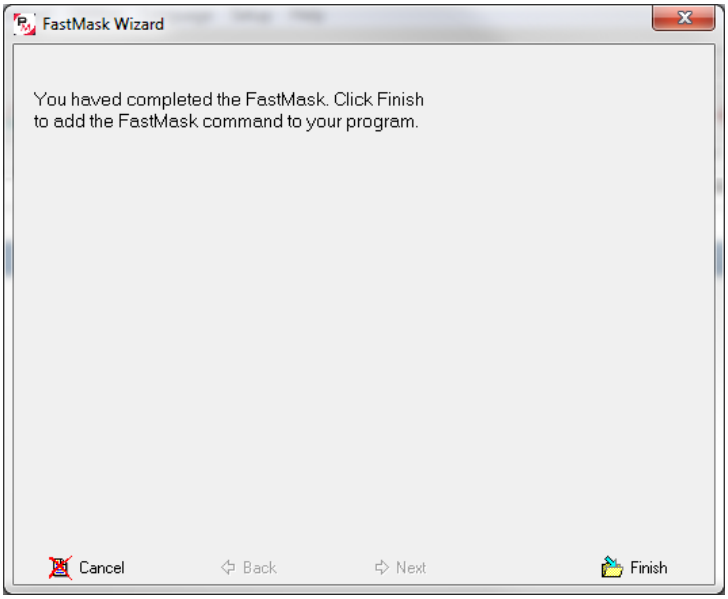


Figure 125: FastMask Complete

19. Select the "**Finish**" button.

The FastMask™ pattern will always start at the point taught closest to the origin of the gantry (the smallest coordinate in the pattern).

20. To edit a FastMask, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.19 Rectangular Spiral

This creates a square spiral pattern with an area defined by the user. This is one continuous dispense and is used when a material is unable to be equally spaced with the area command. There are 3 points, the 1st point is the start, the 2nd point is direction, and the 3rd point gives the size. The Z-axis does not change position in this path.

Command	Position	On	Off	Speed	Other
RSPIRAL	10,0,0,0	(1) W 0	W 0	3.9370	0.1969
	0,0,0,0				
	0,10,0,0				

Figure 126: Rectangular Spiral Programmed

1. Open the Rectangular Spiral function.

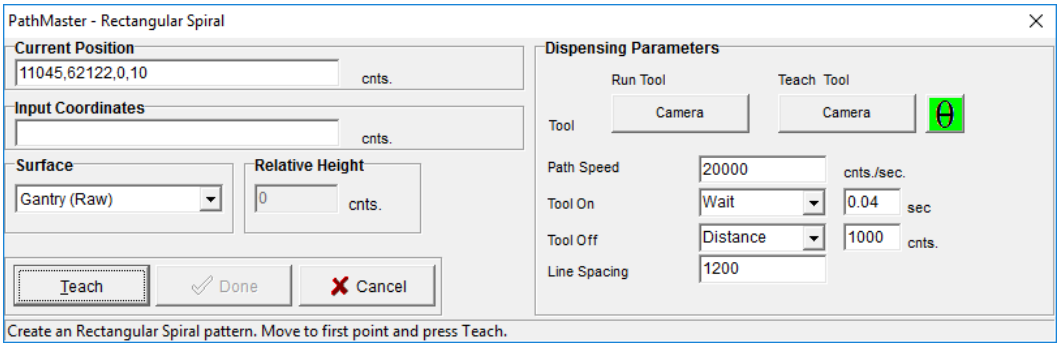


Figure 127: Teach Rectangular Spiral

2. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool** if necessary. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).

NOTE: The "θ" button will only be available on 4-axis machines. When you use the "Teach Tool" (virtual tool 0) it is not necessary to select this button.

5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
6. Put the necessary value in the **Path Speed** box.
7. Teach the points. Point 1 is where the path starts. Point 2 is the direction of the path. Point 3 uses the diagonal distance between 1 and 3 to find the size.
8. Set the **Tool On** and **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
9. Set the **Line Spacing**.
10. Select "**Done**" to save the changes or "**Cancel**" to exit and not save changes.
11. To edit, double click on the path and use the edit window. Refer to Section 7.5.

10.20 Circular Spiral

This creates a spiral pattern with an area defined by the user. The command is taught like an arc command. It uses 3 points where the 1st point is the start, the 2nd point is direction, and the 3rd point forms a diagonal with the 1st point to determine size. In this tool, line spacing is the pitch or distance between arcs and direction refers to in or out direction of the path. The Z-axis does not alter its position during the path.

Command	Position	On	Off	Speed	Other
SPIRAL	0.0000,0.0000,0.0000,0	(1) W 0.02	D 3.0000	100.0000	0.5,0,0
	2,10,0,0				
	10,12,0,0				

Figure 128: Spiral Programmed

1. Open the Spiral function.

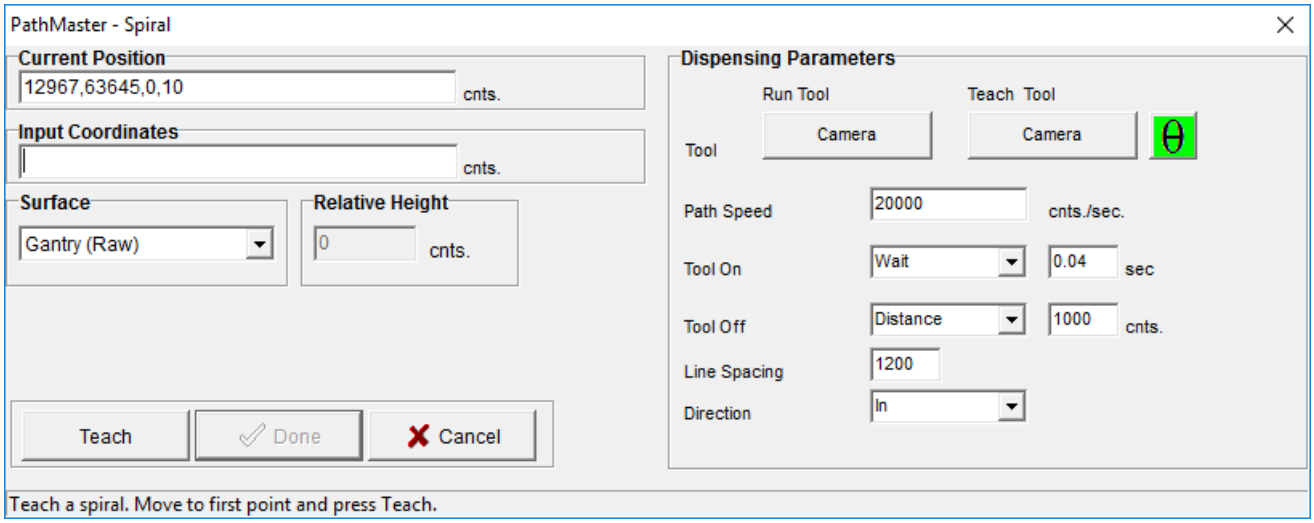


Figure 129: Teach Spiral

2. Select the **Run Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
3. Select the **Teach Tool**. Select (double click) the necessary tool from the Tool Selection window. Refer to Figure 68.
4. Select "**θ**" to move the selected tool to the calibrated W-axis position (theta).
5. Select the **Surface** from the drop-down menu. In some units, you can set the **Relative Height**.
6. Put the necessary value in the **Path Speed** box.
7. Set the **Path Speed**.
8. Teach the points required for the tool selected. Point 1 is where the path will start. Point 2 is the direction of the path. A diagonal line between point 1 and point 3 gives the size of the rectangle.

9. Set the **Tool On** to "**Wait**" or "**Distance**" and set the time or distance in the box.
10. Set the **Tool Off** to "**Wait**" or "**Distance**" and set the time or distance in the box.
11. Set the **Line Spacing**.
12. Set the **Direction to** "**In**" or "**Out**".
13. Select "**Done**" to save the changes or "**Cancel**" to exit and not save changes.
14. To edit a rectangular spiral, double click on the path and change the command in the edit window. Refer to Section 7.5.

10.21 Surface Height (DMC 4000)

The Surface Height command is used to teach surfaces used in PolyLines. The surfaces should be run in order, to count the different surfaces before the related paths are run. The process is similar to fiducials.

1. Click on the surface height icon in the Programming Toolbar to open the surface height interface.
2. Use the tool parameters subsection to find the necessary profile tool and teach tool to teach surfaces for the current product.

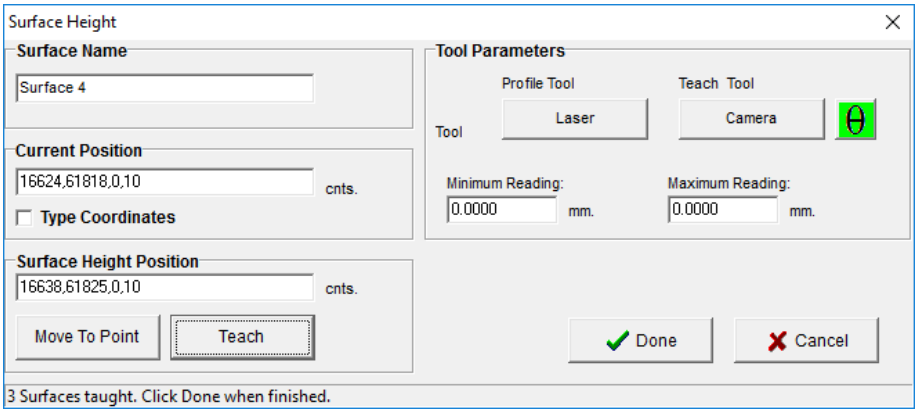


Figure 130: Surface Height Teach Interface

3. If necessary, set a min/max for each surface height in the surface height teach interface (in the tool parameters window). With these values, the machine can make sure a part is within a set tolerance for a surface height reading. This reading can be seen in the Portal front panel.

NOTE: After a Surface Height call, if the Profile Tool selected is on the head on a Z-Slide, the user must program the necessary Tool Command to retract the Z-Slide.

NOTE: In Autocycle, if a part fails a surface height you can try again.

4. The **Surface Name** can be changed to any unique name on a per-program basis.
5. If necessary, use the **Theta** button to rotate the W-axis to the correct position.

Command	Position
SURFACE	11028,-1601,0,0
SURFACE	11028,-399,0,0

Figure 131: Surface Command in Path Program

6. Click "**Teach**" to set the Surface Height Position for the height check.
7. Click "**Done**" to save the point and return to the main PathMaster® screen.
8. Repeat the Procedure to teach as many Surface Height Checks as necessary.

10.22 Run Selection / Sequence

The Run Selection function will play back the selected path segments in Wet, Dry or Camera mode. Run Sequence always plays the entirety of the Path Program.

1. Select one or more commands.
2. Select the **Run Selection** function to play the highlighted commands or **Run Sequence** to play all of the current Path Program.
6. Select "**Wet**", "**Dry**", or "**Virtual Tool 0**". The name for the third option will be the name of Virtual Tool 0.

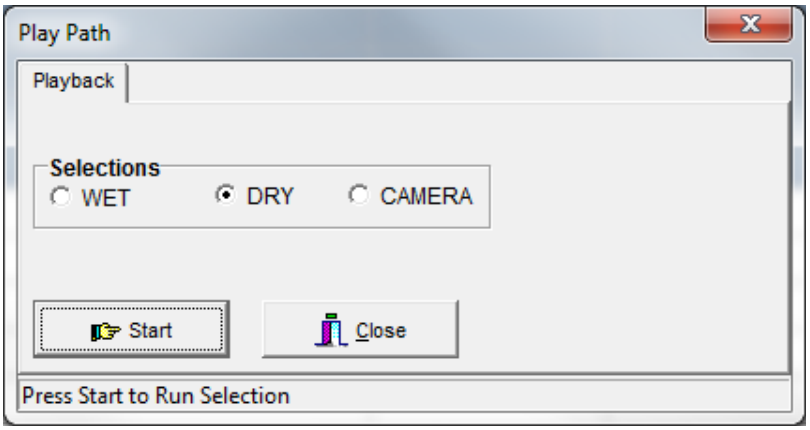


Figure 132: Playback

3. Select "**Start**" to play the highlighted commands.
4. Select "**Close**" to exit and not play the path.

10.23 Z-Axis Height

NOTE: The "Use Current Z Height" and "Use Calibrated Z Height" checkboxes are only shown when the Teach Tool is enabled. The Tool Offset table and Tool Parameters must be correctly configured before use.

The teach tool can be used to make paths on the workcell. After a path segment is taught with the teach tool, the tool can be changed to any other tool and the offset is set by PathMaster.

The Z-axis (height) position is set by the user when path segments are taught, the teach tool's current Z-coordinate or a pre-calculated value, called the Calibrated Tool Height, can be used. If the calibrated tool height is used, it will not be necessary to change the path after it is complete, and when tool changes or needle calibrations are done, the offsets are update for the path programs.

Tool Offset Height: The distance traveled by a specific tool from the Z-axis home position to the workpiece.

Relative Height: The Z distance from the position taught as the tool offset reference position on the calibration plate that the tool will operate at, set in the Tool Configuration window. Also called **Gantry (Relative)** in the **Surface** menu. Not available for 2D Line, 3D Line, Area, Arc, Circle, Dot, Dot Array, Rectangular Spiral, and Spiral. Functions slightly differently when used in the Move command.

Calibrated Z Height: The difference between a tool offset and the tool's Relative Height is the Calibrated Z Height for a tool. Also called **Calibrated Z**, in the **Surface** menu.

$$\textit{Calibrated Z Height} = \textit{Tool Offset Height} - \textit{Relative Height}$$

Additional Options in the Surface Menu:

Gantry (Raw) uses the Z coordinate exactly as it was taught.

Use Last uses the Z height of the previous Surface used in the Polyline. Not available for 2D Line, 3D Line, Area, Arc, Circle, Dot, Dot Array, Rectangular Spiral, Spiral, and Move.

Custom Surface uses the XY coordinates of the Surface command that shares the same name and uses the Z height and the current run tool's "**Calibrated Z**" to set the dispense Z height.

NOTE: The available Z-height options depend on the workcell configuration and the function being used.

10.23.1 Offset Details

The offset height is shown in PathMaster's Tool Configuration window and set in the Camera Offset Training window. Refer to Section 6.6.5 for more information.

- Select the **Offset Details** button to be shown the related tool offset.

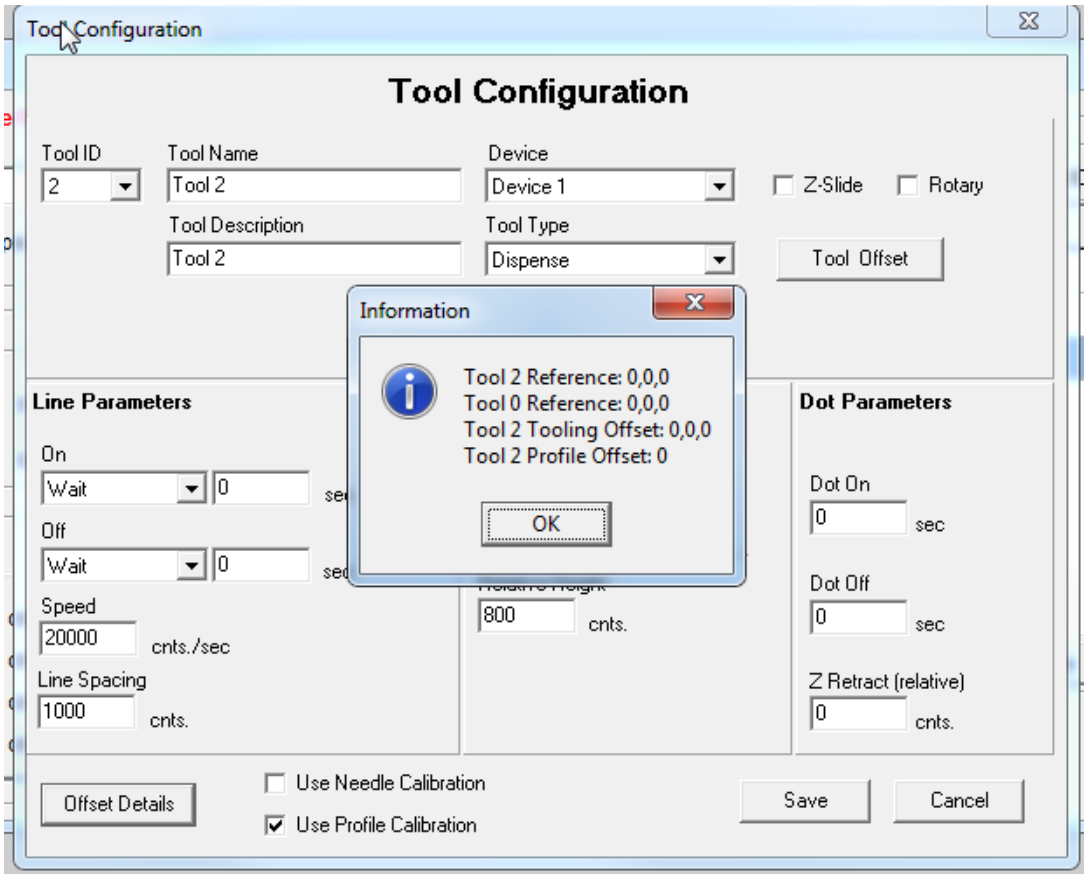


Figure 133: Example Tool Offset

Run Tool Reference – This is the absolute position where the Run Tool is positioned to calculate the tool offset.

Teach Tool Reference – This is the absolute position where the Teach Tool is positioned to calculate the Tool Offset.

Run Tooling Offsets – This is the difference in position between the Teach Tool and the Run Tool (Tool Offset).

Tool Profile Offset – This is the difference between the Profile Z Common reference and the tip of the Run Tool (Profile Offset).

10.23.2 Relative Height

The Relative Height is shown in PathMaster's Tool Configuration window (Figure 134). This value must be correctly set or the workpiece or workcell could be damaged. This value can be found in *Setup -> Machine Parameters -> Tool Parameters* for each tool.

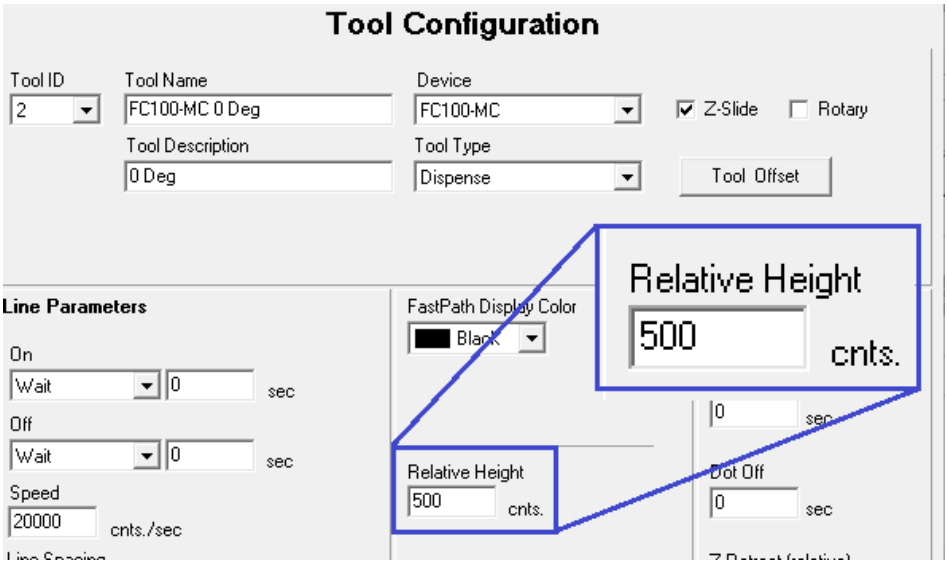


Figure 134: Relative Height Input Box

10.23.3 Calibrated Z Height

The following functions have the ability to make use of "Calibrated Z Height" or the Surface menu options Gantry (Raw), Calibrated Z, and Custom Surface:

- Tool Move
- 2D Line
- 3D Line
- Arc
- Circle
- Dot
- Reference Point
- PolyLine
- PolyLine3D
- Spiral
- Rectangular Spiral
- Area
- FastMask

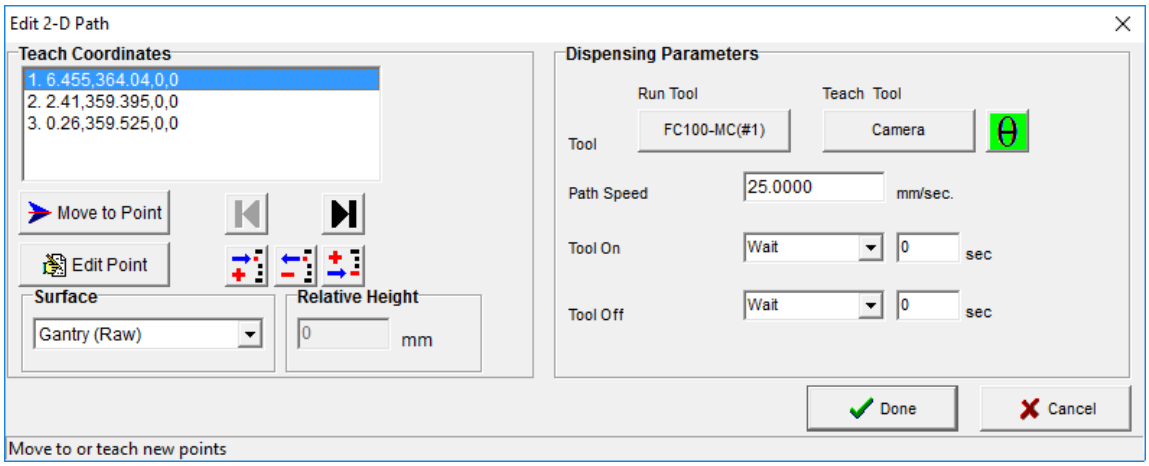


Figure 135: 2D Path with Tool Height

- When "**Use Current Z Height**" is selected and a point is taught, the Z-axis coordinate used is the current Z coordinate of the machine, as shown in the Lower Status Bar.

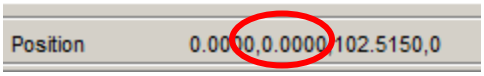


Figure 136: Z-Axis Coordinate in the Lower Status Bar

- When "**Use Calibrated Z Height**" is selected and a point is taught, the saved Z-axis coordinate is the selected tool's calculated tool height. When a user selects "**Use Calibrated Z Height,**" the following message is shown:

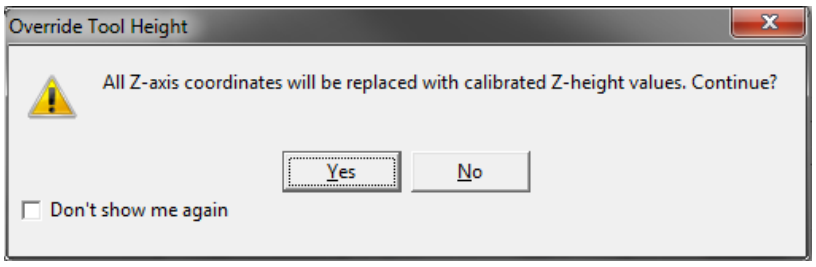


Figure 137: Override Tool Height

- If "**No**" is selected, the "Override Tool Height" checkbox will be automatically selected again, and no change will take place. If "**Yes**" is selected, all the points that have been taught in the current path segment and any future points in the current path segment will have the selected Calibrated Z Height value as the Z-axis coordinates.

10.23.4 How to Use the Tool Height Options

There are two ways to change the Tool Height options as shown below.

- When you teach a path select "**Use Calibrated Z Height**" or "**Use Current Z Height,**" or select an option from the drop-down **Surface** menu. Available options depend on the workcell configuration and the function.

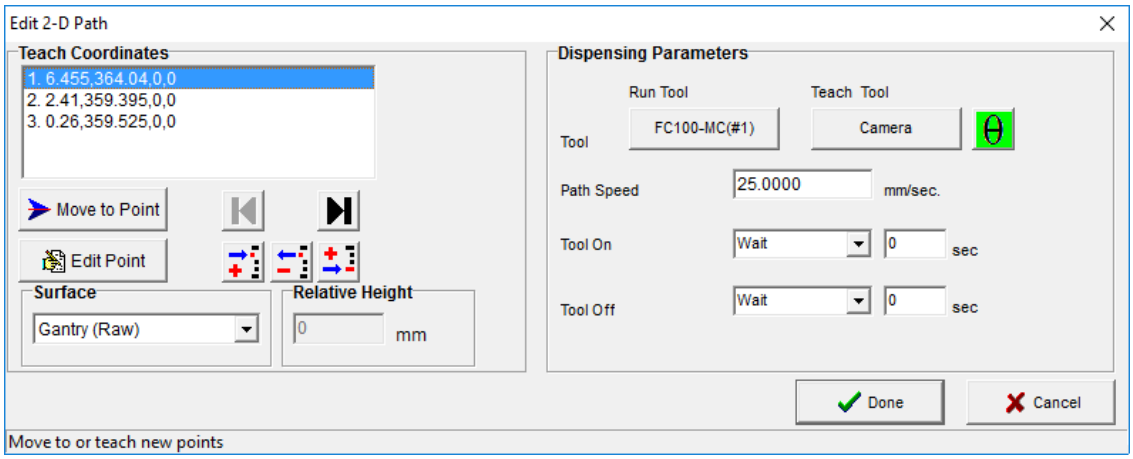


Figure 138: Teach Window Tool Height

- After a path has been taught you can change the settings in the Edit window. Refer to Figure 67.

All necessary offsets are automatically set by PathMaster.

10.23.5 Example

In the example below, the first 2D line is shown with the "**Use Current Z Height**" selected at the Z height of zero. There is no offset shown, and so the displayed value is zero. For the second 2D line, the first function was copy and pasted, another Run Tool was selected and "**Use Calibrated Z Height**" was selected.

Command	Position	On	Off	Speed
LINE(2D)	100,100,0,0	(1) W 0.04	D 5.0000	100.0000
	200,200,0,0			
	300,300,0,0			
LINE(2D)	120,120,75,20	(3) W 0.04	D 5.0000	100.0000
	220,220,75,20			
	320,320,75,20			

Figure 139: 2D Lines Before and After Switching Tools

The difference in coordinates from the first 2D Line and the second, show XYW offsetting and the calibrated height has been used for Z.

10.23.6 Offline Programming (FastPath)

When you use FastPath (the teach tool must be enabled), all taught positions will use the tool height values for the Z position. This makes the transition from programming offline to online easier.

10.24 Step Over

The Step Over function allows playback of previous or next path segment to be executed one step at a time as well as playback wet or dry.

1. Select the Step Over function, select *Main Menu > Utilities > Step Over Path*.
2. Select the correct **Option Wet**, **Dry,** or **Teach Tool.**
3. Select the Command you want to play with the "**Backward**" and "**Forward**" buttons. The highlighted command in the edit window is the command that will play.

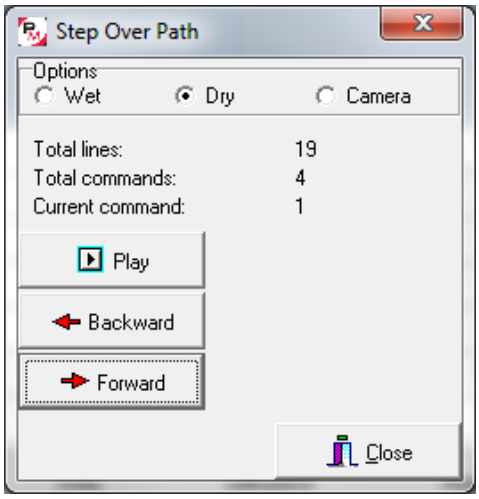


Figure 140: Step Over Path

4. Select "**Play**" to operate the path segment as selected.
5. Select "**Close**" to exit and not play a path.

11. Additional Functions

There are other functions that are not in the programming functions toolbar. Their locations and information on how to use them are in this section.

11.1 Subroutine

With this function the operator can use a command line element in an array sequence or in random placement. Individual subroutines can be put in the program with the Insert option.

11.1.1 To Create

1. Highlight the commands to be included in the subroutine.
2. Select the *Teach -> Subroutine -> Create* option from the main menu.

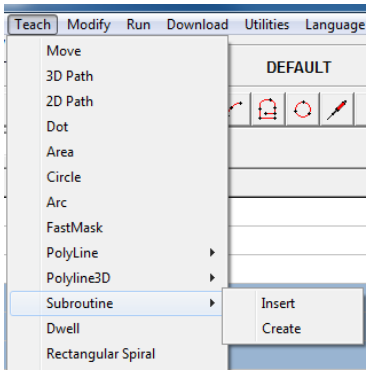


Figure 141: Subroutine Menu

3. Choose a name and description for the subroutine. The description helps the operator to select the correct subroutine.

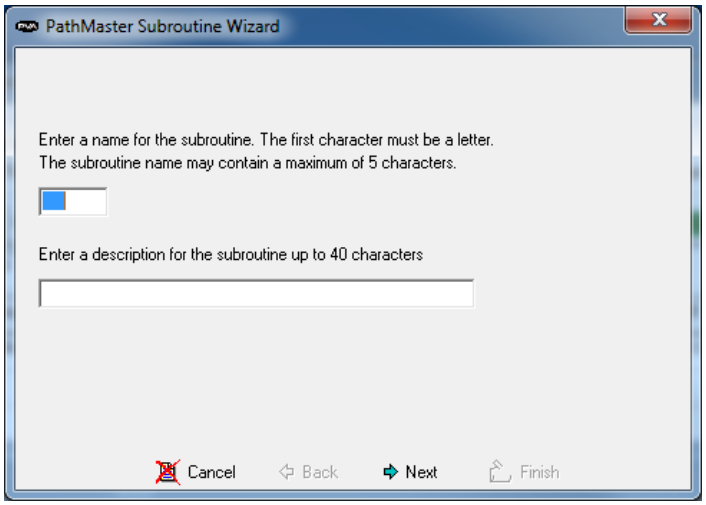


Figure 142: Name the Subroutine

4. Teach a reference point on the part to group the command line sequences. Each subroutine, arrayed or random placed, will be referenced from this point.

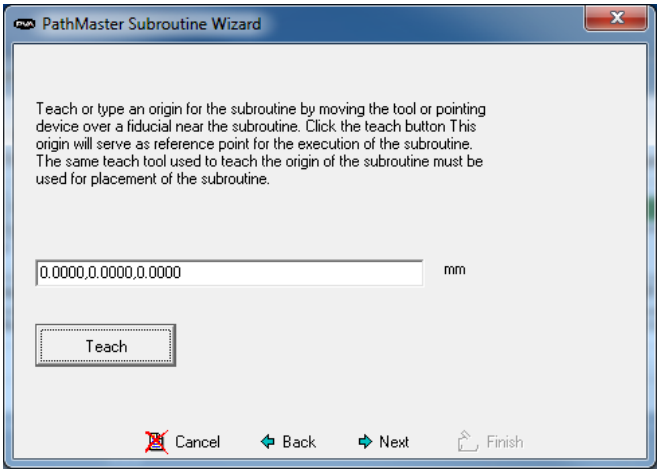


Figure 143: Teach a Reference Point

5. Select **Create an array** or **Place random** for the subroutine.

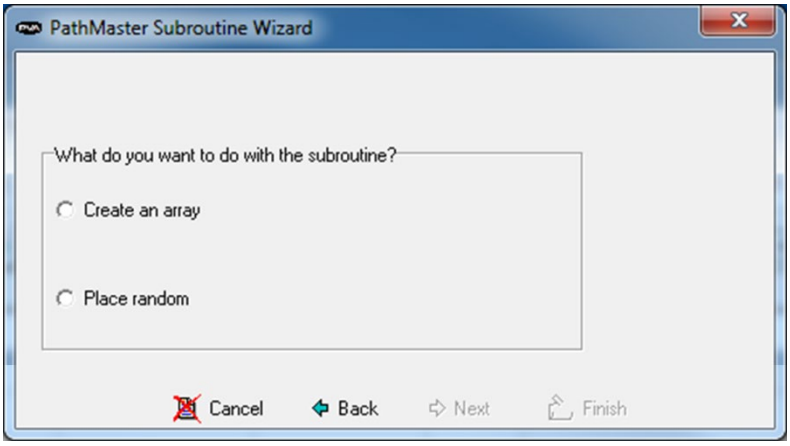


Figure 144: Subroutine Type

6. Select "**Next**".

For place random, continue to step 7. For create an array continue to step 10.

11.1.2 Place Random

7. Select the "**Teach Position**" button for PathMaster® to record the current location of the end effector as an execution point. Or, enter the necessary coordinates in the Teach Coordinates box and select "**Teach Coordinates**".

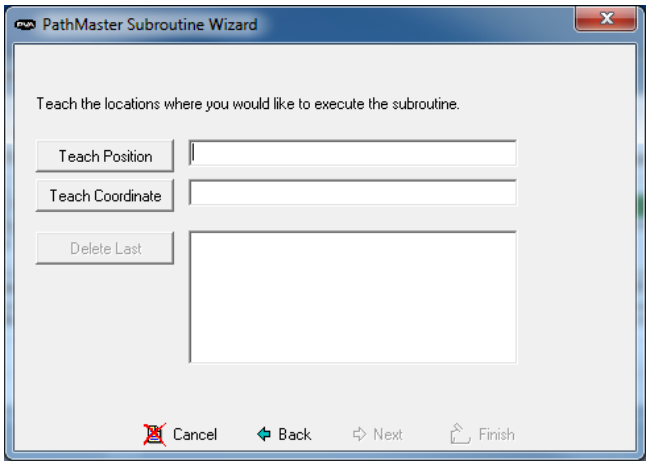


Figure 145: Place Random Routine

8. Select "**Next**" when you have taught all the necessary coordinates.
9. Select "**Finish**".

11.1.3 Create an Array

10. Select the direction of the array. The arrows show direction as related to X, Y 0, 0 origin of the current machine.

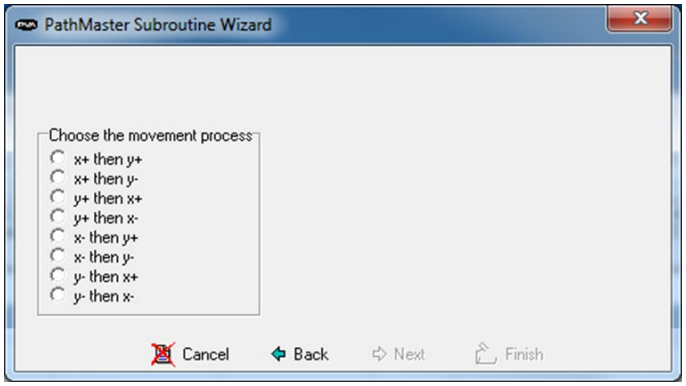


Figure 146: Create an Array Routine

11. Select the number of elements in the X direction and the Y direction.

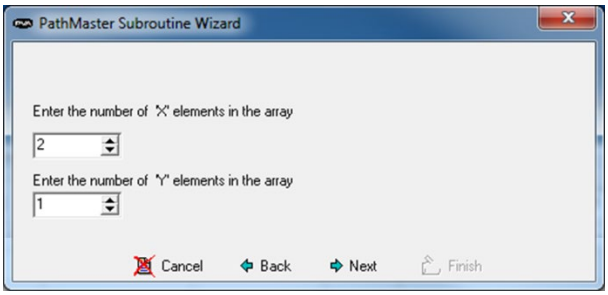


Figure 147: X and Y Elements

12. Teach the first and last points. The coordinates entered are relative to the point of origin taught before. PathMaster® calculates the distance for X and Y spacing.

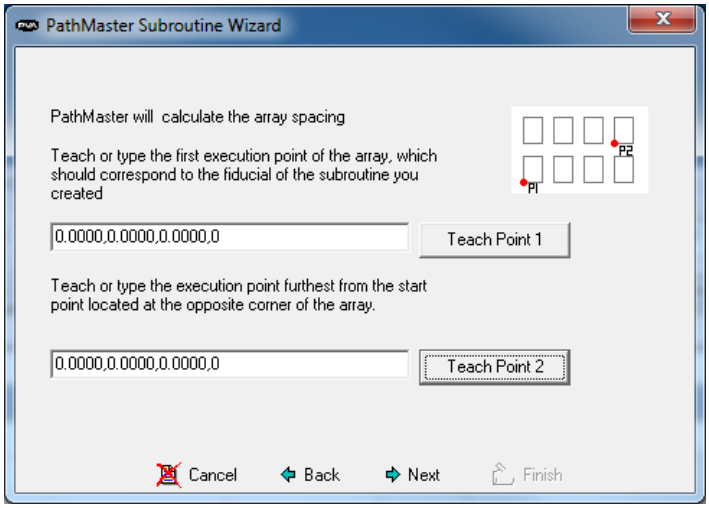


Figure 148: Teach First and Last Points

11.1.4 Finish

13. Select "**Finish**" to save the subroutine, or "**Cancel**" to exit and not save changes.

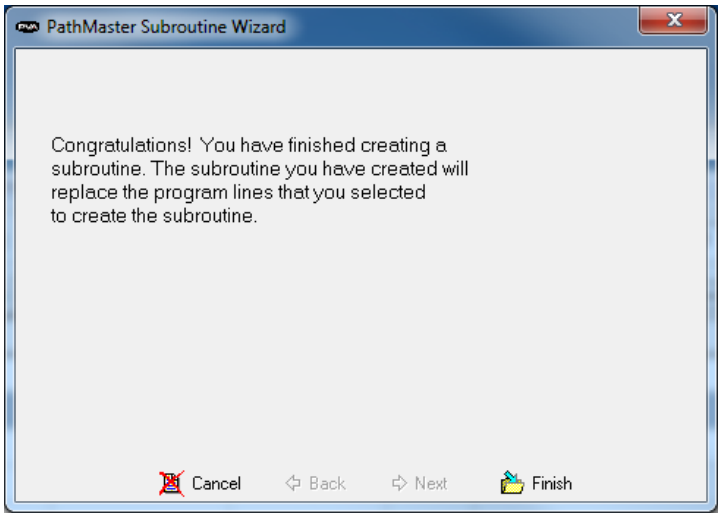


Figure 149: Finish Window

11.1.5 Edit the Subroutine

1. Save the current project.
2. Select *File -> Open -> Subroutine* and choose the subroutine from the list.
3. Edit the routine as necessary.
4. Save the subroutine and open the current project again.

11.2 I/O (Input/Output)

The operator can control outputs or wait for an input to be in a set state. Only operators who understand discrete I/O and its use should use this tool.

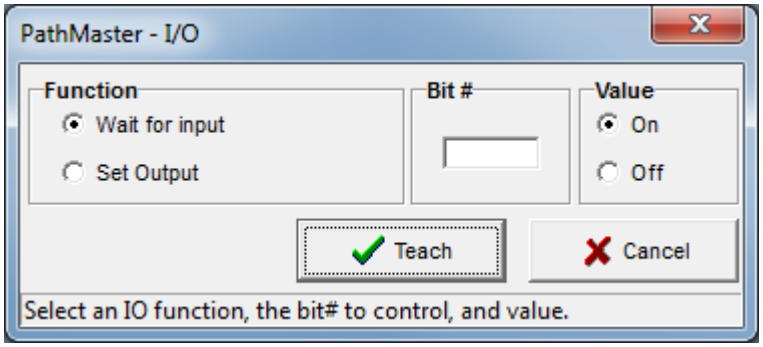


Figure 150 Teach I/O

1. Select *Teach->I/O* from the main menu.
2. Select the necessary function.
3. Select "**Wait for input**" to hold the program until an input is in the set state. Select "**Set Output**" to turn a discrete output on or off.
4. Put the necessary value in the **Bit #** box. This is the location of the discrete I/O bit referenced.
5. Select the necessary Value, "**ON**" or "**OFF**".
6. Select "**Teach**" to add your selections to the program or "**Cancel**" to exit and not save changes.

11.3 Move Speed Change Command

The Move Speed Change command is used to change the speed of independent axis movements between dispense points. This command does not change the speed at which the gantry moves when dispensing. All movements between dispenses are changed by this command. This may be utilized multiple times in a path to change the rate of motion at any time.

To access the Move Speed Change command, click *Teach > Move Speed* from the main menu.

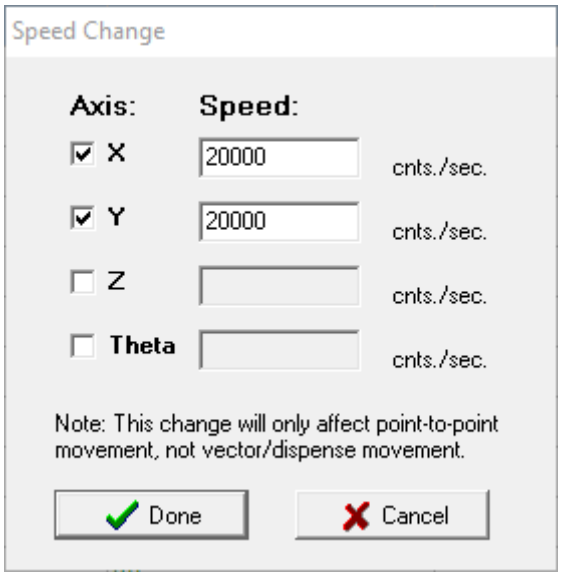


Figure 151: Move Speed Change Window

11.4 Inspection

The function moves to the taught gantry position with X and Y offsets applied. Once the tool is in position, the inspection program and light type DMC parameters are set and the DMC inspection routines are called. The vision module reports a pass/fail status to the controller based on the inspection result defined with the inspection project.

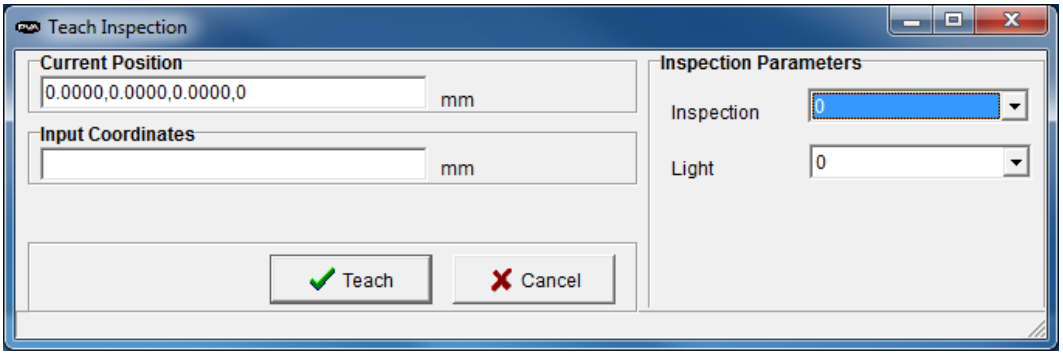
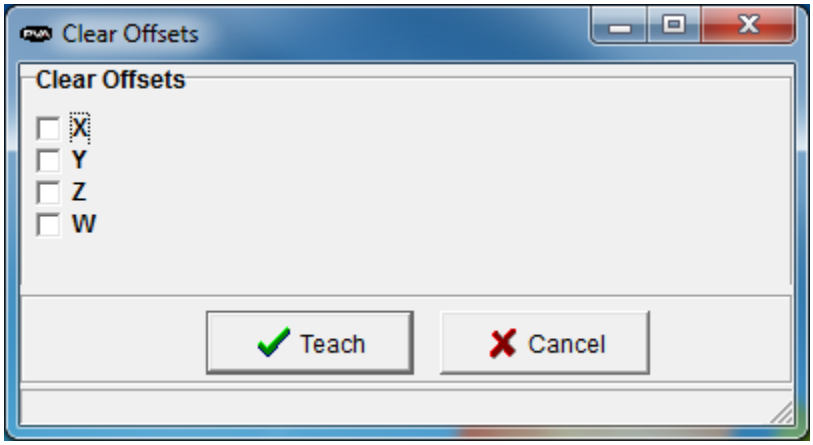


Figure 152: Teach Inspected

1. Select *Teach->Inspection* from the main menu.
2. Set the **Inspection** to be used.
3. Set the **Light** to be used.
4. Input the coordinates or use the teach pendant to teach the coordinates.
5. Select "**Teach**", or select "**Cancel**" to exit and not change the command.

11.5 Clear Global Offsets

Clear any X, Y, Z, or W offset associated with the GX, GY, GZ, and GW variable.



Teach Clear Global Offsets

1. Select *Teach->Clear Global Offsets* from the main menu.
2. Select the boxes you want the global offsets cleared from.
3. Select "**Teach**" to clear the offsets (X, Y, Z, W).
4. Select "**Cancel**" to exit and not change the command.

11.6 Motion Smoothing

The motion smoothing command is a jerk limiting function applied to independent and vector motion profiles. You must have a DMC4000 or DMC 4200 series motion controller to use this function.

1. Select the Motion Smoothing function from the Teach menu.

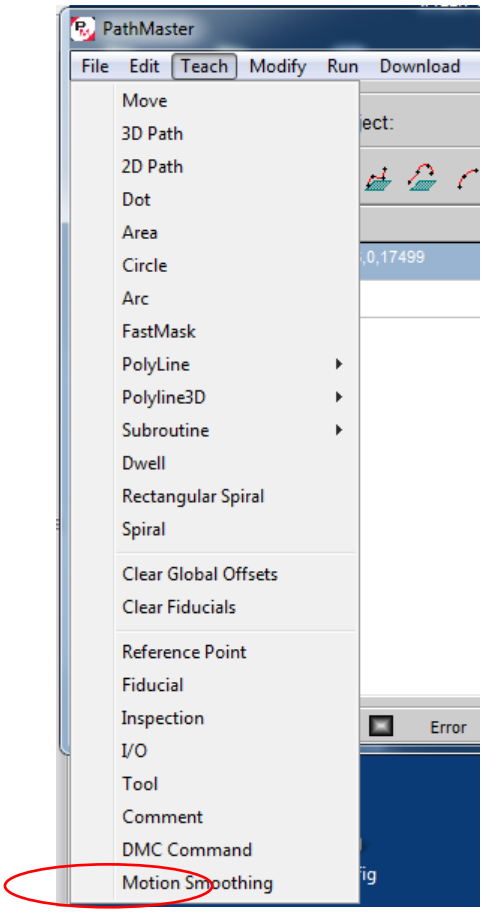


Figure 153: Motion Smoothing

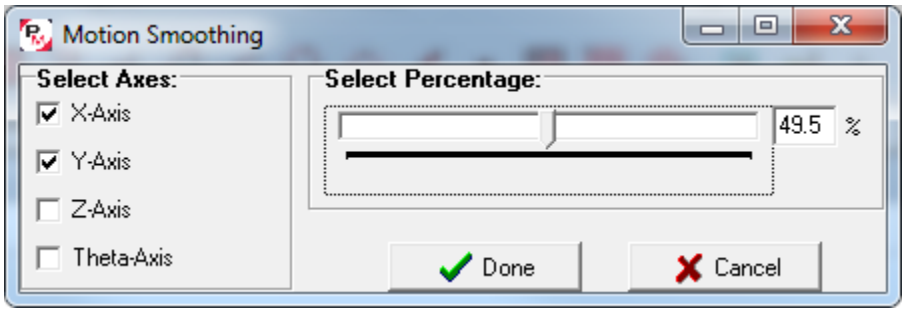


Figure 154: Motion Smoothing Window

2. Select the Axes boxes you want the smoothing to be applied to. If an axis is not checked, no smoothing change will be applied to that axis.
3. Select a percentage of smoothing within the configured range in the motion smoothing interface window. The smoothing percentage is applied to all axes with checked boxes.
4. Create multiple smoothing commands to use different smoothing values for different axes.
5. When a smoothing function is used, it is applied to all motion that follows in that path program or until another smoothing command is applied. Smoothing is reset at the beginning of every path by default.

11.6.1 Smoothing Examples:

No Smoothing applied can cause overshooting on corners.

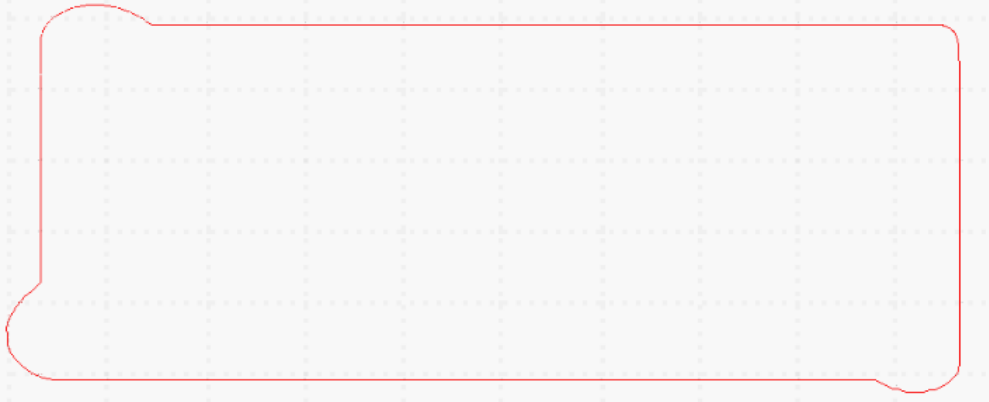


Figure 155: No Smoothing Applied

Smoothing applied minimizes the following error on corners.

Figure 156: Smoothing Applied

12. Offline Programming with FastPath

Before you use FastPath™, tool offsets must be configured. Refer to Section 6.6.5 for more information.

When you are in FastPath your cursor is a crosshair. Each time a point is taught the crosshair will briefly change to an arrow pointer to show that the point was taught.

12.1 Set Up a Background Image

1. Open a new program.
2. Select *Edit->Program->Offline Image* from the main menu.
3. Select "**Change Image**" to change the background image. If no image is selected, the default image will be used. The default image is a 500mm by 500mm image with a workspace of the same size. The background image must be of a known size, approximately the same size as the area to be dispensed upon.
4. Put the correct values in the **Workpiece Dimensions** boxes for **Board Length** and **Board Width**.

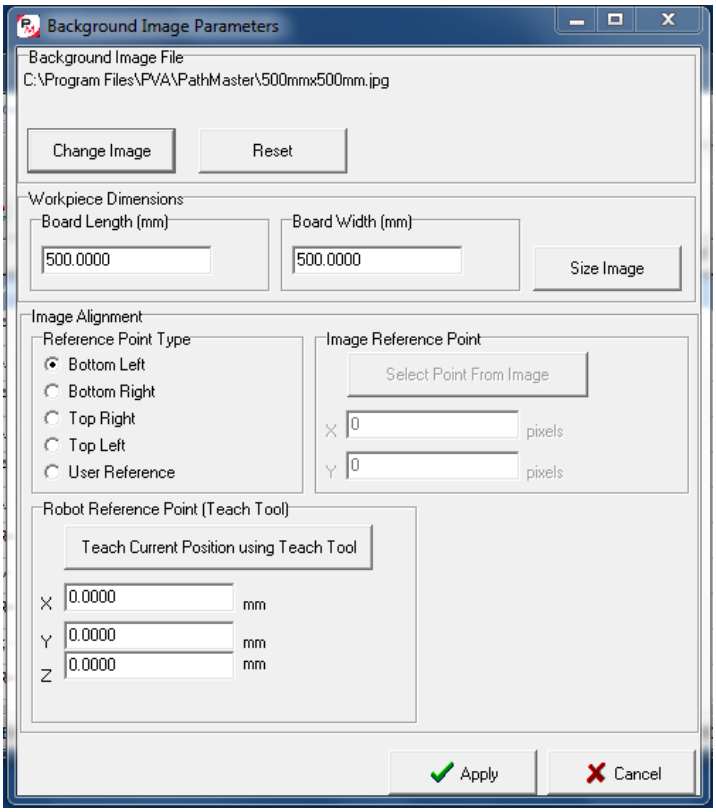


Figure 157: Background Image

5. Select "**Size Image**".

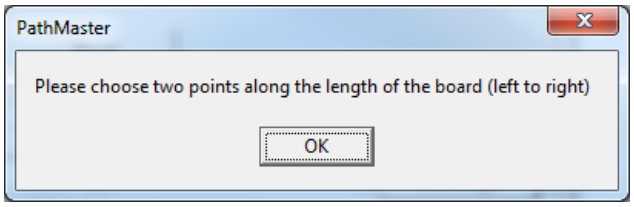


Figure 158: Choose Points

6. Select "**OK**".
7. Select the first point on the image that shows in the **Choose Reference Point** window.

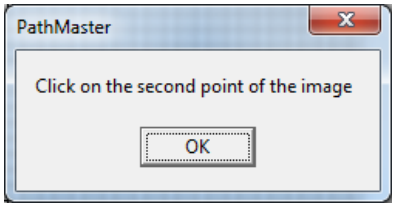


Figure 159: Select the First Point

8. Select "**OK**".
9. Select the second point.
10. Enter the value of the length between the points in the box.
11. Select "**OK**". The Work Piece Dimensions will be updated.

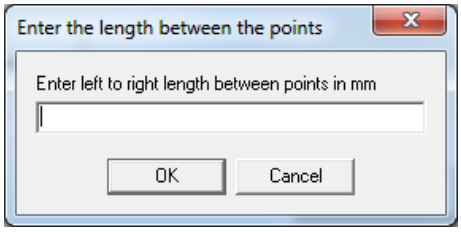


Figure 160: Enter the Length between Points

12. Choose the Reference Point Type.

NOTE: A good reference point is the lower right of your image and the tool 1 coordinates for the intersection of the front rail and the board stop of your machine.

13. Find the machine coordinates for the same location.
14. Put the tool 1 coordinates in the Robot Reference Point edit boxes.
15. Select "**Teach Reference Point**".
16. Select "**Apply**" to save the changes.
17. Select "**Cancel**" to exit and not save changes.

12.2 Tool Selection

With Tool Selection the tool for path segments in FastPath™ can be selected. Tool selection is important because tool offsets are applied.

The tool offsets must be setup before FastPath™ is used, for the path program to run correctly. Select the necessary tool before you select a programming tool. You can change the tool, but it must be selected before the path segment is completed.

For example: If the first two coordinates of an area are taught with tool 2 and tool 3 is selected to complete the third point, the path segment will use tool 3.

12.3 Drawing a Program

1. Select the FastPath™ icon on the programming toolbar to open the FastPath™ window.
2. Use the "**Zoom-In**" and "**Zoom-Out**" buttons to adjust the image size.
3. Select a tool to make a path segment.
4. Teach the necessary functions for the tool selected.
5. Close the FastPath™ window and to return to the PathMaster® window.

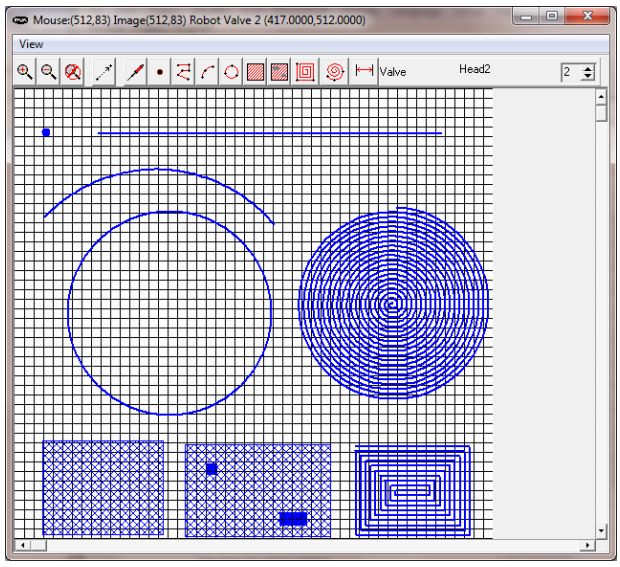


Figure 161: FastPath

Most PathMaster® programming functions are available when in FastPath™. Programming functions are used in FastPath™ similar to the way they are used for regular programming. The FastPath™ points are taught on the board image in the FastPath™ window with the corresponding tool selected, instead of with the teach pendent.

6. To modify or edit an object, double click on the function.

The following functions are used in offline programming the same way they are used in online programming:

NOTE: Each path segment taught corresponds to the tool selected in the FastPath™ toolbar.

- Move
- Tool
- Area
- Spiral
- Rectangular Spiral
- FastMask™

NOTE: The FastMask™ will be shown on the board image as a blue coating area with red keep outs.

- Dot

The following functions are different in FastPath offline programming, their uses are described below.

12.4 2D Line

The 2D Line function makes a line up to 2047 points.

1. Select the 2D Line button.
2. Select all the points of the line on the image.
3. When you have taught all points, right click the mouse to complete the 2D Line.

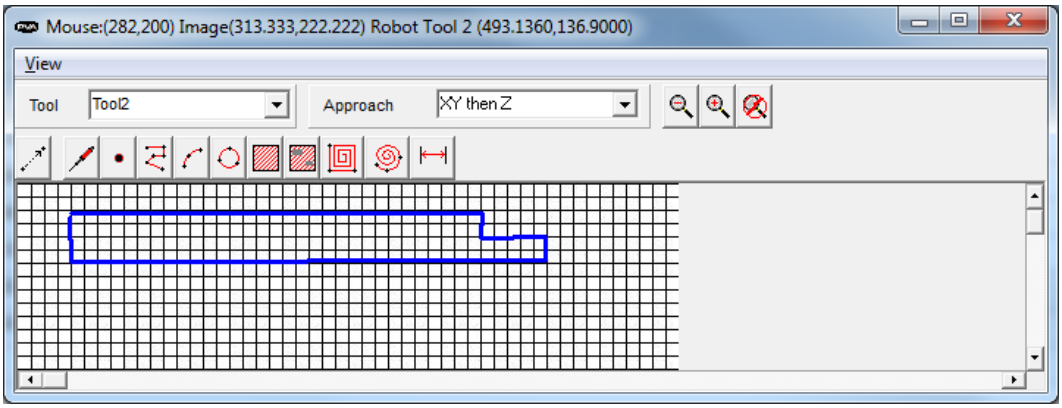


Figure 162: FastPath 2D Line

The line on the board image will have a dispense width equal to the area spacing parameter of the selected tool (Setup-> Machine Parameters->"**Tool Parameters**" -> Line Spacing). The 2D line can be edited graphically.

12.5 Arc

The Arc function has two endpoints and a mid-point.

1. Select the Arc function.
2. Teach the three points.

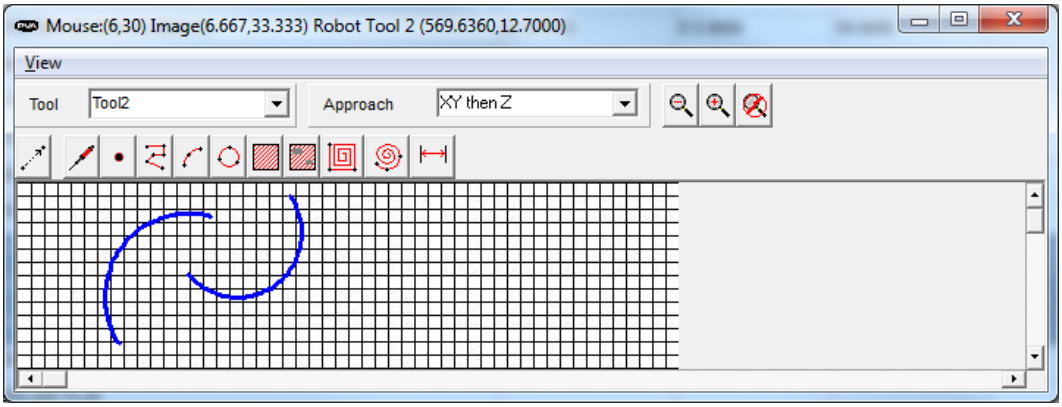


Figure 163: FastPath Arc

Double click on the arc to open the edit screen.

12.6 Circle

The center point is displayed for reference and cannot be moved.

1. Select the Circle function.
2. Teach the three points.

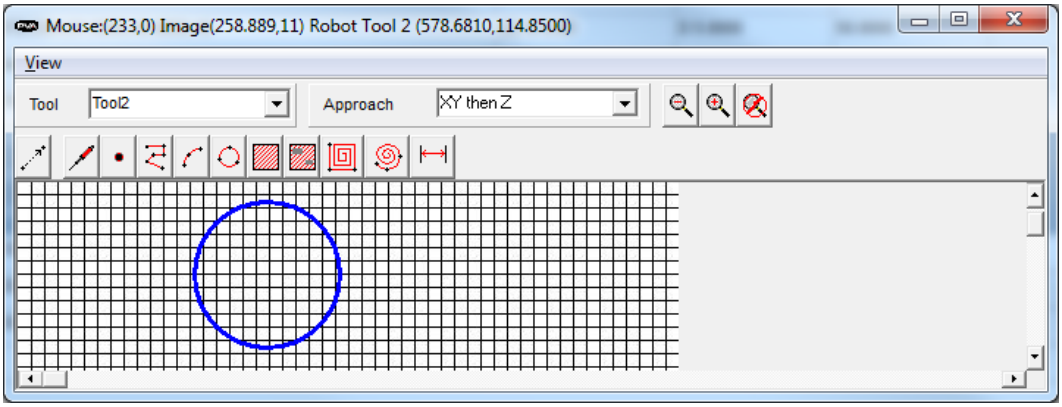


Figure 164: FastPath Circle

Drag any point of the circle to a new location to edit it. This will change the radius and location of the entire circle.

13. Password Protection

Password protection can be added to the download and save functions in PathMaster® to prevent unauthorized or accidental changes to project files.

13.1 Download Password

Password protection can be added to the download function in PathMaster®.

1. Select *Setup -> Password -> Set Download Password* from the main menu.

If no password exists, you will be asked if you would like to create one. If a previous password exists, you must enter it correctly to continue.

2. Enter the new password.
3. Select "**OK**".
4. Enter the password again.
5. Select "**OK**".

The PathMaster® Download Project and Download Main functions are now password protected. A password will be necessary to download with these functions. If the password is entered incorrectly, the download is canceled.

13.2 Resetting Password

1. To reset the save or download password, do the procedure to set the download or save password.
2. Enter a new password in the new and confirm password fields.

14. How to Import and Export Files

The PathMaster® can import and export programs, projects, and subroutines. It can also import CAD files.

14.1 CAD Files

A 2-dimensional CAD drawing can be imported into PathMaster® as a path program.

There are several steps required for a successful import. These include:

- Create the path drawing in CAD.
- Add the PathMaster® codes to the CAD drawing.
- Turn the CAD drawing to the correct position as it relates to the workcell gantry.
- Export the CAD drawing to a *.dxf (Autodesk Drawing Exchange Format).
- Import the CAD drawing into PathMaster® with the CAD wizard.
- Prepare the CAD File.

NOTE: The CAD X+ and CAD Y+ arrows are for reference only and are not necessary.

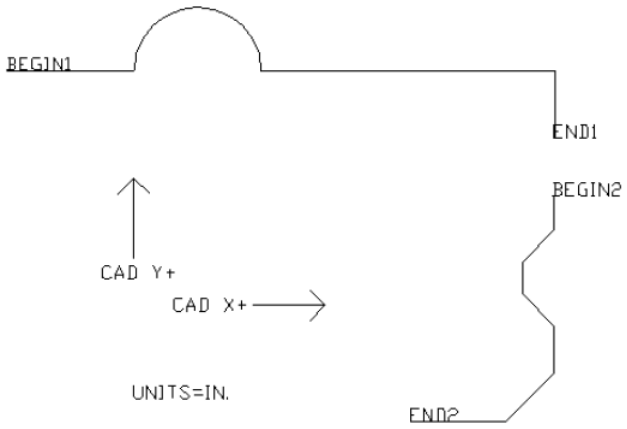


Figure 165: Original CAD Image

1. The start and end of each segment must be labeled as shown in the image above and as described in the table below.
2. Put the units in the CAD drawing as shown.

Required Element	Description
BEGIN1, BEGIN2, etc.	Defines the start of the segment. The tool will turn ON at this point.
END1, END2, etc.	Defines the end of the segment. The tool will turn OFF at this point.
UNITS=IN. **UNITS=MM.** **UNITS=CNTS.**	Defines the units used for creating the drawing.

NOTE: The path will be converted automatically to the units specified in PathMaster® when it is imported.

3. After all necessary elements have been put in the drawing it must be mirrored on the Y axis.

NOTE: In AutoCAD be sure to "Delete Old Objects" when prompted.

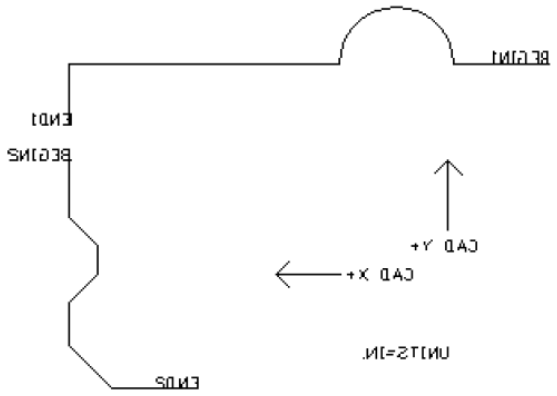


Figure 166: CAD Drawing Mirrored on the Y Axis

4. Rotate the drawing clockwise 90° (-90° for standard AutoCAD Setup).

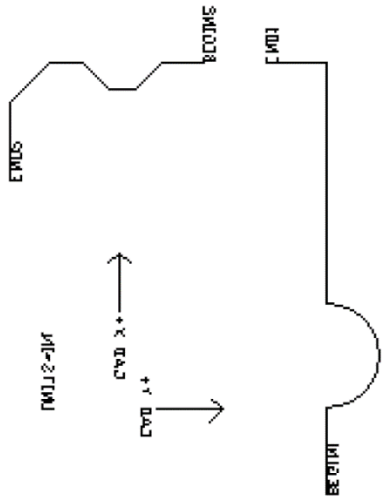


Figure 167: Rotate the CAD Drawing 90°

The final step is to export the file to a *.dxf.

5. In AutoCAD select the *File->Export* menu.
6. When the Export Data window comes up, select “Save As” Type AutoCAD R12/LT2DXF.
7. Under the Options button make sure that the Export Format is ASCII.
8. Give the file a name and save it.

14.2 How to Import a DXF file into PathMaster

The path will be imported to a new program.

1. Select *File ->Import ->Program ->DXF File* from the main menu.
2. Select the **Tool** that will be used with the imported CAD file.
3. Select the “**Next**” button.

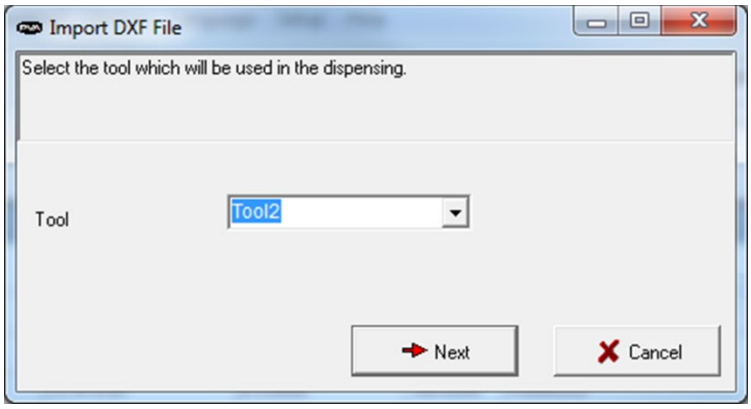


Figure 168: Select the Tool

4. Set the **Snap to tolerance**.

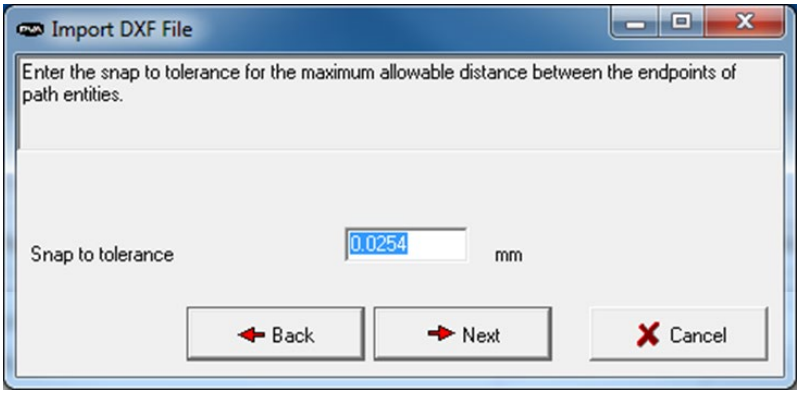


Figure 169: Set the Tolerance

The snap to tolerance is the maximum distance between points where the points are considered connected. If the distance between the points is more than this value the points will not be connected.

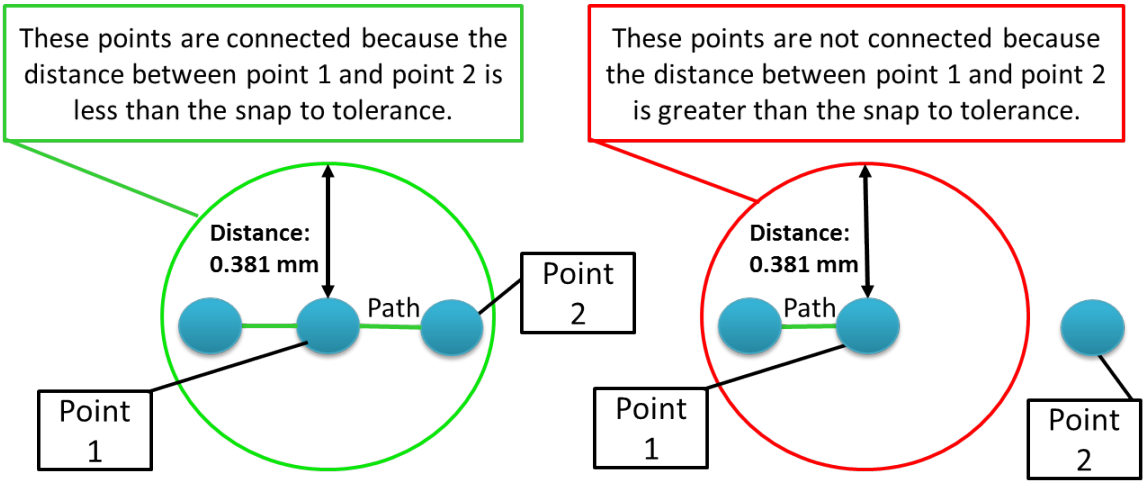


Figure 170: Snap to Tolerance

NOTE: The snap to tolerance makes sure the translation of the drawing entities is correct.

5. Select the "**Next**" button.
6. Select the method of importation as either **Paths from Begin to End** or **All Entities**.

"**Paths from Begin to End**" will import the file as drawn, with the segment order (BEGIN1,END1, etc.) kept as shown. "**All Entities**" ignores commands for order but is useful for large files with many paths, where each segment is not numbered.

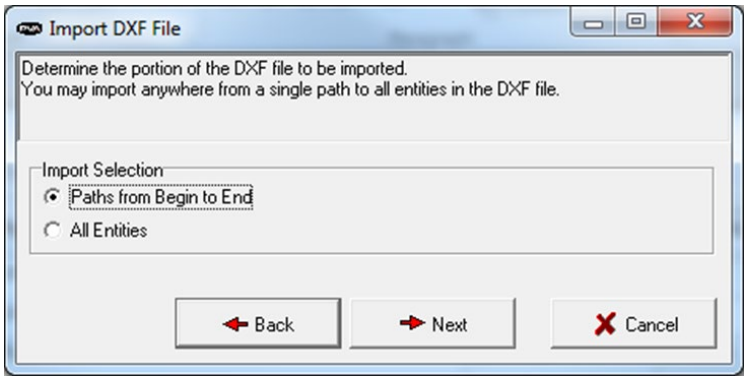


Figure 171: Import Method

7. Teach the start point of the path. You can use the teach pendant or type the position.
8. Select "**Next**".

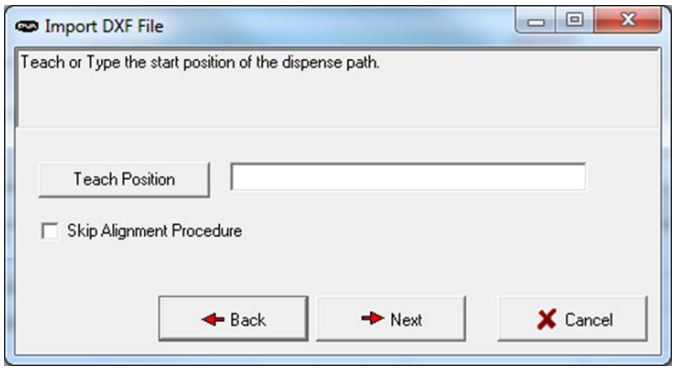


Figure 172: Teach the Start Point

9. Select the file to import.

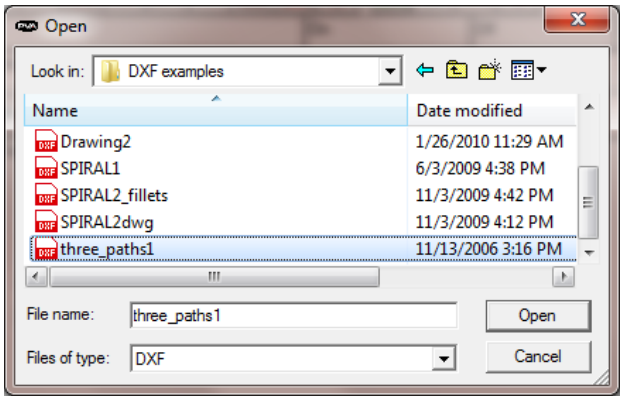


Figure 173: Import Flies

After a successful import the path will be displayed in a path preview window.

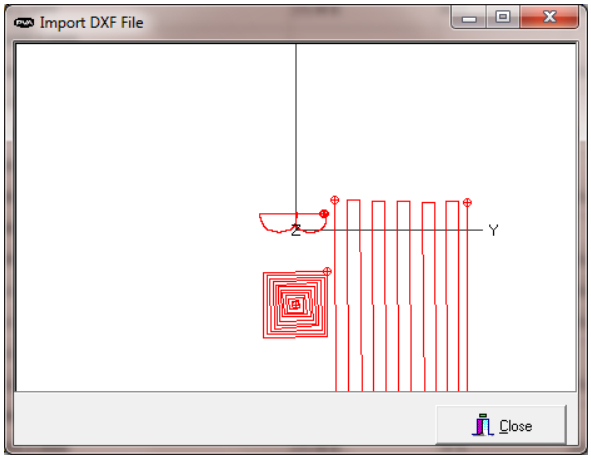


Figure 174: Path Preview

The file will be imported as individual paths (Line, Arc, etc.). The paths are ready for playback or may be made into a Polyline.

14.3 PathMaster 1.5 and Pre 1.5 Projects

PathMaster® 1.5 and earlier projects can be imported into the current version of PathMaster®.

1. Select *File -> Import -> Project -> PathMaster 1.5 or Pre PathMaster 1.5* option from the main menu.
2. When the file dialog box opens, select the location and the file name of the project to import.
3. Select "**Open**".

NOTE: You may need to change the file filter (type) to *.txt, or *.dmc to see the project file in the dialog box.

14.4 PathMaster PRJBCK Files

PathMaster® Project Backup files (PRJBCK) can be imported and exported.

14.4.1 To Import

1. Select *File -> Import -> Project -> Project File (PRJBCK)* option from the main menu.
2. When the file dialog box opens, select the location and the file name of the project to import.
3. Select "**Open**".

14.4.2 To Export

1. Select *File -> Export -> Project - > Project File (PRJBCK)* option from the main menu.
2. When the dialog box appears, select a location and file name for the program.
3. Select "**Save**".

14.5 Text File

A correctly formatted tab delimited text file can be imported into PathMaster® as a path program. PathMaster® can also export text files.

14.5.1 To Import

1. Select *File -> Import -> Program -> Text File* option from the main menu.
2. When the file dialog box opens, select the location and the file name of the project to import.
3. Select "**Open**".

A text file program is typically a file that was exported as a text file from PathMaster®.

NOTE: You may need to change the file filter (type) to *.txt to see the project file in the dialog box.

14.5.2 To Export

1. To export a program to a tab delimited text file, select *File -> Export -> Program -> Text File* option from the main menu.
2. When the dialog box appears, select a location and file name for the program.
3. Select "**Save**".

14.6 DMC File

A correctly formatted DMC file can be imported into PathMaster® as a path program. PathMaster® can also export DMC files.

14.6.1 To Import

1. Select *File -> Import -> Program -> DMC File* option from the main menu.
2. When the file dialog box opens, select the location and the file name of the project to import.
3. Select "**Open**".

NOTE: You may need to change the file filter (type) to *.dmc to see the project file in the dialog box.

14.6.2 To Export

1. Select *File -> Export -> Project - > DMC File or Compressed DMC File* from the main menu.
2. When the dialog box appears, select a location and file name for the program.
3. Select "**Save**".

14.6.3 Compressed DMC Machine File

All of a workcells project files can be exported to compressed DMC Files.

1. Select *File -> Export -> Machine - > Compressed DMC File* from the main menu.
2. When the dialog box appears, select a file folder location.
3. Select "**Save**".

14.7 Subroutine

A correctly formatted subroutine can be imported into PathMaster® with the import subroutine option. PathMaster® can also export subroutines.

14.7.1 To Import

1. Select *File -> Import -> Subroutine -> Text File* option from the main PathMaster® menu or the *File -> Import subroutine* option from the subroutine edit window menu.
2. Select the location and name of the subroutine.
3. Select "**Open**".

NOTE: You may need to change the file filter (type) to *.txt to see the project file in the dialog box.

When the import is complete, the subroutine edit window will open. Refer to Section 7.5.

14.7.2 To Export

1. Select *File -> Export -> Subroutine -> Text File* option from the main PathMaster® menu or the *File -> Export Subroutine* option from the subroutine edit window menu.
2. Select the location and name of the subroutine.
3. Select "**Save**".

15. Modify

PathMaster® has functions to help change completed paths. These functions can be found in the Modify menu.

Program

Select this option to offset or mirror the entire program.

Selection

Select this option to make changes to only the blue highlighted portion of the program.

15.1 Properties

Select *Modify -> Properties* to open the selected commands edit window. Refer to Section 10 for more information on specific programming functions.

15.2 Offset

Select *Modify -> Offset* to see the options *Program* and *Selection*.

15.2.1 Offsetting a Path

1. Select *Modify -> Offset.*
2. Select either *Program* or *Selection.*
3. In the boxes for **'X Offset'**, **'Y Offset'**, **'Z Offset'**, and **'W Offset'**, enter the desired offset in the units shown.

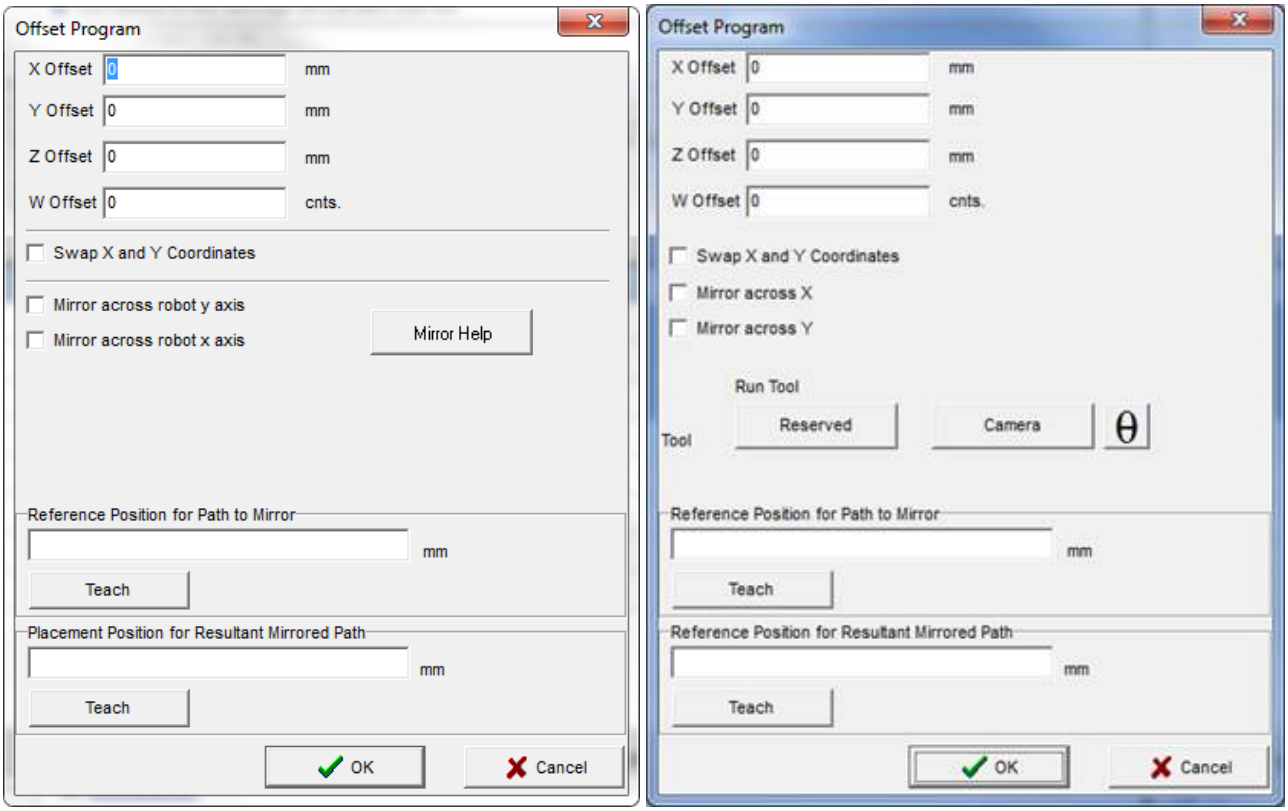


Figure 175: Offset Program Window Without and With Teach Tool Enabled

4. Click **'OK'**.

Your program/selection has been correctly offset.

NOTE: If you Offset W you could cause unintended consequences, and will override existing offsets when the teach tool is enabled. Re-teaching a selected command will reset the W to the pre-taught offsets.

15.2.2 Mirroring a Path

NOTE: It is not possible to mirror and offset a program simultaneously.

1. Select *Modify -> Offset.*
2. Select either *Program* or *Selection.*
3. Select **'Mirror across robot y axis'** and/or **'Mirror across robot y axis'**. See **'Mirror Help'** for an image and description of each action.

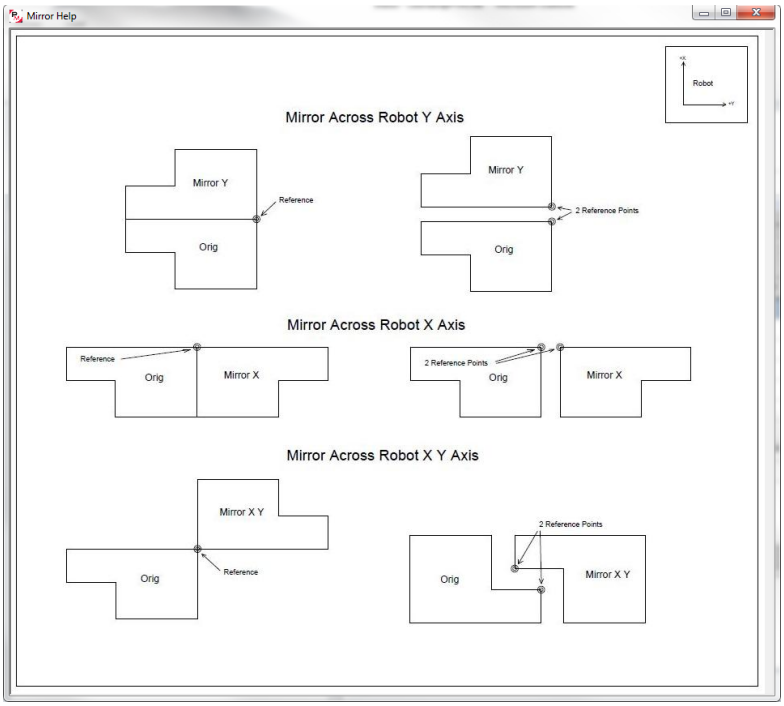


Figure 176: Mirror Help Window

4. Move the robot to the necessary reference point for the path. This point is used to group the selected path components and will also act as the reflection point.
5. Click the first **"Teach"** button.
6. Move the robot to the new location. This location will be used as the origin of the location, based on the first reference point select.
7. Click the second **"Teach"** button.
8. Click **"OK".**

Your program/selection is now mirrored.

NOTE: This will only mirror the X and Y axes and will not affect the Z or W axes.

15.3 Rotate

15.3.1 Rotating a Path

1. Select *Modify -> Rotate.*
2. Select either *Program* or *Selection.*
3. Move the robot to the necessary center point for the path. This point is used as the point to rotate the path around.

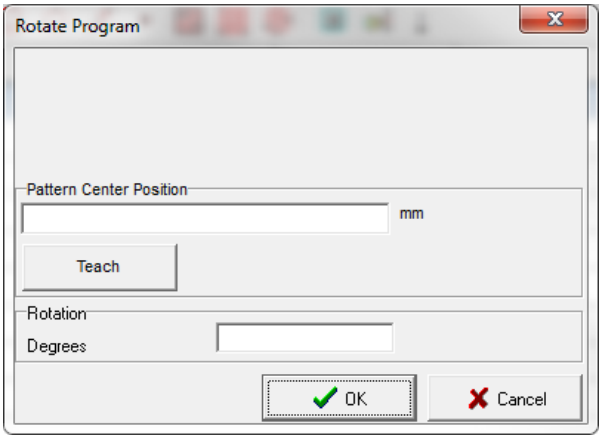


Figure 177: Rotate Path Window

4. Enter the degrees you would like to rotate the program. This will rotate the program counter-clockwise.
5. Click '**OK**'.

Your program/selection has now been successfully rotated.

NOTE: This will only mirror the X and Y axes, and will not affect the Z or W axes.

15.4 Speed

15.4.1 Modify Speed

1. Select *Modify -> Speed.*
2. Select either *Program* or *Selection.*
3. Select either **"Increment/Decrement Speed"** or **"Replace Speed".**
   Increment/Decrement Speed will offset all speeds in in each command by the value given. Replace Speed sets each command at the value given.

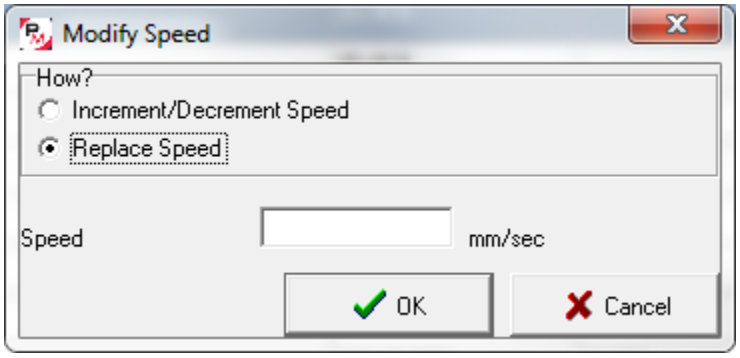


Figure 178: Modify Speed Window

4. Click **"OK"**.

Your program/selection speed has now been changed.

NOTE: If you change the speed you override existing speeds that are pre-programmed in the tool configurations. New commands use the default tool configuration values. Move Speed command values are not affected by this modification.

15.5 Tool Parameters

15.5.1 Modify Tool Parameters

1. Select *Modify -> Tool Parameters.*
2. Select either *Program* or *Selection.*
3. For **"Tool On"** select either **"No Change"**, **"Wait"**, or **"Distance".**
4. Enter the new value in the box to the right.
5. For **"Tool Off"** select either **"No Change"**, **"Wait"**, or **"Distance".**
6. Enter the new value in the box to the right.

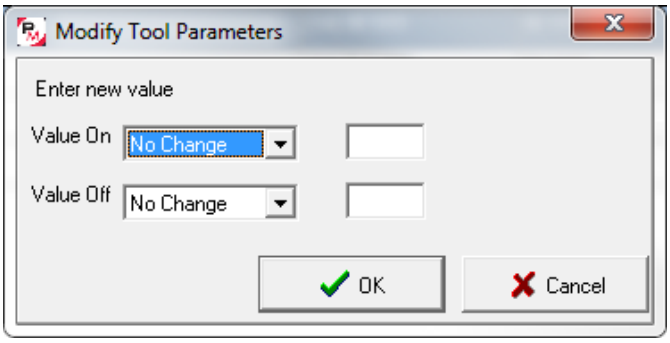


Figure 179: Modify Tool Parameters Window

7. Click **"OK".**

The tool parameters have now been updated.

NOTE: If you change the tool parameters you override existing speeds pre-programmed in the tool configurations. New commands will use the default tool configuration values.

NOTE: Only commands with the same tool may be selected at the same time. You may not change multiple commands that have different tools at the same time.

15.6 Subroutine Call

15.6.1 Selection

This option changes which subroutine will be called at runtime. You must highlight the subroutine to be changed or this modification will not work.

15.6.2 Modifying a Subroutine Call

1. Select *Modify -> Subroutine Call.*
2. Select *Selection.*
3. Select the necessary subroutine to replace the existing subroutine. Use the search bar to help you find the new subroutine if necessary.
4. Click **"Call".**

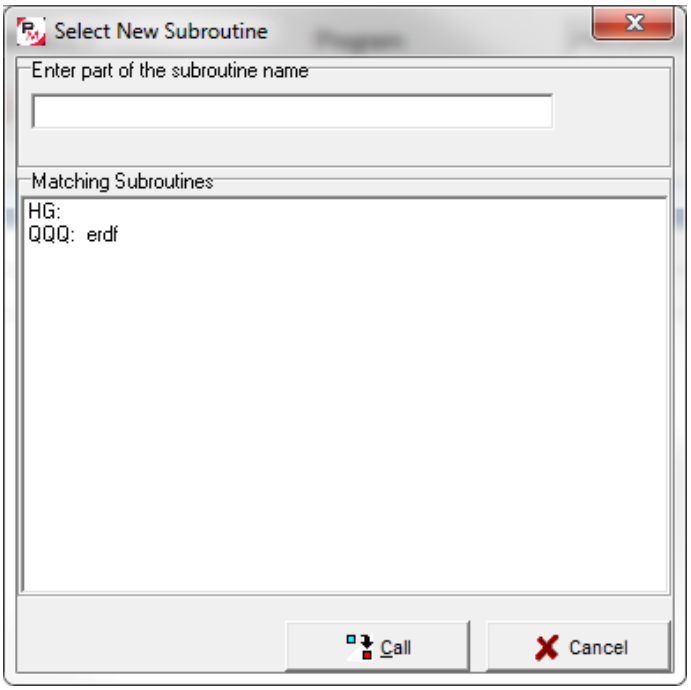


Figure 180: Select New Subroutine

The subroutine has been updated to the selected subroutine.

15.7 Area Spacing

15.7.1 Modify Area Spacing

1. Select *Modify -> Area Spacing.*
2. Select either *Program* or *Selection.*
3. Enter the new desired spacing in the text box.

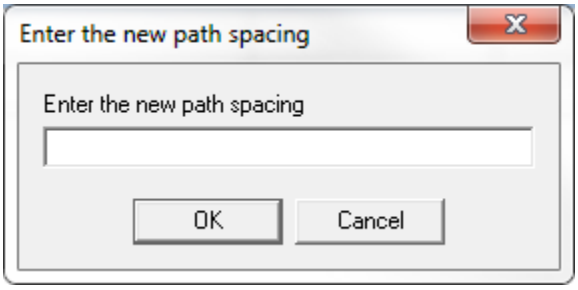


Figure 181: Area Spacing

4. Click **"OK."**

All selected areas now have an updated spacing.

16. Utilities

PathMaster® has functions to help with debugging the workcell and path programs. These functions can be found under the Utilities menu.

16.1 View FastPath

Open the FastPath™ window for offline programming.

- Select *Utilities -> View FastPath* option from the main menu.

NOTE: The FastPath™ window can also be accessed using the FastPath™ button on the programming toolbar.

16.2 Measure Distance

The measure distance tool is used to find the distance between two points in current measurement units.

- Select *Utilities -> Measure Distance* option from the main menu.

16.2.1 To Measure Distance

1. Move the tool to the first point with the teach pendant.
2. Select "**Teach Point 1**".
3. Move the tool to the second point with the teach pendant.
4. Select "**Teach Point 2**".
5. Select "**Calculate Distance**". The distance will be calculated and shown.

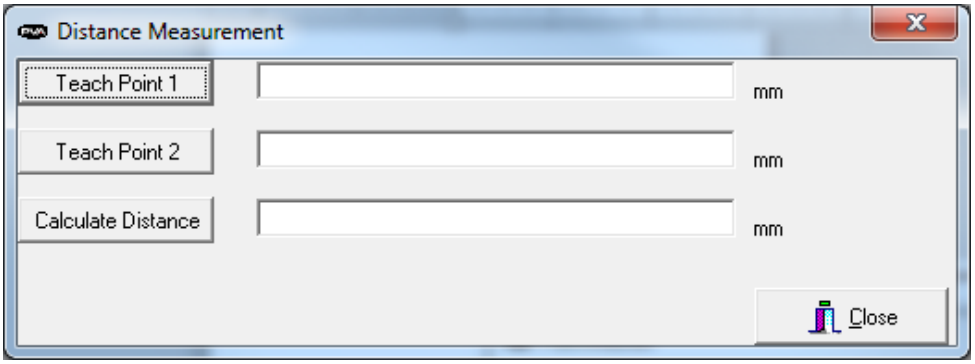


Figure 182: Distance Measurement

6. Select "**Close**" when you are finished.

16.3 Refresh Communication

If PathMaster® loses communication with the workcell the communication must be refreshed.

- Select *Utilities -> Refresh Communications* from the main menu. If communication is not reestablished, check cables and communication settings.

16.4 Jog Toolbar

The jog toolbar can be used to jog the X or Y axis a specified distance.

1. Select *Utilities -> Jog Toolbar* from the main menu.
2. Enter the distance to jog, and select the button with the necessary axis and direction.

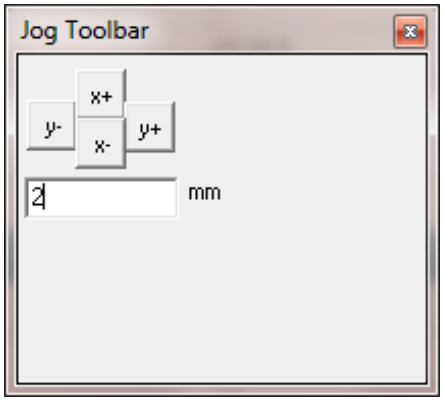


Figure 183: Jog Toolbar

16.5 Path Preview

The path preview will give a graphic representation of the path program or segments.

1. Highlight all path segments to be displayed in the preview.
2. Select the *Utilities -> Path Preview* option from the main menu. The path preview window will display.

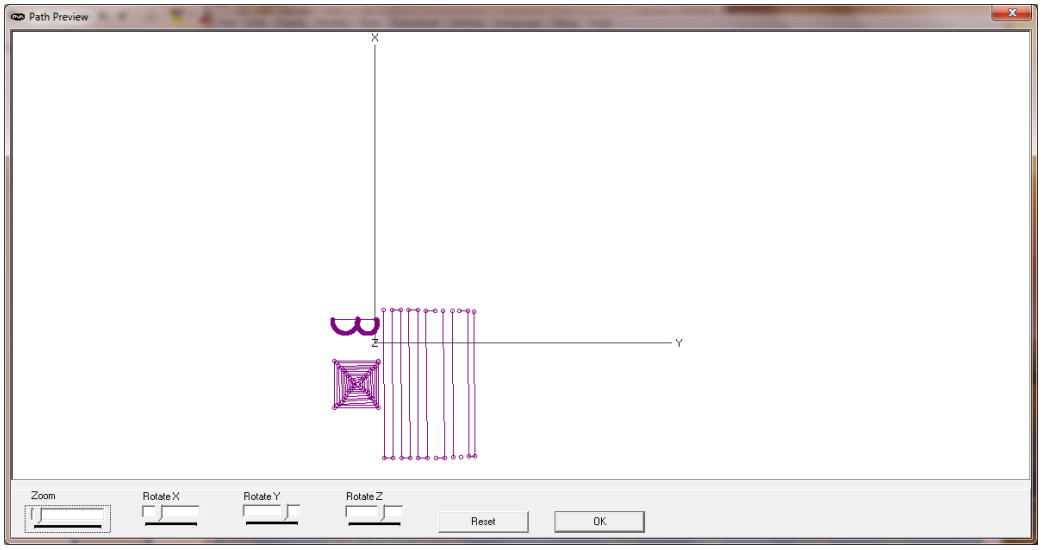


Figure 184: Path Preview

3. Right click the path preview window to see a zoom, pan, rotate, coordinate info menu.
4. Select "**Reset**" to return the preview to default display.
5. Select "**Ok**" when you are done.

16.6 Recover Main and Recover Project

With the Recover Main and Recover Project features the user can upload the compressed main or compressed project from the controller.

1. Select *Utilities-> Recover MAIN* or *Utilities ->Recover Project* from the main menu.
2. When the dialog box appears, select a file folder location.
3. Select "**Save**".

NOTE: The files will be compressed and in DMC, so the files will not be easy to change.

16.6.1 Show Code and Show Code with Surfaces

The show code option will show the compiled machine code for the selected segments. Show Code with Surfaces is used as a debug tool, if necessary, and replaces all of the variables with values used.

1. Highlight the path segments.
2. Select *Utilities -> Show Code* from the main menu, or right click and select **Show Code** from the menu.

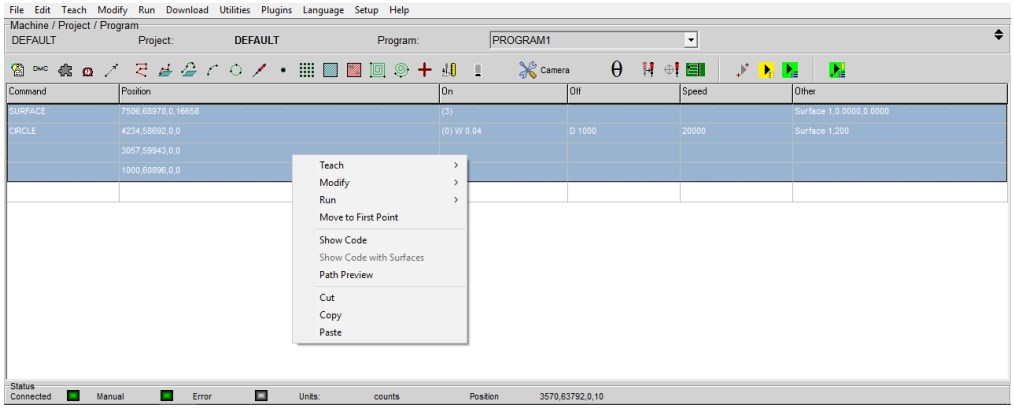


Figure 185: Show Code

A window will open with the machine code from the selected segments.

3. Select "**Save As**" to save the code as a text file.
4. Select "**Print**" to print the code.

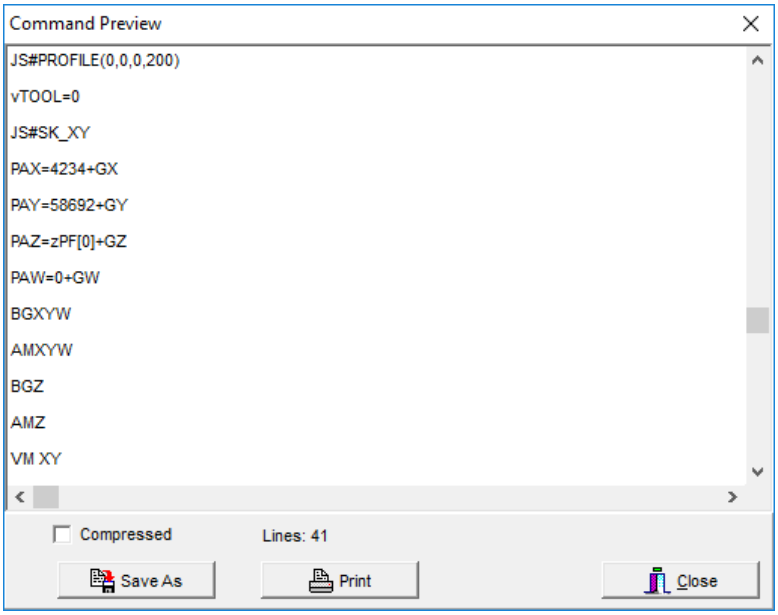


Figure 186: Show Code, Command Preview

5. If the selected segment uses surfaces, run the surface, the text will be green when it has passed.
6. Highlight the necessary path segments and select **Show Code** from the menu.

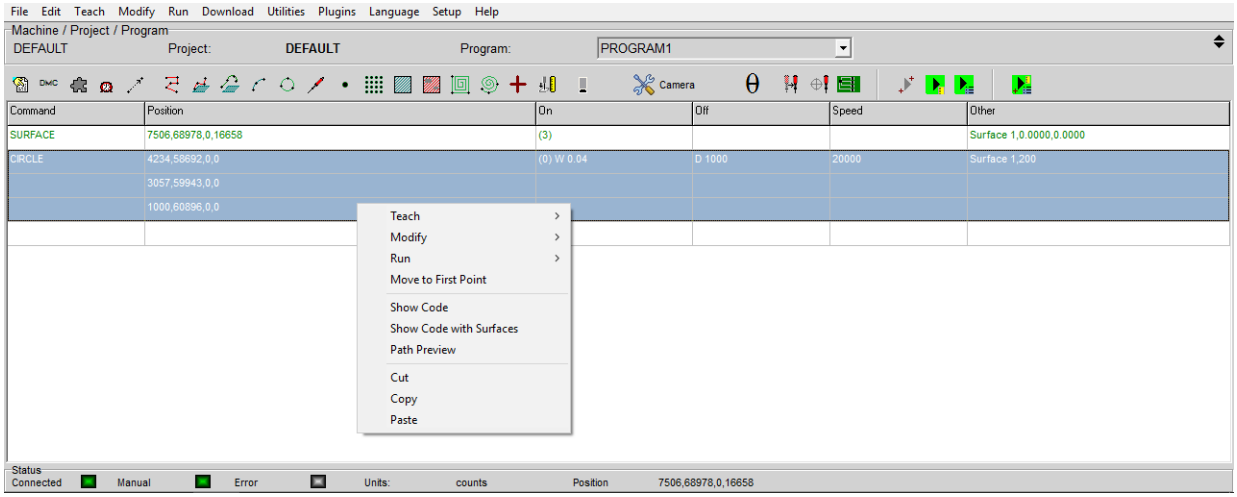


Figure 187: Show Code with Surfaces Menu

A window will open with the machine code from the selected segments.

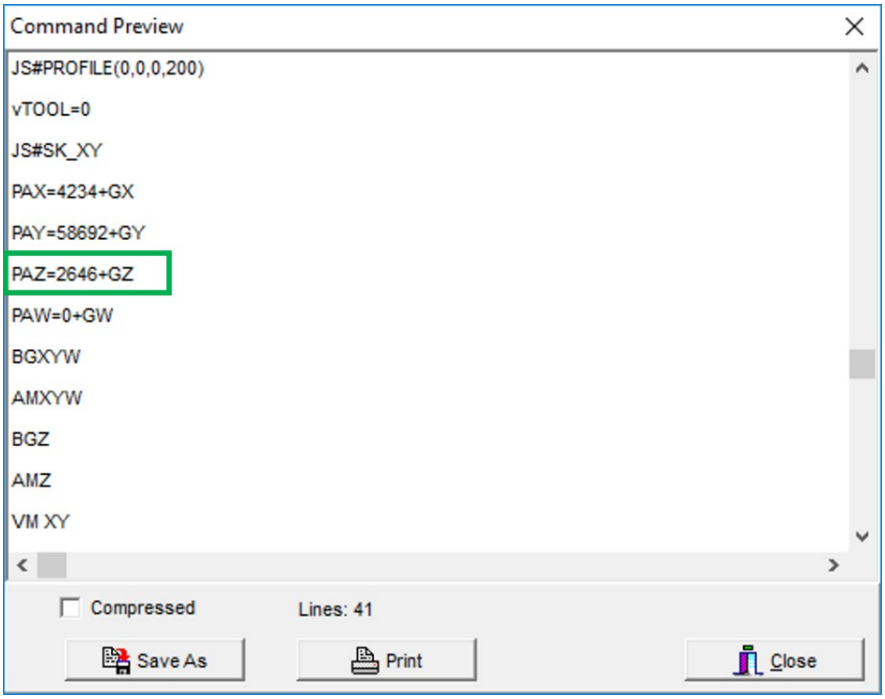


Figure 188: Show Code with Surfaces, Command Preview

7. Use the necessary buttons to "**Save As**" or "**Print**".
8. When you are done select "**Done**".

16.7 Line Check

Use this function to see how many lines of compressed DMC code the current program will occupy.

1. Select *Utilities -> Line Check* from the main menu.

A window will open with the number of lines.

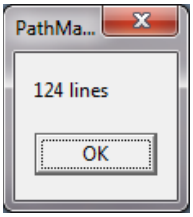


Figure 189: Line Check

2. Select "**OK**" when you are finished.

16.8 Machine Debugger

The machine debugger is an array of tools to aid in the debugging of the .

1. Select *Utilities -> Machine Debugger* from the main menu.

When the machine debugger opens, select the tab for the tool to be used each tab is described below.

16.8.1 Terminal

The terminal lets the operator send commands directly to the controller. To send a command to the controller, make sure the keyboard caps lock is on.

1. Type the command in the terminal window.
2. Push the *Enter* key.

A response from the controller will display under the command that was issued. If the controller does not understand what it received, it will respond with a "?".

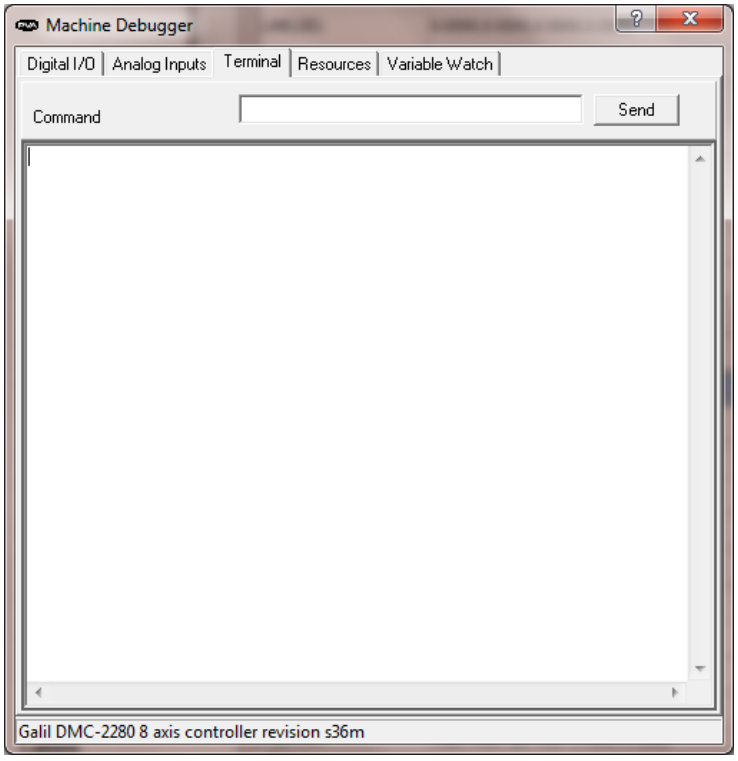


Figure 190: Machine Debugger Terminal

For more information on how to use the terminal or how to work directly with controller, refer to the online controller manual. Refer to the Troubleshooting manual for more information on DMC code.

16.8.2 Digital I/O

The digital I/O tool allows for you to toggle most digital I/O points on the controller. Select the button for the I/O point you wish to toggle. The buttons will change colors when the I/O point changes state. The refresh interval is the frequency of the tool display refresh in milliseconds.

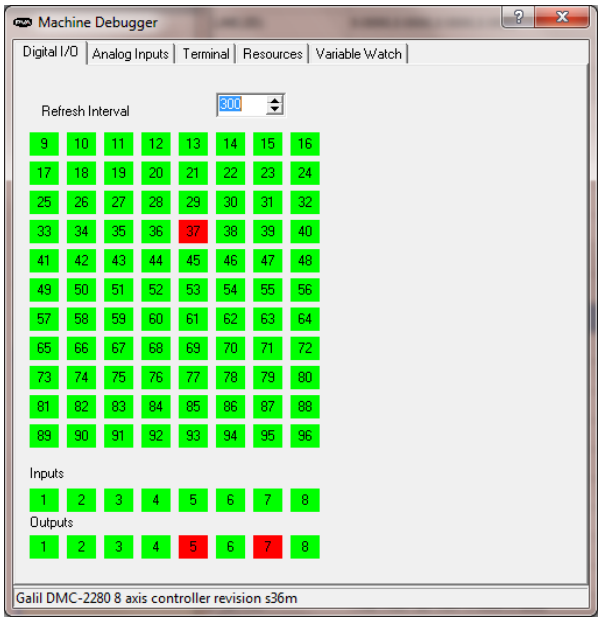


Figure 191: Utilities Machine Debugger Digital I/O

16.8.3 Analog Input

The analog input tool will monitor the voltage of analog input feedback. The refresh interval is the frequency of the tool display refresh in milliseconds.

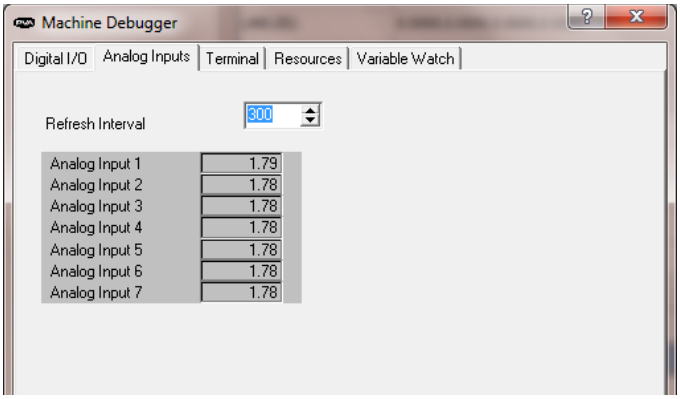


Figure 192: Machine Debugger Analog Input

16.8.4 Resources

The resources tool monitors the controller resources such as available program labels, and program variables. The type of resources displayed on this form will change with the model of controller used.

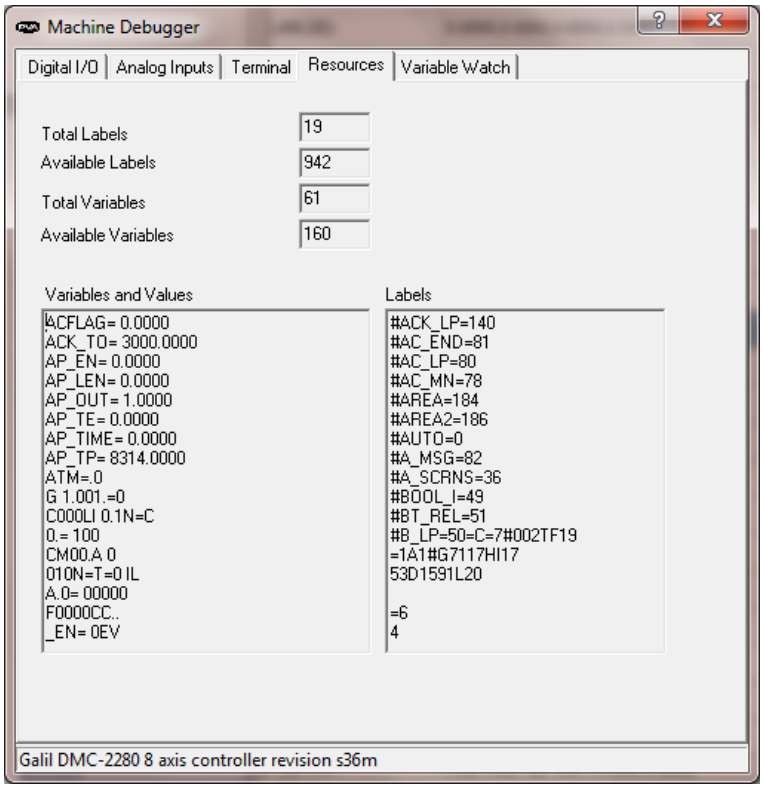


Figure 193: Machine Debugger Resources

16.8.5 Variable Watch

The Variable Watch tool will monitor a list of program variables entered by the user.

3. Type a valid program variable name into the watch list on the left.
4. Select "**Start Watch**" and the value of the variable will be displayed on the right.

Multiple variables can be monitored at the same time. The refresh interval is the frequency of the tool display refresh in milliseconds.

5. Select "**Clear Values**" to erase the value shown.
6. Select "**End Watch**" to no longer watch that variable.

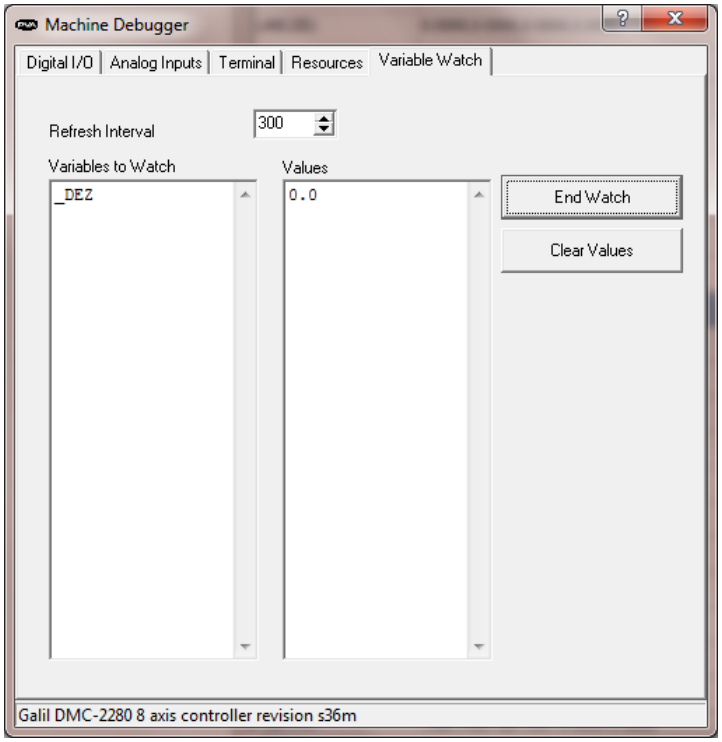


Figure 194: Variable Watch

17. DMC Programming Basics

- All commands must be in uppercase letters.
- Positions are given in counts. In most cases there are 5080 counts per inch, 200 counts per millimeter.
- No line of code may contain more than 80 characters.
- A semicolon (;) is used as a carriage return. This allows for multiple commands on the same line and can be used to save space in the program.

17.1.1 Labels

Sections of a program (subroutines) are defined by **labels**. PathMaster® generates its own labels for programs. These labels do not appear in the edit window, so the operator cannot alter them.

- Labels start with the pound (#) sign followed by a maximum of seven characters.
- The first character must be a letter, after there can be numbers.
- There can be no spaces.
- There can be no duplicate labels anywhere in memory. The *Main* program and PathMaster® are written without any duplicate labels.
- If the operator must put special labels into programs it can cause duplicate labels. If any duplicate labels occur, the operator must find the duplication and fix it.

This usually happens when a section of code has been copied and pasted. There can be no duplicates anywhere within a project, which includes all 30 programs in that project.

- Labels must be at the start of a line. When code is entered manually, make sure there are no labels in the middle of a line. This causes an error when the program is run.

17.1.2 Important Commands

The DMC programming language contains over 135 commands. The program for the workcell does not use most of these commands, and even fewer are used to create a dispense path.

The commands in the table below are the most important for an advanced operator to know. A complete list of commands can be found in the separate DMC-4000 or 4200 manual that came with the machine. Any reference to manually changing or querying in the examples below requires the use of the terminal option in PathMaster® to communicate directly with the controller.

Cmd	Description	Example	Tips
AC	Acceleration for independent moves are in counts per second squared	AC*=100000 (sets all axes) ACX=100000 (only sets the X axis acceleration)	Make sure the acceleration is large enough to get the motion to speed in a reasonable amount of time
AM	After move. This command holds the program until the movement on the specified axes is completed	AM (wait for all axes to finish its motion) AMS (wait for coordinate sequence to finish motion)	The AM command tests for profile completion. Use the AM command to separate multiple movements
AV	After vector distance. This command holds the program until a specified distance has been traveled with a coordinated move, the units are in counts	AV1000 (wait until the axes have moved 1000 counts)	The AV command resets to zero after every use. It can be calculated by summing the distances between each point on the coordinated move
BG	Begin. BG starts a motion on an axis or a sequence	BGX (begin motion on the X axis), BGS (begin motion sequence), BG (begin motion on all axes)	A second BG command cannot be given until the first BG motion is finished. The AM command can hold the program until the first motion is done. The exact axes to put in motion must be given. The BG command starts all the axes according to the last specified motions
BL	Reverse Software Limit		
CB	Clear bit. Clears a bit on the output port	CB40 (clears the bit for the buzzer)	Clearing a bit in DMC terminology turns the bit on. The opposite of CB is SB (set bit). A complete list of the outputs can be found in the Operating Guide

CR	Circle. Select a radius, a start angle and the angle to be traversed. Movement is counterclockwise in the Cartesian coordinate system. This is either clockwise or counterclockwise, as viewed from the front of the machine, and depends on the setup of the machine. A negative traverse angle yields clockwise motion in the Cartesian coordinate system	CR 5000,90,180 arc with length of 5000 counts, starting at 90° and doing a half circle (180°)	The circle command is a coordinated two-dimensional move. The structure is the same as all other coordinated moves, using the VM, VP and VE commands. A start angle of 0° gives a circle, relative to the start point, entirely negative in the X direction and half positive, half negative in the Y. Starting at 180° yields an entirely positive X circle and a half positive, half negative Y. 90° is an entirely negative Y circle 180° entirely positive Y, with both having X half positive, half negative
CS	Clear Sequence	Clears Memory of prior coordinated sequences	
DC	Deceleration for independent moves. The units are in counts per second squared	DC*=100000 (sets all axes), DCX=100000 (only sets the X axis deceleration), DC 10000,30000,40000 (sets X, Y and Z Decelerations separately)	The higher the deceleration, the faster an axis stops its move
DE	Dual (Auxiliary) Encoder Position		
DL	Download. This transfers a text file from the computer to the controller	DL (then select a text file to download)	Use the HX (halt execution) command before using DL. Damage may result otherwise
EN	End. This terminates a subroutine, program thread or program	EN	The Dispensing System also has a subroutine used for a conditional end. The command JP#NOOP operates the same as the EN command
FL	Forward Software Limit		
HX	Halt execution. Halts the execution of the program or any of its threads	HX1 (halt thread 1) HX (halt the entire program)	Always use the HX command before executing a DL command

JG	Jog		
JP	Jump to a program location. Locations are marked by labels. This command can be used in a conditional statement and the jump occurs if the conditional is true	JP#NOOP (jump to location #NOOP), JP#NOOP,COUNT>10 (jump to location #NOOP if the value of COUNT exceeds 10)	It is important not to confuse JP with JS. Using a JP when a JS is required results in the thread being halted once the EN command is reached
JS	Jump to subroutine. Subroutines are marked by labels	JS#H1UP (jump to subroutine #H1UP)	It is important not to confuse JS with JP. Using a JS when a JP is required can result in "nesting" the program continuously until a nesting error occurs. Subroutines can only be nested 16 deep
LI	Linear Interpolation Distance		
LM	Linear Interpolation Mode		
LS	List. The operator can list a single line or multiple lines of the program in a terminal screen	LS 300,0 (show line 300), LS 250,270 (show lines 250 to 270), LS (show all lines in memory)	If a runtime error occurs, use the LS command in the terminal screen to check the line containing the error
MG	Message. This command sends data out the bus. It can also be used by the operator to query the controller for information	MG "Path Complete" (displays the message "Path Complete" on the terminal screen), MG@IN[60] (displays the value of input 60, where 0 is on and 1 is off)	Do not put message commands in programs! If there are message commands, and there is no computer attached to the workcell, the controller halts once the output buffer is full
MO	Motor off. Shuts off motor control	MO (turn all motors off), MOX (turn off only the X axis motor)	MO shuts off the motor(s).The motors are reactivated with the SH (servo here) command
MR	Reverse Motion to Position		
MT	Motor Type		
NO	No operation. This command performs no action and is used to comment a program	NO!!! PROGRAM 1!!!! (description for program)	A semicolon (;) terminates the NO command. Any statements following a semicolon are executed

PA	Position absolute. This sets the destination of a move, referenced to the origin. The units are in counts	PA 10000,10000,1000 (commanded position for X, Y and Z axes), PAX=10000 (commanded position of X axis)	It is best to limit the use of the PA command to designating the start of a dispense path. Overuse of the PA command complicates program editing
PF	Position Format		
PR	Position relative. This sets the incremental position of the next move, referenced to the current position. The units are in counts	PR 10000,10000,1000 (commanded change in position for X, Y and Z axes), PRX=10000 (commanded change in position of X axis)	Be careful not to confuse PA with PR. The PR command begins its move from the current position, without reference to the origin
RS	Reset. Resets the controller to its power on state. All the information in the controller's RAM is erased	RS	If PathMaster® fails to download a file correctly; the program may be halted in the controller. Executing an RS command from the terminal screen restarts the program
SB	Set bit. Sets a bit on the output port	SB40 (sets the bit for the buzzer)	Setting a bit in DMC terminology turns the bit off. The opposite of SB is CB (clear bit). A complete list of the outputs can be found in the Operating Guide
SH	Servo here. The controller uses the current position as the command position and enables motor control	SH (activate all motors) SHZ (activate only the Z motor)	The opposite of SH is MO (motor off) SH resets all position errors to zero
SP	Speed. Sets the speed for independent moves. Units are in counts per second	SP*=100000 (sets all axes), SPX=100000 (only sets the X axis speed), SP 10000,30000,40000 (sets X, Y and Z speeds separately)	Make sure the value of the acceleration is high enough to get the motion to speed in a reasonable amount of time
ST	Stop. Halts motion on the specified axes. If no axes are specified, it halts program execution	STX (stop motion on the X axis), ST (stop all motion and halt the program)	Use the AM command after the ST command to wait for motion to be stopped

TB			
TC	Tell error code. Displays the number and a text description for a command error	TC1	
TD	Tell Dual Encoder		
TE	Tell error. This returns the current position error of the motors. Units are in counts	TE	Use this command in the terminal screen if a motor appears to be working incorrectly. The Dispensing System is programmed to disregard errors of less than 1000 counts
TP	Tell Position. Returns the current position of the motors	TP (All axes) TPX (X axis only)	Use in the terminal screen to verify the current location of the motors. In addition, the Manual mode of the workcell has a push button that accomplishes the same task
VA	Acceleration for coordinated moves. The units are in counts per second²	VA 100000	Make sure the value of the acceleration is high enough to get the motion to speed in a reasonable amount of time
VD	Deceleration for coordinated moves. The units are in counts per second²	VA 100000	Make sure the value of the acceleration is high enough to get the motion to speed in a reasonable amount of time
VE	Vector Sequence End		
VP	Vector Position		
VS	Vector Speed. Sets the speed for coordinated moves. Units are in counts per second	VS 100000. Query the controller with the command MG_VS	Make sure the value of the acceleration is high enough to get the motion to speed in a reasonable amount of time
WT	Wait. Holds program execution for specified time	WT500	Use the WT command whenever the program needs to pause, particularly if another action needs time for completion

18. Notes

19. Warranty

PVA Warranty Policy

PVA warrants the enclosed product against defects in material or workmanship on all components for one year from the date of shipment.

The warranty does not extend to components damaged due to misuse, negligence, or installation and operation that are not in accordance with the recommended factory instructions. Unauthorized repair or modification of the enclosed product, and/or the use of spare parts not directly obtained from PVA (or from factory authorized dealers) will void all warranties.

All PVA warranties extend only to the original purchaser. Third party warranty claims will not be honored at any time.

Prior to returning a product for a warranty claim, a return authorization must be obtained from PVA's Technical Support department. Authorization will be issued either via the telephone, facsimile, or in writing upon your request.

To qualify as a valid warranty claim, the defective product must be returned to the factory during the warranty period. Upon return, PVA will repair (or replace) all components found to be defective in material or workmanship.

(Retain this for your records)

Product Information:

PRODUCT: _____

SERIAL NUMBER: _____

DATE OF PURCHASE: _____

20. Appendix A- Table of Figures

21. Appendix B- Definitions

Auto Cycle – Automated workcell state where dispense cycles can be run.

Cycle Stop – Stopped workcell state where no manual or automated action occurs and the workcell is at the standby position. Actions such as auto purge and solvent position moves may occur at set intervals.

Database Backup File – A collection of projects, programs, tool configurations, and setup parameters for a single machine, typically with the extension .bck or .abck.

NOTE: Prior to PathMaster 4.2 a database file could consist of multiple machines. This functionality has been deprecated in version 4.2.

Database Transfer File – A collection of projects and programs used to transport machine-level data from a source machine to a destination machine. A transfer file (.tfr) also includes the workspace reference position, along with Z offsets for each tool. A transfer file is similar to a database backup file, without the tool configuration and setup parameter data.

Device – Any physical part processing device, such as a spray or dispense valve, a camera, or a laser.

Dispense Path – A continuous motion profile. The tool is on (dispensing or spraying) during the entire motion profile, also known as a path.

Dot Drop Mode – A mode to teach the teach tool to run tool offset. A dot of material is dispensed by the run tool and that dot is used as a reference to align the teach tool.

DMC – Language used to program the motion controller in the workcell.

End Effector – The dispense tool assembly. The end effector is moved by the axes.

Home Position – The (0, 0, 0, 0) location of the workspace. This position is determined by the location of the home sensors. It is NOT the same as the **Standby Position**.

Jog – One or more axes are commanded to move continuously at a specified speed (measured in encoder counts per second) until commanded to stop.

Main Program File –The text file with the code to run the workcell in normal operation.

Needle Calibration – The procedure to find the position of the tool's needle relative to the expected position of the calibration sensors, the **Tooling Offset** is then corrected to match the found values. The difference is applied as a **Program Offset**.

Needle Calibration Reference – Position where the crosshair on the needle calibration block is centered below the system's teach tool.

Offline Programming - A procedure to program path programs when not connected to the workcell, known as FastPath™.

Offset Details – An information screen that shows the teach Tool Reference Position, Run Tool Reference Position, Tooling Offset, and Profile Offset for the selected tool.

PathMaster® – Windows® Operating System based programming software. Used to create, maintain and download program files for the workcell.

Profile Base – A physical device which has a plunger that is used as the **Profile Z Reference** position for all run tools.

Profile Calibration – The process by which the **Profile Offset** is calculated for a given run tool. This is accomplished by determining the difference of the Z position of the run tool and the **Profile Tool** at the **Profile Z Reference**.

Profile Offset – Distance between the **Profile Z Reference** and the tip of a given tool.

Profile Plunger Locate – The process by which the **Profile Offset** is calculated for a given **Profile Tool**. This is accomplished by taking a **Profile Tool** reading at the surface of the **Profile Base**'s plunger.

Profile Tool – A tool which may be used to determine the height of a desired dispense surface in units of distance relative to a common surface.

Profile Z Reference – The common surface that is used in profile calculations. Usually, this is the plunger of the **Profile Base**.

Program – A collection (or series) of **Dispense Paths** and general commands.

Program Offset – Change in position that is applied to all programs in all projects. Program offsets are generated by **Tool Offset Setup**, **Tool Change**, and **Needle Calibration**.

Project – File consisting of up to 30 **Programs**.

Purge Position – The location in the workspace where the end effector moves to perform all auto purge operations.

PVA –Precision Valve and Automation.

Run Tool Reference – The workspace position where the run tool is centered above the system's **Teach Tool Reference** position.

Standby Position – The rest position for the end effector. The machine moves here after homing and after each cycle. This position is usually located near the start point for the program(s). It is not the same as the **Home Position**.

Sensor Locate Sequence – Establish the spatial relationship between the **Needle Calibration Reference** position and a repeatable location relative to the X and Y sensors.

Solvent Position – The location in the workspace where the end effector moves to idle in solvent cups.

Teach Tool Reference – The workspace position where the teach tool is centered above a crosshair or other identifying mark. This identifying mark will be used as a common location for calculating **Tooling Offsets**.

Terminal – A program used as a communication link between the controller and operator.

Tool – A virtualized instance of a **Device**, usually configured to a specific orientation.

Tool Change – Modifying the **Run Tool Reference** position relative to the **Teach Tool Reference** to change the **Tooling Offset**. This function is generally used for adjusting a tool position after a needle change, tool maintenance, etc.

Tooling Offset – Spatial relationship between the teach tool and the run tool.

Tool Offset Setup – Teaching the teach tool to run tool relationship (XYZW) in machine parameters. This function is generally reserved for initial tool setup.

Workspace Reference – A fixed position in gantry space relative to the part fixturing. This position is used as a source and destination machine for the purpose of transporting machine programs. It may also be used to apply a global offset on all programs in all projects.

22. Appendix C: PathMaster INI Details

Sections	Key	Value	Description
[General]	Equip_ID	String	Machine database that is loaded when PathMaster Starts Default = Default
	Language	Enum	Enumerated Value representing current display language 1 – English 2 – Spanish 3 – French 4 – German 5 – Mandarin 6 – Japanese
	ManualFile	Path	File Path to PathMaster User manual PDF file Default = 'C:\Program Files\PVA\PathMaster\manual\PathMasterManual.pdf'
	NeedleCalImage	Path	Path to Needle calibration image that is displayed during needle calibration Default = 'C:\Program Files\PVA\PathMaster\Graphics\NdlCal.jpg'
	ProjectFileOutput	Path	Path to write PartManager project files. These files are in DMC format ***NOTE: UserDefaultProjectFileOutput=1 must be set for this file output path to be used*** Default = 'C:\Program Files\PVA\PathMaster\Projects'
	SpiralSlowSegments	Num	Defines the number of segments before the end of a circular spiral to begin incrementally slowing down Default = 3
	UseDefaultProjectFileOutput	Bool	0 – Prompt User for Path When Saving for PartManager 1 – Use Default Project File Output Path to Store Paths when Saving for PartManager Default = 1
	EnableAutoBackup	Bool	0 – Disable Auto Backups 1 – Enable Auto Backups Auto backups occur prior to changing path data as a result of offsets from Setup, Tool Change, or Needle Calibration

	AutoExportPartManagerOnToolUpdate	Bool	0 – Do Not Automatically Export (Save For PartManager) 1 – Automatically Save for PartManager when Path Data is changed due to Tool Setup, Tool Change, Needle Calibration
	MaxAutoBackups	Num	The number of Auto Backups to save (of each type) before overwriting oldest backup Default = 50
	SafeZHeight	Num	Absolute Z position used when teaching a move with Approach type 'SafeZ' ***NOTE: Approach Type 'SafeZ' is persistent and is excluded from system offsets***
	SurfaceUnits	Enum	Units used by PathMaster for Surface Command Min and Max values mm = Millimeters in = Inches cnts = Encoder Counts (200 / mm) Default = mm ***NOTE: Enum values are case sensitive. Min and Max are always sent to the Galil in units of millimeters regardless of this setting***
	LiveDebug	Bool	0 – Do not log debug messages to file 1 – Log debug messages to time stamped file
	NeedleCalLabel	String	This label overrides any label that specifically reference 'Needle Calibration' ***NOTE: This key is omitted from the PathMaster.ini file and is reserved for custom implementations of the calibration functionality***
	StartupValidation	String	Semicolon separated list of labels/variables to be checked on startup of PathMaster
	ThetaDeadband	Numeric	Tolerance, in counts, of the Theta axis being considered "in position"
[Path]	Segments	Num	Number of Path Segment to use when creating 3D Arcs and Circles Default = 15 Max = 511 Segments (DMC2000) Max = 2047 Segments (DMC4x00)
[Vision]	LightsINI	Path	Path to Vision Module 'Lights.ini' File Default = 'C:\Program Files\PVAPortal\Lib\Vision\Lights.INI'

	InspectionsINI	Path	Path to Vision Module 'Inspections.ini' File Default = 'C:\Program Files\PVAPortal\Lib\Vision\ Inspections.INI'
	FidTool	Num	Tool ID used for Fiducial Function (Used for Tool Offsets Calculations) Default = 0
	InspectionTool	Num	Tool ID used for Inspection Function (Used for Tool Offsets Calculations) Default = 0
	SubroutineTool	Num	Tool ID used for Subroutine Function (Used for Tool Offsets Calculations) Default = 0
[Form]	Red	0..255	Red contribution to RGB Background Color
	Green	0..255	Green contribution to RGB Background Color
	Blue	0..255	Blue contribution to RGB Background Color
	Top	Num	Top Position of Pathmaster On Startup
	Left	Num	Left Position of Pathmaster On Startup
	Width	Num	Width of Pathmaster On Startup
	Height	Num	Height of Pathmaster On Startup
	Border	Bool	0 – Open PathMaster with no Window Border 1 – Open PathMaster with Window Border Default = 1
[PMInterface]	ToolsINI	Path	Path to PMInterface Module 'Tools.ini' File Default = 'C:\Program Files\PVAPortal\Dep_PMInterface\Tools.INI'
Tool Type	0…∞	Enum	Enumerated list of Tool Types Default: 0=Teach 1=Profile 2=Non-Dispense 3=Dispense 4=Spray (Airless) 5=Spray (Atomize) 6=Atom Air Only 7=Servo 8=Jet Note: Tool Types in Red (0, 1) are reserved types and cannot be modified. All others types can be customized as needed

[Profile Type]	0...∞	Enum	Enumerated list of Profile Types Default: 0=None 1=Non-Contact 2=Contact Note: Profile Type None is a reserved Profile Type and cannot be modified. All others types can be customized as needed
[vRETMsgs]	2...∞	Enum	vRET handshake response messages When the vRET response from the Galil corresponds to a RETMsg, PathMaster presents the message to operator
[GalilMemory]	MaxMain	Num	Maximum length of Main program in lines (80 Char / Line) Default = 3200
	MaxPath	Num	Maximum length of Path program in lines (80 Char / Line) Default = 1600
	MaxRam	Num	Maximum length of Main Prog + Path Program in Memory Default = 4800
	MaxSpiralSegments	Num	Maximum Number of motion segments allowed in a Rectangular or Circular Spiral Default =1000
	MaxSegment	Num	Maximum number of motion segments for a dispense sequence (other than spirals) Default = 2047

23. Appendix D: Working with Materials

23.1 Overview

Workcells operate with many different materials in a variety of applications. It is not easy to program with these materials because there are no set rules for an operator to obey. The best procedure to find system settings for the system is trial-and-error. When satisfactory parameters are found, it is easy to maintain those parameters.

It is necessary to adjust each part of the material delivery system for the selected material. Adjust the components in the order shown.

23.2 Material Feed

First, refer to the manufacturer's material specifications to find the applicable settings for the material delivery system. Usually, material is moved through the system by a pump or a pressure vessel. If a pump is used on the system, read the separate pump manual to find the best settings for the material. If a pressure vessel is used, the pressure is too high if material flow is too much, inconsistent, or if air is forced into the material. The pressure is too low if material flow is not sufficient.

23.3 Dispense (Needle) Valve

The stroke of the needle valve can be adjusted. Turn the micrometer knob on the top of the valve counter-clockwise to increase material flow. A fine steady stream of material is all that is necessary. Tighten the locking nut when the flow is satisfactory. Make sure the valve flow rate is correct before you continue.

23.3.1 Needle Selection

Try different needle sizes to find a satisfactory needle for your procedure. If the needle is too large, there will be a drip at the end of the needle. If the needle is too small, the flow will not be sufficient.

23.4 Spray Valve

Valve stroke and atomizing air are adjustable on spray valves.

The stroke controls the flow of material through the valve. Turn the micrometer knob on the top of the valve counter-clockwise to increase material flow. Tighten the locking collar when the flow is satisfactory. Make sure the valve flow rate is correct before you continue.

Atomizing air is controlled by a pressure regulator on the front of the machine. Turn this clockwise to increase air pressure. This pressure can only be adjusted while the valve is active. When the flow is satisfactory, push the cap or tighten the locking collar. When first operating the machine, follow this list of instructions to adjust the spray valve:

1. Set the atomizing air to 0 psi.
2. Take off the spray cap.
3. Turn the stroke down all the way.
4. Purge the valve and open the stroke until the flow is a few drops per second.
5. Put the spray cap on.
6. Purge the valve and adjust the atomizing air until the spray is satisfactory. Test the spray pattern on scrap.

If the atomizing air pressure is too high, the spray will be misty. If it is too low, there will be splatter. For thin, solvent based materials 0.5 psi may be all that is necessary, and with some silicones 15 psi may be necessary.

23.5 Programming

Once the satisfactory physical parameters for the delivery system are set, do not change them. It is better to change the program. Usually, if you increase or decrease the speed of a dispense path, the material output changes to a satisfactory level.

Program with the dispense valve close to the part surface, but not so close that different needle length tolerances will cause the needle to touch the product surface.

With the spray valve, start about ¾" (19 mm) above the product surface. With atomizing air, this should produce a spray width approximately ½" to ¾" (19 mm) wide. If necessary, adjust the spray height so the pattern on the product is consistent and uniform.

24. Appendix E- Optical Bonding with PathMaster

24.1 Theory of Operation

Optical bonding with PVA's PathMaster software should be done with the bonding path template as shown in this document. This document only refers to bonding specific settings. Please refer to the PathMaster manual for additional information on PathMaster.

PathMaster uses a series of plugins to set values for your specific procedure. Please set all of the plugin values before you program additional template values.

Path Template

The easiest way to create a bonding sequence is to use the bonding template and change the values as necessary for your product and process.

- You will need to import the path template from the '\PathMaster\Samples' folder on the workcell computer. For additional information on how to import a path, refer to the PathMaster manual.

24.2 Plugins

There are two types of plugins, Setup plugins and Path plugins. Setup plugins are for machine setup purposes and must be completed before a production path can be run. Path plugins are program specific. In the case of bonding equipment, setup plugins are used to measure the positions that are described in the name of the plugins. The wizard plugin uses the values from the setup plugins to establish the bond base position and the bare pick head reference measurement height. The descriptions of all setup plugins are in this document, for information on the path plugins refer to the PathMaster manual.

Setup Plugins

You must set the reference positions before you can create a bond routine. The Setup Plugins have the four main steps that you must complete to have a succesful routine. The setup plugins must be done in numerical order (1-4).

Offset values should be taught to the bare datum and pick tool. The part values you set will calculate the correct distance off of the datum and pick tool.

NOTE: The setup plugins are used to calculate the bonding reference position. Setup plugins are accessed through the PM machine setup menu and have a global effect.

1. Select *Setup->Machine Parameters* from the Main menu to open the Machine Parameters window.
2. Select the "**Functions**" button form the **Plugins** section of the screen.

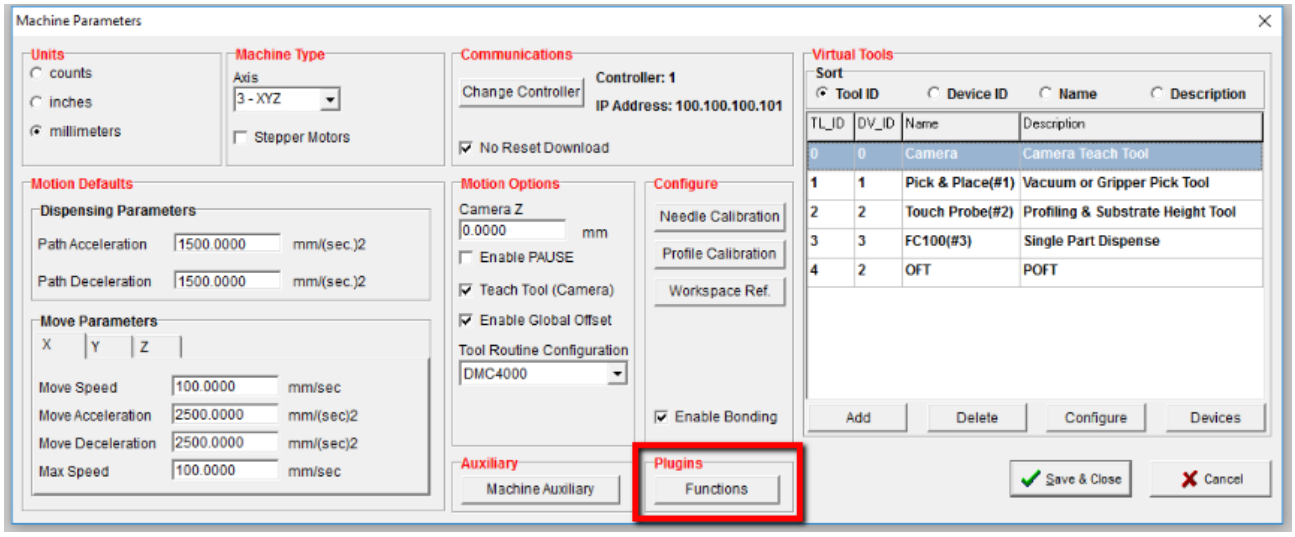


Figure 195: Plugins, Functions

3. The Setup Plugins screen will open. Use the radial **Sort By** buttons to sort by **Category**.
4. Do the four "Bond Setup" plugins in order.

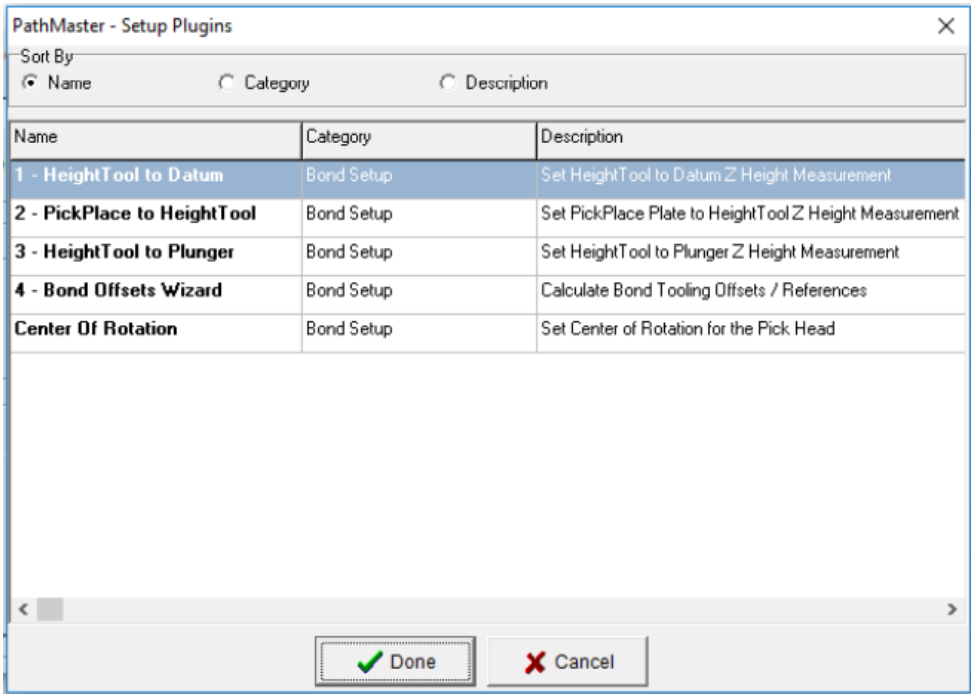


Figure 196: Setup Plugins

NOTE: Plugins must be done in numerical order, as shown. If done out of order, the setup window for the plugin will close and you will return to the previous screen.

24.2.1 HeightTool to Datum

1. In the Bond Setup category, select **1-HeightTool to Datum**.

The HeightTool to Datum window will open.

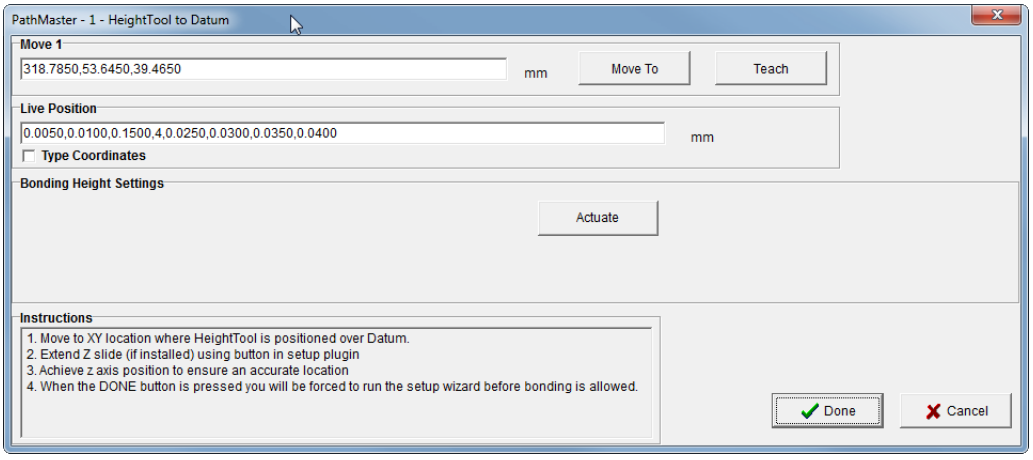


Figure 197: HeightTool to Datum

2. Refer to the instructions in the window to set the correct position.

3. Use the teach pendant to teach the value; push the "**Teach**" button and release the button to record the value.

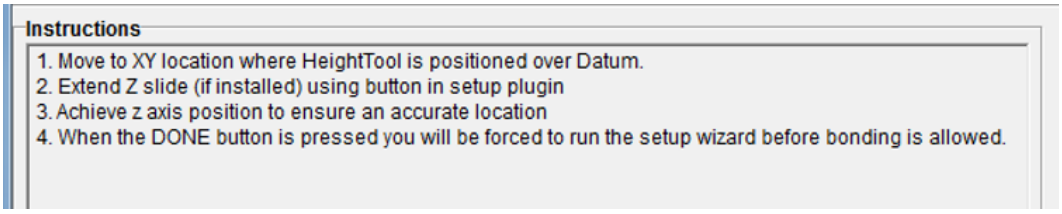


Figure 198: HeightTool to Datum Instructions

4. Select "**Done**" to save the values and return to the Setup Plugins window.

24.2.2 PickPlace to HeightTool

1. After the HeightTool Datum, select plugin **2-PickPlace to HeightTool.**

The PickPlace to HeightTool window will open.

2. Refer to the instructions in the window to set the correct position.
3. Use the teach pendant to teach the value; push the "**Teach**" button and release the button to record the value.

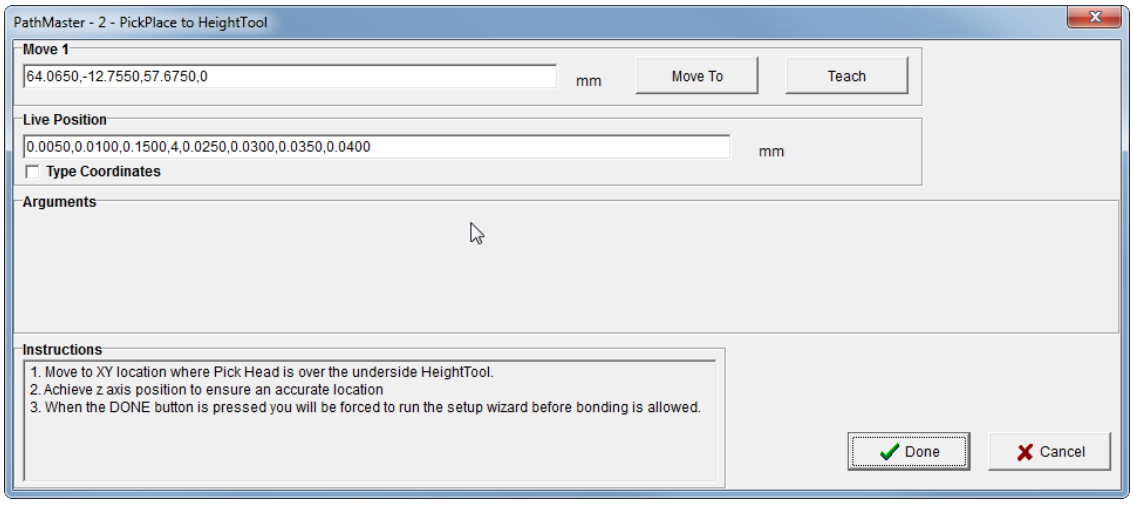


Figure 199: PickPlace to HeightTool

4. Select "**Done**" to save the values and return to the Setup Plugins window.

24.2.3 HeightTool to Plunger

1. After PickPlace to HeightTool, select plugin **3- HeightTool to Plunger.**

The HeightTool to Plunger window will open.

2. Refer to the instructions in the window to set the correct position.

3. Use the teach pendant to teach the value; push the "**Teach**" button and release the button to record the value.

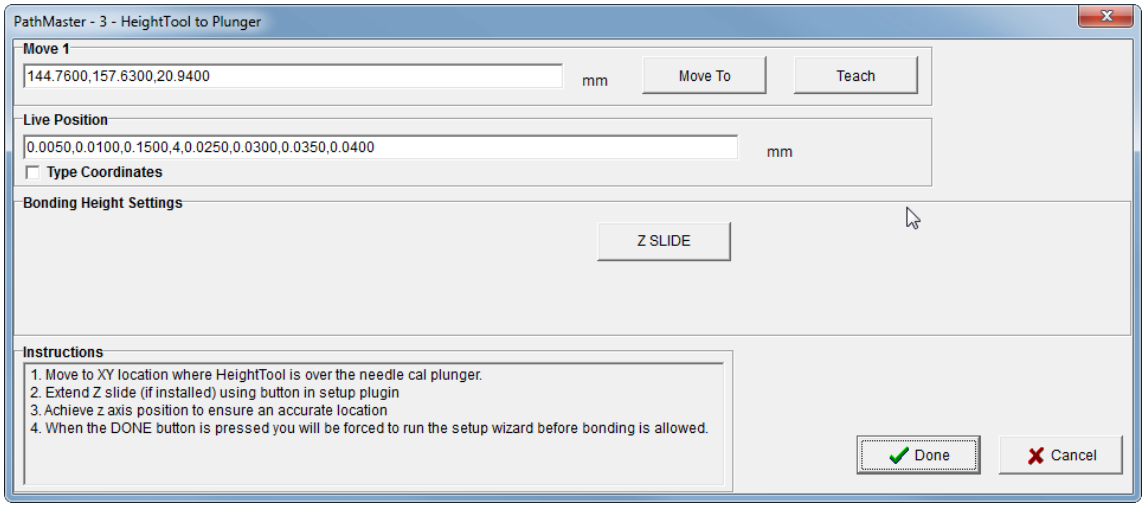


Figure 200: HeightTool to Plunger

4. Select "**Done**" to save the values and return to the Setup Plugins window.

24.2.4 Bond Offsets Wizard

1. After the other three bonding plugins have been setup, select the Bond Offsets Wizard.

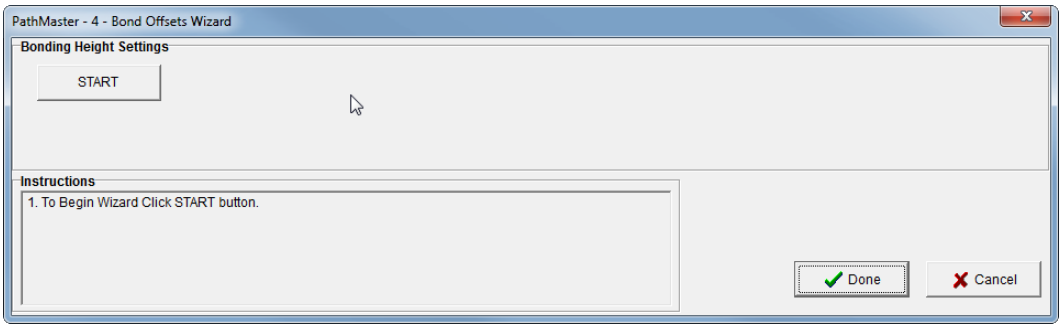


Figure 201: Bond Offset Wizard

2. Select the "Start" Button.

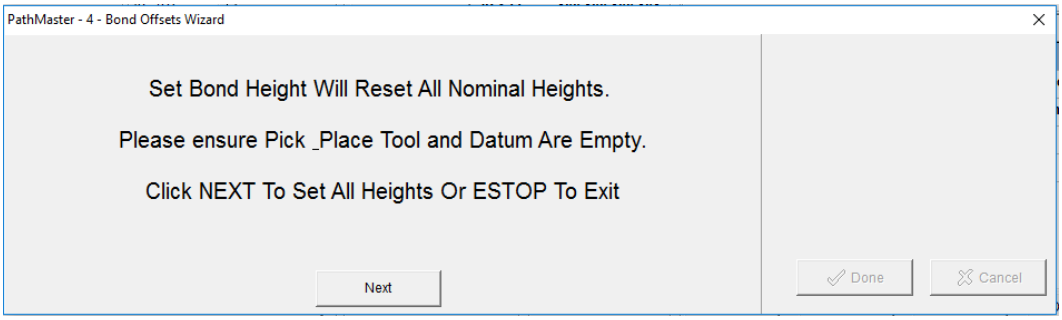


Figure 202: Make Sure Pick Tool and Datum are Empty

3. Select the "**Next**" button when the datum and pick tool are empty.

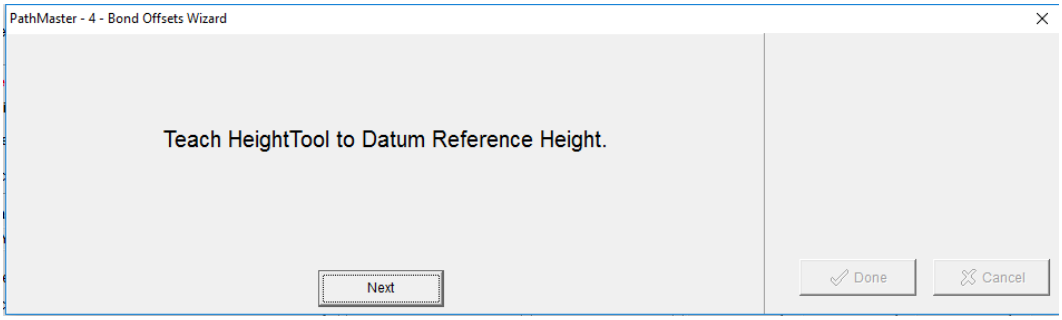


Figure 203: Teach the HeightTool to Datum Reference Height

4. Use the teach pendant to teach the HeightTool to the Datum Reference Height.

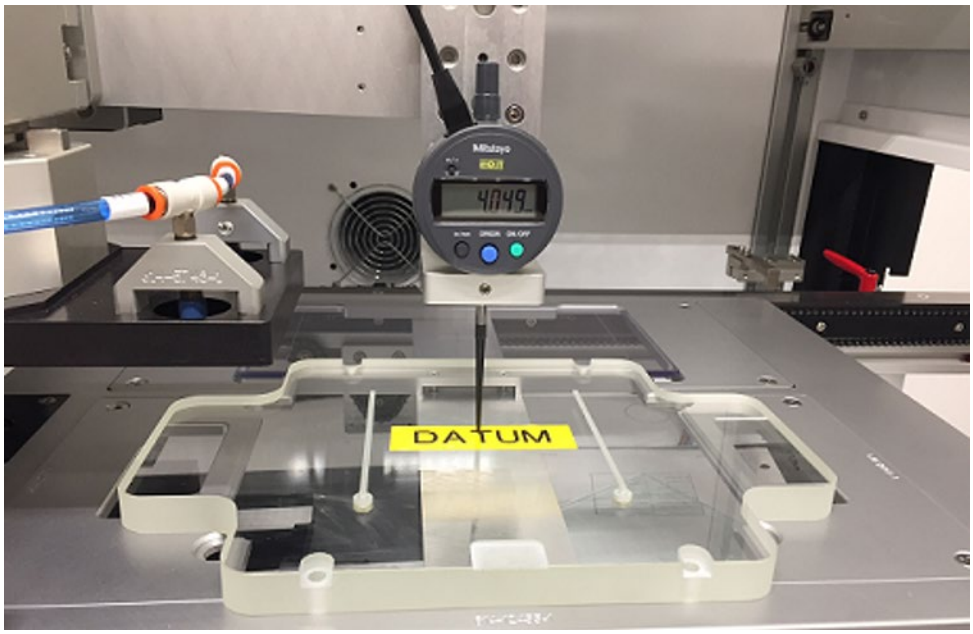


Figure 204: Datum Reference Height

The "Teaching, Please Wait" screen will be shown.

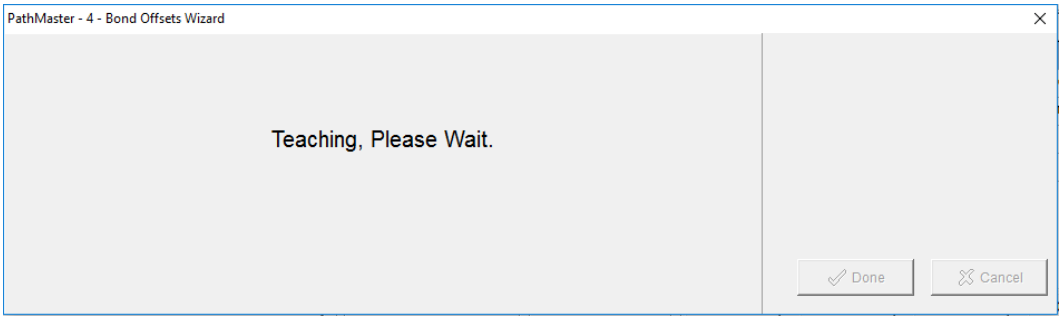


Figure 205: Teaching, Please Wait

5. Next the HeightTool to the Needle Cal plunger is taught. The height is automatically detected by the wizard, there is no user input.

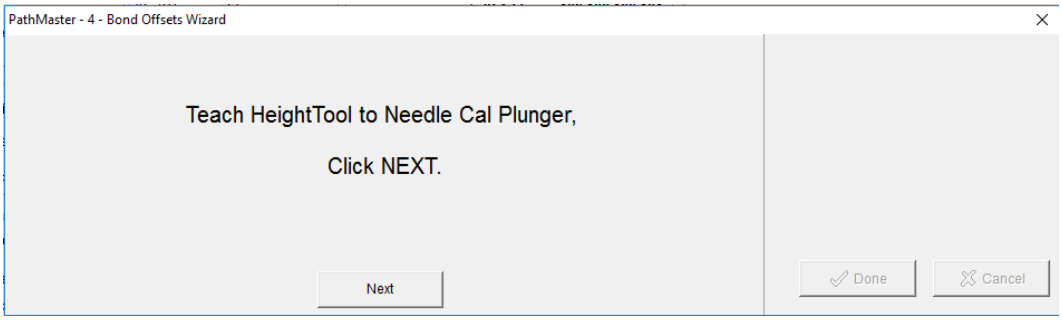


Figure 206: Teach HeightTool to Needle Cal Plunger

6. Click "**Next**". The Teaching, Please Wait screen will be shown.

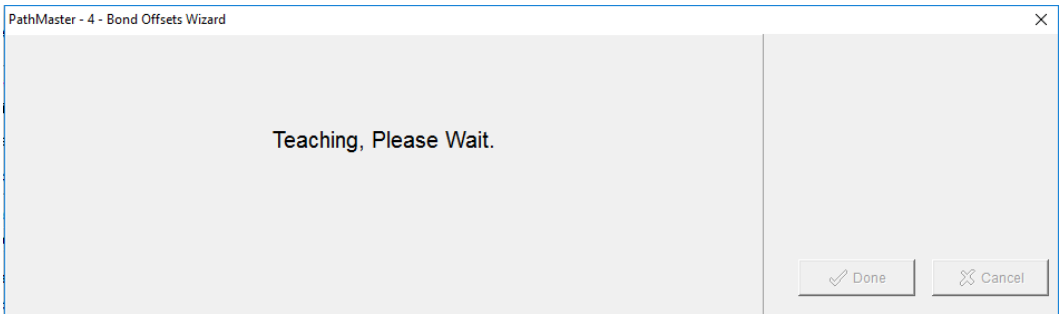


Figure 207: Teaching, Please Wait

7. Use the teach pendant to teach the center of the needle calibration plunger as shown on the screen. Use the teach pendant to make sure the crosshair is in the center of the indicator dot. When the crosshair is correctly aligned, push the "**Teach**" button on the teach pendant.

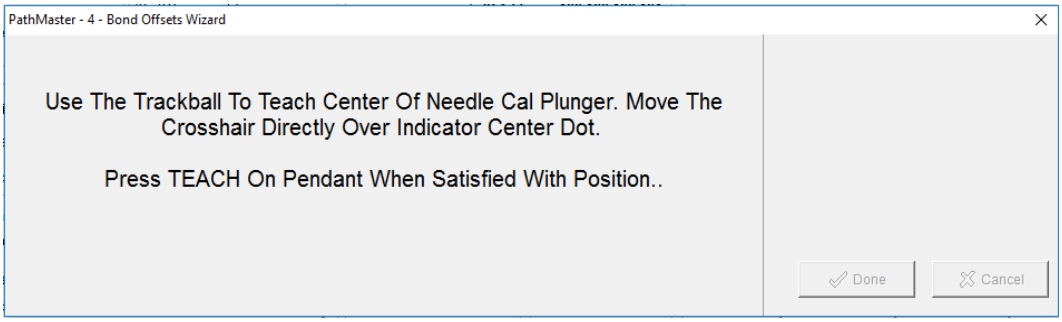


Figure 208: Teach the Needle Cal Plunger Center

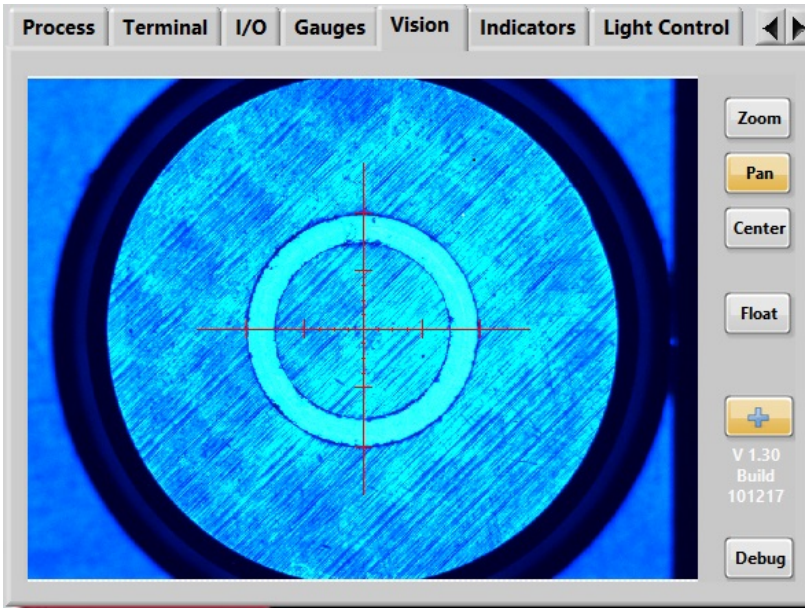


Figure 209: Portal Front Panel Screen, Needle Calibration for Plunger Center

8. Next, to turn the door bypass to on.

9. Install the threaded spike on to the pick and place tool. Turn the threaded spike clockwise until it is tight, do not overtighten.

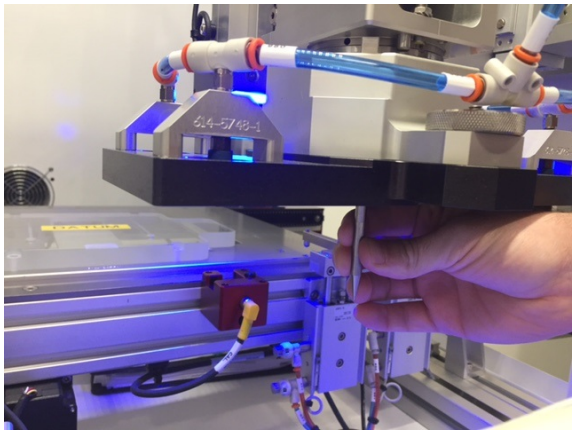


Figure 210: Install the Threaded Spike

10. When the threaded spike is installed, click the "**Next**" button.
11. Use the trackball to move the spike directly over the center of the needle calibration plunger.
12. Push the "**Teach**" button when the position is correct.

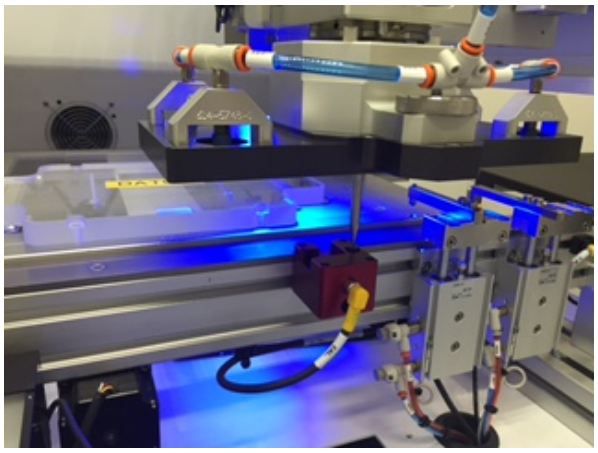


Figure 211: Teach the Needle Calibration Position

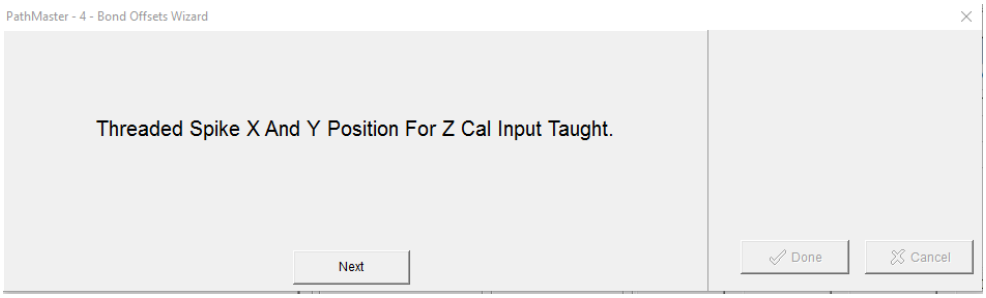


Figure 212: Position Taught Screen

13. After the position is taught a confirmation screen will be shown for the X and Y positions Select "**Next**". Another screen will confirm the Z-position.

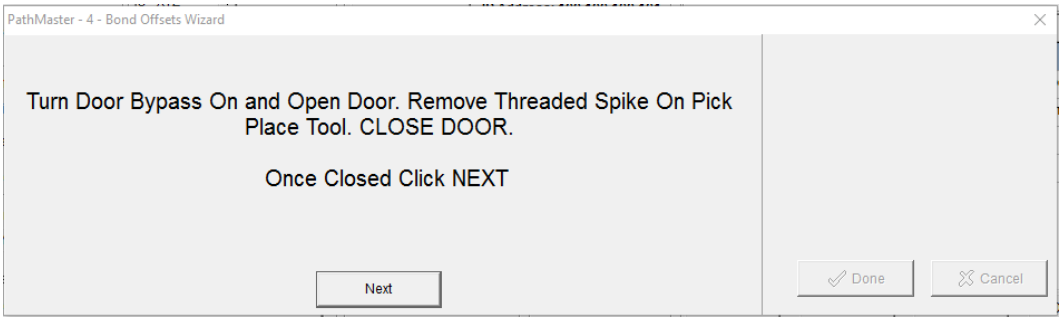


Figure 213: Remove Threaded Spike

14. Turn the door bypass "**Off**" and open the door.
15. Turn the threaded spike counterclockwise to remove it.
16. Close the door.
17. Select "**Next**".

24.2.5 Center of Rotation

1. When you hit the "Move to" button the camera goes live and feed is displayed in the vision tab.

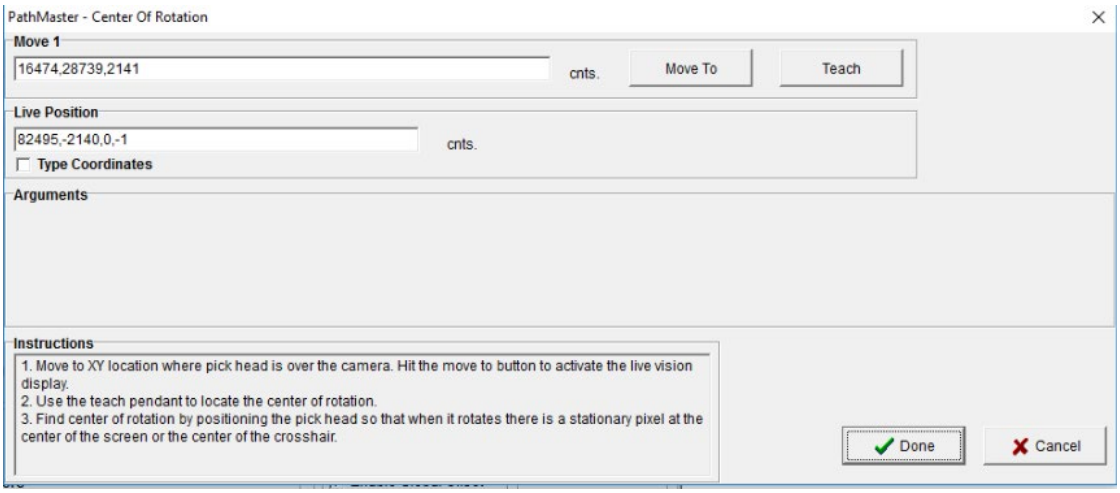


Figure 214: "Move To" Button

2. To teach the center of rotation, use the teach pendant to move the X,Y location so that when you move the W-axis the exact center of the image is stationary and everything is rotating around it (center of rotation).
3. When this location correct push the "**Teach**" button on the teach pendant.

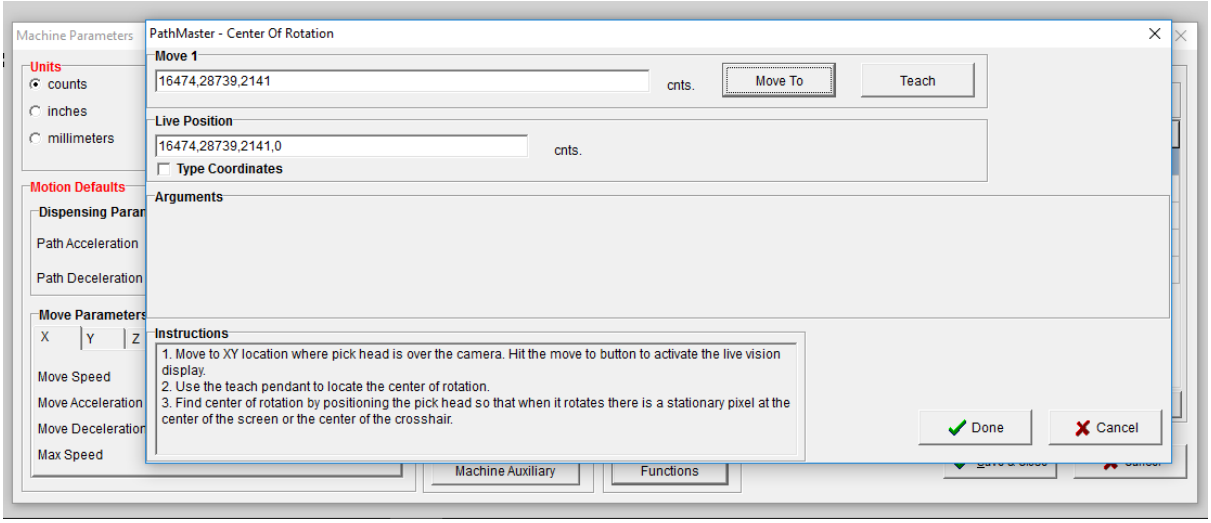


Figure 215: Center of Rotation

This will update the Galil resource associated with the center of rotation for the W-axis relative to the camera.

4. Select the done button. The camera and light will turn off.

24.2.6 Part Thickness

Use the Part Measurement plugin to set the part thickness. You must do this for both the substrate and the component.

1. In PathMaster, select *Plugins->Part Measurement* from the main menu.
2. When the Part Measurement window opens, select the “Perform Check” box.
3. Select **Substrate** or **Component** from the **Operation** drop down menu.
4. Highlight the section of path that has the Part Measurement plugin and run it in manual mode.

After the check is done, the Part Thickness value will be shown on the Portal screen.

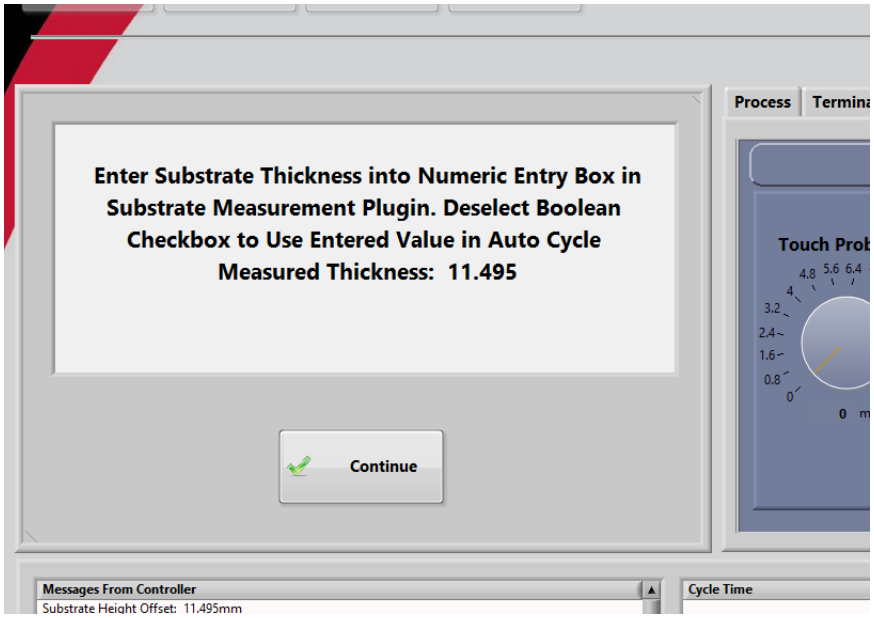


Figure 216: Measured Thickness

5. Enter the value in the Part Thickness box.

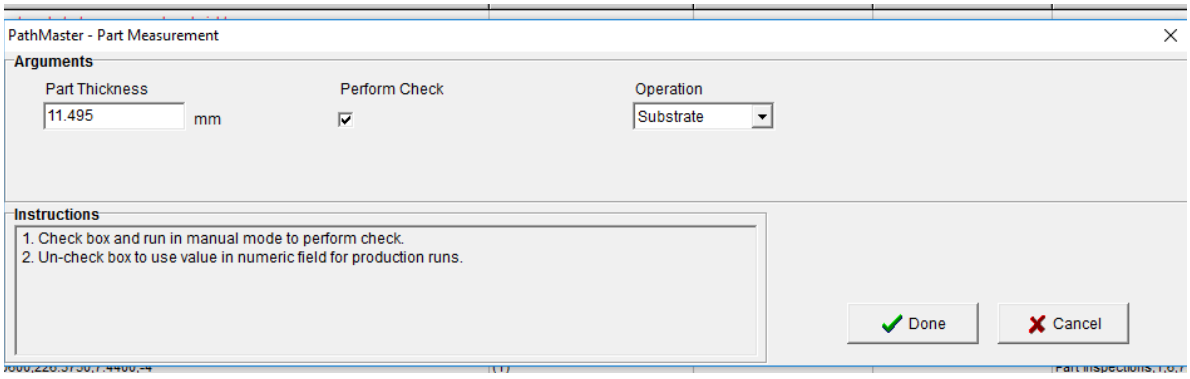


Figure 217: Part Thickness in mm

6. Deselect the "Perform Check" box.

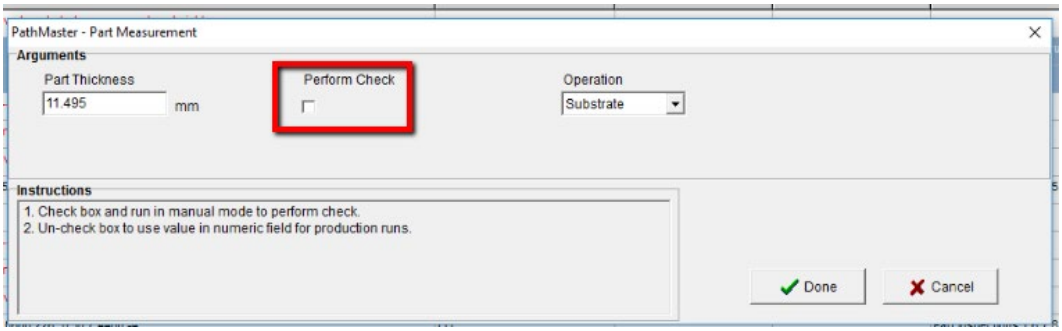


Figure 218: Perform Check Box

24.3 Path Template

After the Setup plugins for bonding are done, the next step to make a new bonding routine is to go through the Path template and set the values for your specific parts. Refer to the Bonding Path Template for more information.

NOTE: When possible, please use part and material values from the manufacturer.

1. Make sure the Path Template values are in the correct order with the correct values set.
   - Set part dimensions.
   - Teach the part pick offset.
   - Set the part thickness.
2. Highlight the section of the path that includes all of the above commands.
3. Run the highlighted section of the path.

After the you have successfully run this section of the path, continue to program the following sections.

- Program the part inspection (Substrate). Double click on this in the Path Template and the plugin will open.
- Program the part inspection (Component). Double click on this in the Path Template and the plugin will open.
- Measure the Component height. Double click on this in the Path Template and the plugin will open.
- Program the part pick. Double click on this in the Path Template and the plugin will open.
- Program the underside dispense. This must be taught to the bare pick tool.
- Program the dog bone dispense. This must be taught to the bare datum.
- Teach the prebonding move. Double click on this in the Path Template and the plugin will open.

When you have completed these steps continue to the Bond Manager section (24.4).

24.4 Bond Manager

After all of the Bond Setup plugins have been run, the path template values have been set for your parts and the part inspection has passed, you can use the bond manager to create the Bond Manger recipe.

1. Select *Teach->Bond Mgr* from the main menu.

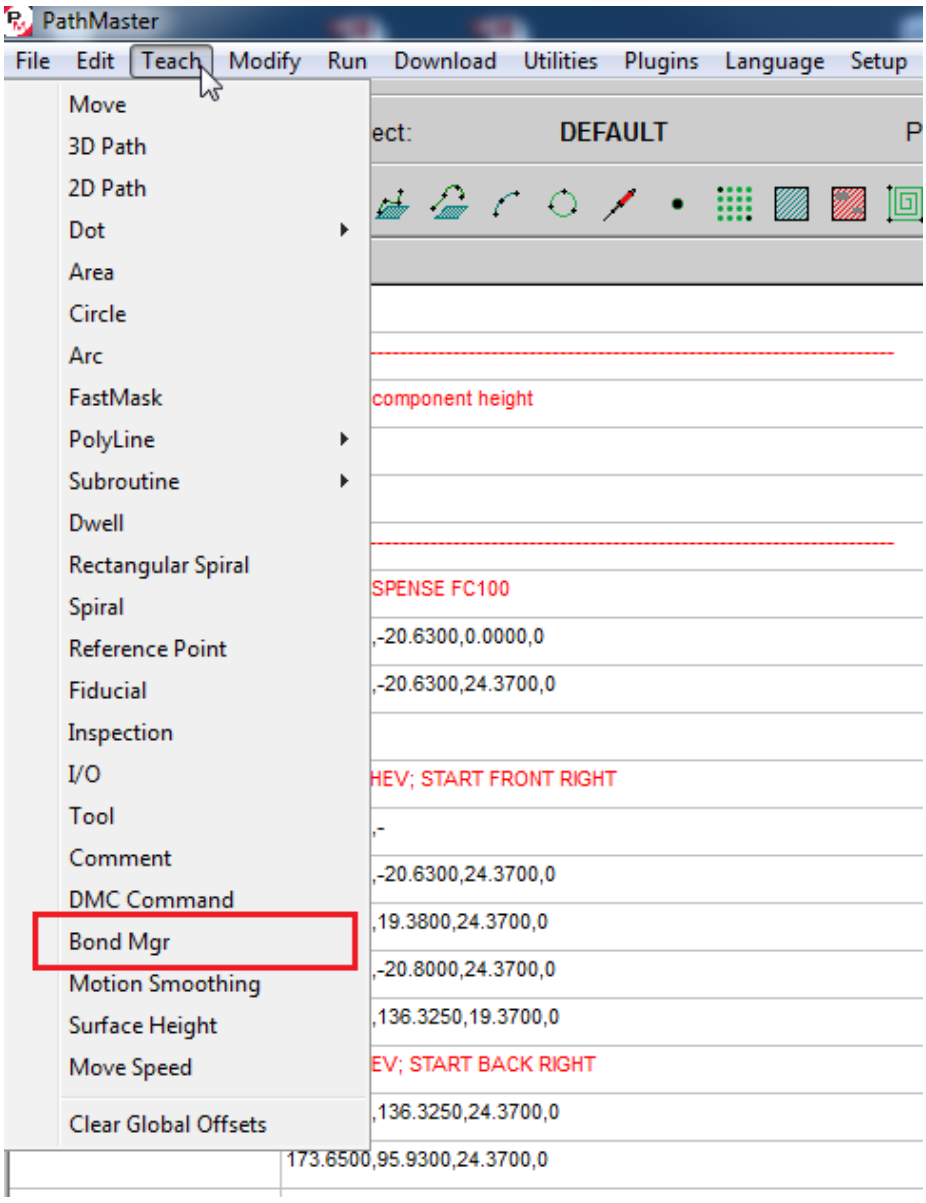


Figure 219: Teach Menu, Bond Manager

2. The bond manager window will open. Set the Routine Name.

3. Set the values for Approach distance, Material Thickness, Speed, Acceleration, and Deceleration.

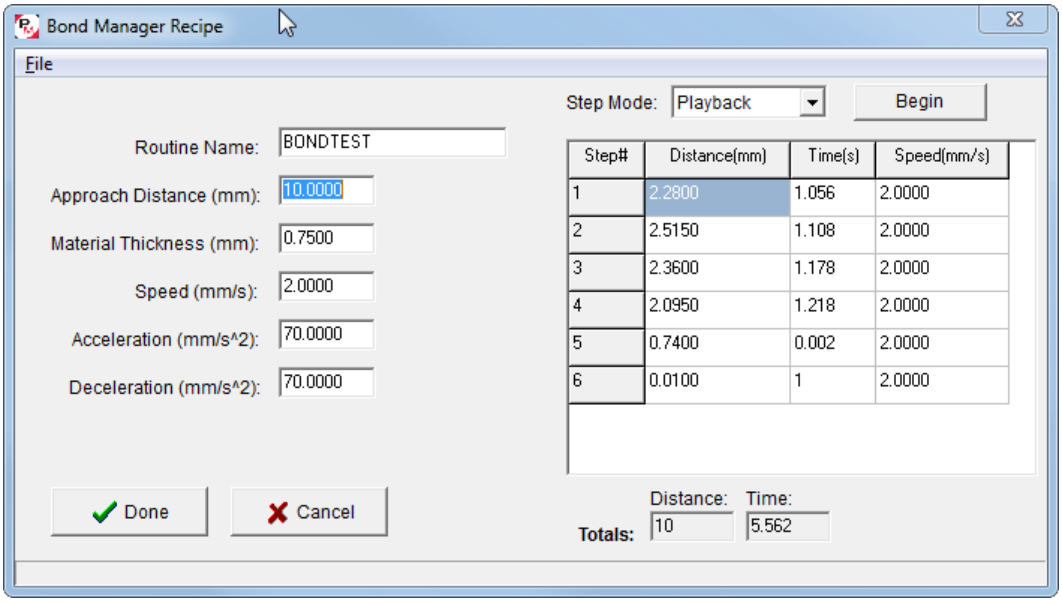


Figure 220: Bond Manager Recipe

4. Make sure Setup Mode is set to "Teach" and Select the "**Begin**" button.

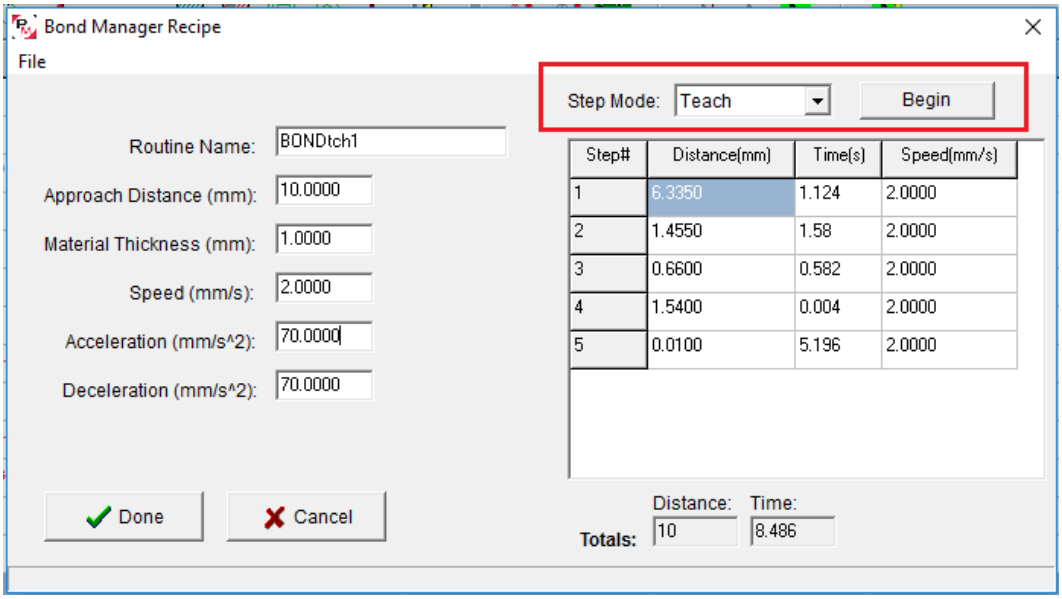


Figure 221: Bond Manager "Begin"

The Initializing screen will be shown.

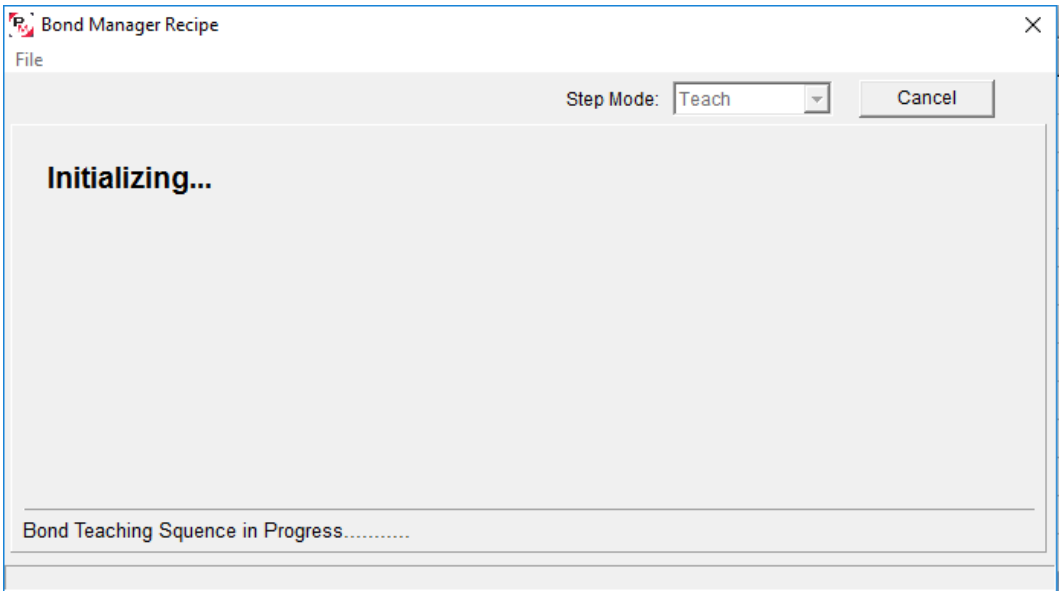


Figure 222: Bond Sequence, Initializing

5. Press and hold the "**Teach**" button on teach pendant to record the first bond step. Release the "**Teach**" button to stop the motion and start to record the first dwell.

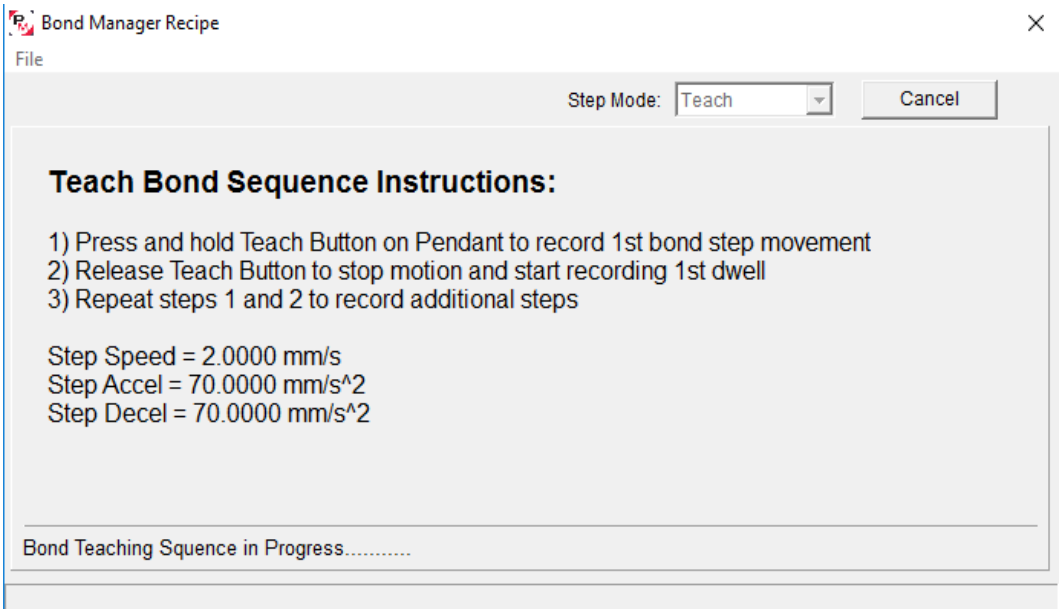


Figure 223: Teach Bond Sequence

The Step Number, Material Thickness, Approach Distance, and Remaining Distance are shown when a step movement is being recorded.

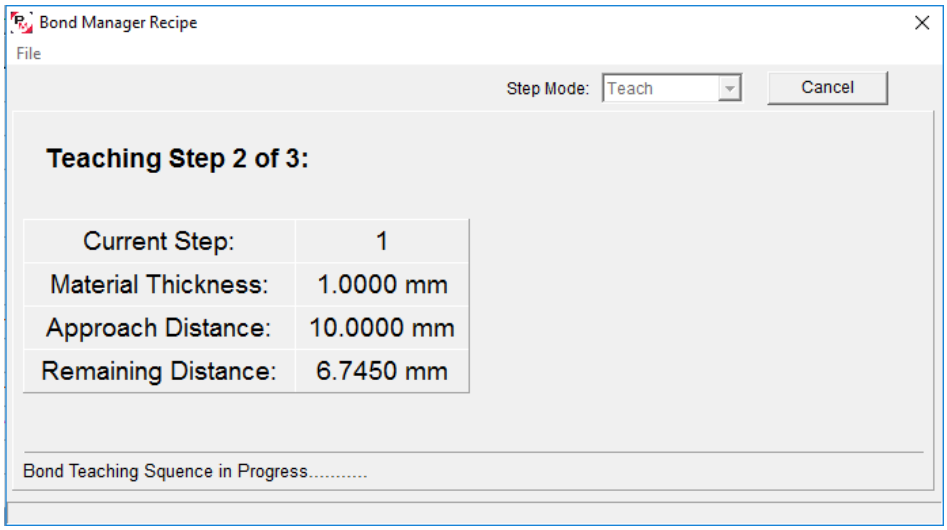


Figure 224: Teaching in Progress

The Dwell time is shown when a dwell step is being recorded.

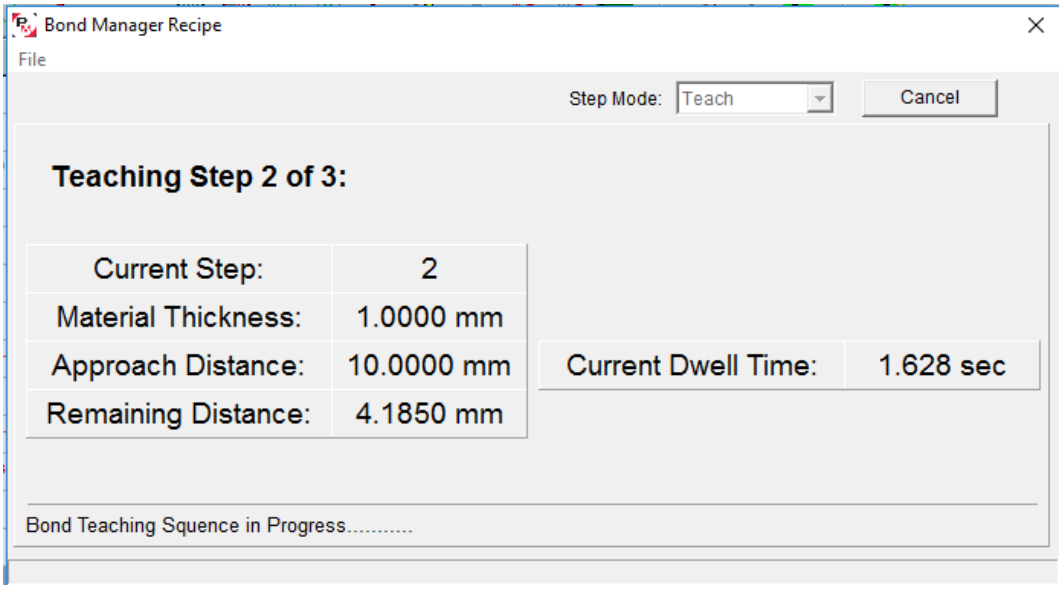


Figure 225: Current Dwell

6. Repeat the procedure to record additional bonding steps. The values will be shown in the table.
7. Press the "**Axis**" button on the teach pendant when the wet out is complete. This will save the value.

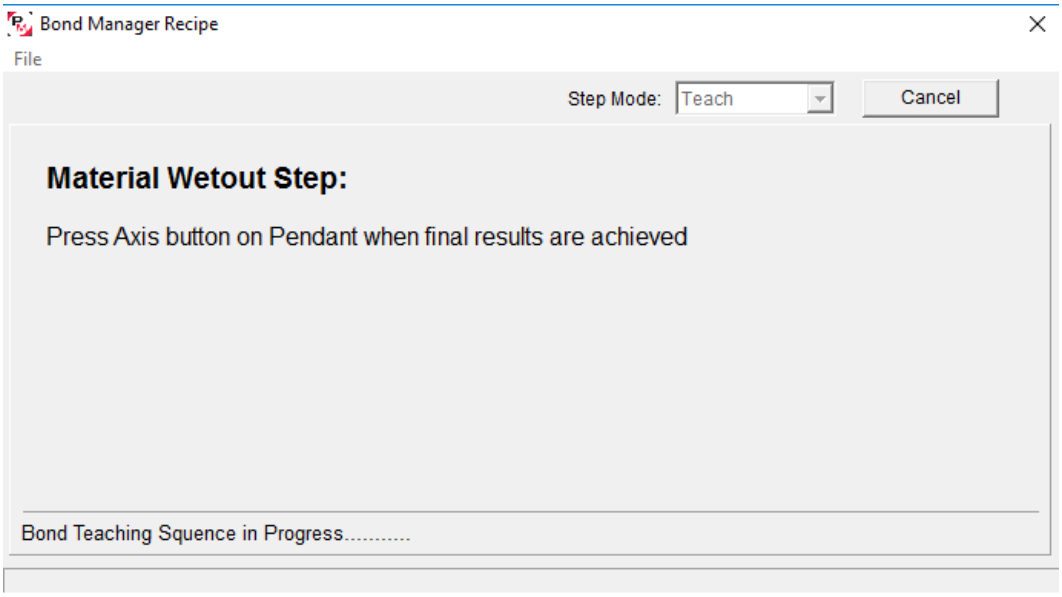


Figure 226: Material Wet Out

The screen below will be shown when the complete bonding sequence has been taught.

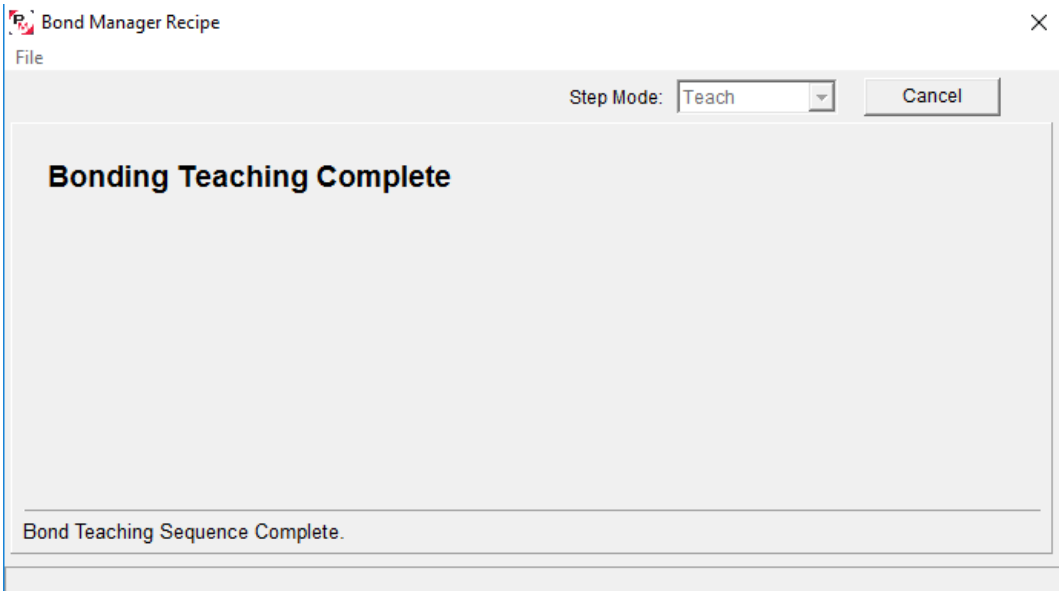


Figure 227: Bonding Complete

Bonding in Auto Cycle

When you use Auto Cycle to make parts, the follow screens are shown in Portal.

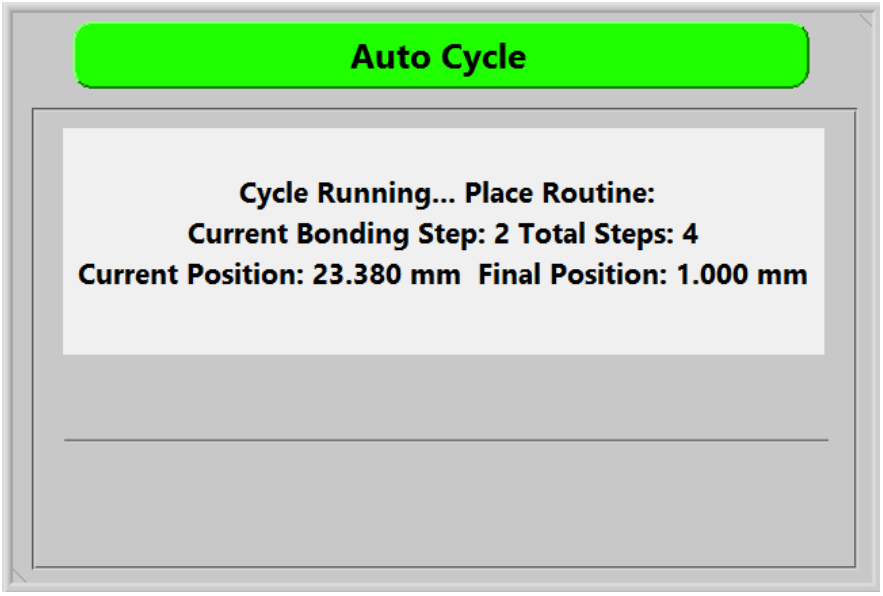


Figure 228: Bonding Cycle Running

When the part placement is complete the following screen is shown.

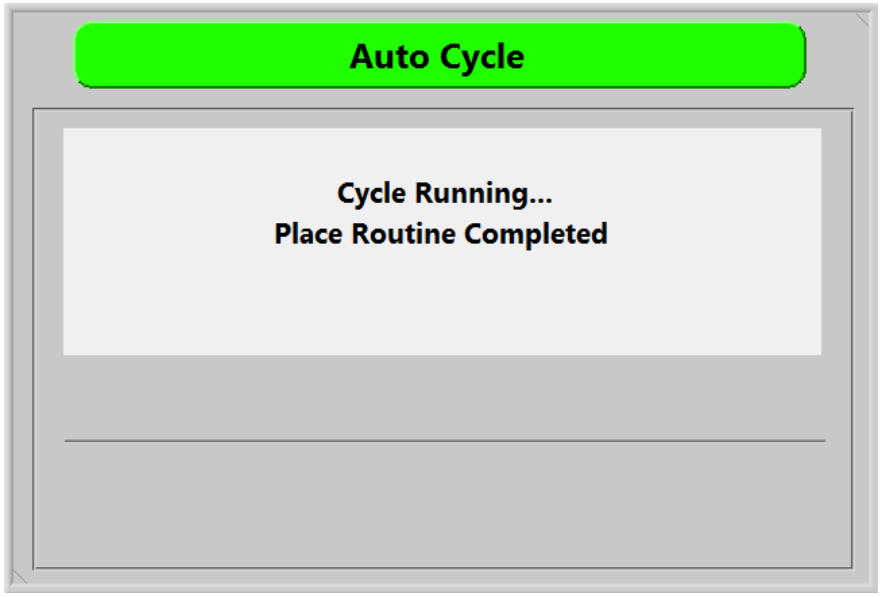


Figure 229: Place Routine Complete

Additional steps of the bond cycle are customer specific and may have additional screens.