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G Code Controller Version 2

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G CODE CONTROLLER

table of contents

Chapter 5

Chapter 6

Chapter 7

Chapter 8

Chapter 9

Chapter 10

Chapter 1

INTRODUCTION

What "G Code" is

The command language commonly referred to as "G Code" is used to control automated machinery such as milling machines, lathes and other devices that typically move a cutting tool over a prescribed path. In the Electronic Industries Association standard RS-274, this language is entitled "Interchangeable Variable Block Data Format for Positioning, Contouring, and Contouring/Positioning Numerically Controlled Machines". Understandably a shorter reference would evolve, and so most technicians involved with numerical controlled machinery refer to control languages which have evolved from the RS-274 specification as "G Code", since the letter "G" is used as a prefix to the most fundamental commands.

The commands for the earliest numerical controlled machines used a method of storing characters as numbers on punched tape. The system of converting numbers to characters, known as ASCII, is still used today. Older machines are programmed by punching tape with ASCII characters via a teletype terminal, and the tape was used as the means of transferring the commands to the machine's controller. More modern machines still use ASCII characters to represent machine commands. However, these characters are stored by means of more efficient electronic media, accessible

to the controller by means of disk drive or network access. Also, the commands are more readily generated, viewed and changed by means of text editors, such as Window's **Notepad**, word processors or versatile graphics based CAD/CAM programs.

In short, the collection of machine commands (called the **Part Program**) that is used to control the machine consists of ASCII "text", stored in "text" type files typically located on the computer's hard drive, and accessible by text editors and word processors capable of reading and writing in ASCII characters.

The types of commands contained in the G Code text not only define the desired paths of motion for the machine's motor controlled **Stages**, but also order other features relating to the machine, such as control over peripheral elements including spindles and coolants etc. The **Part Program** defines the procedure for dispensing these commands and interacts with the controller's front panel. In the case of this software based controller, the front panel consists of the program's user interface.

Although the EIA RS-274 has provided a basis for a numerically controlled machine language, and the EIA RS-267 has defined a standard of nomenclature for referring to axes of motion on various types of machine tools, individual manufacturers of controls have generated different dialects of the control language to suit particular purposes and to accommodate advances in technology. Fortunately, the dialects are similar enough so that a technician familiar with one should have little trouble working with others. Similar to other controllers, the Ability Systems **G Code Controller** shares many common elements of industry wide control language. It can also be customized to emulate various other controllers.

What the G Code Controller is

The **G Code Controller** uses the commands contained text files containing G code to control motors for milling, routing, engraving, plasma cutting, water jet cutting, laser etching, glue dispensing, flame cutting, large scale template plotting, or other operations where the motion of a tool must be directed over a specified path.

The **G Code Controller program** also provides a convenient

operator interface, and includes features especially useful in managing production operations. Pop-up menus and easy-to-use manual positioning options allow the operator to conveniently load and graphically verify **Part Programs**, as well as set up and control manufacturing operations.

Tool programming is quickly stored and retrieved for each **Job**. **Job** set-ups include such things as the names of the **Part Program** text files, as well as other pertinent information relating to the manufacturing of the part, such as an optional tool tray table (list of H and D offsets), arc accuracy, fixture offsets, peck plunge retract distance etc. Many of these values will not change from **Job** to **Job**.

Job setup values are entered via dialog boxes, and are easily duplicated, modified, and stored under descriptive names for later use. Consequently, when a **Job** is retrieved, all of the set-ups pertinent to the manufacturing of the particular part are restored.

What Kind of Machine is Controlled

This program is especially suitable for milling operations in three or more axes, where the primary geometric control contours in three orthogonal dimensions: X, Y and Z. However, it is also suitable for simpler two dimensional machines where G code part programming is preferred - as well as some more complex specialty machines.

The motorized **Stages** are moved by either step motors or step/direction controlled servo motors. Other actuators, which can be effected by means of a digital (on/off) signal, such as solenoids for coolants, tool changers, laser controls, vacuum or clamping can also be incorporated. All of the output signals that this program uses are generated through the Ability Systems **Indexer LPT** device driver.

How the Machine is Controlled

The part program, defining the geometry of tool motion as well as other operations pertinent to the manufacturing of the part, can be generated manually by means of a text editor such as **Window**'s **Notepad** or **Word** (in ASCII mode), which can be

launched from within this program. The **Part Program** can be graphically viewed and simulated. Three dimensional views that can be rotated in real time, and orthogonal (front, end and side) views assist in the process. The **Part Programs** can be incrementally edited, saved and reloaded by the **G Code Controller** - making **Part Program** composition convenient and efficient .

Alternately, the **Part Program** can be automatically generated by third party CAD/CAM software.

Subsequent to generating and verifying the **Part Program**, the technician may wish to do a **Dry Run**. During a **Dry Run**, the machine traverses the geometry of operation at a rate specified (for this purpose) in the **Job** set up, and disables operations (such as activation of coolant or vacuum solenoids) that are not pertinent to a testing the tool path.

Finally, with material in place, the part is manufactured under control of the **Job** set up (for **Production Run**) and the **Part Program**(s). The operator interface menu offers numerous control and display options. Control options include such things as manual motion, feed hold, feed rate override, joystick and “instant block” execution. Also included are block skip, and several break point stop methods. Display options include position readouts, machine state and a graphical display that highlights the progress of the tool across a picture of the tool path in multiple dimensions.

Who Uses this Manual

The **G Code Controller** is a design engineers tool. It provides a powerful and convenient operator interface for OEM's and machine tool retrofitters. It requires a working knowledge of **Indexer LPT** and a knowledge of machine design. Since this product can be used on machines varying from small educational devices to powerful and dangerous cutting tools, the depth of knowledge required will depend on the nature of the design. Safety should be your primary concern. Due to the complex nature of software in general, safety features must be designed into machine wiring and mechanical hardware.

Of course, all machines should be designed for safety, but special considerations for safety must be incorporated by design-

ers and OEM's in anticipation of potential users who may lack some of the detailed technical knowledge involved in the particular machine's design. These considerations may include shields, lock-outs, placards, specialized training and clear written documentation.

The design and setup routines incorporated in this product should ONLY be used by technicians who have an acceptable understanding of the safety issues involved. Likewise, end use of this product should ONLY include those who are familiar with the hazards involved in operating automated equipment and necessary precautions.

WARNING

ALWAYS PLAN FOR THE UNEXPECTED WHEN USING SOFTWARE! If you cannot build appropriate safety features into your hardware by virtue of cost, expertise or any other reason, you should not be using this product!

How to Use this Manual

An Engineers Guide

This ma**nual is an engineer's guide to implementing the G Code Controller**. This text presumes that the reader has a working knowledge of **Indexer LPT**. Details pertaining to the operation of **Indexer LPT** can be found in the **Indexer LPT** documentation.

This manual is not an instructional guide on CNC procedures or G Code part programming. Instead, it is a guide to the particular performance of this product, and how it may be customized to apply to the unique design of your automated machine.

Doesn't Replace End User Manual

Since the **G Code Controller** is meant to be customized to accommodate a large variety of machine designs, the manner in which the program functions is highly dependent on the physical nature of the machine and the software set-ups. An end users guide is therefore necessary to describe the actual operation of the machine. Consequently, although portions of this manual may be referred to from within an end users guide, this manual was not meant to be an end users guide. Documentation in the form of an

end users guide is the responsibility of the machine designer.

Getting Started

Ironically, the last chapter in this publication is devoted to and entitled "**Getting Started**". Unlike documentation associated with software that does not absolutely require customizing, and especially unlike software that doesn't manipulate potentially dangerous equipment, this manual presumes its user will become reasonably familiar with is specifications before applying the software to actual machine hardware.

Obviously not every feature will be used in every design. Some simplified applications only require configuring a **Stage** or two, use the keyboard for **Cycle Start**, and require very little wiring. Even so, it is important to become familiar with at least the existence of features, and the reasons why they are available.

There will be a period of time while your machine is under development before your machine is put into productive use. During this time additional precautions apply. However, the collection of features was designed in a manner to accommodate troubleshooting component parts. Dependencies can be isolated. So, for example, you may first simply exercise motor motion using **Indexer LPT**'s **Diagnostic** program. After you have verified that the motor is working correctly, you may configure it to a **Stage** in **G Code Controller**, and exercise the motor with one of the manual **Stage** control dialogs. After you know that the motor is working and its associated **Stage** is configured correctly, you may automatically move the **Stage** back and forth automatically using a simplified **Part Program**. Perhaps finally you may import a more sophisticated **Part Program** from another CAD/CAM system.

The same development technique applies can be applied to other portions of your machine's design. In another example, you may exercise control over manual and automatic operations at first using the keyboard for **Cycle Start**. You can add wiring for an external **Cycle Start** switch later, but in the mean time, if for example a motor is not yet operation, you are relieved of the task of determining whether the problem is with the **Stage** or the **Cycle Start** configuration. Isolating each functional component not only speeds prototype development, but also greatly aids find-

ing and correcting problems that may occur in the field.

Chapter 2

IMPORTANT FILES

The G Code Controller Program

The file name of the **G Code Controller** program is GIXA.EXE. It is run by snapping over its icon from the **Windows Start > Programs** menu.

The Indexer LPT Device Driver

The **G Code Controller** communicates directly with the **Indexer LPT** motion control software and takes advantage of many of its advanced features. **Indexer LPT** is a **Windows** device driver which is accessed by the **G Code Controller**. All reading from and writing to external control signals is accomplished through the **Indexer LPT** device driver. Refer to the **Indexer LPT** manual for instructions on the proper installation of this software, and for effective use of its many unique features.

The System Configuration File

Information defining the characteristics of the machine which you are designing is kept in a file entitled GIXA.INI, located in the **WINDOWS** folder. **G Code Controller** reads this file when it starts running. The GIXA.INI file is generated when the **G Code**

Controller is run for the first time, and is accessed for set-up and changes by means of menus and dialog boxes which are available from its **System** menu. Since the GIXA.INI file contains information which is specific only to the design and configuration of the machine (such as the step-to-distance ratio of the motorized stages, axis designations, rapid traverse rates, etc.), it is not likely to need changing after initial configuration. You can optionally hide the **System** menu to simplify the user interface and minimize the chances for the machine configuration to be accidentally changed. OEM's can copy a premade GIXA.INI file to the **WINDOWS** folder to expedite the configuration process. It is also good to keep a backup copy of this file to simplify the process of duplicating the machine in case of hard drive failure.

CAM Files

The **CAM File** is NOT the file that contains the GCode **Part Program**. Instead, the **CAM File** can be thought of as a file that keeps all of the information relating to a particular **Job** together.

For example, though most **Jobs** may use only one **Part Program**, some **Jobs** can consist of multiple **Part Programs** that refer to each other. The way that part programs refer to each other is by means of "O" (the letter "O") designations. The **Job** associates each "O" designation (O1, O2, O3 etc.) with a unique file name and location. These "O" files are the **Part Program** files, described later in this chapter. The **Job** (and its associated **CAM File**) contains the file **NAMES** of the **Part Program**(s), not the **Part Program** itself.

CAM Files also contain other information relating to the manufacturing of a part, such as default feed rates, arc accuracy, fixture offsets and other setup values that relate specifically to each **Job**.

As the name implies **CAM Files** have a file name extension ".CAM". The **CAM Files** are opened by means of the **File > Open Job** menu, and are accessible for editing by means of the dialogs available from the **Job** menu. (Menus are context sensitive, so the **Job** menu does not appear until a **CAM File** is opened). Once you open a **CAM File**, it's name appears in the title bar.

CAM Files contain a large amount of information, but it is not necessary for you to manually enter all of this information into each field for each new **Job**. **CAM Files** are easily replicated by means of the **File** > **Save As** menu. One convenient approach is to save a **CAM File** for types of **Jobs** that are used often. To generate a new **Job**, you would open the **CAM File** for that **Job** type, then using the **Job** menu you would only change values pertinent to the **Job** at hand. In some shop settings the only change from **Job** to **Job** might be the name of the **Part Program**. You don't have to save modifications to the **CAM File** in order to use modifications that you had made, so it is possible to open a **Job**, modify it using the **Job** menu, run it, and then abandon the changes. In other production environments it may be desirable to save all of the information pertinent to manufacturing a particular part. In this case you can save each **Job** under its own **CAM File** name.

On a new or upgraded installation, the **G Code Controller**'s **Setup** program installs a file entitled "SAMPLE.CAM" . You may use this file as a template to construct your first **Job**. However, do not permanently save **Job** setup information to this file, as this file is over-written each time you may run **Setup** for upgrades. Instead, after editing SAMPLE.CAM, save your work under another file name using the **File > Save As** menu.

Tool Offset Table Files

Length and diameter offsets are changed from within an operating part program by means of "H" and "D" words respectively. Arguments to these words (e.g. H3 has an argument of "3") provide an index into a table of values that is stored in the **Tool Offset Table**. The actual values associated with each index is stored in a **Tool Offset Table File**.

The **Tool Offset Table File** has the file name extension ".OFF". The file name specification for this file is stored in each **CAM File**, and loaded when the **CAM File** is loaded. Dialogs within the **Job** menu allow you to edit and/or change **Tool Offset Files**.

In most installations the same **Tool Offset Table File** will be used for many **Jobs**. However, the ability to specify a different **Tool Offset Table File** with each **Job** allows the flexibility for the

designer to build into the machine a removable tool tray system.

The **Tool Offset Table File** installed by the **Setup** program is named “SAMPTOOL.OFF’. This file will be overwritten when you re-install the **G Code Controller**, or when you install upgrades. Consequently, you should use the editing features within the **G Code Controller** to “Save As” to another file name, such as “TOOLS.OFF” before investing time in setting up the tool table. Use the menu **Job > Tool Offset Table > Save (Save As)...**

Part Program Files

As mentioned, **Part Program** files contain the “G Code” scripts, and are ordinary “text” type files. These files are stored with the extension “.TXT”. Alternatively, the files may have the extension “.TAP” or “.NC”, as these extensions are commonly assigned by some CAD/CAM graphical tool path editing programs.

The .TXT extension is commonly used by text editing programs such as **Window**’s **Notepad**. It is also used by popular word processing programs to designate files which are to be saved in the ASCII (sometimes referred to as “Text” or “ANSI”) format.

Part Programs can refer to other **Part Programs** by means of the “O” (the letter “O”) word followed by a numerical argument, indexed up starting from a numerical value of 0 (Zero), “O0, O1, O2 etc.”. A **Job** can contain up to ten **Part Programs**, “O0 through O9”. You must associate each “O<number>” **Part Program** file with its associated system filename using the **Job > Programs** dialog. These values are saved to the **CAM File** when you save the contents of the **Job**.

The **Part Program** designated by “O0” will always run first. For **Jobs** that contain only one **Part Program**, you only need to use the **Browse** feature in the **Job > Programs** dialog to snap the name of the **Part Program** file into the **Job** at location “O0”.

You can generate a simple **Part Program** file from scratch by giving it a name in the **Job** > **Programs** dialog, and snapping the dialog’s **Edit** button. A text editor will be launched in another window (the default text editor is **Notepad**) using the file name that you had assigned.

Each line of text in the **Part Program** is referred to as a "**Block**". This nomenclature comes from older CNC systems where GCode was transcribed by hand to blocks on a form, and subsequently copied from the form to paper tape by means of a Teletype. Today "**Blocks**" are lines. In **Notepad**, for example, you would add a **Block** of GCode by typing a line of text and pressing **Return**.

The initial **Setup** configures the **G Code Controller** to invoke **Notepad** from within its own menu driven environment. **Notepad** is convenient because it can only save files as ASCII text. However, very large part programs may exceed the file size capacity of **Notepad**, making a different editor (such as **Wordpad** or other third party program) more desirable. The **G Code Controller** set-ups can be modified to accommodate other word processing programs.When using word processing programs other than **Notepad**, the user must always be mindful to save the part programs ONLY as ASCII (ANSI) text type files. Many word processing programs are capable of storing text in formats that cannot be used.

Chapter 3

MOTOR CONTROL OUTPUTS

The electronic signals which are used to control the motors are generated by the **Indexer LPT**device driver. **G Code Controller** communicates appropriate commands to **Indexer LPT "**in the background", transparently to the user**,** and **Indexer LPT** performs low level control over the motors via the outputs located on the computer's parallel port(s). Refer to the **Indexer LPT** manual for technical information regarding the wiring and use of stepper motors, translators (amplifiers), and limit switches.

Discrete Digital Outputs

All signal input and output between the **G Code Controller** and the outside world occurs through the **Indexer LPT** device driver using **Indexer LPT** commands. Two useful commands for setting the voltage level on discrete output lines are *reduced_current* and *winding_power*. The associated output signals of these commands can be used to control external devices such as optically isolated relays and solenoid actuators.

Set-up menus allow you to specify **Indexer LPT** output commands for different purposes. When configuring your system, it is recommended that you first exercise whatever commands you intend to specify using the **Indexer LPT Diag** program provided with **Indexer LPT**, accessible from **Windows** using the **Start >**

Programs > Indexer LPT Diag menu selection. The **Diag** program allows you to exercise **Indexer LPT** directly from its own console, making it easier to troubleshoot your design. To rule out typographical errors, you can **Copy** (highlight then press **Ctrl** and **C**) and **Paste** (highlight then press **Ctrl** and **V**) **Indexer LPT** commands from the **Diag** program to **Notepad**, then use the same method to transfer the commands from **Notepad** to the setup dialogs in **G Code Controller**.

Limit Switch Inputs

Limit switches are used to define the normal operational boundaries of the motorized **Stages**. Operational limit switches may be wired to the parallel port as per the instructions found in the **Indexer LPT** manual. The **Indexer LPT Diag** program, as well as **G Code Controller**'s **Diagnostic** menu, provide a means to check the functioning of the limit switches.

In some systems, where **Stage** over-travel is likely to present a hazard, an outer set of limit switches may be used for an emergency stop. The outer limit switches must not rely on software to arrest motion. For example, in one design an outer set of limit switches can be used to independently remove all power from the system via a "drop out" relay. In a different design (where removing power may introduce other problems, such as a **Stage** falling under its own weight) outer limit switches may be used in a circuit which interrupts the controlling step pulses. The actual implementation of your over-travel safety strategy depends on the characteristics of machine that you are designing.

Input Query

Indexer LPT commands which are capable of determining the status of an input signal are used by **G Code Controller** to query the state of certain controls, such as the **Cycle Start** switch. **Indexer LPT** commands appropriate for query are *-limit?*, *+limit?*, *aux_input?*, and *scan.* The feedback from any of these query commands is either a 1 or a 0, depending on the logic level or state of the input. **G Code Controller** set-up menus allow you to assign query commands to different control functions. The **Indexer LPT** manual explains the usage and syntax of these input query commands.

Input set-ups can be verified by means of the **Diagnostic** menu. The display routines used by the **Diagnostic** displays continuously exercise the queries which you have specified in associated set-ups. The **Diagnostic** displays show a live view of the results of these queries, so for example if you are monitoring a switch you will be able to see its status, open or closed, as you exercise the switch. You should verify all of your input query commands using the **Diagnostics** menus before using them in active machine operations.

Feed-Hold Input

The **Indexer LPT** *feed hold* feature must be installed in all but the smallest and simplest machines.

When the motors are in motion, **Indexer LPT** occupies the computer's processor as a necessary requirement for fast and accurate timing. As a result, keyboard and mouse input is suspended temporarily when the motors are moving. The *feed hold* feature provides for immediate and controlled interruption of motion. With the introduction of extensive look-ahead contouring where **Indexer LPT** has continuous control over the tool path for potentially long times, incorporation of the *feed hold* feature into the machine design has become more important - and in most cases absolutely necessary.

The *feed hold* feature is conceptually simple and easy to install as per the documentation provided in the **Indexer LPT Users Guide**. See the chapter in this manual entitled SYSTEM SET-UPS for incorporating *feed hold* into **G Code Controller**.

The Stages of Motion

Stages consist of motor driven mechanical devices that either translate motion along a linear path, or rotate about an axis.

The paths that the motorized **Stages** follow are controlled by means of pulse(step)/direction signals generated by **Indexer LPT**. Each pulse results in an incremental movement of its associated **Stage**. The chapter entitled **System Set-Ups** will help you configure each **Stage** according to the step resolution of the motor that you are using (the number of pulses per shaft revolution) and the

mechanical coupling that converts the rotation of the motor shaft to the actual motion of the **Stage**.

G Code Controller accommodates both linear and rotational **Stages**, which may be used in the design of a broad range of machines. However, this program is especially suited for machines that incorporate linear motion in three orthogonal axes (linear stages situated at right angles). Tool offset compensation features accommodate a three dimensional profile mill configuration. Graphical preview and simulation, as well as the canned programming cycles, also assume this configuration. **G Code Controller** is not limited in its use strictly to these types of machines. There are many specialty machines other than profile mills which are perfectly suitable for this program. However, the designer must consider that the program was written with profile cutting in mind, and the features and displays reflect this type of application.

Chapter 4

MENU USAGE

General

G Code Controller is set up and controlled by means of menus and dialog boxes. Most options are selected using the mouse or keyboard according to conventions established for **Windows** programs. Some options, such as those that may effect machine motion, for reason of safety may require depressing two keystrokes simultaneously or an external input.

The **Main Menu** appears across the title bar. Sub-menus drop down in a list when a selection is made from the **Main Menu**. The most commonly used menu selections can be alternatively selected by snapping over its associated icon in the **Toolbar**.

Context Sensitive

Context sensitive menus and dialogs greatly simplify using **G Code Controller**. You are only presented with menus and controls that are suitable to the particular task that you are performing, so for example when a control panel for running a **Job** is up the **Main Menu** only presents items such as viewing and manual positioning, and does not present selections that cannot or should not be used, like setups or diagnostics. You can optionally hide

Job and **System** setup menus to further simplify the user interface.

Dialogs are also context sensitive in the sense that they only present information and selections that you have designed into your machine. For example, **G Code Controller** can control up to six **Stages** of motion, but if you only activate two of these **Stages** the **Position Readout** and **Manual Motion** controls will only display the two **Stages** that you had made available, and sized accordingly.

The size and position of the most used windows and dialogs are saved to disk, so you can adjust them according to your needs, and they will reappear in the same manner that you had left them when you re-enter the **Job** or program. You can save the display settings by snapping **Job > Save**. Zoom, pan and view (default setting: Top, Front or Left view) are saved for the main, orthographic view. Zoom, pan and rotation are saved for the 3D view.

Keyboard Navigation

Some shop environments may require an alternative to the mouse as a pointing device, such as a touch pad or mouse compatible touch screen. If you must only use a keyboard, you can press and release the **Alt** shift to move the highlight to the **Main Menu** bar. Use the cursor keys to navigate the menu or press the character key corresponding to the underlined letter of the menu item to select it. Use the cursor keys or character keys in a similar manner to select the menu item from the drop down list. Drop down menu selections which contain an ellipsis (three dots ...) invoke another menu or a dialog box. You may navigate the dialog boxes using the **Tab** key to change the highlight, and the **Space** key to select an item, change a check box, or press a button. Use the cursor keys to change **Radio Button** selections (these buttons look like little radio dials), or to scroll through selections of a list box. Press the **Enter** key to accept changes, or **Escape** to abandon changes.

The System Setup Menu

Set-up features are broken down into two categories that are accessible from the **Main Menu**: **System**, and **Job**.

The **System** category involves parameters relating to the design of the machine. (These parameters are not likely to be changed in normal production operations). These set-up values are stored in a file named GIXA.INI (located in the WINDOWS directory) and are accessed by means of the **System** menu.

The **System** menu can be hidden and password protected. The initial password to access this menu is “abc”, and the initial setting is not password protected. You can access these settings using the **System > Passwords** menu, where you may change the password and enable password protection. Once you enable password protection, you will be prompted for the password when you try to enter this menu again.

The password helps prevent inadvertent access to **System** set-ups and is NOT an iron-clad access lock. If you forget your password you can find it by printing the GIXA.INI file. The password will appear to the right of the keywords:

```
system password=
```

You can choose to show or hide the **System** menu at any time by means of the **File > Access** menu. If the **System** menu is hidden and password protected, you will be prompted for the password when selecting it to be shown again. If you had saved the option to password protect it (using **System > Save System Setup**), the **System** menu will be hidden by default the next time you run **G Code Controlle**r.

The Job Setup Menu

The other category of set-ups involves parameters relating to the use of the machine at a particular time, and more unique to manufacturing different parts. In other words, these parameters are more likely to change from **Job** to **Job**, and include such things as the name and location of the **Part Program**(s), tool offset file name, arc resolution, default cutting speeds, fixture offsets etc. These set-ups are stored in files with “.CAM” as the filename extension, which this manual refers to as **CAM Files**.

CAM Files are loaded using the **File > Open Job** menu. The settings loaded by the **CAM File** can be changed using the **Job** menu. You may use changes without saving the changes to disk.

This is handy when you have a number of similar **Jobs**, but none that needs all of the settings to be saved permanently. In this case you would open the **CAM File** that has most of your settings, then change only the setting that needs to be different (perhaps only the name of a **Part Program** file). After you have run the **Job** you need not save the changes, leaving that particular **CAM File** intact as a template for other **Jobs**.

Alternatively, you may save the changes you had made using the **File > Save** menu, or save changes to a **CAM File** of another filename using **File > Save As**. This is handy when you want to save all of the information relating to the manufacturing of a part that you wish to duplicate later. Other CNC systems commonly use the system setup for many of these values - but you may require different settings depending upon the size and type of parts that you are manufacturing from time to time. By separating setups most pertinent to the **Job** at hand, **G Code Controller** more ably manages this information. You can even save **Jobs** with part numbering and descriptive text in long file names,

You can optionally restrict access to the **Job** set-up menu by means of a password. Similar to the **System** password, the password protection for the **Job** set-up is only meant to prevent inadvertent changes, and not as an iron clad access lock. The initial password to access **Job** set-ups is “def”. If you forget your password you can find it by printing the GIXA.INI file. The password will appear to the right of the keywords :

```
camedit password=
```

Also similar to the **System** menu, you can choose to show or hide the **Job** menu at any time by means of the **File->Access** menu. If the **Job** menu is hidden and password protected, you will be prompted for the password when selecting it to be shown again. If you had saved the option to password protect it, the **Job** menu will be hidden by default the next time you run **G Code Controller**.

Tool Motion

Tool motion is controlled from dialogs that are launched from the **Production** menu. Selections under this menu bring up a dialog boxes that present the user opportunity to proceed or cancel

the operation. If the user selects **Ok** to proceed, a prompt appears requiring the user to press **Cycle Start** (or **Ctrl-F2** if the **System** is set up for **Keyboard Start**). At this point the user can still abort the operation by selecting **Cancel**. If at this time the user snaps away from the controlling dialog, the **Cycle Start** prompt will be removed and **Ok** must be selected again. Once the **Cycle Start** signal is received, motion commences, or in the case of the **Instant Block** control, the action is performed.

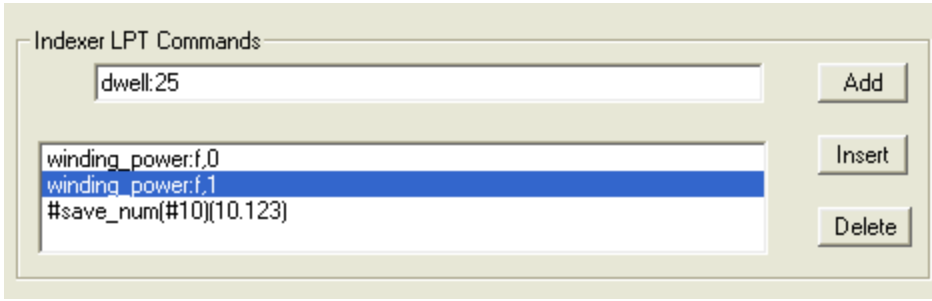
G Code Controller can be set up to accommodate three different **Cycle Start** options: **Keyboard Start**, **Start Switch**, or **Dual Start Switch**.

Chapter 5

LIST DIALOGS

Command Lists

Command Lists are sequences of **Indexer LPT** commands and **List Directives** that may be dispatched by **G Code Controller** for a number purposes and from different parts of the program, such as a sequence of operations that is automatically performed when **G Code Controller** starts. (**List Directives** are explained later in this chapter). **Command Lists** are used to customize M, T and S codes, and used for special sequences that may be designed into initializing each **Stage** during the automatic homing procedure. One command appears on each line of the list. The list shown below is a screen clip from the **System > Startup Commands** dialog. This particular list is executed immediately when **G Code Controller** is started, starting with the first item in the list and working downward. You can add items to the list by snapping over the uppermost **Line Editing** field and typing the



command. The **Add** button transfers the command that you had typed to the bottom of the list. Scroll bars automatically appear when the list grows larger than the display window. You can insert a command by highlighting the command before which you want the item inserted, and then snap **Insert**. Items can be deleted by highlighting the command you want removed and snapping **Delete**.

Indexer LPT Commands

Indexer LPT commands that control digital outputs (such as *reduced_current*, *winding_power* and *bit* commands) are most commonly used in **Command Lists**. The **Indexer LPT** *dwell* command, as its name implies, can be used to introduce a time delay where needed.

It is often handy to check out your hardware and the associated **Indexer LPT** commands used to control the hardware within a list using the **Command Motor** feature in **Indexer LPT**'s **Diag** program. You can transfer an **Indexer LPT** command from the **Diag** program to **Notepad** by highlighting it, and pressing **Ctrl-C** to transfer it to the Windows **Clipboard**, then snapping to **Notepad** and pressing **Ctrl-V**to transfer it from the **Clipboard** into **Notepad**. You can transfer lines from **Notepad** to the **Line Editing** field of the **Command List** dialog in a similar manner.

List Directives

A **List Directive** is a line of text in a **Command List** that operates directly upon **G Code Controller.** It may require **G Code Controller** to perform more complex and interactive tasks. All **List Directives** begin with the "#' character. Unlike the other lines of text in the list, **List Directives** are not directly executed by **Indexer LPT**. Instead, each **List Directive** defines an action taken by the **G Code Controller** program.

No extraneous white spaces (tabs or space characters) are permitted in the **List Directive.**

#save_num(#reference index)(number)

This **List Directive** saves a number that can be used later by another **List Directive**. The **reference index** is an integer preceded by the # character. The **number** can be an integer or floating

point value. The **Diagnostic > Machine Variable** menu can always be used to view the numbers that are saved using this method. In a concrete example, the following **List Directive** stores the numeric value 10.123 to the reference index #10.

```
#save_num(#10)(10.123)
```

In this example, when the following *#rapid_to* **List Directive** (described below) executes, the number 10.123 is accessed from its index location #10, and the **X Stage** is moved to a location 10.123 inches from the **Machine Home** position.

```
#rapid_to(X)(#10)
```

#clear_num(#reference index)

This **List Directive** clears the entry for the system variable saved under **reference index**. For example, the following **List Directive** removes the variable saved under reference index #10.

```
#clear_num(#10)
```

#clear_nums

This **List Directive** removes all of the stored variables.

#wait_for_one(command query)(annotation)

This **List Directive** suspends operations until a qualifying result of one (1) is obtained from the specified **Indexer LPT command query**. Until such a result is obtained the specified **annotation**, preceded by the words “Waiting for”, is displayed in the **Automatic Control** prompt window of the control console (**Run Tool Path** or **Dry Run Tool Path** dialogs).

A **command query** is an **Indexer LPT** command that forces a response of either one (1) or zero (0), depending on the status of an input signal. For example, the directive:

```
#wait_for_one(aux_input?:a)(Air Clamp)
```

... causes the **G Code Controller** to repeatedly send the *aux_input?:a* command to **Indexer LPT** until **Indexer LPT** responds with a one (1) in its mailbox. In this example all other machine operation is suspended until the qualifying result of 1 is received from **Indexer LPT**, and the annotation “Waiting for Air

Clamp" is displayed in the **Automatic Control** prompt window.

#wait_for_zero(command query)(annotation)

This **directive** is similar to the *#wait_for_one* **directive**, except this directive suspends operations until a qualifying result of zero (0) is obtained.

#rapid_to(Stage)(position)

This **directive** moves the specified **Stage** at rapid rate to the designated absolute position relative to **Machine Home**. The **Stage** argument can be any installed stage: X, Y, Z, U, V, W, A, B or C. Use only capital letters for **Stage** names. The **position** argument is a number representing the destination point of the motion. For example, the directive:

```
#rapid_to(X)(2.125)
```

... causes the X stage to move at rapid rate from its current position to a destination point which is located 2.125 inches from **Machine Home**.

A **Machine Variable reference index** can be alternatively used for the **position** argument. The following example moves the **Y Stage** to a position 7.1875 inches from its **Machine Home** position:

```
#save_num(#3)(7.1875)
#rapid_to(Y)(#3)
```

This command has no effect if position tracking is not in effect. (The **position** argument has no meaning outside of position tracking). Position tracking can be put into effect automatically by means of the **Production > Limit Switch Seek** dialog, or manually via **Production > Set Home**. Position tracking is terminated by sudden stopping due to collision with end limit switches.

Each *#rapid_to* directive stores its departure position (the position before *#rapid_to* moved the stage) to the top of a list (the **Return Position List**) that includes prior departure positions for previous *#rapid_to* **List Directives** performed for that **Stage**. When a departure position is saved to the **Return Position List**, the number of positions stored to the list increases by one, and all prior departure positions are moved down in the list.

#rapid_return(Stage)

This **directive** moves the designated **Stage** back to the position that was before the last *#rapid_to* **directive** was performed on that **Stage**.

The *#rapid_to* directive stores the departure position (the position before *#rapid_to* moved the **Stage**) of the **Stage** to the top of the **Stage**'s **Return Position List**. The *#raid_return* **List Directive** returns the **Stage** to the last departure position, and removes its entry from the top of the list. It is thereby possible to return carriage positions over a complex path, for example, to manipulate in and around obstacles when changing tools.

The *#rapid_return* directive has no effect if a *#rapid_to* directive for the particular **Stage** has not previously been executed, if previous positions have been cleared, or if position tracking is not in effect.

In a simplified example, suppose you wanted to construct a list of commands that would move the carriage from its current position to a tool pick-up position, release a clamp to deposit a tool in the last open position on a tray, move a rotary stage to position the tray for the desired tool, clamp the new tool, then return the carriage to its current position in the **Part Program**. A list to perform this might appear like this:

```
#rapid_to(Z)(0.0)
#rapid_to(X)(1.5)
#rapid_to(Y)(2.0)
reduced_current:a,1
#wait_for_zero(aux_input?:a)(Clamp Open)
#rapid_to(C)(90)
reduced_current:a,0
#wait_for_zero(aux_input?:b)(Clamp Closed)
#rapid_return(Y)
#rapid_return(X)
#rapid_return(Z)
```

This is a simplified example, and more commands may be necessary to fully implement a tool changer, but the basic utility of the directives is demonstrated. Here switches are installed to *auxiliary inputs* to detect when the tool clamp is open and closed. Operation is suspended until the clamp opens and closes at the appropriate times. As the list completes, the carriage returns to its

former, arbitrary position in the **Part Program**.

#clear_last_return(Stage)

This **List Directive** removes the last entry from top of the **Stage**'s **Position Return List**. You can *#clear_last_return* if you need to issue a *#rapid_to* **List Directive** without affecting the existing return **Position Return List**. The *#rapid_to* **List Directive** places the last position, which is to say its departure position, at the top of the list. The *#clear_last_return* **List Directive** removes that value from the top of the list.

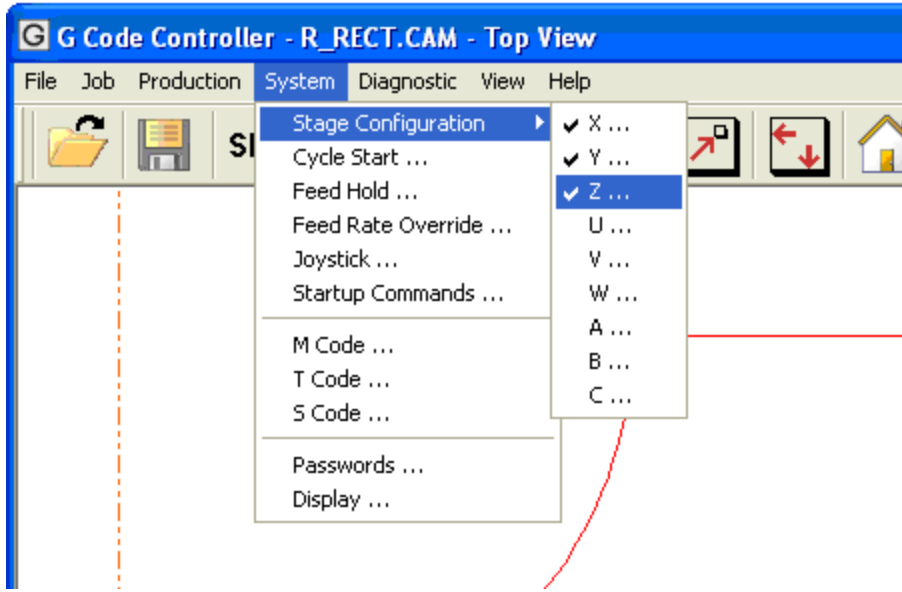
#clear_all_returns(Stage)

This **List Directive** clears the entire **Position Return List** for the designated **Stage**.

#disable_limit_report

In some designs use, such as machines that require squaring parallel stages for initialization, limit switch interruption is intentionally effected as part of the automatic sequence. (See the subsection entitled **Squaring Parallel Drives** in the **Limit Switch Seek Configuration** section of the chapter entitled **System Setups**). This **List Directive** suppresses the pop-up window that alerts the operator when a limit switch interruption occurrs within the list. This **List Directive** must appear as the first entry to the list.

Chapter 6



SYSTEM SET-UPS

System set-up values reflect and constitute the design of your machine. For this reason, though values may appear as place-holders when the software is run for the first time, there are NO default values. Each **System** set-up value must be reviewed by the machine designer and assigned a meaningful setting. **System** set-up values can be edited by means of the **System** selection on the

Main Menu. After changes have been made the **System > Save System Setup** menu option will become accessible. Selecting this menu will save changes that you had made to a file entitled GIXA.INI file, which is located in the WINDOWS folder.

Stage Configuration

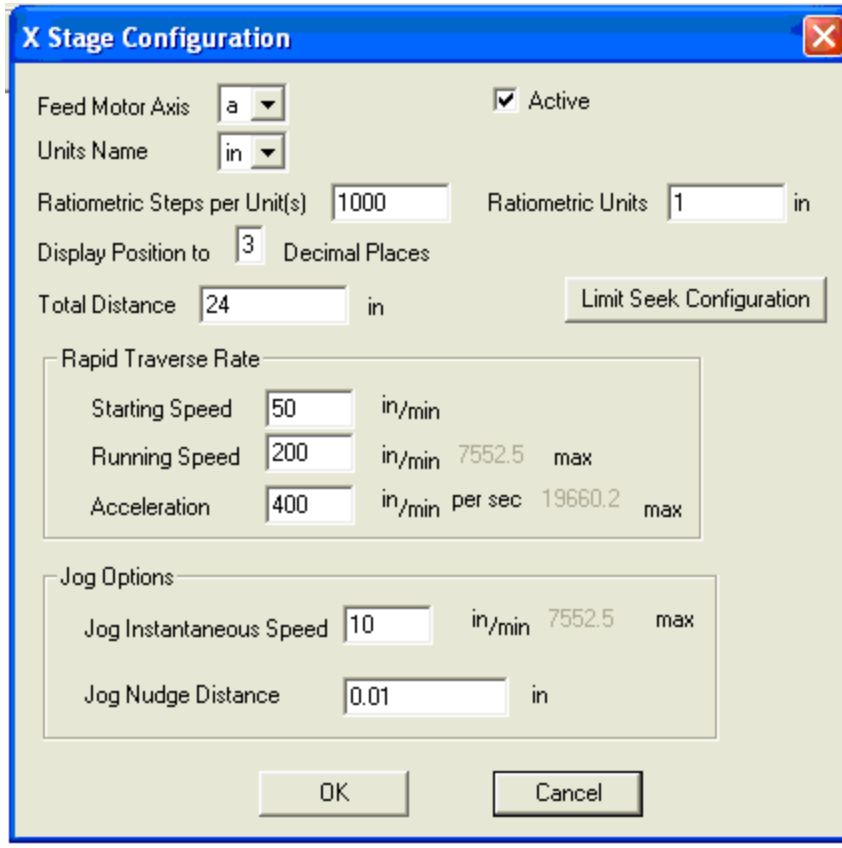
Motor controlled **Stages** are configured by means of dialogs accessible from the fly-out menus that pop up when you select or hover the cursor over the **System > Stage Configuration** menu, as shown in the first illustration in this chapter. Check marks appear next to the stages that have been activated. **Stages** without check marks are disabled. The illustration on the following page shows the dialog used to configure each **Stage**, and the following text describes the meaning of each field in the dialog.

Feed Motor X Axis

This field contains the **Indexer LPT** axis designation for the **Stages**. Acceptable values are “a” through “f”.

Active

This check box must be checked for the **Stage** to be activated. Otherwise, the **Stage** is disabled and not recognized by the system. Once a **Stage** has been activated a check will mark will also appear next to its designation where it appears in the fly-out menu that you used to select this dialog. Only activated **Stages** will appear in other dialogs that refer to **System Stages**, such as the **Position Readout** window and dialogs that you may use for the manual movement of the **Stages**.



Units Name

Select the name of the dimensional units for motion from the list e.g. **in** for inches, **cm** for centimeters, **dg** for degrees **am** for arc minutes etc. This selection ONLY affects the units annotations which appear in various places in this program, and DOES NOT automatically set up the appropriate ratio of step motor steps to units, which is explained below.

Ratiometric Steps per Unit(s)
Ratiometric Units

The ratio of the **Ratiometric Steps per Unit(s)** to **Ratiometric Units** defines the motion of the **Stages** in proportion to the step pulses generated by **Indexer LPT**. Use a convenient number for **Ratiometric Steps per Units(s)** and a corresponding

number for **Ratiometric Units**.

For instance, assume you are directly driving a .200 inch lead screw with a step motor configured for 400 steps per revolution. In this case, 400 steps would move the stage by .200 inches. You may enter a value of 400 in the **Ratiometric Steps per Unit(s)** field and a value of .200 in the **Ratiometric Units** field. Select "in" from the **Units Name** list box to make the other menus and dialogs read correctly.

Assume this same machine is to be used in CAD/CAM operations where centimeters is the standard of measure. In this case, since .200in = .508cm, enter a value of .508 in the **Ratiometric Units** field. In this case "cm" is the most appropriate selection for **Units Name**.

In another example, assume that you are driving a linear **Stage** by means of a cable system. You have determined experimentally, using the **Indexer LPT Diagnostic Program** and an appropriate measuring device that commanding the motor to move 3000 steps results in a movement of 3.103 inches. In this case, enter a value of 3000 in the **Ratiometric Steps per Unit(s)** field, enter a value of 3.103 in the **Ratiometric Units** field, and select "in" for **Units Name**.

For rotary **Stages** the **Ratiometric Units** would apply to the angle of **Stage** rotation. For example, to set up a **Stage** that rotates a complete revolution (360 degrees) as a result of 4000 steps, put 4000 in the **Ratiometric Steps per Unit(s)** field, enter 360 in the **Ratiometric Units** field, and select "dg" for **Units Name**.

Total Distance

This is the distance between the high and low operational limit switches. In a **Production > Limit Switch Seek**, if the **Stage** does not contact the limit switch after traveling the distance specified here, motion will cease and a warning message will appear. For **Stages** X, Y and Z, this distance also defines the operational boundaries that are shown in relation to the tool path on the graphical display.

Rapid Traverse Rate
- Starting Speed
- Running Speed
- Acceleration

Rapid traverse rates apply to **Stage** motion that occurs under **Part Program** control in the rapid traverse mode, instated by G00. It also applies to motion performed under control of the **Move by** and **Position to** menus, and *joystick* control when the *joystick* acceleration selector switch is in the "accelerated" setting.

Speeds are represented in units per minute. The names of the units in the display (in, cm etc.) are the names which were set up in the **Units Name** fields. Acceleration is represented in units per minute per second.

The **Starting Speed** field represents the instantaneous rate which the stepper motor will begin motion. The motors accelerate from the **Starting Speed** at the rate you specify in the **Acceleration** field (in units per minute per second) to the plateau velocity defined by contents of the **Running Speed** field. The **Starting Speed** must never be set to exceed the **Running Speed**. The values which you set up in this dialog box will largely depend on the limitations of your system.

The rapid traverse **Running Speed** is the speed of the **Stage** along its axis, not the combined vector speed (as in contouring modes G01, G02 and GO3).

One limitation for the upper limits of rapid traverse settings is the maximum step rate of which your computer is capable. The dialog box displays maximum values of speed and acceleration which can be attained by your computer, but this does not guarantee that the power of your motor drive system will be able to sustain these maximum rates.

The power of your step motor drive system may be a limiting factor. You should not set the starting speed faster than your motors can instantaneously start, neither should you set the **Acceleration** faster than the capabilities of the motor drive system. Safety and the physical strength of your system components are also considerations.

Jog Options
- Jog Instantaneous Speed

This field sets up the speed for *joystick* control when the acceleration select switch de-selects accelerated motion. ("Instantaneous" rate means constant speed). Refer to the **Indexer LPT** documentation for more information regarding the *joystick* hard-wired options.

- Jog Nudge Distance

An optional *joystick* hard-wired option allows allows the operator to switch select a "nudge" mode. In "nudge" mode, when the operator uses the *joystick* the **Stages** move a small increment every half second. The resulting motion appears to "nudge" the **Stage** in small increments, allowing for very fine positioning. This field sets up the incremental distance.

After selecting **Ok** the value is rounded off to the resolution of the nearest step increment. To view the actual value being used simply bring in the dialog again. Very small values will be presented in scientific notation. The decimal precision of the displayed values will correspond to the set-up entry in the **Display Position to Decimal Places** field.

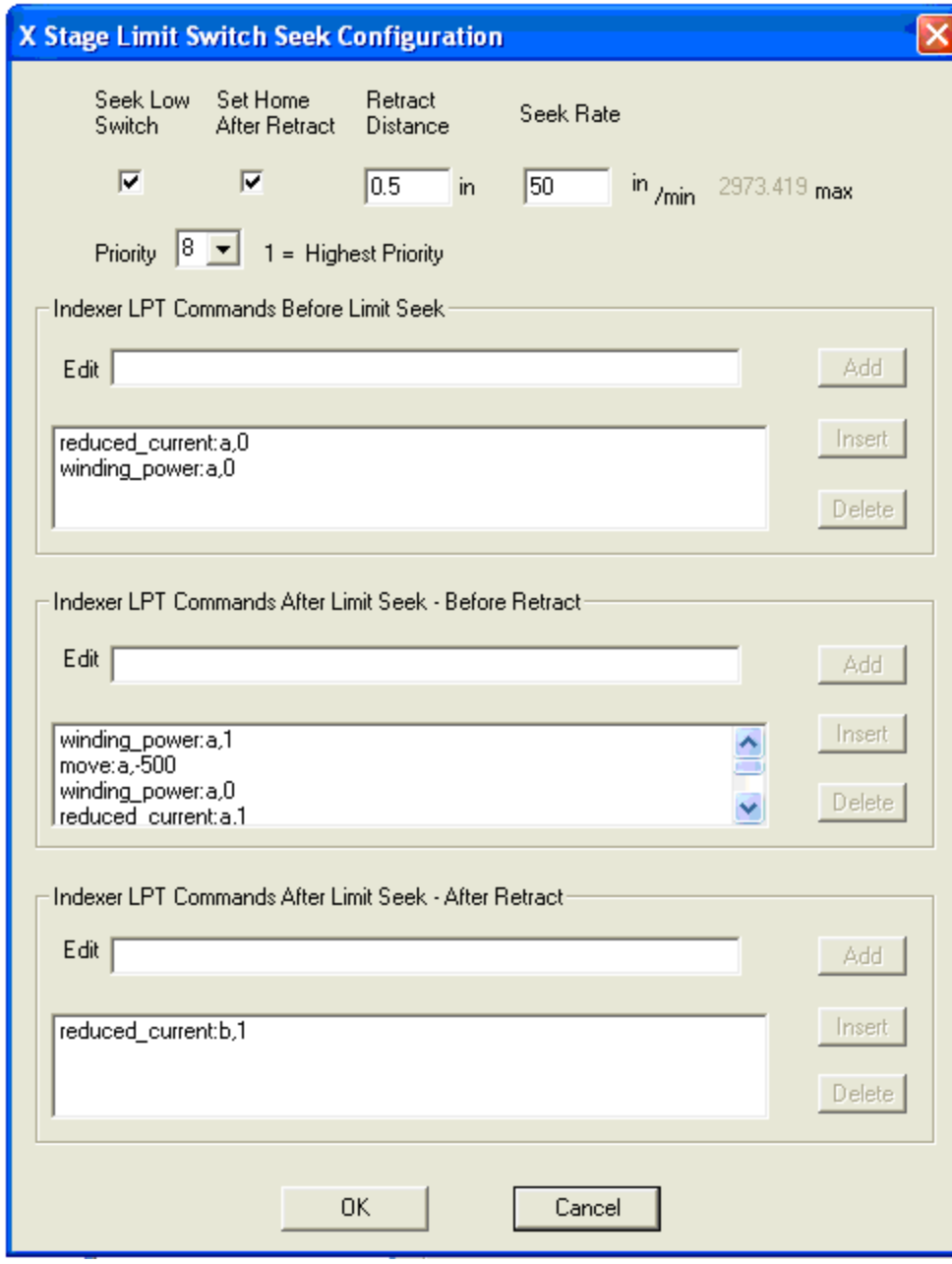
Limit Switch Seek Configuration

Snapping over this button in the **Stage Configuration** dialog launches the dialog box shown on the following page, which is used to set up the limit switch seeking parameters for the **Stage**.

Seek Low Limit Switch

This check box allows you to choose whether the **Production > Limit Switch Seek** operation will seek the high or low limit switch.

Note that in a drilling machine or a profile mill, since the direction of travel to retract the tool is positive (plunge is negative), it is usually convenient to configure the Z **Stage** to seek the high limit switch, as this cycles the stage away from the work. The other stages (X and Y) are generally retracted into the low limit switch.


X Stage Limit Switch Seek Configuration
Seek Low Switch
Set Home After Retract
Retract Distance
Seek Rate
0.5
in
50
in /min
2973.419 max
Priority
8
1 = Highest Priority
Indexer LPT Commands Before Limit Seek
Edit
Add
Insert
Delete
reduced_current:a,0
winding_power:a,0
Indexer LPT Commands After Limit Seek - Before Retract
Edit
Add
Insert
Delete
winding_power:a,1
move:a,-500
winding_power:a,0
reduced_current:a,1
Indexer LPT Commands After Limit Seek - After Retract
Edit
Add
Insert
Delete
reduced_current:b,1
OK
Cancel

Set Home After Retract

A check in this check box causes the program to automatically set the position counter of the associated axis to zero (home position) after the **Production > Limit Switch Seek** sequence. This selection is usually checked.

Retract Distance

This field specifies the distance the **Stage** will retract after contacting its limit switch during the **Production > Limit Switch Seek** operation.

Seek Rate

Motion during the **Production > Limit Switch Seek** operation will occur at an instantaneous rate specified by the value entered into this field.

Priority

The **Production > Limit Switch Seek** control sequences one **Stage** at a time. This field lets you specify the order of operation. The lower number will sequence first.

Squaring Parallel Drives

Some profile cutting systems use two stepper motors (with two tranlators) for a single **Stage**, controlling both motors synchronously from the same set of control signals. These systems attain mechanical stiffness by driving both sides of a **Stage** in parallel instead of from only one driving point. In a concrete example, consider the X **Stage** of a profile cutter driven by two lead screws situated parallel to each other on the extremities of the Y beam. Each X lead screw is driven by its own stepper motor, and each step motor is connected to its own translator. Both X **Stage** step motor translators are controlled by the same “step” and “direction” signals (one **Indexer LPT** axis), so that both lead screws track as if directly coupled. In order to maintain accuracy and system integrity in this design, the parallel X drives must be “squared” before manufacturing is allowed to begin. The list boxes provided in this dialog provides for an automatic squaring procedure.

A simple circuit is necessary to accommodate the squaring

sequence. Refer to the translators on each side as X1 and X2. Limit switches are installed on both sides, XL1 and XL2. In this example they are low limit switches. Two **Indexer LPT** discrete outputs enable and disable each side. When a side is enabled, its associated limit switch is also enabled. When it is disabled, its limit switch also is disabled. When both sides are enabled, motion is arrested by either limit switch. (See the *#disable_limit_report* **List Directive** in the chapter entitled **List Directives**).

The squaring sequence is accomplished as follows. Commands in the list **Indexer LPT Commands Before Limit Seek** enable both sides, X1 and X2. The system then travels at instantaneous rate towards the limit switches XL1 and XL2. The first switch that makes contact arrests the motion. Commands in the list, **Indexer LPT Commands After Limit Seek - Before Retract** execute a squaring sequence, alternately enabling only one side and moving towards and against its respective switch. The squaring sequence in this list finishes by enabling both sides. The system then retracts the distance specified in **Retract Distance**, and sets the machine home reference position. Finally, the list in **Indexer LPT Commands After Limit Seek - After Retract** is executed. This list is handy to complete hardware initialization that may be necessary, set system variables or (for example) initialize portions of a tool changer.

Indexer LPT Commands Before Limit Seek

This list will be executed at the beginning of the **Production > Limit Switch Seek** sequence.

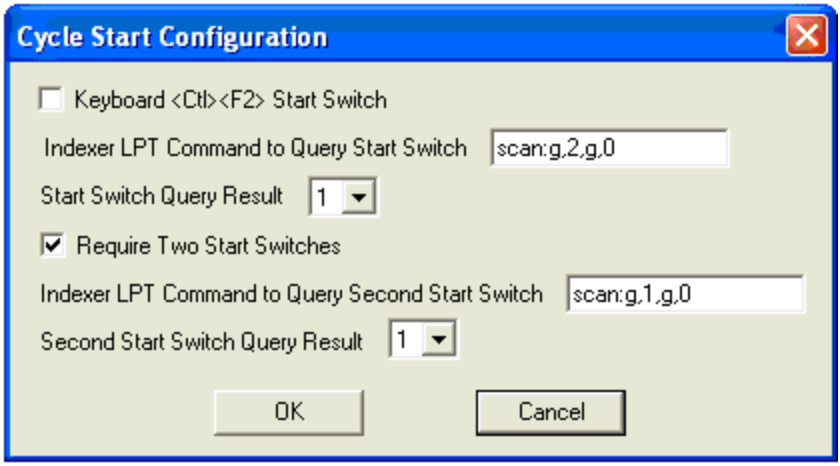
Indexer LPT Commands After Limit Seek - Before Retract

This list will be executed immediately after the **Production > Limit Switch Seek** action causes a limit switch interruption, and before the sequence moves the **Stage Retract Distance** from the point of interruption.

Indexer LPT Commands After Limit Seek - After Retract

This list will be executed at the end of the **Production > Limit Switch Seek** sequence.

Cycle Start Configuration



Keyboard <Ctrl><F2> Start Switch

When this check box is checked motion sequences requiring **Cycle Start** are initiated by simultaneously pressing the keyboard **Ctr**l and function key **F2** . If this box is not checked, external signals are used for **Cycle Start**, and appropriate set-up fields appear in the dialog box.

Indexer LPT Command to Query Start Switch Start Switch Query Result

The **Cycle Start** input is used by the **G Code Controller** to determine when the operator wishes to initiate motor movement. The **Query Start Switch** field can be set up for any **Indexer LPT** query which responds with “1” and “0”. **Start Switch Query Result** represents the query result necessary for motion to commence.

In a concrete example, the dialog in the illustration demonstrates using *joystick* switches S6 and S7 (installed as normally open push buttons) for a dual purpose as **Cycle Start** switches. Refer to the **Indexer LPT** documentation for the wiring of these switches and the syntax for the *scan* command.

CAUTION

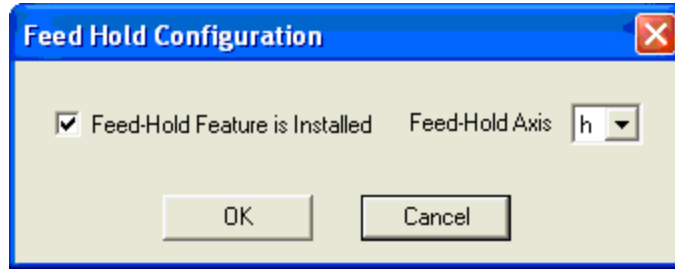
Using the *Auxiliary Input* signal for the start switch may pres-

ent a safety hazard. Unless terminated to either ground or logic 1 (5 Volts), the *Auxiliary Input* signal may randomly fluctuate and could possibly cause a spurious Cycle Start, a dangerous condition. Even if properly terminated, an accidentally unplugged cable could break external termination and present this hazard. Using the *Auxiliary Input* for this purpose is therefore not recommended.

Require Two Start Switches
Indexer LPT Command to Query Second Start Switch
Second Start Switch Query Result

In some applications it is prudent for safety to require the operator to occupy both of his hands before motion is allowed to commence. This option provides for a second switch input for **Cycle Start**.

Feed Hold Configuration



The *feed hold* feature allows the operator to bring motion to a decelerated and controlled stop. Since the keyboard is ineffective while the motion is in progress, **this feature must be installed in all but the smallest and simplest applications.** Refer to the **Indexer LPT** documentation for a detailed explanation of the *feed hold* feature, and how it can be wired.

Most installations support the feed hold feature with two switches: a toggle switch, entitled “feed hold”, to effect a holding state, and a pushbutton, entitled “abort” to be optionally activated to release the system from the holding state. When the *feed hold* switch is activated, **Stage** motion is brought to a decelerated and controlled stop, and the system is frozen in a suspended state. If

the *feed hold* switch is released at this time, the system resumes motion, accelerating to feed or rapid rate and completing the geometry "as if" *feed hold* had not been activated. The *feed hold* command is very robust, and for example, in a **Dry Run** it can be activated and deactivated as an alternative to *feed rate override* to slow motion around critical areas.

If the *abort* switch is activated when the system is suspended in a *feed hold* state, the suspended state is terminated and the operator is presented with recovery options, such as resuming the **Job** from a previous point in the tool path. **G Code Controller** also supports automatic sequencing following *abort* from *feed hold* (typically used to automatically turn a spindle off. See the section in this chapter entitled **Special M Codes**).

Recovery procedures when *abort* from *feed hold* occurs within a customized list (e.g. customized M or T codes) are not supported, so for example, if *abort* from a *feed hold* occurs within a *#rapid_to* **List Directive**, **G Code Controller** will discontinue the **Job** that is being run. However, **Stage** motion designed into M and T codes can be designed to accommodate **Job** recovery by either defeating the abort switch during the course of the motion (if safety permits), and/or alerting the operator with a light indicating that the *abort* switch cannot be used at that time.

In a concrete example, the *abort* switch is wired in series with a normally closed relay that is opened by the **Indexer LPT** command *winding_power:c,0*. Another pole of the relay lights a light on a panel, indicating that the *abort* switch has been disabled. The **System > Startup Commands** list includes the **Indexer LPT** command *winding_power:c,1* to make sure that the relay is closed, permitting the *abort* switch to operate normally on startup. In this example you are customizing **M06** with a sequence of commands that move the **Stages** to a tool change position. Insert *winding_power:c,0* in the list before the commands that cause **Stage** motion, disabling the *abort* switch. Insert *winding_power:c,1* at the end of the list, restoring the *abort* switch to its normal function. In this design, if the operator activates the *feed hold* switch during the tool change cycle, he will be able to toggle the *feed hold* switch off and on until the stages move beyond the critical section and the light goes off. He can then use the *abort* switch and **Job** recovery features built into **G Code Controller**.

Feed-Hold Feature is Installed

This check box should be checked if the system is designed to utilize the **Indexer LPT** *feed hold* feature.

Feed-Hold Axis

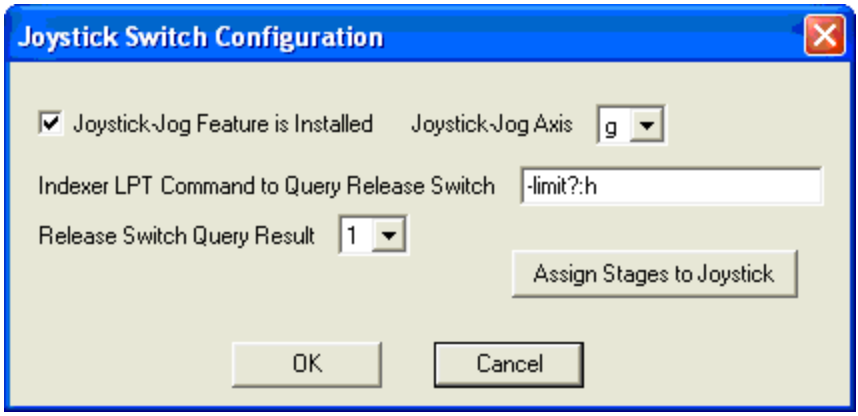
This field contains the **Indexer LPT** axis designator for the *feed hold* feature. Allowable values are “a” through “h”, providing you had not already assigned the selected axis to another function, such as a **Stage**, *joystick* or spindle control. Recommended values are “b”, “d”, “f” or “h” if you wish to consolidate wiring for the *joystick*, *feed hold* and *feed rate override* to a single DB25 connector to the back of the **Hardware Assist Module** (HAM), since the HAM does not wire through signals that would permit the *joystick* to be installed to pins 6, 7, 8 and 9.

In a concrete example, where the HAM is situated on a parallel port mapped to **Indexer LPT** axes “g” and “h”, *joystick* wiring to the back of the HAM is supported for **Indexer LPT** axis “g”, and *feed hold* wiring is supported on “h”. The *feed rate override* feature can be wired to the same connector. The dialog for **Cycle Start** shows how optional *joystick* switches can be used for a double purpose as **Cycle Start** switches - thus wiring can be conveniently extended to a control pendant with a single DB25 extender cable. The *feed hold abort* switch can be used to serve a double purpose as the *joystick release* switch, described below. In this example the **Indexer LPT Command to Query Release Switch** (described below) would be *-limit?:h*, and the **Release Switch Query Result** would be 0.

Feed Rate Override

The **Feed Rate Override** control is a powerful method of smoothly controlling the operational speeds of motion while the **Stages** are actually in motion. If the hardware to support **Feed Rate Override** (in most applications, a potentiometer connected to the **Indexer LPT Hardware Assist Module**) is not installed, this feature should be disabled here at a **System** level using the **Setup >Feed Rate Override** dialog. Refer to the chapter entitled **Job Setups** for selectively applying **Feed Rate Override** to rapid traverse and feed operations.

Joystick



Wiring

See the chapter in the **Indexer LPT** user guide entitled **Switch Scanning and Joystick** for a description of *joystick* features and wiring. The option to choose the set of signals inclusive of parallel port pin numbers 2, 4, 5, 3, 14, and 1 in the diagram is suggested. Switch S8, refered to in the **Indexer LPT** manual as "Remain/Exit", is refered to in this manual as the "Mark" switch.

Joystick-Jog Feature is Installed

This check box should be checked if the system is designed to utilize the **Indexer LPT** *joystick* feature. When this box is checked, fields which relate to setting up the *joystick* controls appear in the dialog box.

Joystick-Jog Axis

This field contains the axis designator for the *joystick* jog feature. Allowable values are "a" through "f". You cannot designate the same axis for both *joystick* and *feedhold*. You cannot specify here any axis which is being used for a **Stage** or spindle control.

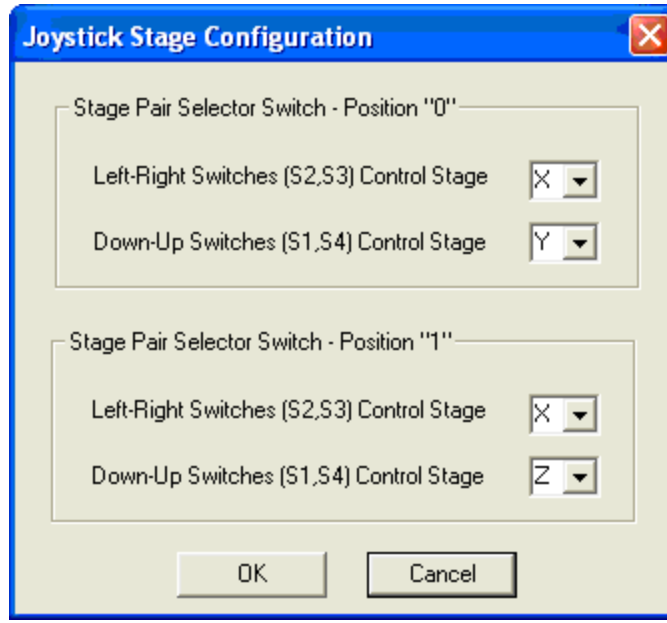
For a more thorough explanation on the implementation and wiring of the *joystick* and *feedhold* features, consult the **Indexer LPT** documentation.

Indexer LPT Command to Query Release Switch Release Switch Query Result

The release switch input is used by **G Code Controller** to determine when the operator wishes to exit the *joystick* jog mode. The release switch input can be set up for any **Indexer LPT** query that responds with “1” and “0”.

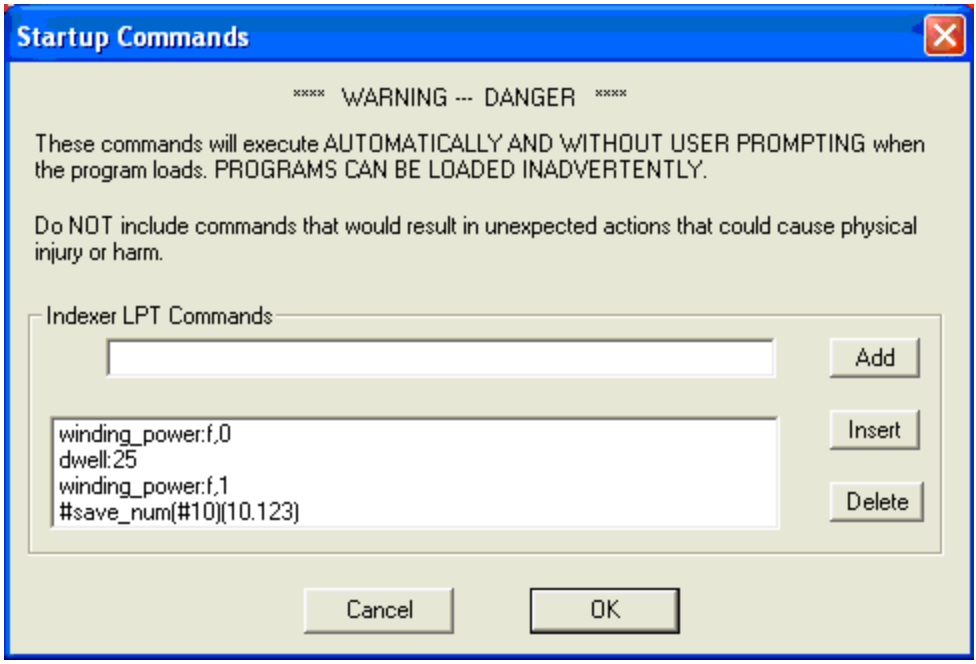
The machine designer may consider using the *feedhold abort* input for this purpose. Since *feedhold abort* releases the machine from a suspended motion state, and since the *feedhold* feature is never active in *joystick* jog mode, a single input entitled “release” may be used to accomplish a dual purpose.

Assign Stages to Joystick



Snapping over this button invokes the **Joystick Stage Configuration** dialog. The **Indexer LPT** *joystick* option can control up to four axes of motion from a single joystick. The **Joystick Stage Configuration** dialog allows you to assign motion stages to the joystick control switches. The switch numbers in the dialog, S1-S4, refer to the schematic diagram in the **Indexer LPT** documentation.

Startup Commands



This dialog provides for execution of a sequence of **Indexer LPT** commands and **List Directives** when the program is started. (**List Directives** are explained in the chapter entitled **List Dialogs**). This list is typically used for initializing hardware components and setting machine variables.

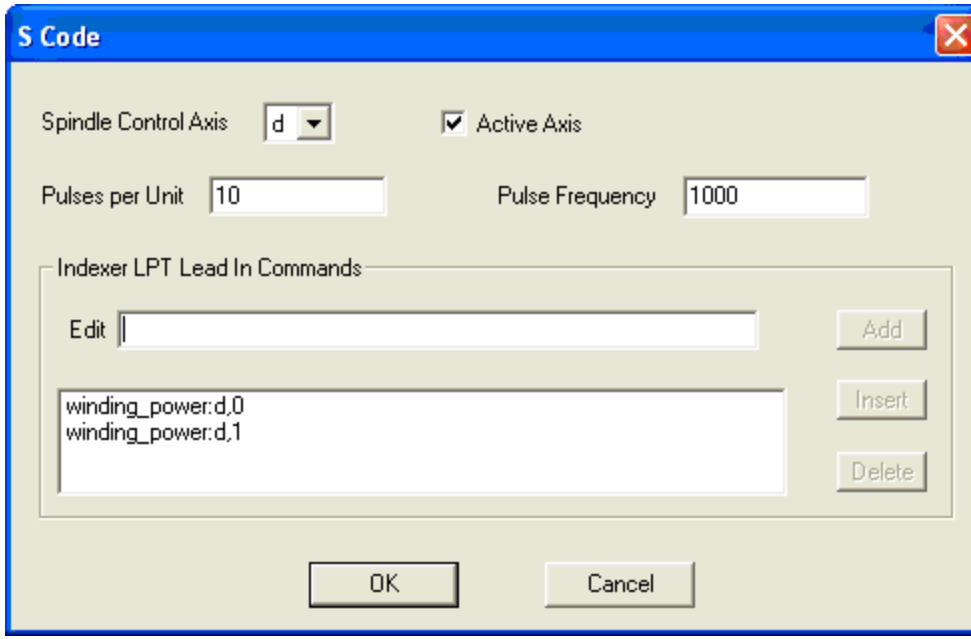
When the power is first turned on to the computer, a period of time passes when the parallel output signals are in an indeterminate state. These signals may even change values as the computer performs a power on self-test prior to loading **G Code Controller** and **Indexer LPT**. In order to prevent spurious activation of components, hardware may need to be designed that requires a specific signal sequence to make the component in question ready to accept the signal that will ultimately turn it on and off. This list provides a means to use a sequence of **Indexer LPT** commands to provide for this type of component enabling.

List Directives can also be included in this sequence. For example, it may be desirable to store **Machine Variables** that designate the physical locations of tools in a tool tray, or at least

an initial drop off location for the last tool that was used. (Tool changing requires releasing a prior tool before positioning to engage the selected tool. An initial drop off location would release a tool that may be present at startup to a location chosen for tools that had been inadvertently left in place when the machine was shut down).

In a concrete example given in the illustration, the output controlled by the **Indexer LPT** *winding_power* command is used to bring the voltage that it controls on the **Indexer LPT** *f* axis momentarily to ground for 25 hundreths of a second. Then this voltage is brought to five volts. The next command saves the value 10.123 to **Machine Variable** #10.

S Code



S Codes are typically used for spindle speed control, although they may be used for other things on specialized machines. S Codes are NOT effective during **Production > Dry Run.**

Spindle Control Axis
Active Axis

An **Indexer LPT** axis can be assigned to the spindle control for the purpose of rapidly generating pulses. If the **Active Axis** check box is not checked, the **Spindle Control Axis** is disabled and the designated **Indexer LPT** axis is made available to the system for use with other functions.

Pulses per Unit
Pulse Frequency

In the execution of the S command in a **Part Program**, the argument of the S word is multiplied by the value of the **Pulses per Unit** field and applied to the **Indexer LPT** *jog* command on the **Indexer LPT** axis specified by the **Spindle Control Axis** at the rate designated in the **Pulse Frequency** field. In a concrete exmple, using the set-up values in the illustration, S50 would send 500 pulses from the step output of the **Indexer LPT** "d" axis at a rate of 1000 pulse per second.

Indexer LPT Lead In Commands

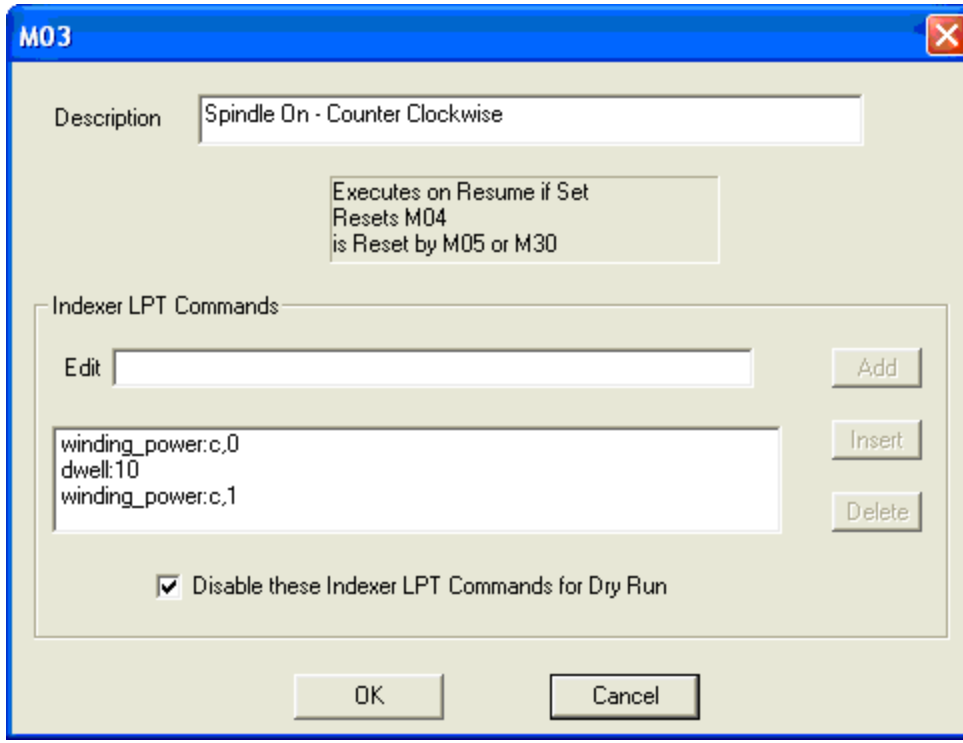
Indexer LPT commands in this list are executed with each S command prior to any subsequent pulse generation, and regardless of the condition of the **Active Axis** field.

M Codes

G Code Controller supports over one hundred (100) customizable M codes. Each M code can dispense a unique list of **Indexer LPT** commands and **List Directives**. The argument to the M word in the **Part Program** determines which customized M code list is executed. To edit the list of **Indexer LPT** commands associated with any M code, select the code number using the spin control in the dialog that appears after you snap **Setup > M Codes**. (The spin control will skip over system M codes, such as M00, M01, M02, M98 and M99. System M codes cannot be customized). When you snap over the **Configure** button a **List Dialog** editor appears for the selected M code number. You may enter any number of **Indexer LPT** commands and **List Directives** using the list editor.

Description

This field provides the machine designer a place for a short



written description of the function designed into the particular M code.

Annotation

The sunken box that appears between the **Description** field and the list editor displays a reminder of system effects for **Special M Codes**, described below.

Disable these Indexer LPT Commands for Dry Run

When this check box is checked the list of **Indexer LPT** commands associated with this M code are not executed for **Production > Dry Run**.

"On the Fly" Switching

Prior to **G Code Controller** Version 2 the appearance of an M code in a part program would temporarily interrupt continuous

contouring, execute the M code, then if followed by contouring commands (mode G01, G02, G03), proceed loading the look-ahead buffer for the next contour. Version 2 supports switching a digital output signal while the motors are moving at speed, and without interrupting smooth, contouring motion. This feature accommodates applications that require motion to be at feed rate and typically not while accelerating nor decelerating when a component is switched on or off. However, the part program determines the geometric point where switching occurs, so it is possible to perform "On the Fly" switching at a specific location even while motion is accelerating or decelerating.

Backward Compatibility Warning

If you are upgrading from Version 1, and you had used an M code that contained one or no entries in the Command List to intentionally close the look-ahead contouring buffer, then you will need to modify that M code so that it includes more than one entry in order to preserve backward compatibility with your existing Part Programs.

In order to customize an M code so that it does not interrupt smooth motion, enter only one **Indexer LPT** command in the **Command List**. This command can be one of the **Indexer LPT** commands that control digital output, specifically the *reduced_current* or the *winding_power* command. Also, within the **Part Program** this M code must be the only delimiting command from **Block** to **Block** at any transitional point in a smooth contour. So for example if **M14** and **M15** had only one **Indexer LPT** digital output command (and presuming that **Contouring** is turned on for the **Job**), the following part program code would move smoothly through the transition, moving X and Y stages ten (10) inches, but activating the digital output half way while the motors remain at speed:

```
G91 G01 X5 Y5
M14
X5 Y5
```

Alternatively, the M code can appear in the same block as the motion command. When this occurs, the M code will be executed before the motion. The following sequence behaves the same as the previous example, smoothly accelerating X and Y stages from rest, decelerating to the destination point ten inches from the start, but performing the switching action in the middle without affect-

ing the continuity of the motion.

```
G91 G01 X5 Y5
X5 Y5 M14
```

The following code, however, would decelerate motion to a stop, execute each M code, then proceed:

```
G91 G01 X5 Y5
M14 M15
X5 Y5
```

Specifically (since two M codes delimit the contour), motion decelerates to a stop in the middle, M14 and M15 are executed, then motion accelerates and decelerates to a stop at the destination point.

In another example, consider a machine that sprays a coating at a carefully controlled density. M14 turns a spray nozzle on and M14 turns the nozzle off. Since the speed of the spray nozzle affects the density of the coating, it is important to activate the nozzle only after the motors have accelerated to vector rate, and to deactivate the nozzle before decelerating to a stop. Here is example code for motion that activates the nozzle while the X **Stage** is at speed and only within a specified region:

```
G91 G01 X1.0
X5.0 M14
X1.0 M15
```

In this example **M14** is executed exactly 1.0 inches into the motion and while the **X Stage** is at speed. Exactly six inches into the motion M15 executes, also while the **X Stage** is at speed. The remaining 1.0 inch that remains provides room for the **Stage** to decelerate with the nozzle off. It should also be noted that this feature is not limited in its performance to the number of stages that are being moved, which in the example is only the X **Stage**. "**On the Fly" Switching** can be performed while the maximum number of **Stages** are being moved simultaneously.

Special M Codes

These M codes "special" in the sense that **G Code Controller** adds features to them that are not present in the other general purpose M codes.

Inclusive (M07, M08, M09)

We call **M07** and **M08** "inclusive" because they represent functions that can be active simultaneously. **M09** cancels both **M07** and **M08**.

In a concrete example, you may use **M07** to execute an **Indexer LPT** command or series of **Indexer LPT** commands that activates a solenoid to turn on a mist coolant. You may use **M08** to activate a different solenoid for a flood coolant. Sometimes you may want both solenoids to be activated at the same time. Other times you may want only one or the other. **Indexer LPT** commands associated with **M09** should be designed to deactivate both solenoids. **M09** cancels both **M07** and **M08**.

G Code Controller program keeps track of the status of **M07** and **M08**. The status of these M commands is important in handling program stop and resume sequences. However, it is up to the machine designer to make sure that the **Indexer LPT** commands in the associated lists physically accomplish the desired hardware responses.

The status **M07** is set when the part program executes **M07**. Likewise, the status of **M08** is set when the part program executes **M08**. The status of these commands governs certain machine operations when the **Part Program** stops and when the operator decides to resume from a stopped condition. When **M09** is executed from within the **Part Program**, the status of both **M07** and **M08** are cleared.

When the **Part Program** stops due to an **M00** (Program Stop), **M30** (End of Program Stop), or **Abort from Feed Hold Stop**, if the status of **M07** or **M08** is set, the list of **Indexer LPT** commands stored under **M09** will be executed.

If the program stops due to an **M30**, the status of **M07** and **M08** will also be cleared.

When the operator decides to resume by means of a **Cycle Start** after a program stop: if the status of **M07** is set then the **Indexer LPT** commands stored under M07 will be executed, and if the status of **M08** is set then the **Indexer LPT** commands stored under **M08** will be executed.

Using the example of the coolants, if the **Part Program** stops

as a result of **M30**, any coolant solenoid that may have been activated will be shut down. When the operator resumes, the coolants will not be turned on until the **Part Program** turns them on. If the program stops due to **M00**, **M01**, **Abort from Feed Hold Stop** or **Breakpoint Stop**, any coolant solenoid that may have been activated will be shut down. However, when the operator resumes, the coolants that were shut down will be automatically re-activated.

Exclusive (M03, M04, M05)

We call **M03** and **M04** "exclusive" because they represent functions that cannot be active simultaneously. **M05** cancels **M03** and **M04**. However, when **M03** is executed it cancels **M04**, and when **M04** is executed it cancels **M03**.

The exclusive nature of **M03** and **M04** make them useful not only in stop and resume procedures, but also in **Part Program** control that requires a reversal of a particular process, such as for a spindle in the canned tapping cycle, **G84**.

For example, you may use **M03** to execute **Indexer LPT** commands that control relays in such a manner as to set up spindle rotation in the clockwise direction. **Indexer LPT** commands to control relays in a manner to set up spindle rotation in the counterclockwise direction can be set up under **M04**. The rotation of the spindle represents an exclusive condition because the spindle can be turning clockwise or counterclockwise, but not both directions at the same time.

The machine designer must make sure that the **Indexer LPT** commands in **M03** disable set-ups performed under **M04**. Likewise, **Indexer LPT** commands set up under M04 must disable set-ups performed under **M03**. **Indexer LPT** commands in M05 should disable set-ups performed under **M03** and **M04**.

When the program stops due to an **M00** (**Program Stop**), **M30** (**End of Program Stop**), or **Abort from Feed Hold Stop**, if the status of **M03** or **M04** is set, the list of **Indexer LPT** commands stored under **M05** will be executed.

If the program stops due to an **M30**, the status of **M03** and **M04** will be cleared.

When the operator decides to resume by means of a **Cycle Start** after a **Part Program** stop: if the status of **M03** is set, then

the **Indexer LPT** commands stored under **M03** will be executed. If the status of **M04** is set, then the **Indexer LPT** commands stored under **M04** will be executed.

Using the example of the spindle, if the **Part Program** stops as a result of **M30**, the spindle will be turned off under control of the **Indexer LPT** commands for **M05**. When the **Part Program** resumes, the spindle will not be enabled until the **Part Program** enables it, since its status had been cleared by the implicit execution of **M05**. If the **Part Program** stops due to **M00**, **M01**, **Abort from Feed Hold Stop** or **Breakpoint Stop**, the spindle will be turned off, but when the operator **Resumes**, the spindle will immediately be enabled in the mode (**M03** or **M04**) that it was in before the **Part Program** was stopped.

In the tapping cycle, **G84**, if the status of **M03** is set at the beginning of the cycle, then at the bottom of the cycle (where the spindle must be reversed to withdraw the tap) the **Indexer LPT** commands associated with **M04** are executed. At the end of the **G84** cycle, the commands for **M03** are executed to prepare for the next cycle.

Similarly, if the status for **M04** is set at the beginning of an **M84** cycle, at the bottom of the cycle **Indexer LPT** commands associated with **M03** are executed. Commands associated with **M04** are subsequently executed at the end of the cycle in preparation for the next cycle.

Associated (M10)

The list of commands set up under M10 is automatically executed under the canned cycle instated by **G88**.

In a concrete example, a sequence of commands are set up under **M10** to accomplish a punch press cycle. The commands: 1) activate a solenoid to extend a hydraulic cylinder. 2) Wait for a switch signal that indicates the cylinder is extended. 3) Deactivate the solenoid to retract the cylinder and 4) wait for a switch signal that indicates the cylinder is retracted. In this example, subsequent to **G88**, the **Part Program** need only include rapid traversals to the locations of the punch points. After each rapid traversal **M10** will be executed, until **G88** is cancelled with **G80**. (See the chapter entitled **Part Programming** for more on canned cycles).

T Codes

The **G Code Controller** supports up to one hundred (100) customizable T codes. Each T code can dispense a unique list of **Indexer LPT** commands and **List Directives**. The argument to the T word in the **Part Program** determines which list is executed. To edit the list of **Indexer LPT** commands associated with any T code, select the code number using the spin control in the dialog that appears after you snap **Setup > T Codes**. When you snap over the **Configure** button a list editor appears for the selected T code number. You may enter any number of **Indexer LPT** commands using the list editor.

T codes are typically used to implement automatic tool changing. It is common in automated systems to use a tool change carousel that indexes tools to a common position where the tool may be picked up and dropped off. However, using **G Code Controller** you can customize each T code to pick up and drop off each tool in a different location, thus eliminating the need for the cost and complexity of an indexing carousel.

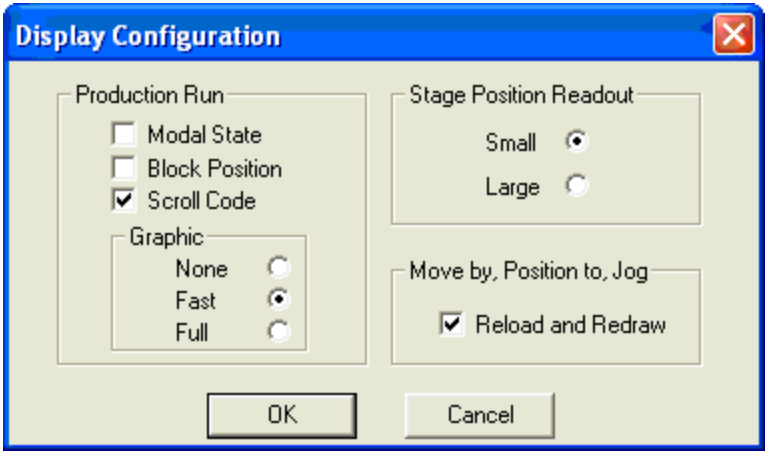
The **Return Position** list automatically maintained for each **Stage** when the **List Directive** *#rapid_to* is used, and the capacity to save and access **Machine Variables** within the **Command List**, allows each T code to accomplish the tasks necessary to implement a tool changing from a static tray. Each T command can be customized to: 1) Depart from an arbitrary position in the work area along a necessarily complex “safe” clearance path to the storage location of the currently used tool. 2) Drop the current tool off in its storage location. 3) Pick up the new tool from a different location. 4) Store the drop off location for the newly selected tool in a **Machine Variables** (so a subsequently used T code has sufficient information to drop off the current tool before picking up the next one) and finally 5) Return along a “safe” path to the arbitrary point of departure from the tool path in the **Part Program** to resume operation.

In order to implement this strategy for tool changing, **Machine Variables** for an initial drop off location must be initialized in the **Startup List**. This could be a location where a tool that may have been inadvertently left engaged when the machine was turned off may be released without damage. When the first tool is selected after starting **G Code Controller**, a machine cus-

tomized according to this strategy will cycle through its tool release sequence in a safe spot.

Display

Production Run



This portion of the dialog permits you to enter default settings for items in the **Production > Run** control dialog. (These default settings will also apply to the **Production > Dry Run** dialog). Each of these items can be changed at run time.

Modal State and **Block Position** check boxes will make information windows of the same names visible with the **Production Run** dialog.

When the the **Scroll Code** check box is checked, each **Block** of the **Part Program** is written to the screen as it is processed. On very large **Part Programs** this is typically left unchecked, for even though it may take only a fraction of a second to update the screen for each **Block**, processing thousands of **Blocks** this way can take a considerable amount of time.

The **Graphic** radio button selection field allows you choose options **None**, **Fast** and **Full**. **None** shows the tool path graphic, but does not update the color change to show the progression of processing along the tool path. **Fast** updates the display after each rapid traverse and each full contour is processed. **Full** updates the

graphic display as each element in every **Block** is processed. **Fast** is the most commonly used option.

Refer to the chapter entitled **Production Operations** for a more complete description of these settings and the **Production > Run** control dialog.

Stage Position Readout

This portion of the dialog permits you to choose between a small and large **Position Readout** window. A large **Position Readout** is handy when it is more convenient to view the operational position of the **Stages** at a distance. The small **Position Readout** is more convenient when you wish to customize screen area to show other relevant information.

Reload and Redraw

The graphical display of the tool path is shown in the **Orthographic** and **3D Windows** in a position relative to the limit switch boundaries. Manual motion of the **Stages**, as may be accomplished by means of the **Production > Move by**, **Position** to or **Jog** dialogs, changes the graphic display. Some users prefer not to update the display for very large **Part Programs** in order to conserve on the time that it may take to redraw the screen after each manual motion.

This check box is usually left checked, especially on systems where the joystick **Jog** option is used. Unlike the **Production > Move by** and **Position to** method, small increments of manual motion (typically used for setting up a **Job**'s starting position) can be accomplished under the **Production > Jog** dialog without automatically updating the display until the joystick option is released. (See the chapter entitled **Production Operations** for more details regarding joystick **Jog**, **Job** set-up, and manually moving **Stages**).

This option can be easily selected or deselected at run time.

Passwords

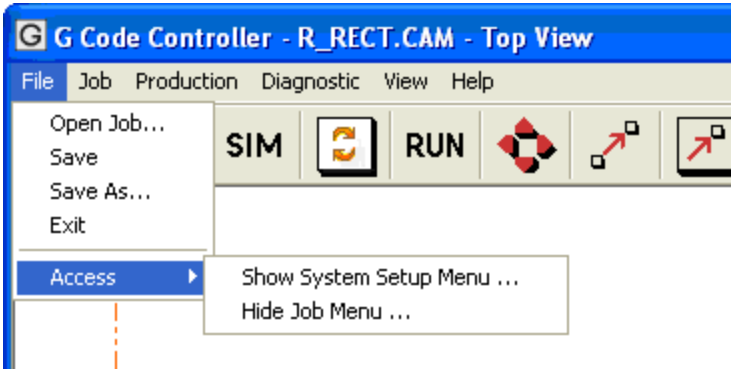
Purpose for Passwords

Password access is provided to protect **System** and **Job** set-

ups from accidental modification. **These passwords should be used only to avoid accidental modification of setup values and not as an iron-clad protection against access to certain features**. The initial password which comes with the product is “abc” for the **System Setup** and “def” for **Job Setup**. You may choose not to use this feature, or temporarily restrict access without changing the set-up.

Affect on System Menu

The **Password** setting affects the **File > Access** menu when **G Code Controller** starts. The illustration shows a common con-



figuration as it may appear right after start-up, where the **System** setup is password protected and the **Job** setup is not. The menu entitled **System** is absent in the Main Menu, but the menu entitled

Job is visible and accessible. If you were to select **Show System Setup Menu** from the fly-out, you will be prompted for the **System** password. The **System** menu will then be visible and accessible, and the fly-out will be changed to read **Hide System Setup Menu**.

You can show or hide **System** and **Job** setup menus at any time using the **File > Access** menu. If the check box requiring a password is checked in the associated field in the **Passwords** dialog, then you will be prompted for a password when selecting the menu to **Show**. Otherwise, the **File > Access** menu can be used to alternately **Show** and **Hide** the menus without prompting.

Recovering Passwords

If you forget your password, you can find it by printing the GIXA.INI file using **Notepad**. (Be very careful not to alter the contents of GIXA.INI within **Notepad**). The passwords will appear under the section:

```
[Password]
```

Save Setup File

This menu selection will only become visible after changes have been made to the **System** setup. Use this menu to store changes that you have made to the **System** configuration file, GIXA.INI, which is located in the WINDOWS folder.

Diagnostics

A full range of diagnostic menus are available to assist you in troubleshooting your **System** set-ups, and in diagnosing other problems. Switch diagnostic menus, such as the one shown below, continuously monitor switch inputs, giving you a live display of the switch status.

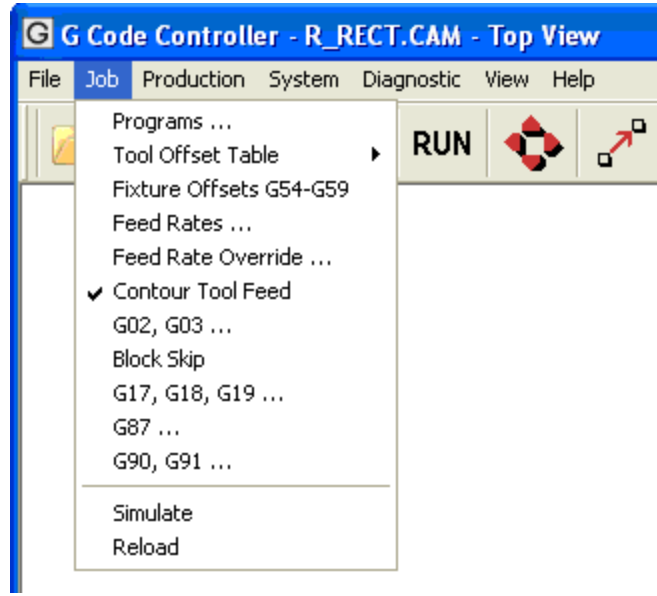
The **Error List** dialog collects system and part programming errors in a list format that can be easily reviewed.

Part programming errors are shown with the location of the error, **Block** number (“N” number) and program number (“O” number) preceding the description of the error. In cases where

you optionally omit the **Block** number, the display shows the number that was assigned to the block by the **G Code Controller**.

Chapter 7

JOB SET-UPS



Job setups can be modified by means of the dialogs accessible from the **Job** menu, which becomes visible when you have opened a **Job** by means of **File > Open Job**. As mentioned, in the chapter entitled **Important Files**, **CAM Files** contain information about the **Job**, including but not limited to the file name of the **Part Program** file(s). For this reason **File > Open Job** is used to read a **CAM File**, and NOT used to directly open a **Part**

Program file. Opening a **CAM File** reads the **Job** settings into **G Code Controller**, which can then be used immediately, temporarily changed and used, changed and saved back to the original **CAM File** using **File > Save**, or changed and saved under a different name using **File > Save As.** The name of the **Job** is the name of the opened **CAM File**, and appears in the title bar.

CAM Files contain information which pertains to the individual part which is being manufactured, some of which will change from **Job** to **Job** and some of which will not. It may be convenient, therefore, to have a number of template, or "default" **CAM Files** that contain information pertinent to different types of **Jobs** that you may run. Using **File > Save As** saves you the trouble of entering information that will not change when creating another **Job**.

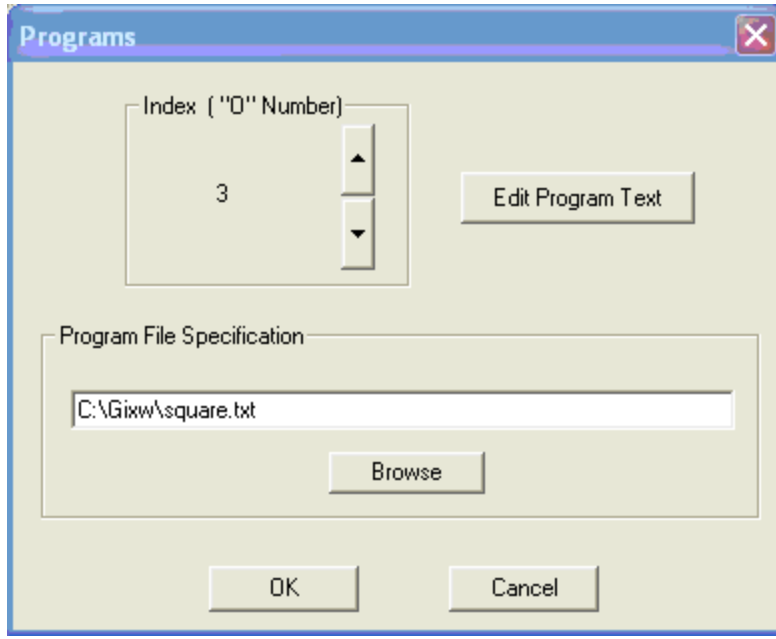
The working directory, which the **File > Open Job** browser initially displays is, the "Start in:" field which is set up under the **Windows Shortcut**. (To change the working directory, right snap over the **G Code Controller**'s icon and snap over the **Properties** selection of the pop-up menu that appears. Snap over the **Shortcut** tab, then enter the complete path to the location of your **CAM Files** in the field entitled "Start in:").

Programs

File Names and O Numbers

As per the chapter entitled **Important Files**, **Part Program** files contain Gcode control scripts. **Part Programs** are "Text" type files stored on the computer using path and file names. Each line of text in the **Part Program** script is referred to as a **Block**. **Blocks** can transfer control to other blocks within the same script using N numbers. (See the chapter entitled **Part Programming**). **Blocks** can also transfer control to **Blocks** in other **Part Programs** by means of O (the letter O) numbers. This dialog establishes the relationship between the **Part Program** file name and the Onumber that represents it.

G Code Controller starts executing a **Job** in **Part Program** O0 (the letter "O", index Zero). Up to nine other part programs can be accessed in the same **Job**, thus **G Code Controller** supports the use of up to ten **Part Programs** per **Job**, designated



from O0 through O9.

In the example **Programs** dialog, the file entitled “square.txt” contains a **Part Program** that is stored on the computer’s disk under the name and location **C:\Gixw\square.txt** This **Part Program** would be referenced from other **Part Programs** in the same **Job** by means of the code O3 (letter O index three), since this dialog sets the file up under the **Index (“O” Number)** at a value of 3. For example, to call a subroutine located in this **Part Program** located on line N550, another **Part Program** in the **Job** might use the following line of code:

```
M98 P550 O3 L1
```

Selecting a Program File

To bring an existing file into the **Program File Specification** field you may snap over the **Browse** button to bring up a **Windows** browse menu, then snap over the file that you desire. Files with extensions “.txt”, “.tap” and “.nc” will be listed in the files available for selection, as these extensions are commonly appended to **Part Program** files generated by CAD/CAM post processors. The extension “.txt” is handy because it is often automatically appended to new files by **Notepad**. As mentioned, and

regardless of the file name extension that you are using, **Program Files** are "Text" type files. The **Browse** window can alternatively expose files of every extension if you use the **All Files (*.*)** option in its **Files of type** field. If you use this option, only select "Text" type files that contain Gcode scripts, and do NOT select a file with ".CAM" as its extension.

Editing a Part Program

You can edit a **Part Program** selected into the **Job** by snapping the button entitled **Edit Program Text** in the **Programs** dialog. A text editor will pop up with the **Part Program** file read into it, and you can begin editing. The text editor used in the default installation of the **G Code Controller** is **Notepad**.

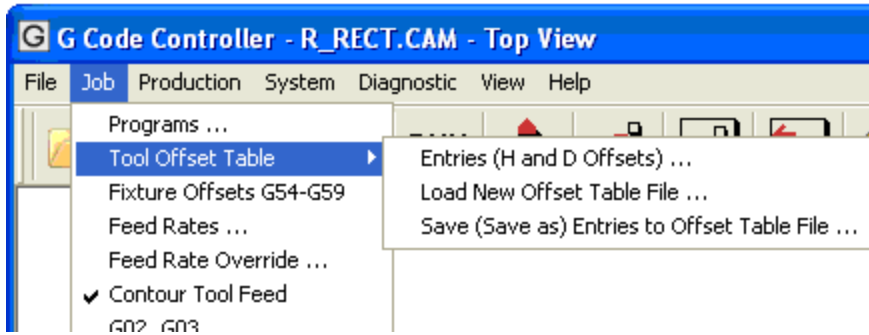
To create a new **Part Program** you can type a name for the file in the **Program File Specification** field, then snap **Edit Program Text**. The default path (e.g. C:\Gixa) will be used if you do not specify the path name. If a file does not exist in the folder path for the name you have chosen, **Notepad** will ask you if you want to create a new file of that name. You may then snap **Yes** and begin editing a new **Part Program**.

You are not constrained to use **Notepad** to edit your **Part Programs**. You may use any editor capable of working with "Text" type files, and capable of accepting a file name from a command line argument.

Interacting with the Text Editor

After you finish editing the **Part Program** in the text editor you must save it to disk to make it accessible to **G Code Controller**. In **Notepad** you would used **File > Save**. Then snap to **G Code Controller** and use **Job > Reload**, or its associated **Toolbar** button, to load the changes that you had made into the **Job**. **Reload** will immediately display changes to the **Orthographic** and **3D** windows as it makes the **Job** ready for either running or simulating. You can work back and forth between the text editing windows and the **Simulator** to verify the **Part Program**(s) that you are developing or changing. See the chapter entitled **Job Simulation** for more information about verifying **Part Programs**.

Tool Offset Table



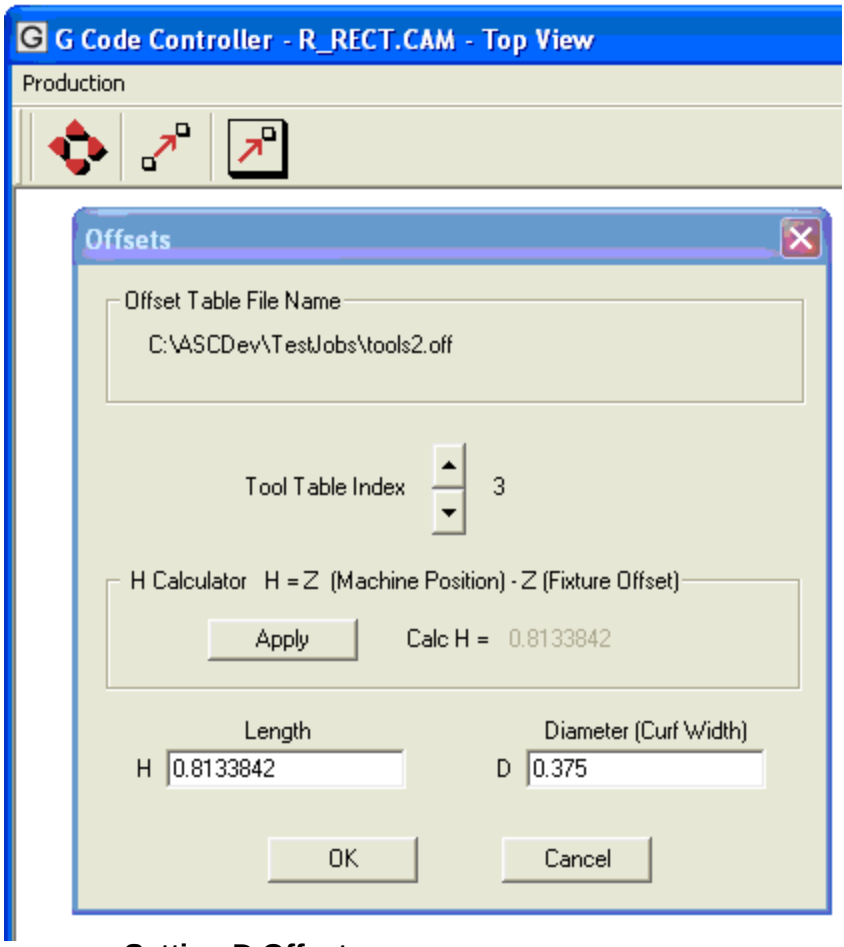
The **Tool Offset Table** is used to store values used for tool length and tool radius compensation, and to make these values accessible from within the **Part Program**. The values contained in the **Offset Table** are stored to disk in a special type of file that we call an **Offset Table File**. When the **CAM File** loads a **Job**, values from the **Offset Table File** are read into the **Tool Offset Table**. The **Tool Offset Table** can store diameters and lengths for 100 (one hundred) different tools.

Save (Save as) Entries to Offset Table File
Load New Offset Table File

These menus allow you to create new **Offset Table Files** and to load different **Offset Table Files** into the **Job**. This feature is convenient for machines with removable tool trays, making it easy to save and retrieve all of the tool offsets together as part of the **Job**.

Entries (H and D Offsets)

The tool index is the means by which the **Part Program** can refer to the offset values via arguments to the H and D words. You can select the particular D and H index for editing, (D1/H1, D2/H2, D3/H3 etc.) using the spin buttons in the **Offsets** dialog entitled **Tool Table Index**. See the chapter entitled **Part Programming** for more information on how the **Part Program** applies the values assigned to H and D words to the tool path.



Setting D Offsets

D offsets are used in conjunction with G41 (left offset) and G42 (right offset) to alter the cutting path and automatically compensate for cutting tool diameter or curf width. The value assigned represents the diameter a circular cutting tool, or the width of a flame cut (curf). Instating G41 or G42 offsets the path of the tool from the contour by one half the amount of the D entry. Using the D value in the illustration as an example, when used with G41 or G42 the cutting path for D3 would be offset by one half 0.375, or 0.1875.

When CAD/CAM software is used to generate the **Part**

Program, this feature is often processed into the generation of the tool path, obviating the need for this feature. However, D offset compensation is often useful when manually generating simple cutting paths, since the exact dimensions of the part can be more easily used when manually composing the **Part Program**. D offset compensation can also be used in applications that must compensate for the wear of the tool without having to change the **Part Program**.

Setting H Offsets

H offsets are used in conjunction with G43 to alter the cutting path to automatically compensate for length of the cutting tool. Length offset compensation is usually unnecessary unless more than one tool is being used in a **Job**, since the tool length for a single tool can be easily compensated for as a **Fixture Offset**. (See the section of this chapter entitled **Fixture Offsets**). Tool length compensation is less often applied by CAD/CAM software when generating tool paths, since the actual length that a tool protrudes from its mount is more often determined at a later time, when the **Job** is being set up to run on the machine.

The H value assigned to the tool represents the distance the cutting end of the tool is from a reference position located along its length. One method for determining the H value for each tool is to select a reference location at the seat of the tool chuck, and measure the distance from the seat to the end of each tool. The values for each tool length can be subsequently typed into the D field for the associated tool index.

A more convenient method and takes advantage of measurement capabilities built into **G Code Controller**. **G Code Controller**'s context sensitive menus expose manual positioning options when the **Offsets** dialog is active, similar to when the **Fixture Offsets** dialog is up (see the section of this chapter entitled **Fixture Offsets**). Mount the first tool, and manually position it so that it touches its reference location (the zero position) of its **Fixture Offset**. The **Fixture Offset** menu allows you to automatically apply this position to the **Job**. Close the **Fixture Offsets** dialog, and use the **Offsets** dialog to assign the value of 0.0 (zero) to the H field of the first tool. Now you can physically mount subsequent tools, and for each tool manually "touch off" on the reference location. By snapping the **Apply** button, the length of the

tool is calculated and automatically applied to the H field.

In a concrete example, suppose your **Job** uses two or more tools, situated in carriers so that they can be mounted and dismounted to consistent lengths, but you have not yet determined the actual length of each tool in its carrier. Place the first tool in the spindle, launch the **Fixture Offsets** dialog and manually position the tool along the Z **Stage** until its tip touches a reference position. Snap the **Apply** button to transfer the machine position to the **Fixture Offset** for the Z **Stage**. Snap OK to save, and drop from the **Fixture Offsets** dialog. Now launch the **Offsets** dialog and assign 0.0 to the H field of **Tool Table** Index 1. Manually move the spindle (e.g. using the *joystick* **Jog**, **Position to** or **Move by** control) to a point where you can replace the first tool with the second one. Use the spin button to select Tool Table Index 2. Now with the second tool seated in the spindle, manually move the Z **Stage** to the position where the tool touches the reference position. Snapping **Apply** automatically transfers the calculated value for the tool length to the Hfield. For subsequent tools you need only advance the **Tool Table** Index, manually touch the tool, and **Apply** it to the H field.

If you are using the *joystick* **Jog** feature for manual motion, pressing the **Mark** switch calculates the H value and displays it to the dialog. Snap over the **Apply** button then press **Mark** to automatically apply the current position to the H field.

You can include into your design a feature that automatically stops the **Z Stage** at the touch off location using a circuit that activates the Z **Stage** low limit switch input when a tool contacts the reference position. When incorporating this feature, however, you must be sure that the *joystick* is operated in “Instantaneous” mode, as position tracking cannot be maintained if a limit switch interruption occurs in “Accelerated” mode. See the chapter in the **Indexer LPT** manual entitled **Joystick** for more information on *joystick* wiring and optional mode switching.

Contour Tool Feed

This selection allows you to enable and disable the advanced look-ahead contouring feature. Look-ahead contouring, described in detail in the **Indexer LPT** users guide, provides for exceptionally smooth speed modulation through complex contours, looking

ahead as many **Blocks** as necessary to begin deceleration when necessary to avoid over-stress.

Block Skip

This selection allows you to enable and disable the **Block Skip** feature. If **Block Skip** is enabled, lines of the part programs that begin with the slash character (/) will be ignored. Consider this line (block) of code, for example:

```
/N325 G00 X5.200 Y3.00
```

If **Block Skip** is enabled, this block will not be interpreted. Otherwise it will be read into program for execution.

Arc Translation (G02, G03)

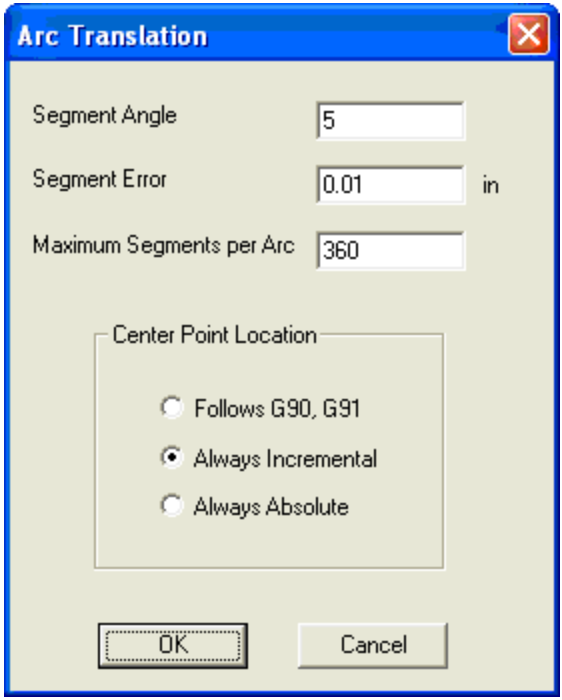
The manner in which the **G Code Controller** interprets the circular interpolation codes G02 and G03 is set-up using **Arc Translation** dialog shown on the following page.

Center Point Location

It may be desirable to configure the **G Code Controller** to be similar to other controllers that exist in the field in order to more easily accommodate existing **Part Programs**, or CAD/CAM post processors that are set up for other systems. One manner in which controllers differ is the way that they interpret center point location values. (See the **Circular Feed** section in the chapter entitled **Part Programming**). Some controllers always consider these values as an absolute location referenced to the **Program Zero** point (**Absolute**). Others always consider the values to represent distances relative to the current location of the tool (**Incremental**). Still others interpret the values as **Absolute** or **Incremental** depending on the positioning mode of the machine at the time, **Absolute** following G90, and **Incremental** following G91. The radio button controls allow you to choose which interpretation to use. **Always Incremental** is very commonly used, and recommended.

Segment Angle

G Code Controller approximates circular interpolation by



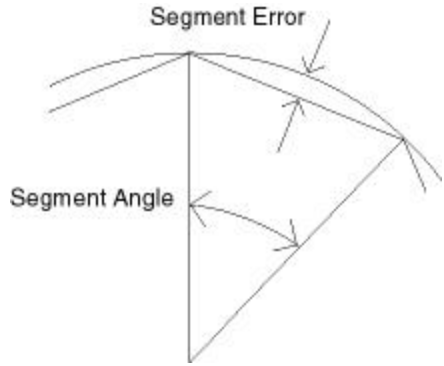
means of line segments situated end to end across the path of the true theoretical arc. As per the diagram on the next page, the **Segment Angle** is the maximum subtended angle for each line. In other words, as long as the geometry does not violate the **Segment Error**, or the **Maximum Segments per Arc**, the arc will be constructed in segments using **Segment Angle** or less.

It is important to note that **Segment Angle** is a maximum angle, and that the total included angle of the arc is not limited to resolve to this angle. In other words, if the **Segment Angle** is specified as 5 degrees, an 8 degree arc will be drawn using two segments subtended by 4 degrees. A ten degree arc will be drawn using two segments subtended by five degrees.

This setup is useful in optimizing jobs where tolerances of smaller radii arcs are held tighter than the **Segment Error** allows for larger radii arcs.

Segment Error

This value is the maximum dimensional error due to linear



approximation. In other words, it is the farthest distance that the segment deviates from the true theoretical arc.

This set-up over-rides **Segment Angle**. Smaller arcs subtended at **Segment Angle** may generate errors which are less than this set-up value. Larger arcs are broken down into more segments so that **Segment Error** is not violated.

If the destination point designated in a G02 or a G03 **Block** deviates from the radius (established by the starting point and the center point) by an amount greater than the **Segment Error**, a warning is posted in the **Diagnostic > Errors** dialog.

Maximum Segments per Arc

This value over-rides both **Segment Error** and **Segment Angle**. The number of segments used to approximate an arc is limited by this value.

Accuracy Guidelines

Do NOT enter tolerance requirements that greatly exceed your manufacturing requirement. In other words, use sensible values. A greater number of segments will result in greater memory usage, slower screen updates and longer pre-calculation dwell at run time. Excessively tight tolerance may even compromise the quality of machine motion.

Reference Plane Selection (G17, G18, G19)

The default reference plane that is in effect at the start of the **Job** can be set with this menu: X-Y (G17), X-Z (G18) or Y-Z (G19). The **Part Program** can change the reference plane by executing G17, G18 or G19.

Chip Break Cycle (G87)

This set-up dialog allows you to specify the tool retract distance that occurs after each peck plunge during the G87 chip break cycle.

Positioning Mode (G90, G91)

The default positioning mode that is in effect when the **Job** starts can be set with this menu: **Absolute** (G90) or **Incremental** (G91). The **Part Program** can change the positioning mode by executing G90 or G91.

Feed Rates

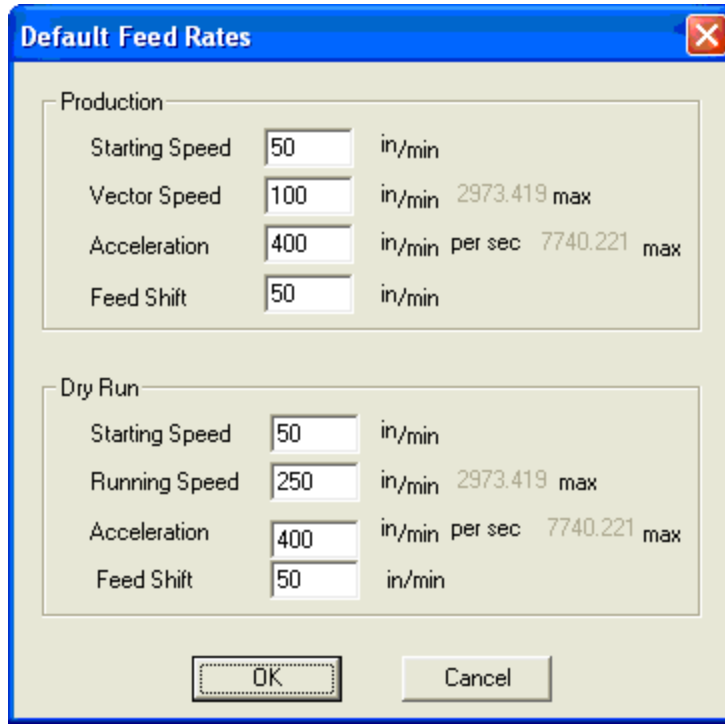
The mode of motion is either **Rapid Traverse**, instated by G00, or **Feed**, which is instated by G01, G02 or G03. **Rapid Traverse** dynamics are set up under the **System > Stage Configuration** menus. This dialog allows you to set up the default motion dynamics for **Feed**. Notice in the illustration on the following page that there are two groups of similarly named fields. The groups are entitled **Production** and **Dry Run**. The group of values that are in effect depends on whether the **Job** is being run under the **Production > Run Tool Path** or the **Production > Dry Run Tool Path** control.

Starting Speed

The **Starting Speed** is the instantaneous rate at which motion for tool feed starts from rest. This value is used to compute **Indexer LPT**'s *feed_lowspeed*, described in the **Indexer LPT** manual.

Vector Speed
Running Speed

Vector Speed is the speed of the tool across the work. This



value is used to compute **Indexer LPT**'s *feed_highspeed*, described in the **Indexer LPT** manual. The value in the **Vector Speed** field is the default **Feed** rate. The **Feed** rate can be changed within the **Part Program** using the F command.

In a concrete example, the value for **Vector Speed** in the illustration defines the default feed rate at a value of 100 inches per minute. If F80 occurs within a **Part Program** that is being executed under the **Production > Run** menu, the **Feed** rate changes from 100 to 80 inches per minute. When the **Job** re-loaded (or **rewinded** via M30), the default feed rate of 100 is reinstated.

Running Speed is nomenclature that we use to specify the vector speed when a **Job** is run using the **Production > Dry Run** menu. F commands within the part program have no effect during a **Dry Run**.

Acceleration

This is the rate of acceleration between **Starting Speed** and **Vector Speed** (or **Running Speed**). It is used to compute **Indexer LPT**'s *feed_accel*, described in the **Indexer LPT** manual**.**

Feed Shift

Feed Shift is the maximum instantaneous shift in velocity that is permitted during contouring operations. This value is used by **G Code Controller** to calculate **Indexer LPT**'s *vshift* parameter, described in detail in the **Indexer LPT** manual.

Increasing the value of **Feed Shift** increases the consistency of velocity when negotiating transition points, and also increases the stress on the motors. In stepper motor controlled systems. **Feed Shift** is generally set as high as the system can stand without risking loss of steps. In servo motor controlled systems, motor stress relates more closely to accuracy requirements, and **Feed Shift** should be set accordingly. The value of **Feed Shift** cannot exceed the numeric value of **Starting Speed**.

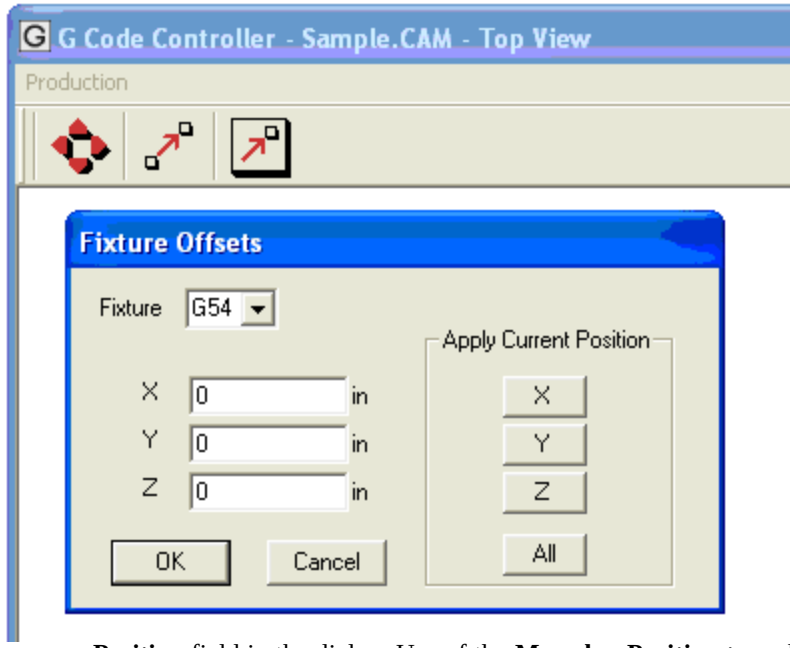
Fixture Offsets (G54, G55, G56, G57, G58, G59)

All absolute position references in the **Part Program** are distances from the currently instated **Fixture Offset** position. The **Fixture** that is instated when a **Job** starts is G54. **Part Program** commands G54 through G59 can be used to change the **Fixture** references, instating the values that can be set up using this dialog.

The fields for each stage shown in this dialog contain distances from the **Machine Home** reference location, which is either automatically set as part of the **Production > Limit Seek** sequence, or manually set using **Production > Set Home**. See the chapter entitled **Part Programming** for more information on using **Fixture Offsets**.

Assigning Current Stage Position

The **Fixture Offset** menu can be useful in setting up the **Fixture Offsets**. Using the **Move by**, **Position to**, or **Jog** methods of manual positioning, the machinist can situate each **Stage** at the **Program Zero** point for the particular **Fixture Offset** position. The **Apply Present Position** button will read the current position of the associated **Stage**, and automatically insert it into it's **Offset**



Position field in the dialog. Use of the **Move by**, **Position to** and **Jog** dialogs is described in the chapter entitled **Production Operations**.

Special Considerations for Apply using Jog

The **Jog** method of manual positioning is particularly useful in assigning current stage positions to the **Fixture Offsets**. Here's how.

You can launch the **Jog** dialog from within the **Fixture Offset** dialog by snapping over the **Jog** button in the **Toolbar** or by using **Production** > **Jog** from the **Main Menu**. Before entering the **Jog** mode (by pressing the **Mark** and **Release** pushbutton switches), drag the **Jog** dialog to the side so that it doesn't overlap the **Fixture Offset** dialog. Once you enter the the **Jog** mode, both the *joystick* and the cursor will be active, but the mouse snap will have no effect until you press the *joystick* **Mark** pushbutton. (Consequently, to avoid inadvertent mouse selections, do not snap the mouse button until you are immediately ready to apply it with the *joystick* **Mark** pushbutton). You can rapidly set the fixture offsets for each **Stage** without leaving the **Jog** dialog by positioning

each **Stage** with the *joystick*, snapping over the associated **Apply Present Position** button in the **Fixture Offset** dialog, and then pressing the *joystick* **Mark** pushbutton.

Simulate and Reload

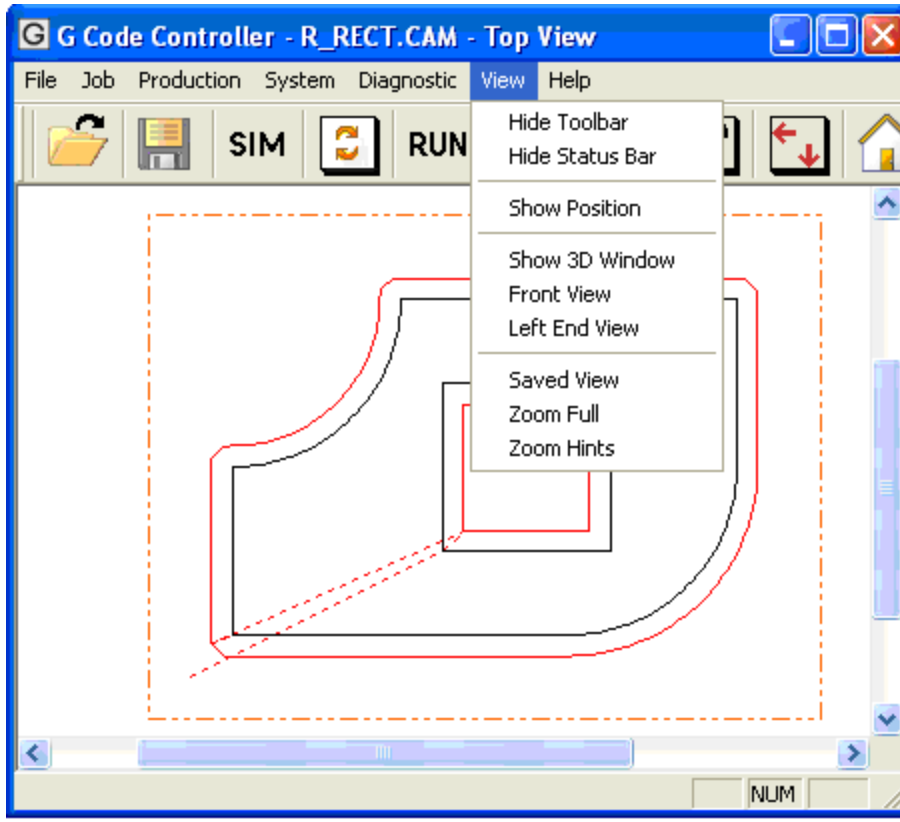
Simulate and **Reload** are located in the **Job** menu because they are closely related to **Part Program** development. The chapter entitled **Simulation** describes the features that are available to you under the **Simulation** menu.

You will probably use **Job > Reload** frequently during **Part Program** development. For this reason it is also accessible by means of the curved arrow button on the **Toolbar**. This menu selection reads the **Part Programs** from disk into **G Code Controller**'s memory and updates the graphics displays.

Suppose you are changing one of the **Part Programs** in your **Job** with **Notepad**. From **Notepad** select **File > Save**. When you snap the **Job > Reload** icon on the **G Code Controller**'s **Toolbar**, the changes you had saved from **Notepad** will be immediately loaded into your **Job**, and will be visible on the screen and accessible for simulation. (See the heading in this chapter entitled **Interacting with the Text Editor under** this chapter's **Programs** section).

Chapter 8

JOB SIMULATION



The Main Window

Orthographic Display

When you open a **Job**, or select a **Part Program** into an existing **Job**, a static **Orthographic View** of the tool path is drawn to the **Main Window**. The particular **Orthographic View** (Top, Front or Left side view), as well as the zoom factor and pan positions, conforms to the settings the last time the **File > Save** or **File > Save As** menus were used. The name of the **Orthographic View** appears next to the name of the **Job** in the **Title Bar**, and selections for alternative views appear in the context sensitive **View** menu and **Toolbar**.

Line Types

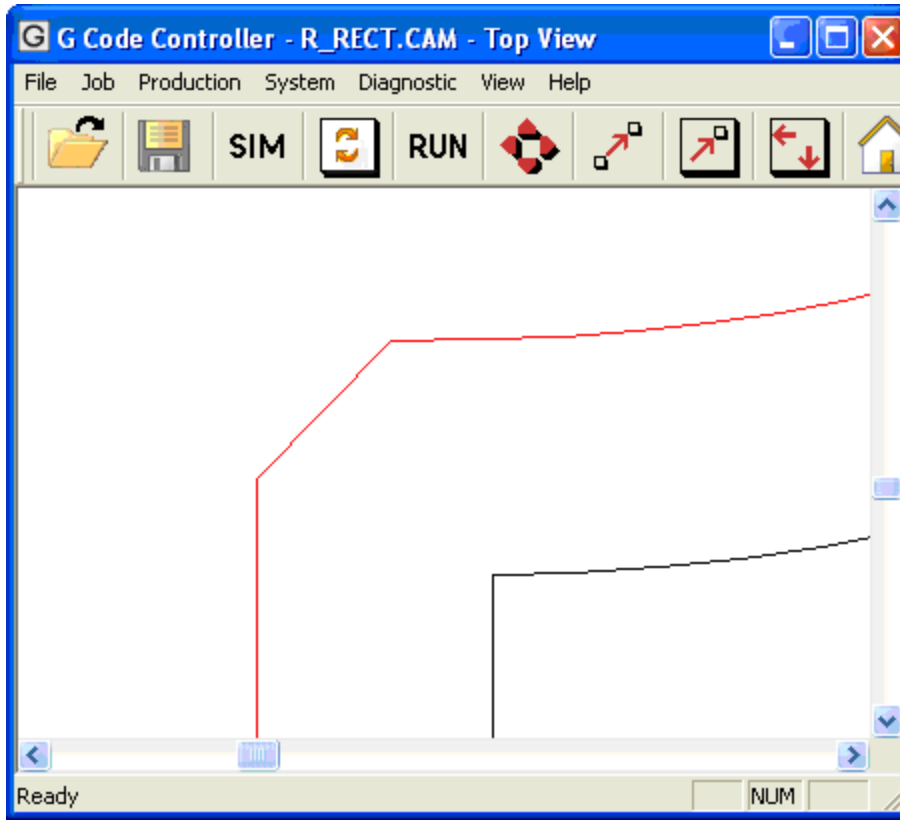
The graphical display of the **Rapid Traverse** (G00) and **Feed** (G01, G02 or G03) path represents the path of the tool's reference point. **Rapid Traverse** is shown in dotted lines. The **Feed** path is shown in red. The **Contour Path**, which is (basically) subscribed by a point on the radius of the tool normal to the tool path and vertically offset by the tool height, is shown in dark grey. When radius and length compensation are not instated, the **Contour** and the **Feed** paths overlap.

The operational boundaries of the working volume, which is to say the limit switch boundaries, are shown in dashed lines. The dashed lines showing the X-Y plane in the most positive Z direction are displayed in a different color than the other boundaries.

Zoom and Pan

Zoom describes the magnification of the tool path image, and **Pan** controls the portion of the image that is displayed. When loading a new or revised **Part Program** into a **Job**, but especially when opening a **Job** generated by previous versions of **G Code Controller**, it may be necessary to use **View > Zoom Full** to make all portions of the tool path visible within the **Main Window**.

To magnify the image (Zoom In), locate the cursor over the portion of the image that you want to appear in the center of the screen after magnification, then press the **Page Down** key on the



keyboard. Magnification is increased each time you press **Page Down**, and the **Scroll Bars** are automatically adjusted to according to the point that you had selected to appear in the center of the screen. Press **Page Down** successively to increase magnification (Zoom In). Press the **Page Up** key to decrease magnification (Zoom Out). The cursor position has no effect when pressing **Page Up** to Zoom Out.

You can change the **Pan** position using the **Scroll Bars** similar to most **Windows** programs. Panning over an irregular tool path at higher magnifications can be cumbersome, since it requires working back and forth between the vertical and horizontal **Scroll Bars**. Alternatively, you can locate the cursor over a any point and bring it to the center of the screen by pressing the **End** key on the keyboard. By successively locating the cursor over the path that you are following and pressing **End** you can quickly pan

along an irregular shape. Each time you press **End** the **Scroll Bars** are adjusted automatically.

Snapping **File > Save** saves the current **Orthographic View**, the current magnification and its **Pan** positions. These settings will be reflected in the display of **Main Windo**w the next time you open the **Job**, or when you select **View > Saved View**.

Changing Views

You can rapidly change from one **Orthographic View** to any other **Orthographic View** by snapping over its button on the **Toolbar**, or by selecting it via the **View** menu.

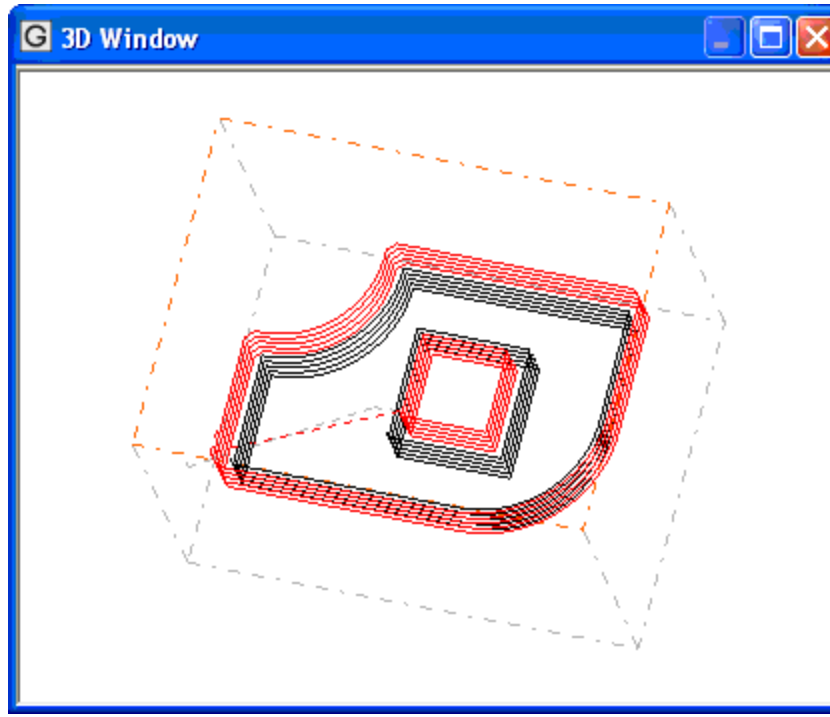
Zooming in using the **Page Down** key automatically increases the magnification for all of the **Orthographic Views**, and adjusts the **Pan** positions for the current **View** according to the location of the cursor. The **Pan** position for the remaining axis in the adjacent View, since it extends into the screen, is indeterminate. Panning to a suitable location in an adjacent **View**, however, is very easy even at elevated magnification. Since the adjacent view has one axis in common, you can use the **Scroll Bar** for the uncommon axis to bring the visible portion of the tool path image into the display.

In a concrete example, consider increasing magnification (Zooming In) from the **Top View**. The horizontal (**X Stage**) and vertical (**Y Stage**) Pan positions are automatically adjusted according to the location of the cursor when you pressed **Page Down**. The **Pan** position of the **Z Stage**, which extends into the image, is indeterminate. The **Front View** has the horizontal (**X Stage**) in common. Consequently, when you switch from the **Top** to the **Front View**, you can slide the image into the view using only the vertical scroll bar, which in the **Front View** represents the **Z Stage**. Similarly, when switching from the **Top View** to the **Left View**, the vertical (**Y Stage**) **Pan** position is common, so from the **Left View** you can slide the image into the display using only the horizontal scroll bar, which in the **Left View** manipulates the **Pan** position along the Z **Stage**.

The 3D Window

Launching, Sizing and Placing

The **3D Window** can be launched by selecting **View > Show 3D Window** from the **Main Menu**, or by snapping over its button on the **Toolbar**. As its name implies, the **3D Windows** shows the tool path in three dimensions. Line colors and styles follow the same convention used for the **Orthographic View** in the **Main Window**



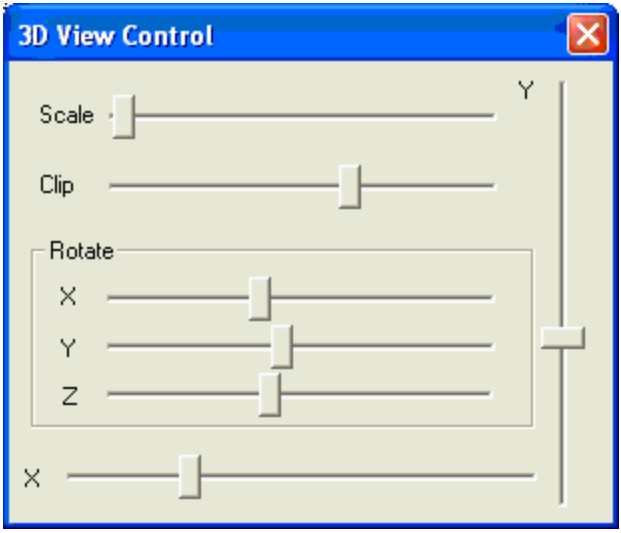
The **View** menu and **Toolbar** are context sensitive, so after the **3D Window** is launched the **View** menu replaces its selection item with a selection entitled **View > Hide 3D Window**. Accordingly, the **3D** button on the toolbar changes to represent its new function of reversing the former selection.

You can size and place the **Orthographic Window** on your screen, or maximize it to cover the entire screen.(It is often handy,

and easy, to maximize this window to more clearly show intricate detail). If you remove the **3D Window**using **View > Hide 3D Window**or its button on the **Toobar**, its size and position will be preserved. The next time you launch the **3D Window**it will appear in the same size, in the same place and with the same settings for **Zoom**, **Pan** and **Rotation** (described below). You can save these settings for the next time you open the **Job** by snapping **File > Save**.

If you remove the **3D Window**using the X on the upper right corner of its title bar, then changes you may have made to this window will not be preserved.

The 3D View Control Window



The 3D **View Control** window is automatically launched with the **3D Window**, and automatically closed when the **3D Window**is closed. You can place it anywhere on the screen by dragging its title bar. You can closed it without removing the **3D Window**by snapping over the X on the right side of its title bar. If you allow it to close with the **3D Window,** any changes you may have made to it will be preserved. Otherwise it will revert back to its last preserved state the next time you launch the **3D Window**. You can save its preserved state to the **Job** using **File > Save**.

You can manipulate the **3D** display by dragging the sliders with the mouse. You can also snap over a slider to select it, then use the keyboard cursor keys to move it by small amounts.

The **Scale** slider manipulates the “Zoom” magnification of the graphic. When the scale is made sufficiently small, the entire volume within the operational boundaries is displayed, delimited by dashed lines. When the scale increased, a “clipping region” is established that only makes visible a range of depth into the screen. The **Clip** slider allows you to move the visible depth towards and away from the screen, allowing you to focus on a particular portion of the tool path by clipping foreground and background paths that may confuse the image

The sliders in the **Rotate** group control rotation of the image around the respective axes. The sliders outside of the **Rotate** group, situated along the bottom and right sides of the **3D View Control** window and entitled X and Y, are used for horizontal and vertical panning.

Errors

System and **Translation Errors** are reported in the **Errors** dialog, accessible from the **Diagnostic > Errors** menu. (All **System Errors** should be resolved prior to using the **Simulator**). The presence of a red exclamation point button on the **Toobar** indicates one or more errors. Snapping this button opens the **Errors** dialog, where each error is reported according to type of error, **Block Number** (N number) and **Program Number** (O0 - O9).

Block Numbers optionally included in the text of the **Part Program** make finding errors within the text of the **Part Program** easier to isolate. When **Block Numbers** are not included in the text, **Errors** are reported according to the **Block Number** that was automatically assigned to the **Block** when it was translated. In this case the **Simulator** may be helpful in locating the errant **Block**, since it prefixes each **Block** with its **Block Number** in the text readout.

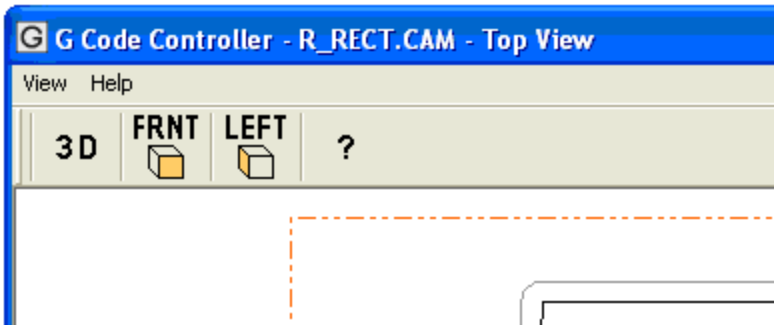
The absence of reported errors does not guarantee that errors do not exist in the **Part Program**(s) or for the **Job**. Some errors may prove to be inconsequential, and may have no effect on the

Job. Other errors my be severe to the extent that the translation process is aborted. Subtle errors that cause unexpected results are of course the worst. Error reporting and **Simulation** tools in and of themselves do not assure that the the **Job** is error free, but instead provide additional resources to be used in alerting the technician of potential problems before machine motion is initiated.

Simulation Control

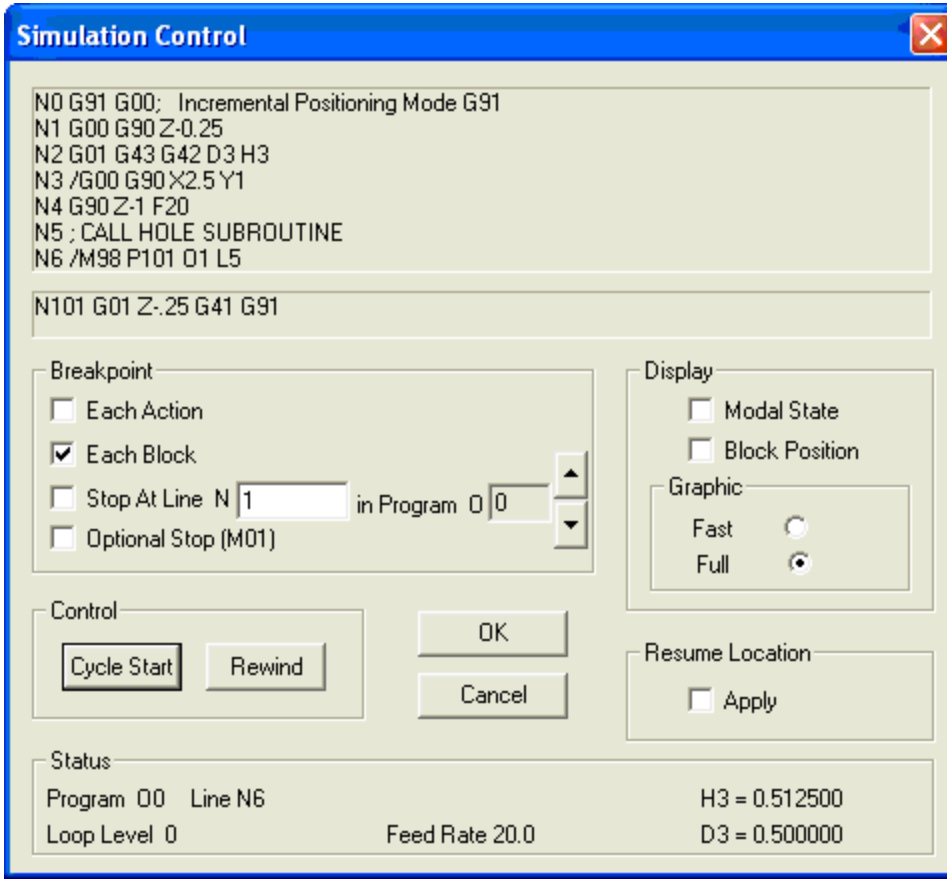
The **Simulation Control** dialog is used to animate your **Part Program** to the screen. You can use this control to verify the integrity of the **Job** before it is used to effect machine motion. You can also use this control to display the state of a suspended **Job** and start or resume a **Job** from different locations within the **Part Program**(s).

The **Simulation Control** dialog is opened using the **Job** > **Simulate** menu or by snapping over its button on the **Toobar**. When the **Simulation Control** dialog is open, the **Main Menu** context and **Toobar** changes to permit only visual operations that are pertinent to the **Simulation,** as shown in this screen clip. When the **Simulation Control** dialog is closed, the **Main Menu** returns to its prior state.



Code Windows

Two “sunken” windows located in the upper part of the dialog display the part program code during the animation process. The lower text window displays the block of code that is about to be animated by the simulator. The larger text window scrolls blocks of code that have been processed. If line numbers (N numbers) are absent from the original text of the **Part Program**, they



are consecutively assigned and inserted in the display.

Display Graphic

The static simulation in the **Orthographic** and **3 D** display shows **Rapid Traverse** and **Feed Paths** in red. When the **Simulation Control** dialog is opened these representations are changed in color to light grey. The color is changed to back to red as motion along its path is effected when each **Block** is processed by the **Simulator**. The **Full** selection updates the screen with the color change after each action. The **Fast** selection updates the screen after each contour. The **Fast** selection is typically used to save time when advancing very large **Part Programs** to a desired stopping point.

Cycle Start

Animation begins when you snap the button entitled **Cycle Start. Blocks** of **Part Program** code are processed line by line, and the resulting effect of each **Block** is consecutively displayed in the graphic and information windows. Animation is stopped when a stop condition is reached (such as M02 or M30) or if a **Breakpoint** condition occurs. You can manually stop the animation at any time by pressing the **Shift** key on the keyboard.

Rewind

Snapping the **Rewind** button re-initializes the **Simulator** to the starting point for the **Job**.

Breakpoint Group

Breakpoints can be set for verification or for actual production operations. A "breakpoint" is a condition that causes the **Part Program** to be stopped. If multiple conditions are set, either within the program (e.g. M00) or on the screen control, the first breakpoint condition will arrest the **Part Program**. Execution is resumed by snapping **Cycle Start**.

Each Action

Some **Blocks** of code contain multiple actions. For example, a block that executes G02 or G03 (circular interpolation) is composed of many linear interpolation actions. Checking this check box will stop program execution at each action.

Each Block

Check this check box if you wish to step through the **Part Program** a block at a time.

Stop At ...

Checking this check box will set a breakpoint at the **Block Line Number** (N Number) and **Program Number** (O Number) that you specify in the adjacent fields.

Optional Stop (M01)

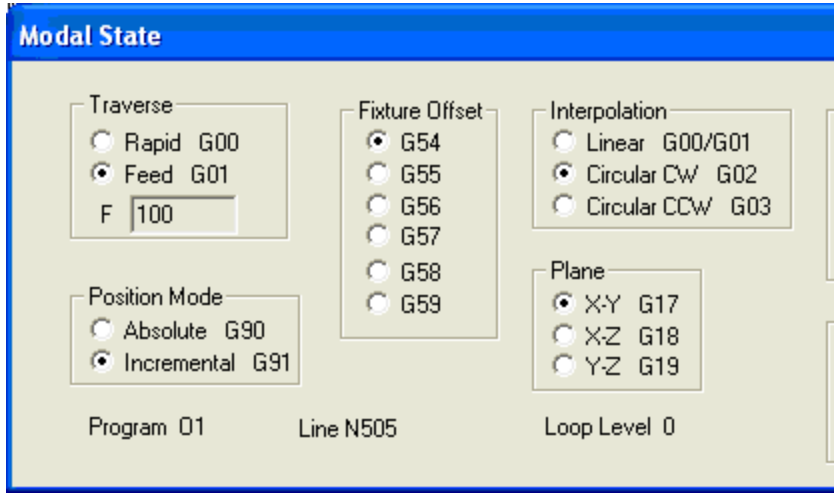
When this check box is checked the **Part Program** will stop when it encounters an M01 command.

Auxiliary Displays

We call **Modal State** and **Block Position** windows **Auxiliary Displays**. These displays are launched by checking the associated check box. You can place these displays anywhere on your screen by dragging them by their title bar. You can remove these displays by either snapping over the X in their title bar or by un-checking the check box in the control dialog. The position is automatically saved, so when you open the display again it will appear on the screen in the same position it was in when it was last removed.

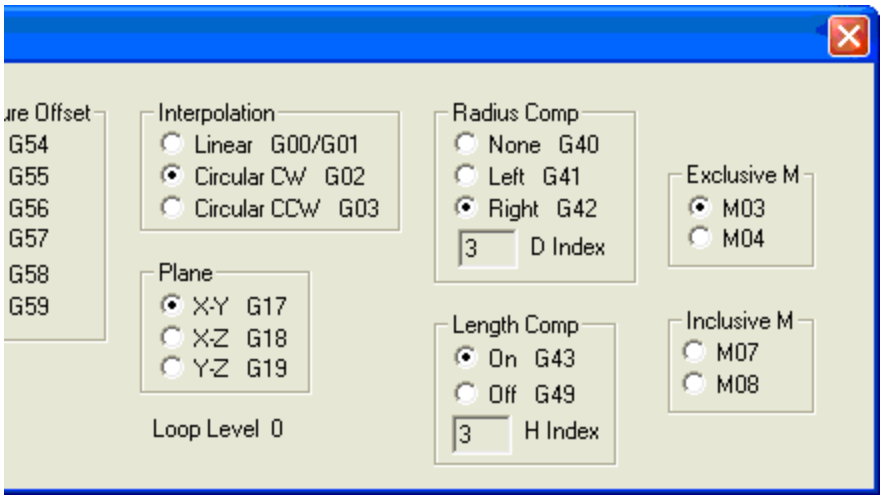
These displays are available from both **Simulation** and **Production** operations. However, due to the space that they occupy on the screen, and the small amount of time that it takes to refresh the display when processing each **Block**, they are usually opened only to diagnose certain types of problems.

Modal State



The **Modal State** display (split in the illustration to fit on the page) shows states of the machine that remain in effect as they are controlled by the part program. (Commands that set a machine state and remain in effect from **Block** to **Block** are called “Modal”).

Block Position



The **Block Position** display shows the position of the tool before and after the execution of each **Block**.

Resuming a Job

Starting Condition

When the **Simulator** is run from a newly opened **Job**, or run when the **Job** is not **Suspended** from within a **Production** operation, nor being **Resumed** from within a prior simulation, simulation starts from the first **Block** of code in Program Number O0 (Letter O, Zero). Snapping the **Rewind** button restores the **Simulator** to this condition.

Similar to its **Production** counterpart, an initializing **Block** entitled N0 is always executed first. The initializing **Block** executes G00, making the default mode of motion **Rapid Traverse**. It also executes either G90 or G91, depending on the **Job** setting for default coordinate interpretation: **Absolute** or **Incremental**.

When the **Simulator** is run from a **Suspended Job**, the next **Block** to be processed is displayed in the lower code window, and processed **Blocks** are listed above. If resuming from a **Production** *feed hold* condition, the **Block** of the interrupted segment of motion is listed as the next **Block** to be processed.

Resuming from Within a Part Program

You can start or resume a **Job** from a location within a **Part Program** by simulating to the **Block**, and checking the **Apply** check box under **Resume Location**, than snapping **Ok**. The **Simulation Control** dialog will close, and the **Main Menu** will present options “as if” you had suspended a **Production** operation from the **Block** you had advanced to in the **Simulator**.

Notice from partial image of the **Toolbar** that the **Job** is considered in progress, and options to **Run** (resume) or **Cancel** the **Run** operation are available. Manual positioning options, including screen display options (not shown in this illustration) are also available. The **Simulator** does not simulate through M, T or S codes, so for example if you are turning on a spindle within the **Part Program** by means of M03, and the spindle needs to be on at the **Block** that you are resuming from within the **Simulator**, you will need to execute M03 manually by means of the **Production > Instant Block** dialog, or its button on the **Toolbar** (BLK).

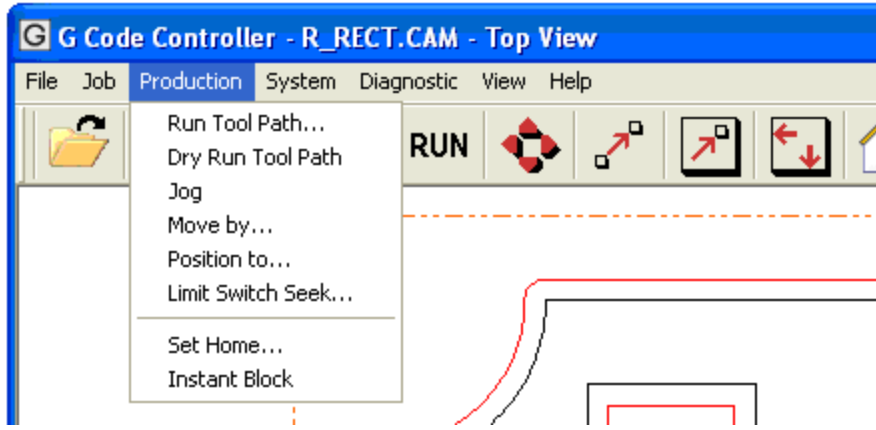
In a concrete example, suppose you are operating a three dimensional milling cutter and you wish to start machining at some point within a the **Part Program**(s). Use the **Simulator** to advance to the **Block** that you want, then with the **Apply** check box checked, snap **Ok**. Use manual positioning options (**Production > Move** by or **Position to**) to make sure that the **Z Stage** is at a clearance height above the work. The **Simulator** records the positions that the **Stages** should be when resuming, so if you want to **Run** the **Job** from the resuming location, first use **Production > Resume** to (checking only X and Y Stages for motion) to move the tool over the top of the resuming location. (The resuming location is presented automatically by this dialog). With the tool still above the work, turn the spindle on using **Production > Instant Block**. Use **Production > Resume to**, now with the **Z Stage** checked, to to plunge the active spindle into the work. Finally, **Run** (resume) the automatic operation of the **Job** from there.

If you had **Suspended** the **Job** from a *feed hold* condition, then entering the **Simulator** immediately advances the simulation up to the **Block** of the segment of motion that was interrupted. If you immediately check **Apply** (Resume Position) from the **Simulation Control** dialog and snap **Ok**, then the **Resume to** position of the **Stages** and the resuming state of the **Job** will correspond to help you retrace the tool path leading into the point of interruption. If you need to retrace from a point in the **Part Program** prior to the interrupted **Block**, you can snap **Rewind** and simulate to the **Block** that you want to resume from. Please note that you are not constrained to retrace the tool path after *feed hold*. You may resume from the interrupted location. Whatever course of recovery that you choose, however, the **Resume to** dialog assists you in positioning the **Stages** to resume processing the **Job** after interrupting the tool path.

You may defer using the manual positioning and **Instant Block** dialogs until after you selected **Production > Run** to resume the **Job**. Under control of the **Production > Run** dialog, if the position of the stages do not correspond to their simulated positions within the **Part Program**, you will be prompted for a decision to proceed with an offset condition. If you respond “Yes” to this prompt, the **Job** will proceed to subtend the geometry taking the current offset condition into account for both G91 (incremental) as well as G90 (absolute) motion prescribed within the **Part Program**. Thus you can easily apply a geometric offset for a resuming location within the **Job** without having to recalculate **Fixture Offset** values.

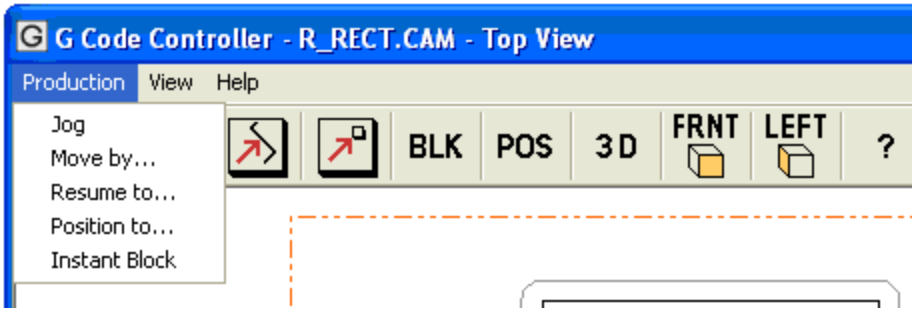
Chapter 9

PRODUCTION OPERATIONS

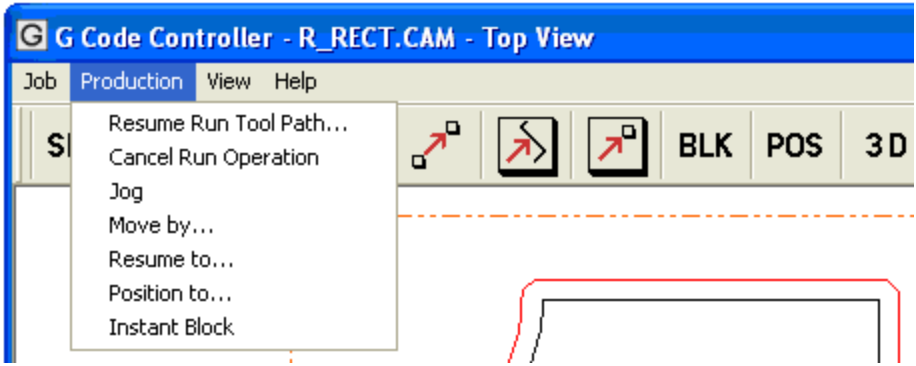


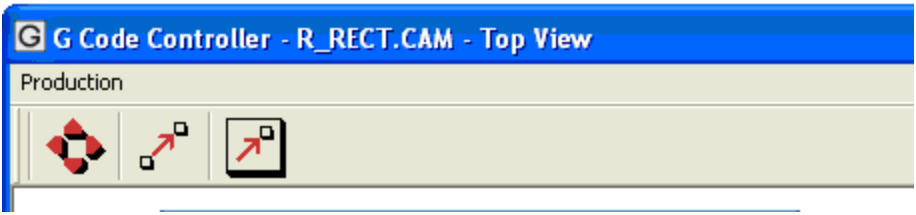
Context Sensitive

Similar to the **Main Menu**, the sub-menus that are accessible from the **Production** menu depend on the context from which it is accessed. The illustration on this page shows selections that are available after a **Job** is opened, but before it is **Run**. Manual **Stage** positioning options such as **Jog**, **Move by** and **Position to** are accessible, but since a path had not been interrupted, the **Resume to** positioning menu is absent. (Control dialogs for manual positioning are explained later in this chapter).



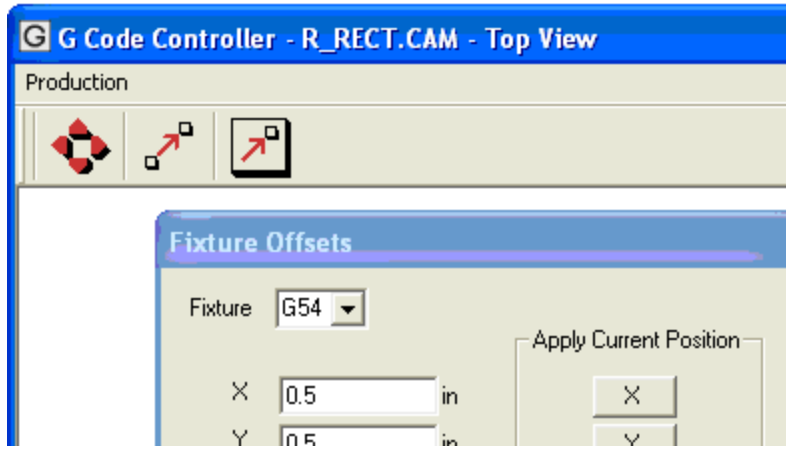
This illustration shows how the **Production** menu may appear after the **Run** (or **Dry Run**) **Tool Path** dialog has been opened. Manual motion dialogs are accessible, including **Resume to,** which provides assistance positioning the **Stages** to a resuming position along the tool path. Dialogs that affect initializing the **Machine Home** position: **Set Home** and **Limit Switch Seek**, are absent in this context.





If a **Job** is currently in progress, either by **Apply**(ing) a resuming **Block** location from the **Simulator**, or **Suspend**(ing) from a **Production Run** dialog, then options to **Resume** or **Cancel** the **Job** also appear under the **Production** menu and in the **Toolbar**. (**Resume** appears in the **Toolbar** as a button entitled

RUN. **Cancel** appears as a button with X over greyed **RUN**).



Before a **Job** is **Simulated** or **Run**, manual positioning commands are available to use physical **Stage** positioning to help you determine **Fixture** and **Tool Offsets**. When the dialogs to set **Fixture** or **Tool Offsets** are opened (from the **Job** menu), only manual motion dialogs for manipulating **Stage** position are accessible (**Jog**, **Move by** and **Position to**) from the **Production** menu, as reflected by this picture of the **Toolbar**. Notice that when dialogs to set **Offsets** are open, the **Main Menu** only presents this abreviated **Production** menu. You can snap back and forth between the controls in the **Offsets** dialog and the **Main > Production** menu. The selections in the **Production** menu help you manipulate the **Stages**, or "touch off" on desired positions. The buttons in the **Apply Current Position** group help you use actual **Stage** positions as setup offset values. Tool lengths can be similarly sized. (For a more complete explanation for setting **Fixture** and **Tool Offsets**, see corresponding sections in the chapter entitled **Job Set-Ups**).

Physically Setting up a Job

Controls available from the **Production** menu provide methods for positioning **Stages** to accommodate the **Job** that is being run. This entails locating **Machine** and **Fixture Offset** locations that are used to reference starting points for manual and automatic tool motion, as well as sizing the length of tools that are being

used. Manual methods for manipulating **Stages** are also used to address recovery and resumption in cases where the **Job** has been interrupted.

Reference locations for the **Stages** must be established before automatic operations can proceed for a **Job**. These locations are referred to as “0” (Zero) or “**Machine Home**”. It is also helpful for the software to record the reference locations in relation to the operational boundaries, typically delimited by **Limit Switches.** This relation is typically determined shortly after the machine is powered up by driving the **Stages** into their limit boundaries, and from there traversing to the reference position where it establishes “0” reference, **Machine Home**. The **Production > Limit Switch Seek** menu is used for that purpose.

It is also possible to manually set the **Machine Home** position anywhere within the operational boundary of each **Stage** using the **Production > Set Home** menu. If a **Limit Switch Seek** operation had been formerly performed for that **Stage**, the change in position is taken into account when using the **Set Home** control, and the integrity of operational boundaries is preserved. If **Set Home** is used to establish **Machine Home** without using the **Limit Switch Seek** operation, operational boundaries are estimated but unreliable. For some simplified applications this is acceptable, but most applications use the automatic **Limit Switch Seek** sequence to establish **Machine Home**.

Limit Switch Seek

The Limit Switch Seek Sequence

This menu provides a means for the system to automatically seek the operational limit switches on each or every **Stage**. The set-up values in **System > Limit Switch Seek Configuration** set-up dialog governs the motion, and operations that may occur during a **Limit Switch Seek** cycle. See the **Limit Switch Seek** section in the chapter entitled **Job Setups** for more detailed information on the things that can be set up to occur under this procedure.

Check boxes let you select which axes you wish to operate on. If more than one axis is chosen, the **Limit Seek Sequence** will complete one **Stage** at a time, proceeding from **Stage** to **Stage** automatically according to the **Priority** that it was assigned

in its set-up dialog.

Snapping on **Ok** prompts the user for **Cycle Start**. Once the operator activates **Cycle Start**, the **Stage** will seek its associated limit switch until contact with the switch is made, or until it has moved the distance specified in **Setup > Stage Configuration > Total Distance**. If a limit switch closure is not encountered within the specified distance, the **Stage** will stop moving and a message will appear. If the limit switch is contacted, the **Stage** will immediately retract by the distance specified in **System > Stage Configuration > Limit Switch Seek Configuration > Retract Distance**. **System > Stage Configuration > Rapid Traverse Rates** governs the speed of retraction. **Machine Home** position is automatically set at the final position after retraction. If the **Limit Switch Seek** operation fails to find the limit switch, **Machine Home** position is not automatically set.

Graphic Display Considerations

The **Limit Switch Seek** sequence and the **System > Stage Configuration > Total Distance** set-up value is used to determine the operational boundaries shown on the graphical display. After completion of the **Limit Switch Seek** sequence, the **Machine Home** position can be relocated using **Production > Set Home**. The graphical display will show the tool path in proper relation to the operational boundaries. However, if **Machine Home** is located without first performing **Limit Switch Seek,** the graphics will reflect the position of the tool path as if the initially assigned **Machine Home** position was located at the **Stage's Retract Distance** from the limit switch boundary. It is therefore advisable to always perform a **Limit Switch Seek** operation to establish the initial **Machine Home** position.

Set Home

It is always necessary to specify a starting point for automatic tool procedures. References to tool locations within the **Part Program** are relative to the **Fixture Offset** position, which is the distance the **Fixture Offset** is from the **Machine Home** location. Since all references to **Stage** location refer back to **Machine Home**, this location must be established before a **Job** can be run. As described above, **Machine Home** can be automati-

cally assigned from the **Limit Switch Seek** sequence, or it can be applied to any position using the **Production > Set Home** control.

In certain simplified applications, where for example only one **Fixture** is used and the **Fixture Offsets** for each **Stage** are always zero (0), positions relative to **Machine Home** and **Fixture Offset** are the same - so in this case the operator could move the **Stages** to their reference positions, use this dialog to set the zero points, then procede to **Run** the **Job**. This method, however, circumvents the usefulness in separating **Machine** coordinates from **Fixture** coordinates. Customized M and T codes may require locating **Stage** positions on the **Machine**, not the work, and so using this menu to arbitrarily change the **Machine**'s reference points may have negative effects. It is just as easy to apply the reference home positions for the **Part Program** using the **Job > Fixture Offsets** menu, which is the recommended procedure.

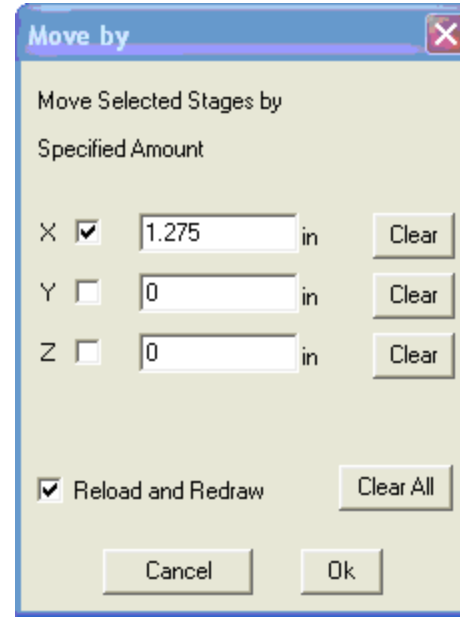
If the home position had been previously established by means of a **Seek Limit Switch** sequence, the tool path display will be updated to show the correct relation of the tool path to the operational boundaries, since the relative position of the tool path to the boundaries changes when the **Machine Home** position is moved.

The actual relationship between the tool path and the operational boundaries can only be established by means of a **Limit Switch Seek** sequence. If **Set Home** is used to establish position tracking without first completing a **Limit Switch** sequence, then the operational boundaries will not be displayed correctly. (Refer to the precautions under the **Limit Switch Seek** section of this chapter).

Move by

This option allows the operator to move the **Stages** by incremental amounts relative to the present position. Like the other controls, the size of this dialog is context sensitive, and adjusts to the number of **Stages** that are checked **Active** in the **System > Stage Configuration** dialogs.

The contents of the fields in the dialog box represent the desired motion, and the check boxes are used to select which



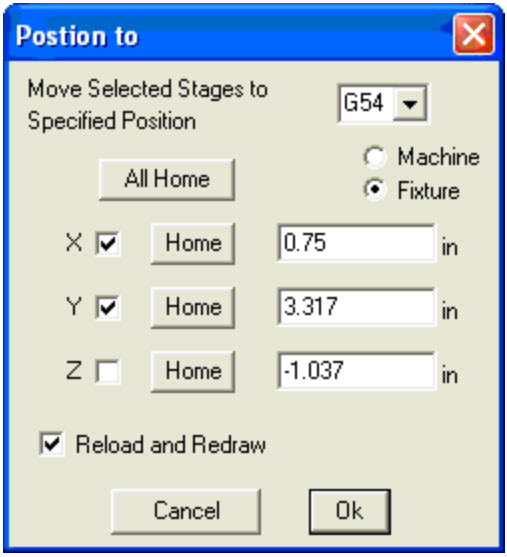
Stages are to be moved. When the **Ok** button is snapped, the distances you entered are rounded off to the step resolution of the system (The step resolution is the minimum distance which can be moved, or the distance which is moved as a result of a single control pulse.) and the you are prompted for **Cycle Start**. **Cycle Start** will initiate motion. Holding **Cycle Start** will automatically repeat the motion. If you snap away from this dialog before activating **Cycle Start** the prompt will be removed and you will need to snap **OK** once again.

This option does not require position tracking to be initialized. The field entries are persistent and remain effective until over-typed by another value. The **Clear** buttons resets the values to zero (0). **Clear All** resets all of the **Stages**. Leaving the **Reload and Redraw**check box unchecked defeats the screen update after each motion.

Position to

This control allows you to move the **Stages** to a designated position. Like the other controls, the size of this dialog is context sensitive, and adjusts to the number of **Stages** that are checked **Active** in the **System > Stage Configuration** dialogs.

Similar to the **Move by** control, this dialog also prompts for **Cycle Start** and displays the selected values rounded off to the step resolution of the system.



Unlike the **Move by** dialog, **Position to** requires position tracking to have been initialized via the a completed **Limit Switch Seek Sequence** or the **Set Home** control.

The default values in the fields of the **Position to** menu represent the current **Stage** positions, making it easier for you to move each **Stage** individually. The radio buttons allow you select between **Machine** and **Fixture** relative positioning.

For **Fixture** relative positioning, you may select one of the six available fixtures by means of the drop down list. The fixture that you select in this dialog will govern the View > **Position** window **Fixture** display when the **Position** readout window is placed in the **Fixture** mode. The fixture you select in this dialog also determines the fixture that the **H Calculator** in the **Offsets** dialog (**Job > Tool Offset Table > Entries**) uses to automatically calculate tool length.

The **Home** buttons set the field values to zero (0). **All Home** applies a desintation point of zero (0) to all of the **Stages**.

Similar to the **Move by** dialog, leaving the **Reload and Redraw**check box unchecked defeats the screen update after each motion

Jog

This option uses the **Indexer LPT** *joystick* control for manually controlled positioning. The *joystick* options that are available will depend on the options that you include in the system wiring. Refer to the **Indexer LPT** and the **Joystick** section of this manual in the chapter entitled **System Set-Ups**.

To enter **Jog** mode you must simultaneously press the **Mark**

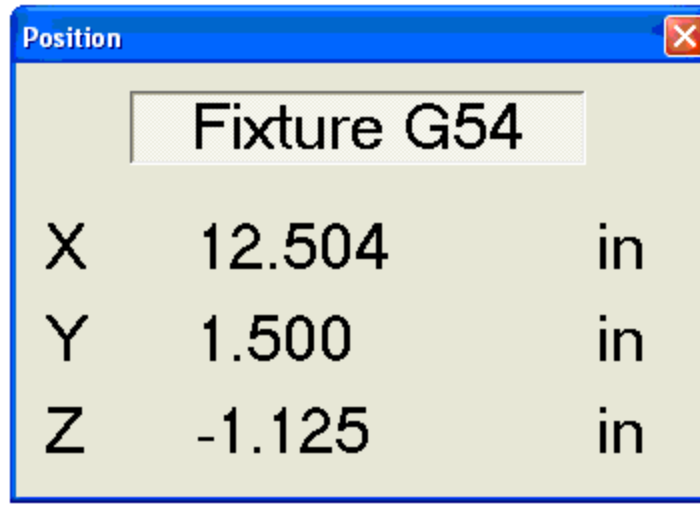
(which is the **Indexer LPT** *joystick "exit"* switch) and **Release** switches.

If the **Position** display is active, the current position fields will be masked when the *joystick* is active. To view the current position press the switch entitled **Mark**. This momentarily deactivates the *joystick* and displays the current position.

To leave the **Jog** mode simultaneously press **Mark** and **Release**.

Position Readout

The system **Position** window is launched by snapping **View > Position**. The position that it displays reflects the actual position read from **Indexer LPT**. Position tracking is only in effect after a **Limit Switch** seek sequence, or after the **Set Home** control has been used. Position tracking is lost after a limit switch interruption. The large **Position** window, as its name implies, presents a display large enough to be read at a distance, and is useful when using a control pendant to set up **Fixture** or tool length offsets. You can select between the larger display or the smaller one to manage screen space with the set-up dialog accessible from **System > Display**.



Similar to the control dialogs, the size of the **Position** readout

is sensitive to the context of the **Stages** that are marked **Active** in the **System > Stage Configuration** setups. Only **Active Stages** are shown, and the window is sized accordingly.

When the **Position** readout is first launched it shows **Machine** coordinate values, as indicated by the annotation in the mode button, which reads “Machine”. In this case the readout displays distance from the **Machine Home** location.

Snapping over the mode button changes the readout mode to fixture relative. The annotation in the button will indicate “Fixture - “, followed by the name of the current fixture, e.g. “G54” as in the illustration. In this case the readout displays distance from the **Fixture Offset** location designated in the **Job** for the current fixture. (See the secton entitled **Fixture Offsets** in the chapter entitled **Job Set-Ups**). The current fixture can be changed by means of the drop down selector in the **Production > Position to** control.

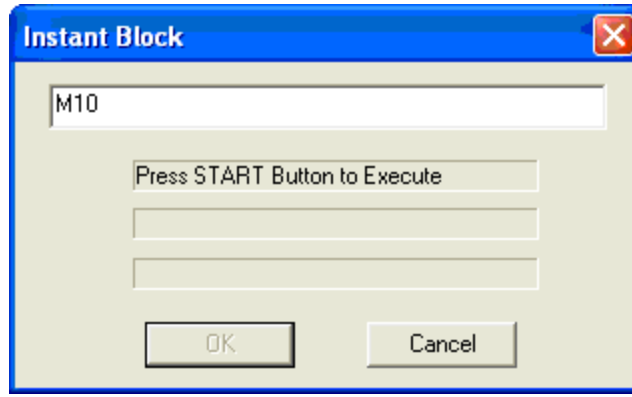
You can alter the location of the **Position** readout by dragging its title bar. When the **Position** readout is open the **View** menu and **Toolbar** changes to present the option to close it. The screen location of the **Position** readout is preserved, so when it is re-opened it will return to its former location, even after the program has been closed and re-started.

Instant Block

This control is used to exercise M, T and S codes outside of the **Part Program**. It is a useful diagnostic tool when used while customizing these codes. It is typically used when needed to assure certain conditions (such as activating a clamp or turning on a spindle) when resuming from a **Job** that has been interrupted.

Type the command that you want to execute, for example “M03”, then snap **OK**. The **OK** button will then grey, and you will be prompted for **Cycle Start**. When you activate **Cycle Start** the **Block** will be executed. If you snap the focus away from this dialog and then return to it, you will need to snap **OK** once again.

The upper two sunken fields beneath the input field are used



by this dialog for user prompts. The lowest sunken field provides feedback annotation from **List Directives** such as *#wait_for_one* and *#wait_for_zero*, as the feedback would appear in the **Production > Run** control. See the section entitled **List Directives** in the chapter entitled **Command Lists** for more information on annotations associated with these **List Directives**.

Dry Run and Run Tool Path

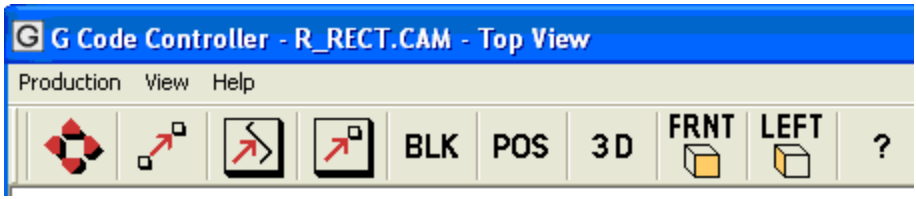
Differences between Dry Run and Run

Production > Run and **Production > Dry Run** operations are essentially the same, with the following exceptions. During **Dry Run** the feed rate does not respond to to the F command words in the **Part Program**. Instead, feed rate is governed by the **Dry Run** settings in the **Job > Feed Rates** dialog. The user definable M codes can optionally be disabled during **Dry Run**. Spindle S codes have no effect under **Dry Run**.

Similarities to the Simulate Control Dialog

The **Code Windows** and all the controls in the **Breakpoint** group are identical in function their counterparts in the **Simulate Control** dialog, and are explained in the previous chapter. Also like the **Simulate** control, the **Modal State** and **Block Position** auxiliary displays can be opened and closed by means of check boxes located in the **Display** group.

Main Menu Context



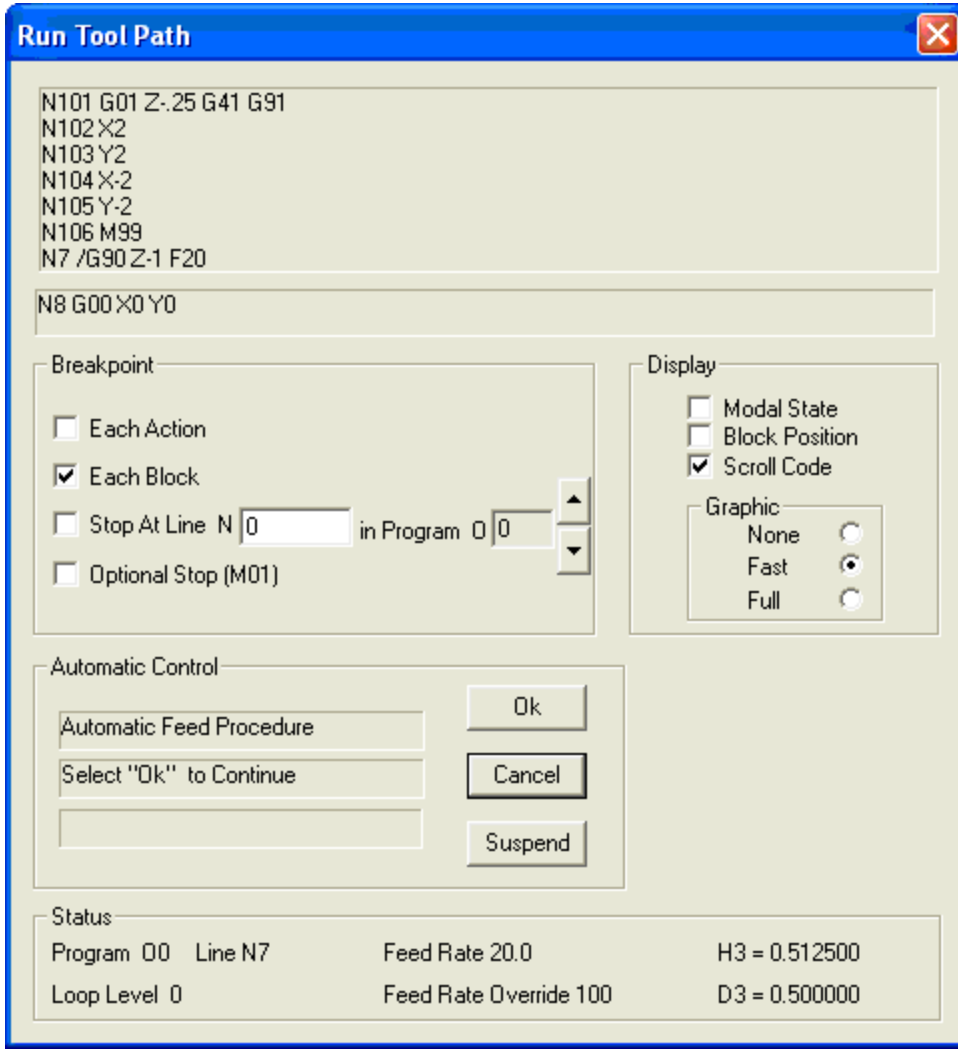
The **Run** control cannot be launched unless position tracking is in effect. (Postion tracking is instated automatically via a **Seek Limit Switch** sequence, or manually using the **Set Home** control). You can open the **Run** control from its entry in the **Production** menu or from its associated button on the **Toolbar**. When the **Run** dialog is active the **Main Menu** and associated **Toolbar** options change according to context, as shown in the illustration. Manual positioning, **Instant Block** and display options are available. **Job** and **System** set-up options will not be available until you close the **Run** control, and **Manual** motion will not be possible if the **Job** is interrupted at a time when the look-ahead **Queue Buffer** is being loaded.

Automatic Control

This group consists of buttons entitled **Ok, Cancel and Suspend** situated next to three “sunken” text annotation windows, as shown in the following illustration.

As its name implies, the **Cancel** button cancels the automatic operation. The **Ok** button is active when the dialog is first invoked. After the **Ok** button is pressed, the middle annotation window prompts the operator for **Cycle Start** to commence automatic operation, which is to say, sequential execution of the **Blocks** in the **Job’s Part Program**(s). After automatic operations begin, **Cycle Start** is generally used to commence and repeat operations, freeing the operator from the mouse and keyboard (providing, of course, that **Cycle Start** is not set up to be activated with the keyboard).

Automatic operation can be halted from a number of sources, including this dialog’s **Breakpoints**, M codes within the **Part Program** or external *feed hold.* From a halted condition, you can snap to the **Main Menu** to use positioning or display options, then snap back to restore focus to the **Run** control window. When you restore focus to the **Run** control you will need to snap OK once again before you will be prompted for **Cycle Start**.



The **Suspend** button temporarily closes the **Run** control while preserving the state of automatic operation. The **Main Menu** reflects the context of a suspended **Job,** offering additional capability to use the **Simulator** to recover and resume from any place in the **Job**. (Using the **Simulator** to recover from an interrupted **Job** is explained later in this chapter). **Select Production** > **Run** or its counterpart on the **Toolbar** to reopen the **Run** control from a suspended condition. You can easily determine if the auto-

matic operation is being suspended by observing the **Main Menu**'s **Production > Cancel Run Operation** menu or its button on the **Toolbar**.

The lower annotation windows provides the operator with useful information as the **Job** is being processed, such as when the look-ahead queue buffer is being loaded, halt conditions and annotations customized to M or T Codes with **List Directives**. (See the chapter entitled **List Directives** for more information on customized annotations).

Danger of Calculation Dwell

With the the massive look-ahead capability of **Indexer LPT**, the time to pre-calculate a very large contour can be long enough to deceive an operator or bystander into thinking that the machine is either not in operation or malfunctioning. This may be dangerous if unexpected motion occurs at an inopportune time. Consequently, in installations where pre-calculation dwell times may constitute a safety hazard, it is recommended that appropriate measures be designed into the machine, such as annunciator lights and/or lock-out mechanisms.

From an operational standpoint, however, calculation dwell, as well dwell introduced by other aspects of processing introduced by the display options, should not affect the tool motion when it is in contact with the work. In other words, you can arrange your **Part Program** so that ALL calculation dwell occurs while the tool is not in contact with the work. Using look-ahead processing techniques, the **G Code Controller** allows you to change feed rates after the entry feed into the work, and pre-calculate subsequent complex contouring before the entry feed is initiated. The result is that there is no calculation dwell between the entry feed and the complex contour. All is accomplished with continuous, smooth motion.

Display Options

The **G Code Controller** provides information relative to the state of the automatic process by means of a variety of displays. These displays are especially useful in developing and verifying your **Part Program**, as well as tracking the progress of the **Job** during production operations. However, a small amount of time is

necessary to update the displays. In operations that involve large **Part Programs** and/or many machine cycles, the time to update the displays as the machine is running can accumulate significantly. For this reason, elements of the display can be activated or deactivated as needed.

The **Modal State** and **Block Position** check boxes open the **Modal State** and **Block Position** display windows, just as in the **Simulator**. The contents of these windows are updated after the execution of each **Block**.

When the **Scroll Code** check box is checked, the **Part Program** code is displayed in the text windows as it is executed, just as in the **Simulator**.

The static display, shown in the **Main Window**, can be used to show the progress of the **Job** similar to the **Simulator**. The static display shows rapid traverse motion with grey dotted lines, contour paths with black lines and offset tool paths with grey lines. Progress is shown by changing colors of the rapid traverse and offset tool paths from grey to red.

The radio buttons in the **Graphic** group determine how the **Main Window** graphic displays the progress of the **Job**.

When the **None** radio button is selected the progress of the tool path is not followed by the **Main Window** graphic.

When **Contouring** is turned off, there is no difference between the **Full** and the **Fast Graphic** radio button selection. In both **Full** and **Fast** modes, the graphics are updated after each tool motion is communicated to **Indexer LPT**. The **Full** and **Fast** modes differ in the way the graphics update during **Contouring** operations.

In the **Full** mode, each tool path motion is displayed after it is communicated to **Indexer LPT**. Progress along feed paths will be highlighted in red as the **Indexer LPT** look-ahead buffer is being filled, and before actual motion begins.

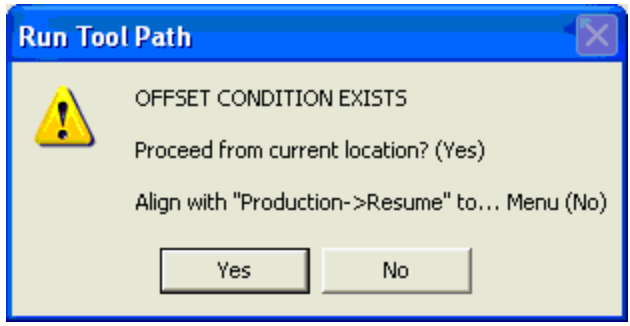
The **Fast** mode, as the name implies, uses considerably less time to update the display for long and complex feed paths. In this mode screen updating is postponed until after the look-ahead buffer is loaded and executed. The offset path is updated in red after the completion of each complex motion, .

Status

This group displays useful information about the **Part Program** as it is running. The **Feed Rate** annotation reflects the last value set by the F command. The **H** and **D** numbers show the last selected indexes into the **Tool Offset Table** for H and D, and the respective H and D values at those selections.

Starting from a Resuming Location

You can start a **Job** or resume from a suspended condition from any **Block** in the **Job**'s **Part Program**(s). For more detailed information concerning this see the section **Resuming from Within a Part Program** in the chapter entitled **Job Simulation**.



If the actual position of the **Stages** align with the **Resuming Location**, when you snap OK to start the **Job** you will be prompted for **Cycle Start** to proceed. Otherwise a pop up dialog will alert you to the offset condition, and ask if you want to proceed from the current location. If you select "Yes", the offset condition will be preserved for the remainder of the **Job**. If you select "No" you will have opportunity to correct the condition using manual motion controls accessible from the **Main Menu**. The **Production > Resume to** control, described later in this chapter, was designed specifically for that purpose.

In a concrete example, suppose in a milling operation your **Job** uses only one tool, and the tool breaks somewhere during the course of running the **Job**. You stop the **Job** using *feed hold*, and use manual positioning controls to move the spindle to a position where you can replace the tool, but the extension of the tool in the Z direction does not accurately replicate the position of the former

one. In this case, you **Suspend** the **Run** operation, and snap to the **Simulator**. The **Simulator** preserves the halted operation, making it easier to **Rewind** and simulate to a known position close to the **Block** where the tool was broken. Checking **Apply**, then OK from the **Simulator** moves the **Resuming Location** to the **Stage** positions specified at this point in the **Part Program**. Using the **Resume to** dialog, you quickly locate the X and Y **Stages** over their resuming coordinates. From there, you precisely lower the Z **Stage** until the tool touches the work. When finally you snap OK from within the **Run** control, you are asked if you wish to proceed from an offset location, since the new position of the Z **Stage** no longer corresponds to its ideal location due to the different length of the replacement tool. Snapping "Yes" preserves the offset, and the **Job** is completed "as if" the tool length was the same for the replacement tool.

In another concrete example, suppose you stopped a **Job** because you needed to relocate a clamp. Using manual positioning controls you move the spindle out of the way, but before resuming you forgot to restore it to its **Resuming Location**. When you snap OK from the **Run** control you are warned of an offset condition, and asked if you want to proceed from the current location. You snap "No", then use the **Resume to** control to correct the condition. With the actual **Stage**s aligning with their expected position in the **Part Program**, the next time you snap OK from the **Run** control you are immediately prompted for **Cycle Start** to proceed.

Stopping

There is No Keyboard Stop!!!

All but the smallest and simplest applications of this program require the *feed hold* feature to be installed. The *feed hold* switch is the method used to accomplish immediate and controlled stopping.

Breakpoint Stop

The **Run** control's **Breakpoint** group include options that stop automatic execution similar to the **Simulator**. Use **Cycle Start** to continue.

The **Each Action** check box halts operations that may happen within a particular **Block**. For example, G02 and G03 subtend an arc by means of approximating linear segments. When **Each Action** is checked, automatic execution is halted before each segment is processed. When **Each Block** is checked, processing is halted after the completion of the entire **Block**. You can stop at any **Block** by checking the **Stop at Line** check box and specifying the line number (N number) and Program Number (O number) where you want the **Job** to halt. Automatic processing will proceed to, and stop after the specified **Block**. Checking Optional Stop (M01) stops after encountering M01 in the **Part Program**.

Limit Switch Stop

If motion is arrested by means of **Indexer LPT** end limit switches, a **Program Stop** sequence will be executed (as set up under M03, M04, M05 and M07, M08, M09), automatic processing is discontinued and the **Job** must be cancelled. A pop up window alerts you to the occurance, and reports the **Stage** and switch (high or low) that generated the interruption. Abrupt limit switch interruption destroys position tracking, so the **Home Position** must be reestablished for the affected **Stages** before the **Job** can be started again.

Feed-hold Stop

Installation of the *feed hold* feature, as explained in the **Indexer LPT**users guide, comprises two external switches: the *feed hold* switch, which is typically a normally closed switch contact to ground, and the *abort* switch, which is typically a normally open pushbutton. When *feed hold* is activated by opening the contacts of the *feed hold* switch, motion immediately decelerates to a controlled stop. All control activity is suspended as long as *feed hold* is activated. If *feed hold* is deactivated by releasing the *feed hold* switch, then the **Job** will resume. However, if contact closure of the *abort* input is made to ground via the *abort* switch, a **Program Stop** sequence will be executed (as set up under M03, M04, M05 and M07, M08, M09), and recovery options are made available to the operator. The lower text annotation window in the **Run** control will indicate that the machine was stopped by means of ***feed hold***.

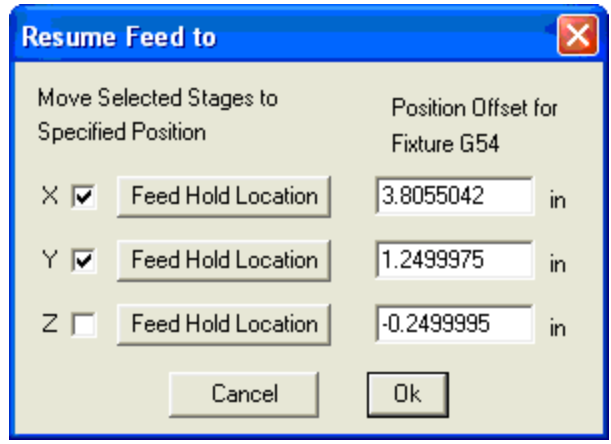
The **Resume Position** for each **Stage** is set at its location

immediately following *abort* from *feed hold.* Manual positioning options from the **Main Menu** can be used to reposition the **Stages** as necessary, depending on the reason the machine was stopped. The **Resume to** control (described below)l, also available from the **Main Menu**, can be used to restore the **Stages** to the **Resuming Position** prior to continuing the **Job**.

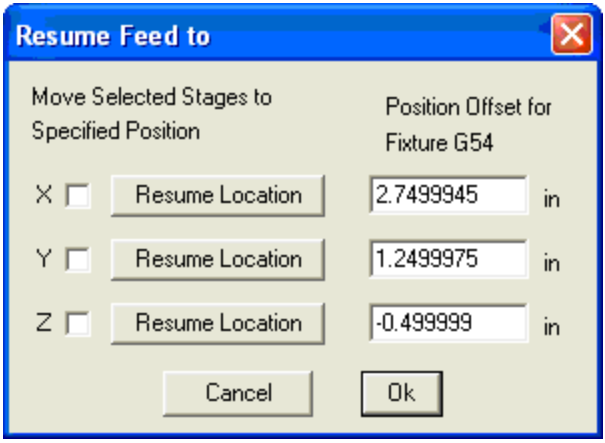
As mentioned earlier in this chapter, by suspending the **Job** and entering the **Simulator** the **Resume Position** can be changed to correspond to any **Block** within the **Job**. If the **Resume Position** is changed, reentering the **Run** control will resume the operation as if the **Job** was started from the designated **Block**. Only M codes associated with stop and resume sequencing are automatically handled. You must make sure conditions set by other M codes are suitable for resuming from the point in your **Job** that you specified in the **Simulator**. You can do this using the **Instant Block** control.

Resume to

The **Resume to** control moves **Stages** selected by associated check boxes to destination positions at the current **Feed** rate. The destination is specified relative to the current **Fixture**. (The current **Fixture** is the **Fixture** that was last selected within the **Part Program**, but it can be changed using the **Position to** control). When the control is launched, the default destination positions reflect the current **Resume Position**. This position can always be restored to the dialog by snapping the



adjacent buttons. If the **Resume Position** was established by an *abort* from *feed hold*, the buttons will be entitled **Feed Hold Location**. Otherwise, the buttons will be entitled **Resume Location**.



In a concrete example, you had interrupted a **Job** and used the **Simulator** to retrace over a tool path to a **Block** earlier in the **Part Program**. You retract the tool to a safe height by checking the Z **Stage,** and type its temporary destination, leaving the other stages unchecked. Snap Ok and Cycle Start to move. Now by checking the X and Y Stages, you can move the tool over the top of the **Resume Position**. Snap Ok and Cycle Start to move. **S**napping the **Resume Location** button for the Z **Stage** restores the value of its **Resume Position** to the destination point field. Snap **Ok** and **Cycle Start** to complete positioning to the point where you may resume automatic operations.

Chapter 10

PART PROGRAMMING

The Programming Environment

As described in the **Part Program Files** section in the chapter entitled **Important Files**, **Part Programs** are scripts (of text) that contain the automatic sequence of operations. **Part Programs** are often created by means of CAD/CAM software, such as **MasterCAM**, **BobCAD**, **Pro Engineer** etc. They can also be manually composed using a text editor (like **Notepad**), and verified using **G Code Controller**'s **Simulator**. See the **Programs** section in the chapter **Job Set-ups** for more information on interacting with the contents of **Part Programs**. See the chapter entitled **Job Simulation** for more on the use the **Simulator**.

Composing a Job

Start a new **Job** by duplicating the settings of a previous **Job**. The initial software **Setup** of **G Code Controller** installs a **Job** entitled **Sample.cam** to the working directory. You can open **Sample.cam** using **File > Open Job** from the **Main Menu**. Use **File > Save As** to duplicate the settings under another name, such as **Default.cam**. Use the **Job** menus in the **Main Menu** to make modifications and establish settings appropriate to the **Job** that you are composing.

You may use **Default.cam** as a template to subsequently create other **Jobs.** Open **Default.cam**, and use **File > Save As** to replicate it under another name. You may have many "default" CAM files, representing the set-ups for different types of **Jobs**. It is recommended that you do not save settings under **Sample.cam**, as this file is likely to be over-written when you upgrade or re-install the **G Code Controller**.

As mentioned in the chapter entitled **Important Files**, the **Part Program** is NOT the **CAM File**. Instead, it is a text file that contains the programming code. The **Job** specifies the name and location of the **Part Program** file(s), and stores this file name information to the **CAM File**.

The remainder of this chapter explains the syntax and format of programming code that **G Code Controller** supports. The word "line", meaning "line of text", is used synonymously with "**Block**".

Line Numbers

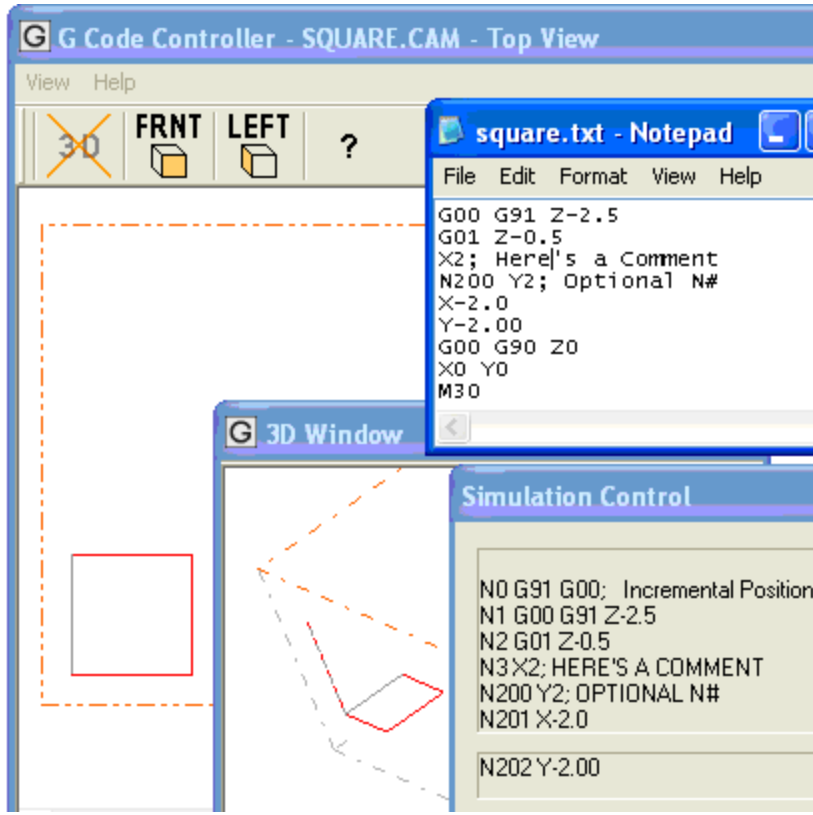
Line numbers with the prefix N can be optionally begin each Block of program text. **G Code Controller** will use the line number that you specify. Otherwise, it will assign line numbers in sequential order after the last specified line number. The initializing line number is assigned a value of 0 (Zero). Consequently, automatic line numbering for unassigned **Blocks** begins at 1 ("One", meaning it starts with N1). All lines, including comments, either have or are assigned line numbers.

If you are assigning line numbers you must observe the following precautions:

The N prefix to the line number must appear as the first character in the line.

Line numbers can only be assigned in ascending order within each **Part Program** file. When assigning a line number after lines that have no line numbers, you must be careful not to use a smaller number than the next incremental value that would have been automatically assigned to it.

The screen clip in the following illustration shows how both automatic and assigned line numbers are handled. The **Notepad**



window shows the original text of the **Part Program**. Blocks preceding the line assigned a number, N200 are automatically assigned and incremented. After N200, unassigned lines are assigned incrementally higher values.

Comments

The semicolon character, " ;", is used to insert comments into the **Part Program**. Be careful to follow the following rules when applying comments:

If you wish to insert an entire line as a comment, make sure that the semicolon occurs as the first character in the line.

Otherwise, you may place a comment for a **Block** of code on the same line as shown in the previous illustration. Everything to

the right of the semicolon will be ignored in translation.

You MAY NOT use the comment character in **Blocks** that contain procedural statements, such as M98 (Jump to Subroutine) and M99 (Return from Subroutine).

Optional Block Skip

If the slash character, "/", appears as the first character in the **Block**, and **Block Skip** is enabled for the **Job**, the entire block will be ignored. Line numbering, however, will not be affected. See the **Block Skip** section of the chapter entitled **Job Set-Ups** for more information on enabling and disabling **Block Skip**.

In a concrete example, the following **Block** is ignored when **Block Skip** is enabled in the **Job**:

```
/N200 Y2.0 X1.5
```

If the next **Block** in the **Part Program** is not numbered within the **Part Program** (with an N number), the next line number N201 will be assigned to it whether or not **Block Skip** is enabled for.

Command Word Arguments

Line Number N Words

N words accept whole number arguments.

G Words

Arguments to the G code prefix must be at least two digits in length.

```
G01 X1.0 Y2.3; Correct
```

Do not abbreviate the G code by eliminating the leading zero.

```
G1 X1.0 Y2.3; Wrong!!!!
```

Be especially careful not to use the letter "O" instead of the leading zero.

```
GO1 X1.0 Y2.3; Wrong - O instead of 0
```

M, T, D, H, P, O Words

These words accept whole number arguments with or without leading zeros.

Position Words

Words designating **Stage** positions , such as X, Y, Z...A,B,C...I, J, K, are followed by decimal numbers. For whole number values the decimal point is optional.

Rate Control - F and S Words

The **Rate Control** words F and S are followed by a decimal number. For whole number values the decimal point is optional.

G00 - Rapid Traverse

This command word is used to move rapidly from point to point using the **Rapid Traverse** rates set up under **System > Stage Configuration > (Stage) > Rapid Traverse Rate**. After G00 is executed, rapid traverse remains in effect until it is cancelled by G01, G02 or G03.

When **Rapid Traverse** is in effect, if multiple positioning words appear in the same block motion will occur along the shortest path to the destination point. All stages will start motion together, finish motion together, and remain in linear proportion along the way. The **Stage** that requires the greatest number of control pulses to reach the destination point will automatically master the motion. Other **Stages** will “slave” as if connected by gears.

Example:

```
G00 G91 X8.66 Y5.0
```

This **Block** of code will execute motion from the current position (incremental motion is specified by G91) to a location 8.66 inches (or other units, as per the **System** set-up) in the positive direction along the **X Stage** and 5.0 inches along the **Y Stage**. If the step resolution is the same for the X and Y **Stages**, the speed of the motion will be governed by the values set up under the X **Stage**’s **Rapid Traverse Rate**.

Rapid Traverse motion is graphically displayed with dotted lines. During **Simulation** and **Run** operations the path is shown in grey, and the tool traverses over the path, the path graphic is changed to red.

G01 - Linear Feed

Syntax

This command word is used to traverse from point to point at vector feed rate. The vector speed is either the value set up under **Job > Feed Rates** or the last value established by the F command word if automatic operations are in operation under **Production > Run**. (The F command has no effect under **Production > Dry Run**). The starting speed and acceleration rate will be governed by the values set up under **Job > Feed Rates**. After G01 is executed, feed traverse remains in effect until it is cancelled by G00 or G28.

When **Feed Traverse** is in effect and multiple positioning words appear in the same **Block,** motion will occur along the shortest path to the destination point. All **Stages** will start motion together, finish motion together, and remain in linear proportion along the way. The **Stage** that requires the greatest number of control pulses to reach the destination point will automatically master the motion. Other **Stages** will "slave" as if connected by gears.

The vector rate is the speed of the tool across the work according to a square root of the sum of squares calculation. The master axis will accelerate to a speed that establishes the speed rate across the work.

Example:

```
G01 G91 X86.6 Y50.0 F10.0
```

This **Block** will cause the tool to subscribe a 30 degree path. The X **Stage**, which dominates the movement, will automatically accelerate to 8.66 inches per minute to establish the speed across the surface of the work at 10 inches per minute, which is the cutting speed established by F10.0

The speed of the master axis is calculated by dividing the

number of control pulses required by the master axis by the square root of the sum of the squares of all participating axes. This establishes the scaling factor which is multiplied times the desired feed rate and applied to the master axis to establish the feed rate across the work. This calculation is accurate in up to three dimensions if the step resolution of all three stages is the same. If the step resolution between stages differ, the accuracy of the calculation will vary accordingly. It is therefore preferable to design the step resolution of all **Stages** to be the same, or as close to each other as possible. (Please note that the inaccuracies involved here relate to SPEED and NOT to position or path).

Also consider that the same method of motion is applied to rotational **Stages** as linear stages. In fact, the square root of the sum of squares calculation is performed across all axes that are being moved simultaneously. Consequently, if your machine is designed to rotate a fourth axis while simultaneously contouring in three dimensions, you can expect the actual vector rate in three dimensions to be somewhat slower when using the rotational axis. Designing the step resolution of the linear **Stages** to be small in relation to the step resolution of the rotational **Stages** minimizes this effect.

The **G Code Controller** graphically shows feed traversal as solid lines, showing both the contour path that is specified by the Stage positioning commands and the actual tool path when offset compensation applies. When there is no offset compensation, the contour path and the actual tool path coincide.

The graphical display shows the contour path in black and the actual tool path in red. When the two coincide, the path is shown in red. During **Simulation** and **Run** operations, the actual tool path is shown in grey, and as the tool traverses over the path the path it is changed to red.

Smooth Contouring

When **Contouring** is turned off, feed traverse motion is executed immediately as each **Block** is processed. In this case, feed traverse is executed immediately from **Indexer LPT**, and each motion accelerates from rest to vector velocity and decelerates to a stop at the completion of each **Block**. Although this mode is acceptable for rectangles and other sharp angular shapes, abrupt

stopping and starting is not suitable for tool paths that follow segments defining a smooth, contoured path.

G Code Controller is designed to take advantage of the advanced look-ahead contouring feature of **Indexer LPT** (described in the **Indexer LPT** users guide in the chapter entitled "Queue Processing"). When **Contouring** is turned on, feed traverse motion is loaded into and executed from the **Indexer LPT** look-ahead buffer. **Indexer LPT** pre-processes the motion dynamics involved in the contour, and then executes the motion in a smooth, continuous manner, modulating acceleration as needed to avoid over-stress through the transition points.

When multiple points are used to describe a contour path by means of many **Blocks** of code in the **Part Program**, considerations must be made for the time that it takes to process. This time is called "calculation dwell". It is often not desirable for the tool to be in contact with the work during the calculation dwell.

It easy to construct a **Part Program** so that calculation dwell does not occur while the tool is in contact with the work. Simply begin the contour at a point where the tool is not in contact with the work. As long as the state of the **Part Program** is in a feed traverse mode, and as long as subsequent blocks of code only contain positioning information, **G Code Controller** will automatically load motion commands into the look-ahead (queue) buffer instead of executing them immediately. Once a condition is encountered that cannot be executed from the look-ahead buffer, the current buffer is executed as if it were a single, complex motion command. The comment in the following code fragment indicates where calculation dwell will occur:

```
G00 X1.0; Rapid Traverse
;Calculation dwell occurs here
G01 Z-1.75; Begins loading queue
X1.0 Y.25
X1.5 Y.37
;Many more feed traverses may be here
X2.3 7.75
Z1.75; Executes motion queue here
G00 X1.0 Y1.5; Next Rapid Traverse
```

The programmer should note that any command that cannot be loaded into the **Indexer LPT** look-ahead buffer will force **G**

Code Controller to stop loading the queue, and immediately execute the buffer that it was loading.

Rapid traverse G00, as well as T and S commands, cannot be loaded into the look-ahead buffer, and will force an end to queue loading. M codes can either be accepted into the queue or not, depending on how the particular M code is customized. See the **"On the Fly" Switching** section in chapter entitled **System Setups** for detailed information on how M codes can be executed during smooth, contoured motion.

F - Change Feed Rate

Initial Entry Feed Rate

The **Part Program** can change the feed rate, which is the vector velocity (speed across the work) along a path defined under the feed modes G01, G02 and G03. (G02 and G03 are explained in the next section of this chapter).

In most machining operations it is highly desirable to feed the tool into the work at one traverse rate, then subtend a contour path at another rate. **G Code Controller** makes special provision for changing feed rate after an initial entry into a contour, and absorbing calculation dwell before the initial entry while the tool is not in contact with the work.

The F command is used by the part program to change feed traverse rate. The following code fragment shows the relation that the F command has to calculation dwell:

```
G00 X1.0; Rapid Traverse
;Calculation dwell occurs here
;Initial entry at existing feed rate
G01 Z-1.75 F10; Plunge feed rate
X1.0 Y.25 F50; Feed rate changed here
X1.5 Y.37
;Many more feed traverses may be here
X2.3 7.75
Z1.75; Executes motion queue here
G00 X1.0 Y1.5; Next Rapid Traverse
```

Other commands that cannot be executed from the queue can be inserted in the second block of a contour, such as S, T and

some M codes. Similar to processing the F command, the **Code Controller** will process the queue so that all of the calculation dwell that occurs when the queue is loading is absorbed before the entry **Block** is executed. However, the part programmer should be aware that there may be dwell times connected to the particular M, S or T code that is used, depending how it is customized in **System** set-ups. Immediately following the first linear segment into a contour, the F command can set the feed rate for the contour to any value within the machine's operational range.

Changing in Feed Rate Within a Smooth Contour

In some machining operations it is desirable to change the contouring feed rate while the tool is in motion, and without stopping. The F command can be used for this within a contour. However, the effective range of acceptable values is constrained to the range of variation that is set up for **Indexer LPT**'s feed rate override control. (See the chapter in the **Indexer LPT** manual entitled **Feed Rate Override** for more information on setting override range).

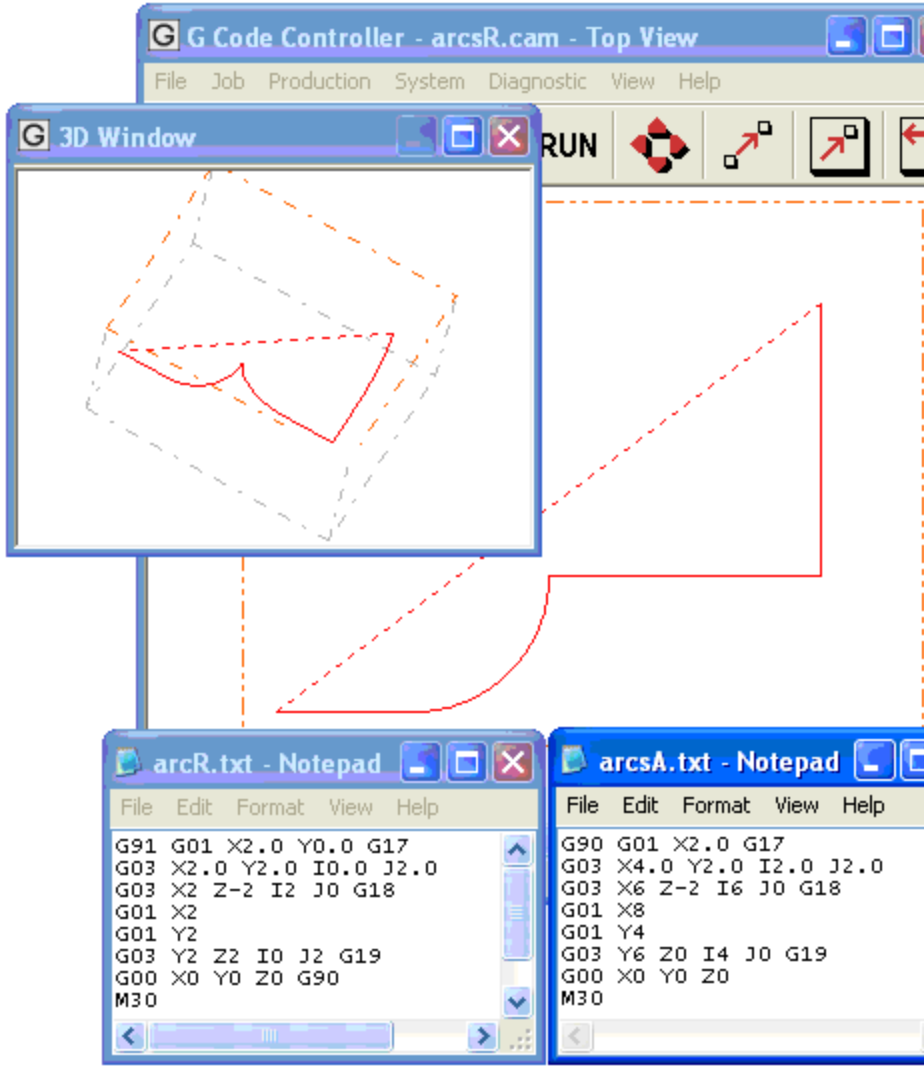
In a concrete example, consider the following code fragment:

```
N200 G01 Z-1.0 F50
N201 X10.0 F100
N202 G02 X2.0 Y2.0 I0.0 J2.0 F75
N203 Y5.0 F100
```

In this example the tool plunges into the work at a speed of 50 at N200, and starts cutting the contour at 100 through N201. Without stopping it enters into the arc at N202, where it smoothly decelerates to 75. At N203, and without stopping, it accelerates back to 100.

If in this example **Indexer LPT**'s *fro_high* register was set to 130 (representing 130 percent high limit), and the *fro_low* register was set to 30 (representing 30 percent low limit), then the F command used in N202 could not be used to change the feed rate lower than 30 (30% of 100), nor higher than 130 (130% of 100). The change in feed rate specified going into the contour at N201, however, can be any value within the machine's operational limits.

G02, G03 - Circular Feed



Orientation

The G Code Controller is capable of circular interpolation within three reference planes: X-Y, the default which is also instated by G17, X-Z, which is instated by G18, and Y-Z, which is instated by G19. Circular interpolation is approximated by means of linear segments, which are generated according to accuracy

requirements that you set up for the **Job** under **Job > G02, G03**. (See the **Arc Translation** section of the chapter entitled **Job Setups**).

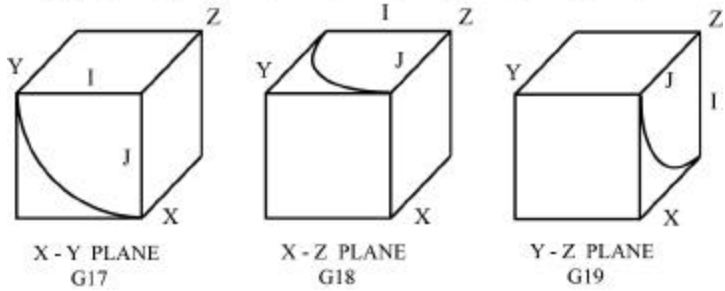
G02 effects clockwise circular feed, and G03 effects counterclockwise. The direction of rotation, clockwise and counterclockwise, is determined by viewing the plane from the positive direction of the remaining axis. For example, the direction of circular feed in the X-Y plane is determined by viewing the rotation from the positive Z direction. On a gantry type milling machine, this would be looking down on the work in the direction that the cutter would plunge into the material.

By far, the easiest way to visualize the implementation of G02 and G03 is from the **Simulator**, which not only provides views that you can scale and rotate, but also allows you to animate the progress of the tool along its path, showing you the relationship between the **Part Program** code and the direction of the path that it produces. Setting the **Each Action** check box in the **Breakpoint** group of the **Simulation Control** allows you to step through each segment of the arc - although this is seldom necessary, as even running the simulation without breakpoints is usually adequate to determine tool direction.

Syntax

The geometry of the arc is defined by the current location of the tool, the center point of the arc and the destination of the tool after the arc has been subtended.

PLANE	I	J	K
G17 X - Y	X	Y	Z
G18 X - Z	X	Z	Y
G19 Y - Z	Y	Z	X



X - Y PLANE G17 X - Z PLANE G18 Y - Z PLANE G19

Stage position words are used to specify destination points according to the plane of operation. For the (G17) X-Y plane use X and Y, for the (G18) X-Z plane use X and Z, and for the (G19) Y-Z plane use Y and Z.

Arguments to the **Stage** position words are used according to the current positioning mode. If the current positioning mode is (G90) **Absolute**, then the arguments to the stage positioning words represent the distance of the destination point from **Program Zero**. If the current positioning mode is (G91) **Incremental**, then the arguments to the stage positioning words represent the distance of the destination point from the current location of the tool.

The words used to specify the center point of the arc are I and J. I is used to specify the center point along the X axis except for plane (G19) Y-Z, in which case I represents a Y axis position. J is used to specify the center point position in the Y axis for plane (G17) X-Y, otherwise it is used to specify Z axis position.

Arguments to the center point location words are used according to the method set up for the job under **Job > Defaults > G02, G03**. (See the **Arc Translation** section of the chapter entitled **Job Set-ups**).

If the **Job** set-up specifies the arc center points to be **Always Incremental**, then the arguments to center point location words will always be the distance from the current location of the tool.

If the **Job** set-up specifies the arc center points to be **Always Absolute**, then the arguments to the center point location words will always reflect the distance from **Program Zero**.

Otherwise, if the **Job** set-up specifies **Follows G90, G91**, then the arguments to the center point location words will reflect the current positioning mode, absolute or incremental.

The example **Part Programs** in the screen clip are set up in the **Job** using the **Follows G90, G91** to govern the interpretation of I and J. The screen clip shows two **Part Programs** that produce the same result. The **Part Program** shown in the left-most window, named **ArcsR.txt**, defines arcs in three different planes using incremental positioning. The **Part Program** on the right, named **ArcsA.txt**, uses absolute positioning.

G17, G18, G19 - Reference Plane Select

These commands select the reference plane used in interpreting commands that assume a reference plane selection, such as G02, G03 and canned cycles G81 through G89.

G17 selects the plane in X-Y, G18 selects the plane in X-Z and G19 selects the plane in Y-Z. The screen clip in the previous section shows a concrete example of the effect changing reference planes has on G02 and G03.

The default reference plane is determined by the **Job** set-up under **Job > G17, G18, G19**.

G04 - Set Dwell Time

The G04 command is used to set up the delay time that is used by other commands that require a time delay in part of their execution cycle. G04 is used only to set up the value of the delay, and does not perform the delay itself.

The P word is used to designate the delay time in hundreths of a second. The argument to the P word must be a whole number value.

The following code sets up a dwell time of 1/4 second (25 hundreths of a second).

```
G04 P25
```

G40, G41, G42 - Radius Offset Compensation

Radius Offset Compensation (sometimes called “Curf Width Compensation”) automatically adjusts the path of the tool away from the work so that the contour described by G01, G02 and G03 commands can represent the dimensions of the finished part. Offset compensation occurs in the X-Y plane, and assumes that the tool enters the work from the Z direction.

Retrieving Offset Values

The actual diameter of the tool is stored in the **Tool Offset Table**, and read into the **Part Program** using the index into the **Tool Offset Table** as an argument to the D word. (To edit the

Tool Offset Table refer to the chapter entitled **Job Set-Ups**).

For example, suppose the diameter 1.00 is stored under index 3 in the **Tool Offset Table**. To retrieve this value for use in **Radius Offset Compensation**, D3 would be used by the **Part Program**. The amount of offset applied to the tool path in this case would be 0.500, which is one half of the diameter.

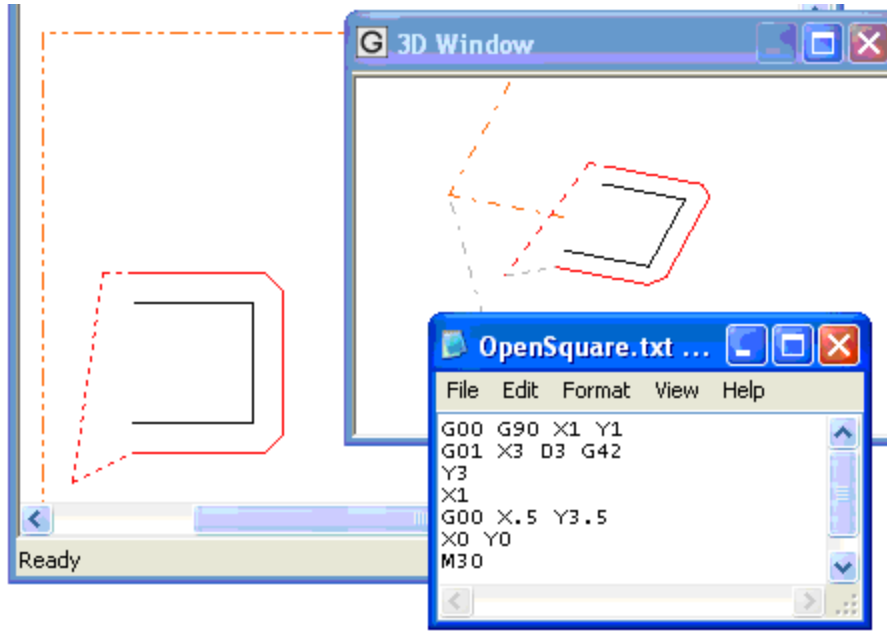
Left and Right Offset

With the of the diameter of the tool read by means of the D word, G41 or G42 can be used to automatically offset the tool path. Looking in the direction of tool motion, use G41 to offset the path to the left or G42 to offset the tool path to the right.

Radius Offset Compensation is instated after G41 or G42 is executed. It will remain in effect until it is cancelled by means of G40.

Only Applies to Tool Feed

Offset Compensation only applies to contours, which is to say, tool paths defined G01, G02 or G03. The destination of



Rapid Traverse (G00) entering into and leaving a contour is automatically adjusted, as illustrated in the screen clip. (The part programmer should be aware that in some circumstances it is necessary to insert an intermediate rapid traverse movement to keep the automatically adjusted rapid path clear of the material).

Optimized Path Around Outside Corners

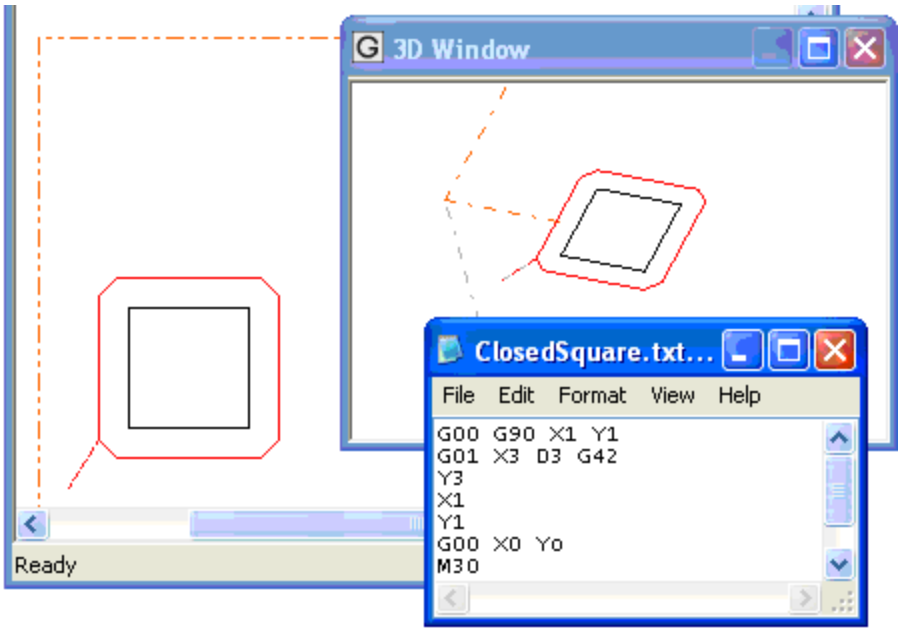
The offset tool path around outside corners is optimized by using the best intermediate straight line across the vertex, also shown in the accompanying screen clip.

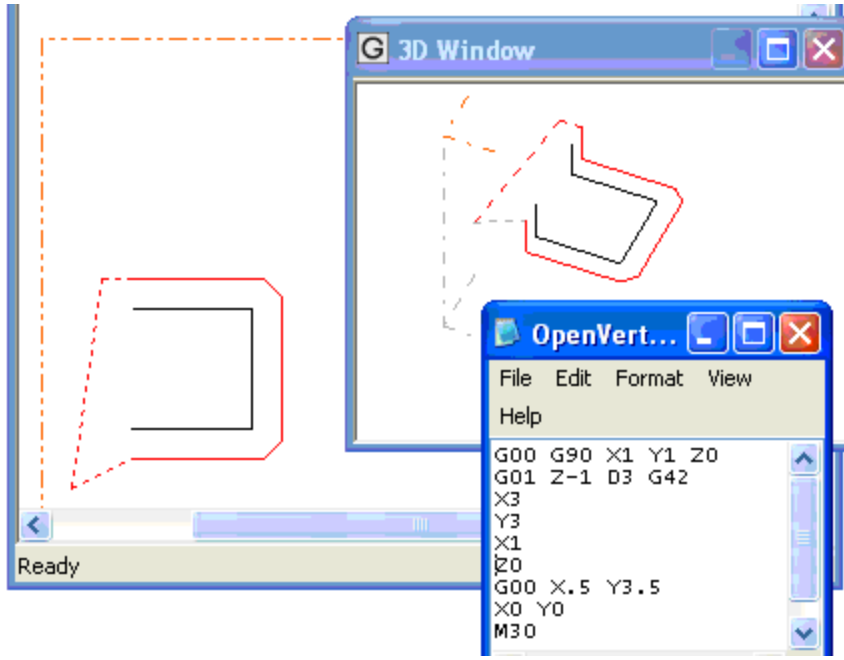
Open Contours

An open contour is a feed path that does not end at the same location in the X-Y plane as it starts, as the one shown in the previous screen clip. The entry point into the offset tool path is a point located a distance of one half the diameter of the tool on a perpendicular projection from the starting segment of the contour.

Closed Contours

A closed contour is a feed path that finishes at the same posi-



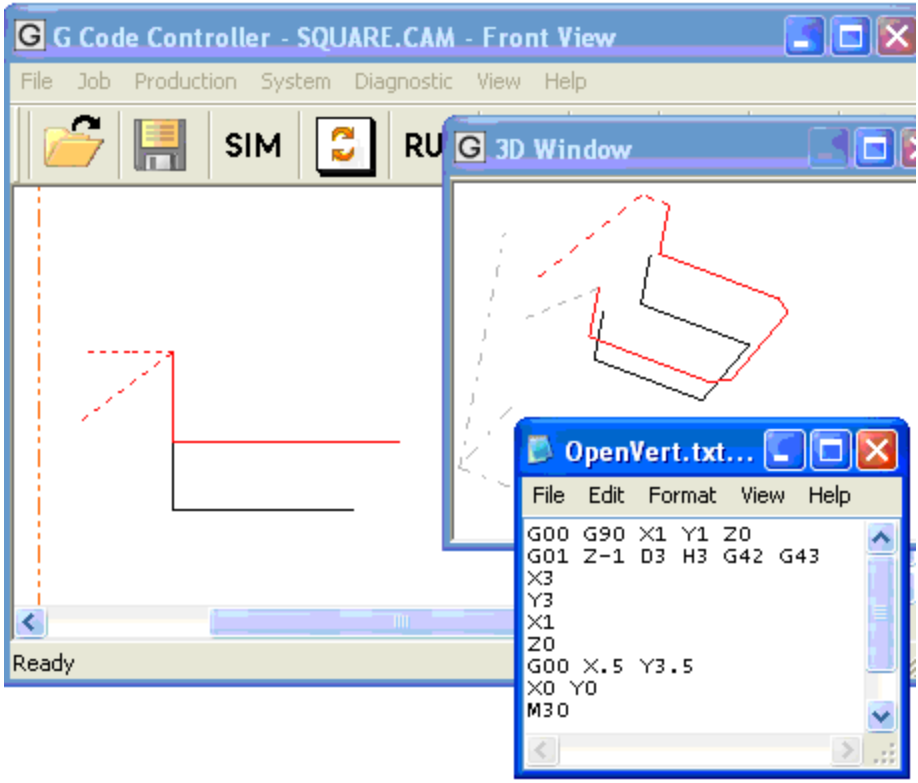


tion in the X-Y plane as it starts, as shown in the illustration. For closed contours the best offset path needed to cut the entire perimeter of the contour is used. The offset point into a closed contour is located at a point on the optimized tool path, also shown in the screen clip.

Vertical Entry and Exit

Any segment of motion that does not contain movement in X or Y directions does not contain enough information to apply **Radius Offset Compensation**. However, it is often desirable to plunge the tool vertically into the work along the Z axis at the start of a contoured tool path. In the same manner, it is often desirable to retract the tool vertically at the completion of a contour.

The **G Code Controller** accomplishes this by applying the offset entry point of the first segment containing motion in the X or Y direction to the X-Y coordinates of the entry and exit vertical segments, as shown in the screen clip.



G43, G49 - Tool Length Compensation

Tool Length Compensation adjusts for the extension of the tool from the tool reference (zero) location in the negative Z direction. As its name implies, it compensates for the length of of the tool.

The extension of the tool from the tool zero position is stored in the **Tool Offset Table**, and read into the **Part Program** using the index into the **Tool Offset Table** as an argument to the H word. (To edit the **Tool Offset Table** refer to the chapter entitled **CAM Set-Ups**).

Tool Length Compensation is instated using G43 and cancelled with G49.

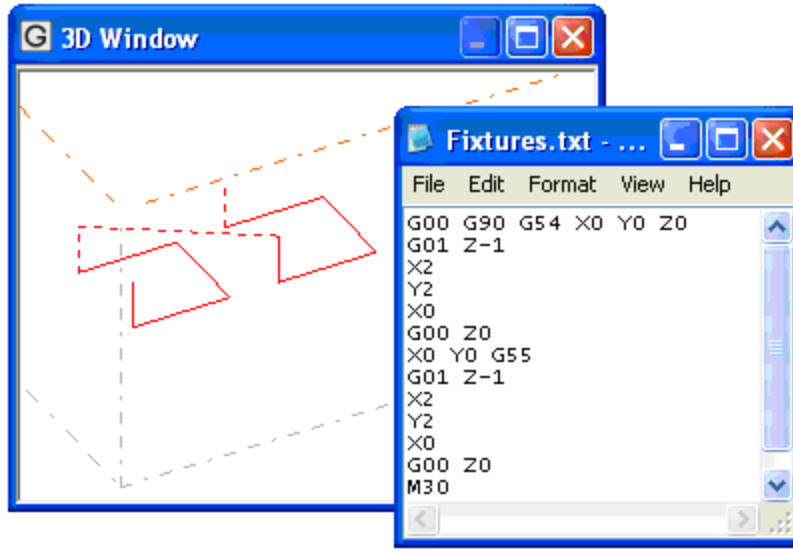
For example, suppose the length 0.75 is stored under index 3 in the **Tool Offset Table**. To retrieve this value for use in tool

length compensation, H3 would be used in the **Part Program**. The amount of **Tool Length** offset applied to the tool path in this example is 0.75. The red path in the graphic represents the zero point on the tool. The black represents the point of contact along the contour, which in the illustration accounts for both **Tool Radius** and **Tool Length Compensation**.

Adjusts Destination of Rapid

If G43 it is instated in the rapid traverse (G00) mode, it will adjust the destination of the current rapid. If it is instated in a feed mode (G01, G02 or G03), it will adjust the destination of the preceding rapid. It will have no effect on the current feed contour if it is instated after the first interpolation. It will also compensate for tool length in the canned plunge cycles G80 - G87, G89.

G54, G55, G56, G57, G58, G59 - Fixture Offsets



All absolute positions referenced in the part program represent distances from the current fixture offset position, otherwise known as **Program Zero**. The fixture offset position is specified as a distance from the **Machine Home** position, which is either automatically set after a **Limit Switch Seek** sequence, or reset by means of the **Production > Set Home** dialog (Refer to the section

entitled **Fixture Offsets** in the chapter entitled **Job Set-Ups**).

The current fixture offset can be changed under program control by calling its associated command word. In the example screen clip, the fixture offset position for G54 is X=0, Y=0, Z=0, and for G55 is X=3, Y=0, Z=0. Although G54 appears in the first programming line, it is not necessary since it is the start-up default. The same program code is used for each fixture to simplify this example. In an actual **Job** it is often convenient to change the fixture in one portion of the program and call the repeated operation using a subroutine.

Canned Cycles

Canned cycles are commonly used machining sequences that can be more easily programmed using a single **Block** of code. This section describes some common terms used in the canned plunge cycles G81through G89.

Drill Axis and Positioning Plane

The most common type drilling operation requires positioning in the X-Y axis and drilling along the Z axis. Canned cycles operate according to this mode when the current reference plane is X-Y, as selected by default or by G17. When the current reference plane is X-Z, as selected by G18, then positioning occurs in the X-Z axes and drilling along the Y axis. When the current reference plane is Y-Z, as selected by G19, positioning occurs in the Y-Z axes and drilling along the X axis.

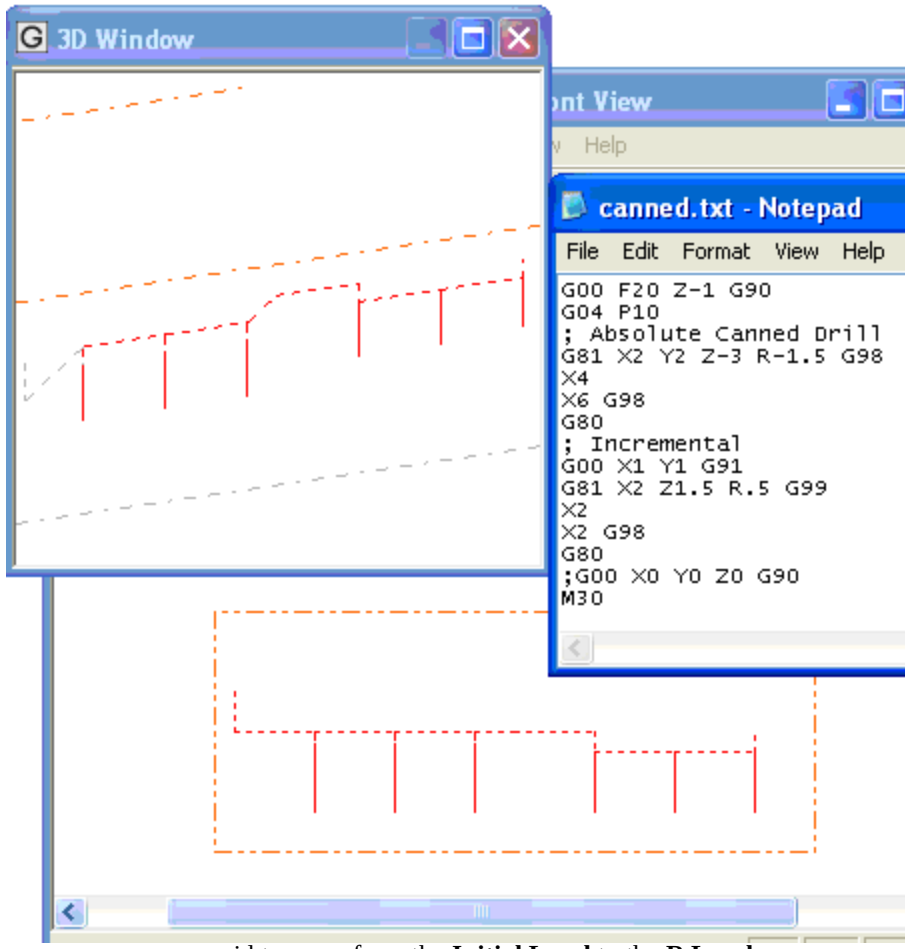
The examples in this book assume that the current reference plane is X-Y (G17). Explanations will reference the Z axis as the drilling axis, and X-Y axes as positioning axes.

Initial Level

This is the position of the Z axis before the beginning of the first operation in a canned cycle or sequence of canned cycles.

R Level

Sometimes called the “gage height”, this is a point along the Z axes located below the **Initial Level**, but above the work. Typically, the first motion of the Z axis in a canned cycle is a



rapid traverse from the **Initial Level** to the **R Level**.

Tool Length Compensation, if instated by G43, is applied during this portion of the canned cycle.

R Level in Absolute Mode

If the **Part Program** is in absolute positioning mode (instated by G90) then the argument to the R word is the position of the **R Level** with respect to **Program Zero** on the Z axis.

The **R Level** is determined by the R word used in the **Block** that instates the canned cycle. If the R word is not included in the **Block** its value is assumed to be 0.0. For this reason it is good

practice to always include the R word in the **Block** that instates the canned cycle when in absolute positioning mode.

R Level in Incremental Mode

If the **Part Program** is in incremental positioning mode (instated by G91) then the argument to the R word is the unsigned distance of the **R Level** from the **Initial Level**.

In other words, in incremental mode the argument to the R word will always be interpreted as a positive value (an unsigned distance) and subtracted from the value of the **Initial Level** to establish the absolute position of the **R Level**.

Z Level

The **Z Level** is the position along the Z axis at the bottom of the hole. It is the furthest distance into the work along the drill axis.

Z Level in Absolute Mode

If the **Part Program** is in absolute positioning mode (instated by G90) then the argument to the Z word is the position of the **Z Level** with respect to **Program Zero**.

Z Level in Incremental Mode

If the part program is in incremental positioning mode (instated by G91) then the argument to the Z word is the unsigned distance of the **Z Level** from the **R Level**.

In other words, in incremental mode the argument to the Z word will always be interpreted as a positive value (an unsigned distance) and subtracted from the value of the **R Level** to establish the position of the **Z Level**.

G98, G99 Canned Cycle Return Point Level

These G codes allow you to select the Z axis position at the completion of a canned cycle. Each command is in effect until it is cancelled by the other.

If G99 is in effect, at the completion of a canned cycle the Z axis will be retracted to the **R Level**. This mode is used to save

time, and is typically instated at the beginning of a sequence of canned cycles.

If G98 is in effect, at the completion of a canned cycle the Z axis will be retracted to the **Initial Level**. This command is typically used in the last of a sequence of canned cycles.

The programmer should note the the **Initial Level** is stored before the first **Block** of a sequence of canned cycles, and can only be changed after the canned cycle mode is cancelled by means of G80 (**Cancel Canned Cycle**).

G80 - Cancel Canned Cycle

This command should be used in a the **Block** after the canned cycle. After this command, the traverse mode of the machine is returned to the mode prior to the instating the canned cycle.

This command clears the **Initial Height** stored by the canned cycle.

G81 - Canned Drill Cycle

This command is used for normal drilling operations. Traverse is performed at feed rate from the **R Level** to the **Z Level**, then retracted to the finish position at rapid rate.

Rapid traverse is first performed to the X-Y positioning point to initiate the cycle. For example:

```
N200 G81 X1.5 Y2.0 R.5 Z2 F20 M3 G99 G91
N201 X1 G98
N202 G80 M05
```

The G91 in block N200 instates incremental positioning mode. The machine then rapid traverses in the X-Y plane to a point located 1.5 inches in the X direction and 2.0 inches in the Y direction. M3 turns the spindle on, and a **Rapid Traverse** plunges the Z axis 0.5 inches in the negative direction, from the **Initial Level** to the **R Level**. A **Feed Traverse** at 20 inches per minute (set up by F20) continues to plunge the Z axis an additional two inches to the **Z Level**, which is 2.5 inches beneath the **Initial Level**.. G99 establishes the finish point at the**R Level**. Consequently, a final **Rapid Traverse** lifts the Z axis 2.0 inches

in the positive direction to complete N200.

Block N201 rapid traverses to a location 1.0 inches from the current position in the X direction, and thereafter immediately plunges the Z axis from its existing position at the **R Level** to the **Z level**, 2.0 inches negative, at feed rate. G99 in N200 had established that the finish point should be the **Initial Level**. Consequently, a final rapid traverse lifts the Z axis 2.5 inches in the positive direction to complete N201.

N202 cancels the canned cycle and turns off the spindle.

G82 - Canned Spotfacing (Drilling with Dwell)

This command is commonly used for spotfacing operations, where the tool must dwell at the **Z Level** for a specified length of time. G82 is identical to the **Drilling Cycle**, G81, except that dwell is introduced after the **Feed Traverse** to the **Z Level**. The extent of the dwell is set up by G04.

For example:

```
N200 G04 P25
N201 G82 X2.0 R.5 Z.050 F10 G91
```

Block N202 rapid traverses to 2.0 inches in the X direction, then rapid traverses 0.5 inches in the negative Z direction to the **R Level**. From there, **Feed Traverse** plunges the Z axis an additional 0.050 inches to the **Z Level** at 10 inches per minute. At the Z Level the tool dwells for 25 hundreths of a second (1/4 second), which is the amount that was set-up by the G04 command in block N200. Finally, the Z axis is retracted to the finish position at **Rapid Traverse** rate.

G86 - Canned Drilling with Operator Interaction

This command is used in drilling operations where adjustments must be made when the drilling **Stage** is fully extended. This command identical to the **Canned Drilling** cycle G81, except the operation stops at the **Z Level**, prompting the operator for **Cycle Start** to resume operation.

G85 - Canned Boring

This command is used in boring operations where cutting feed rate must be maintained while withdrawing the tool from the work. It differs from the **Canned Drilling** cycle (G81) only in the manner that the drilling axis is withdrawn from the **Z Level** to the **R Level**. The **Canned Drilling** cycle (G81) withdraws drilling axis at rapid rate, while this command withdraws it at feed rate.

G88 - Canned Punch Press

This command simply executes M10, which can be customized to implement a punch press cycle.

G89 - Canned Boring with Dwell

This command is identical to the **Canned Boring** cycle G85, except this command dwells when the Z axis reaches the **Z Level**, similar to the **Canned Spotfacing** cycle (G82).

G84 - Canned Tapping

This command accommodates tapping operations where the drilling axis is extended at feed rate, spindle rotation is reversed at the **Z Level**, dwell permits the spindle enough time to reverse, and the tool is retracted to the **R Level** at feed rate. At the completion of the cycle, the spindle is restored to its original direction of rotation.

This command operates in conjunction with special miscellaneous functions M3 and M4. If M3 is in effect at the beginning of the cycle, then M4 will be executed when the Z axis reaches the **Z Level**. After M4 is executed, the machine will dwell for the amount of time set up by the previous G04 command. At the completion of the cycle, M3 will be executed to restore original rotation.

In a similar manner, if M4 is in effect at the beginning of the cycle, then M3 will be executed when the Z axis reaches the **Z Level**, and M4 will be executed at the completion of the cycle.

G83 - Canned Deep Hole

This command is used in drilling operations where the tool

must be repeatedly removed from the work to clear the accumulation of debris in the hole. Each time the tool is removed drilling proceeds to an incrementally deeper depth. The operation is complete when drilling finally reaches the **Z Level**, .

The incremental distance is specified in the G83 Block by an unsigned argument to the Q word.

For example:

```
G83 X1 Y1 R1.0 Q0.5 Z1.062 F20 G91
```

This command rapid traverses to the X and Y location, followed by a rapid traverse 1.0 inches in the negative Z direction to the **R Level**. After that the Z axis feeds an additional 0.5 inches in the negative direction at 20 inches per minute, then rapid traverses 0.5 inches in the positive direction back up to the **R Level**. After that a **Rapid Traverse** 0.5 inches in the negative direction occurs, bringing the Z axis down to the depth that it had previously fed to. It continues in the negative direction at feed rate for an additional 0.5 inches, then retracts 1.0 inches in the positive direction, again bringing it to the **R Level**. This is followed by a **Rapid Traverse** 1.00 inches in the negative Z direction to the depth that it had previously fed to, followed by an additional 0.062 of movement at feed velocity to the **Z level**, 1.062 beneath the **R Level**. Finally, the Z axis rapid traverses to the finish position.

G87 - Canned Chip Breaking

This command differs from the **Canned Deep Hole** cycle G83 only by the distance that the Z axis is retracted after each incremental plunge. Instead of retracting all the way to the **R Level**, this command only retracts by the amount set up for the **Job** in the **Job > G87 > Partial Retract Distance** field.

The part programmer must assure the incremental distance specified by the argument to the Q word exceeds the value set up in the **Job**'s **G87 > Partial Retract Distance** field.

M00 - Program Stop

This command causes the **Part Program** to stop. Program execution can resume when the operator presses **Cycle Start**.

Unlike the user definable M codes, you MUST INCLUDE THE LEADING ZERO with this M code.

```
M0; **** WRONG ****
M00; CORRECT!
```

A **Program Stop** conditionally executes special commands M05 and M09..

M01 - Optional Stop

This command causes the **Part Program** to stop only when the check box entitled **Optional Stop (M01)** in the **Breakpoint** group of the **Control** dialog is checked.

Unlike the user definable M codes, you MUST INCLUDE THE LEADING ZERO with this M code.

```
M1; **** WRONG ****
M01; CORRECT!
```

A **Program Stop** conditionally executes special commands M05 and M09.

M30 - End of Program Stop and Rewind

This command should appear at the end of the **Part Program**. It causes automatic operation to stop, and it re-initializes (rewinds) the **Part Program**.

Re-initializing occurs for **Production > Run** and **Production > Dry Run**, but not during **Job > Simulate**. (If you wish to re-initialize any time during a simulation session, simply snap the control's **Rewind** button).

A **Program Stop** conditionally executes special commands M05 and M09. (Refer to the section explaining these commands).

Cycle Start resumes automatic execution of the **Part Program**. In this case, program execution will be re-initialized and repeated. This is especially useful in the production of multiple pieces, as the operator need only press **Cycle Start** to repeat the **Part Program**.

M03, M04, M05- Spindle Control

These user definable M codes are typically set up to be used for spindle control, where M03 turns the spindle on in the clockwise direction, M03 turns the spindle on in the counterclockwise direction and M05 stops the spindle.

These M codes are uniquely handled by the system, and interact with **Program Stop** and **Resume**, as well as the **Canned Tapping** cycle (G84). Refer to the explanation under **Special M Codes** in the chapter entitled **System Set-Ups**.

M07, M08, M09 - Coolant Control

These user definable M codes are typically used for coolant control, where M06 turns a mist coolant on, M07 turns a flood coolant on, and M09 turns all coolants off.

These M codes are uniquely handled by the system, and interact with **Program Stop** and **Resume**. Refer to the explanation under **Special M Codes** in the chapter entitled **System Set-Ups**.

M98, M99 - Subroutine Call/Return

The **Part Program** normally executes from **Block** to **Block** in sequential order. When portions of the **Part Program** are repeated, rather than duplicating these portions within the **Part Program** it is often desirable to call them in when needed. This not only reduces the size of the **Part Program**, but also helps in program organization and maintenance.

Subroutine Call Within a File

Code that is called from another location within the **Part Program** is called a “subroutine”. Subroutines are identified by the line number of the first block in the subroutine. The last block in the subroutine must be M99.

M98 causes program execution to leave its normal sequence, and begin executing at the subroutine that it identifies. M99, located at the end of the subroutine, causes the program to return execution to the **Block** where it departed from in M98.

M98 uses the P word to identify the location of the subrou-

tine. The argument to the P word corresponds to the N line number of the subroutine.

For example:

```
N200 G00 Y2 G91
N201 M98 P500; Calls N500
N202 G00 Y2.0
;
N500 G01 Z-0.25
X2
X-1 Y1
X-1 Y-1
M99
```

In this example program execution normally proceeds from N200 to N201. Then it jumps to N500 where it executes **Blocks** of code sequentially until it reaches M99, after which it resumes execution at N202.

Subroutine Call to Another File

M98 uses the O word to locate a subroutine in a different file. The argument to the O word is the index assigned to the **Part Program** file set up for the **Job** under **Job > Programs**. In other words, the argument to the O word associates one **Part Program** to another **Part Program** by its O number, while the **Job** set-up correlates each O number to the **Windows** file name. If the O word is missing from the M98 block, then the subroutine called is assumed to exist within the current file as in the previous example.

Example:

```
N201 M98 P500 O1
```

This **Block** calls a subroutine starting at line N500 in a **Part Program** file stored in the **Job** under index 1 of the **Job > Programs** dialog.

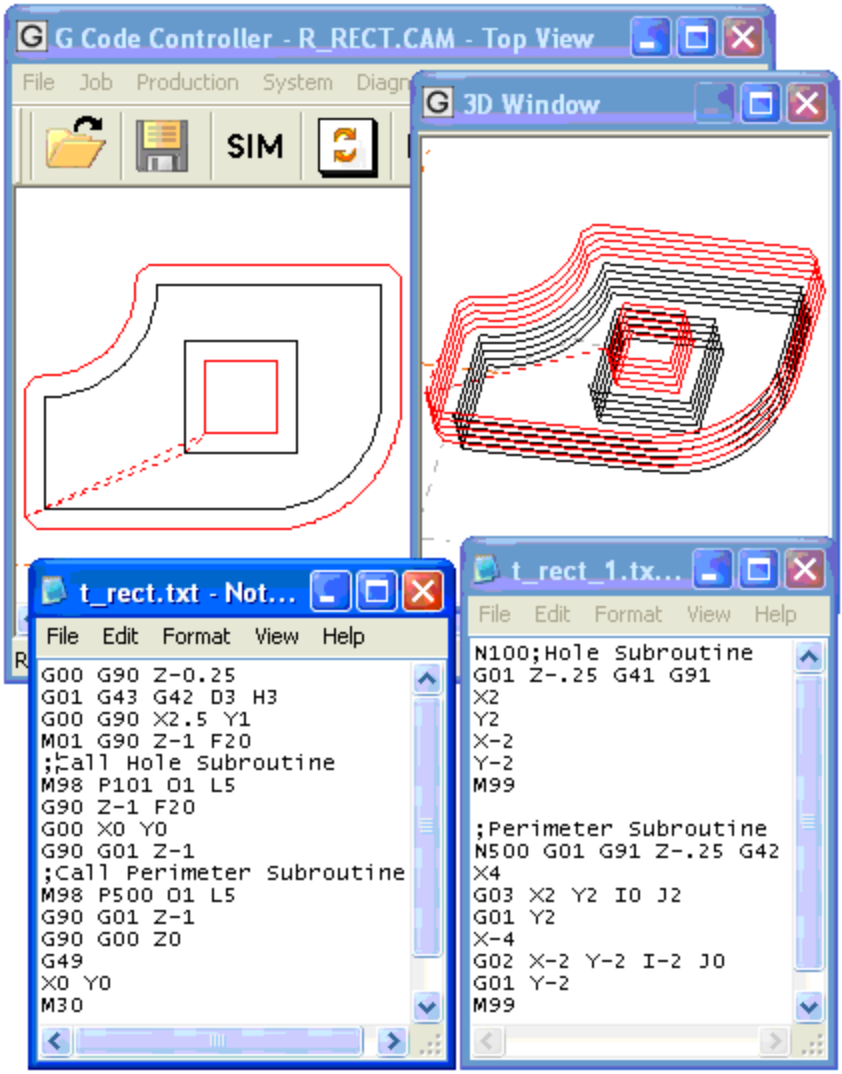
Multiple Calls to a Subroutine

M98 uses the argument to the L word to designate how many times a subroutine is called. If the L word is missing from the M98 block it is assumed to be one (1).

Example:

```
N201 M98 P500 L4
```

In this example the subroutine located at line N500 of the same file as N201 is executed four (4) times.



Nested Subroutines

The practice of calling a subroutine from within another subroutine is called “nesting”. The called subroutine, in turn, can call another subroutine and so forth. The number of times this occurs is called the “level” of nesting. **G Code Controller** supports leveled nesting of subroutines.

Chapter 11

GETTING STARTED

Before Starting

Before starting read and understand the terms and conditions of the Program License Agreement. If you do not agree with the terms and conditions do not use the software, and return it to the place of purchase for full credit allowance.

Be sure to read the notes in the README file for important information regarding the latest software release.

System Settings

CAUTION

There is no short-cut to getting started. You are the machine designer. G Code Controller can help you automate tool path control, but you must think through every implication of your design, especially safety factors. ALWAYS PLAN FOR THE UNEXPECTED WHEN USING SOFTWARE! Build adequate electrical and mechanical safeguards into your system. If you think that adequate safeguards are impractical, then do not use this product!

In order to get the **G Code Controller** to run, you must have **Indexer LPT** installed correctly. Refer to the **Indexer LPT** man-

ual for installation instructions. You must have a good working knowledge of **Indexer LPT** before setting up your machine with the **G Code Controller**. Use the diagnostic program, IXDIAG.EXE (supplied with **Indexer LPT**) to exercise **Indexer LPT** and to become familiar with its features.

To copy the **G Code Controller** files on to your system from a distribution diskette, place the **G Code Controller** diskette in drive A, Snap **Start > Run,** then type

```
A:\SETUP
```

Alternately, if you were provided an installation image via Email, unzip the image to a directory on your hard drive and run SETUP from there.

Follow the menus in the SETUP program to install the appropriate files onto your hard disk. After running the SETUP program, installation of **G Code Controller** is still **NOT COMPLETE**. You must first review every field in every dialog of **G Code Controller**'s **System** menu, then make an appropriate **CAM File** template by reviewing every field in every dialog in the **Job** menu.

The best way to get started with this software is to become familiar with the menu structure and the meanings of all of the set-ups. Since many of the set-ups are dependent on other set-ups, there is no quick way to configure a system without learning the implications of each set-up field. Fortunately, the menus are logically arranged and easily accessible. This manual is organized according to the appearance of the menus. A good method of completing the installation is to systematically review each **System** dialog, changing parametric set-up values as per the instructions in this manual.

The initial values which appear in the Setup dialogs are arbitrary. Since each machine design can vary in substantial ways, and each set-up field can potentially affect others, there are NO default set-up values. Each and every field must be reviewed by the designer and replaced by a meaningful value.

After the first change is made, the **System > Save System Setup** menu becomes available. The first time this selection is chosen **G Code Controller** creates the system set-up file entitled GIXA.INI in the WINDOWS directory.

When changing **System** values you may find the **Diagnostic** menu to be very helpful. This menu makes screens available which give a live display of the state of configured limit and control switches. Also, it is useful to periodically check the **Diagnostic > Errors** dialog, which helpful to use while troubleshooting different kinds of set-up and run-time problems.

If you are unable to get satisfactory results using **G Code Controller**'s built in diagnostics you can use **Indexer LPT**'s diagnostic program, IXDIAG.EXE, to troubleshoot your system at a lower level. All physical input and output performed by **G Code Controller** goes through **Indexer LPT**.

Upgrading

Contouring

Maintaining backward compatibility with previous versions has always been a priority for Ability Systems software. With the addition of the **"On the Fly" Switching** feature, however, **Part Programs** that used an M code to force the look-ahead buffer to execute and start reloading may not run the same on this version as previously. If you had used an M code for this purpose, you may need to modify it as per the **"On the Fly" Switching** section in the chapter entitled **System Set-ups**.

In prior versions an F command that occurred more than one segment into a contour would force the look-ahead buffer to execute and start reloading. This version can use the F command anywhere within a contour to modulate the feed rate continuously without interrupting motion. See the **F - Change Feed Rate** section in the chapter entitled **Part Programming** for a more detailed description.

Menus

In prior versions inaccessible menus were displayed, but disabled and grayed. Menus in the current version are context sensitive, and so only the menus that are appropriate to the current state of the machine appear at any one time. For example, the **Job** menu doesn't appear until a **Job** is opened, and the **System > Save System Setup** menu doesn't appear unless changes are made to the **System** set-ups.

File > Open was changed to **File > Open Job** to be more descriptive. **Main Menu "Edit"** was changed to "**Job"** to be more descriptive of its function in changing **Job** specific settings, and to remove name redundancy that might be confused with changing ("editing") a **Part Program**. Similarly, **Main Menu "Setup"** was changed to **"System"** to remove name redundancy that might be confused with the SETUP program used to install **G Code Controller**.

Toolbar icons follow the same theme as previous versions, but they have been colorized and made larger to enhance visibility and ease of access. Some icons have been added to support additional features.

Display

The **Main Window** now displays an orthographic image instead of the 3D image, as in previous versions. Top, front and end views are now quickly accessible from the **Toolbar**. A 3D image is also quickly accessible from the **Toolbar**.

When opening a **CAM File** created with a prior version you may need to snap **View > Zoom Full** to make the images visible. Once adjusted to your liking, use **File > Save** to save your new **View** settings to the **Job**.

Folder and File Names

The executable file name for **G Code Controller** was changed from GIXW.EXE to GIXA.EXE.

The default installation folder created by the SETUP program for prior versions was **C:\Gixw**. The default installation folder is now **C:\Gixa**. You can change the installation folder to C:\Gixw when you run **SETUP**. SAMPLE.CAM and SAMPTOOL.OFF will be overwritten, but you will be able to run both the older version and the newer version of **G Code Controller** from the same folder. As an alternative to running SETUP you can obtain GIXA.EXE from Ability Systems and manually copy it your working folder.

The name of the **System Configuration File** in older versions was GIXW.INI. The new name for this file is GIXA.INI.

Upgrading Using SETUP

The quickest way to upgrade is to run SETUP from the new installation image. You may prefer NOT to use the default installation folder, and instead install to the path of your existing installation e.g. **C:\Gixw**.

Making a copy of your **System Configuration File** and renaming the copy GIXA.INI transfers all of your **System** settings from the older version to the new.

The older version will remain usable. The **Shortcut** icon for the upgraded version is visibly different from the old, making it easy to distinguish between them.

Once again, please be mindful (if you install to the existing installation folder) that SAMPLE.CAM and SAMPTOOL.OFF will be overwritten and any information that you may have saved to these files will be lost.

Manual Upgrade

Manually upgrading gives you the most control over how you want to transition from the older version to the new, especially if you want to keep your older version intact until you are sure that any potential backward compatibility issues have been addressed. Consider, for example, that you had installed your older version to the default folder **C:\Gixw**. Proceed as follows:

Step 1 - Install the new program.

Copy GIXA.EXE to **C:\Gixw**

Step 2 - Transfer your existing system settings.

Use **Windows Explorer** to make a copy of GIXW.INI, and rename the copy to GIXA.INI. Locate GIXW.INI in the C:\WINDOWS folder. Highlight it, then press Ctrl-C. Pressing Ctrl-V will create a file entitled “Copy of GIXW.INI”. Rename this file GIXA.INI

Step 3 - Make a new shortcut.

Right snap on the **Desktop**, and select **New > Shortcut**. Snap **Browse** and locate C:\GIXW\GIXA.EXE. Follow the menus to complete the **Shortcut**. You can access the new version from the **Desktop**, or drag its **Shortcut** to the **Program Files** group if you prefer to see it there.

Setting the Look-Ahead Queue Buffer

If you expect your application to accommodate smooth contouring (most application do), then you will need to set the size of **Indexer LPT**'s look-ahead queue buffer. Refer to the chapter entitled **Queue Processing** in the **Indexer LPT** manual for more detailed technical information.

The **Indexer LPT**command *set_q_mem*is used to set the size of the buffer. The **Indexer LPT** command *command_mem?* can be helpful to determine how much memory you wish to set aside for this purpose. Both of these commands are described in detail in the chapter entitled **Commands** in the **Indexer LPT** manual.

Look-ahead memory is only used for continuous contours ("feeds": G01, G02, G03). At the end of each contour (such as the occurrence of G00), the queue buffer is emptied and re-used. Consequently, it is not generally necessary to fit the entire **Part Program** into the queue buffer.

The object of this section is to arrive at a reasonable figure that meets your performance expectations. If you expect at any time that a contour within your **Part Program** may exceed the amount of memory your system is capable of, you may insert code that cannot be buffered, such as G00, which would force the buffer at that juncture to automatically execute, making buffer memory once again available. Even so, the amount of look-ahead memory available to most systems is usually more than adequate, as the following example illustrates.

Use the **Command Motor** dialog in the **Indexer LPT**'s **Diag** program to query how many bytes a *feed* command occupies in the look-ahead buffer:

```
command_mem?:feed
```

At the time of this writing the reported number of bytes a *feed* command occupies in the look-ahead buffer (for the current version of **Indexer LPT**) is 724. This represents the memory required for each segment in a smooth contour. (The number of segments used for arcs depends on **Job** settings for arc accuracy.)

For the sake of this example, select fifty megabytes for the size of the queue buffer. Use **Command Motor** in the **Diag** pro-

gram to set the value like this:

```
set_q_mem:50000000
```

Indexer LPT will report back the actual amount of memory that was set aside. Usually it is the number that you requested or a number close to it. You must then re-boot the computer.

In this example the number of segments that your **Part Program** is capable of smoothly executing from the look-ahead buffer for each contour is 50000000 / 724 = 69,060. With this setting roughly sixty nine thousand facets are available to accurately approximate the smooth shape of a single contour!

The look-ahead buffer size is stored by **Indexer LPT** to the **Registry**, so you need only set it once. If you re-install **Indexer LPT** at any time, however, you will need to go through this procedure again.

CAM File Settings

Making “default” CAM Files

As described in the chapters entitled **Important Files** and **Job Set-ups**, **CAM Files** contain information which pertains to the individual part which is being manufactured. The **CAM File** not only contains the file specification of the **Part Program**(s), but also other vital information necessary to control your machine. Some of this information will change from one **Job** to the next. Other information will remain the same. For this reason, **G Code Controller** makes **CAM Files** easy to change and replicate.

One **CAM File** is provided in the installation image entitled SAMPLE.CAM. This file must be modified to accommodate the design of your machine and the type of manufacturing operations which you are anticipating. After the SAMPLE.CAM file has been read by means of the **File > Open Job** menu, you can modify it by means of the **Job** menus. You can then save your modified **Job** under another name (leaving the original intact) using **File > Save As.**

You can change set-up values by means of dialogs in the **Job** menu. Make sure each set-up is appropriate. When you are finished editing SAMPLE.CAM, it can be easily saved and/or dupli-

cated under a different name, such as DEFAULT.CAM. You may wish to have several “default” **CAM Files**, one for each general type of operation which you anticipate. Save your files under descriptive names.

As you carefully edit your first “default” **CAM File**, make sure that each dialog box has reasonable entries, even if you do not immediately foresee a use for a particular function.

Making “default” Tool Offset Table File

When you make your “default” CAM File, don’t forget to replicate the installed **Tool Offset Table** file under another file name using **Job > Tool Offset Table > Save (Save As)**. Change the name from SAMPTOOL.OFF to something like TOOLS.OFF

DO NOT USE SAMPLE.CAM OR SAMPTOOL.OFF TO SAVE YOUR DEFAULT SETUPS. SAMPLE.CAM and SAMPTOOL.OFF may be overwritten by the installation SETUP program, should you need to re-install the software, or when you perform subsequent upgrades. Files that are not part of the initial installation will not be automatically removed by the installation SETUP program during the de-installation procedure, nor overwritten during upgrades. You should nevertheless make backup copies of all your work.