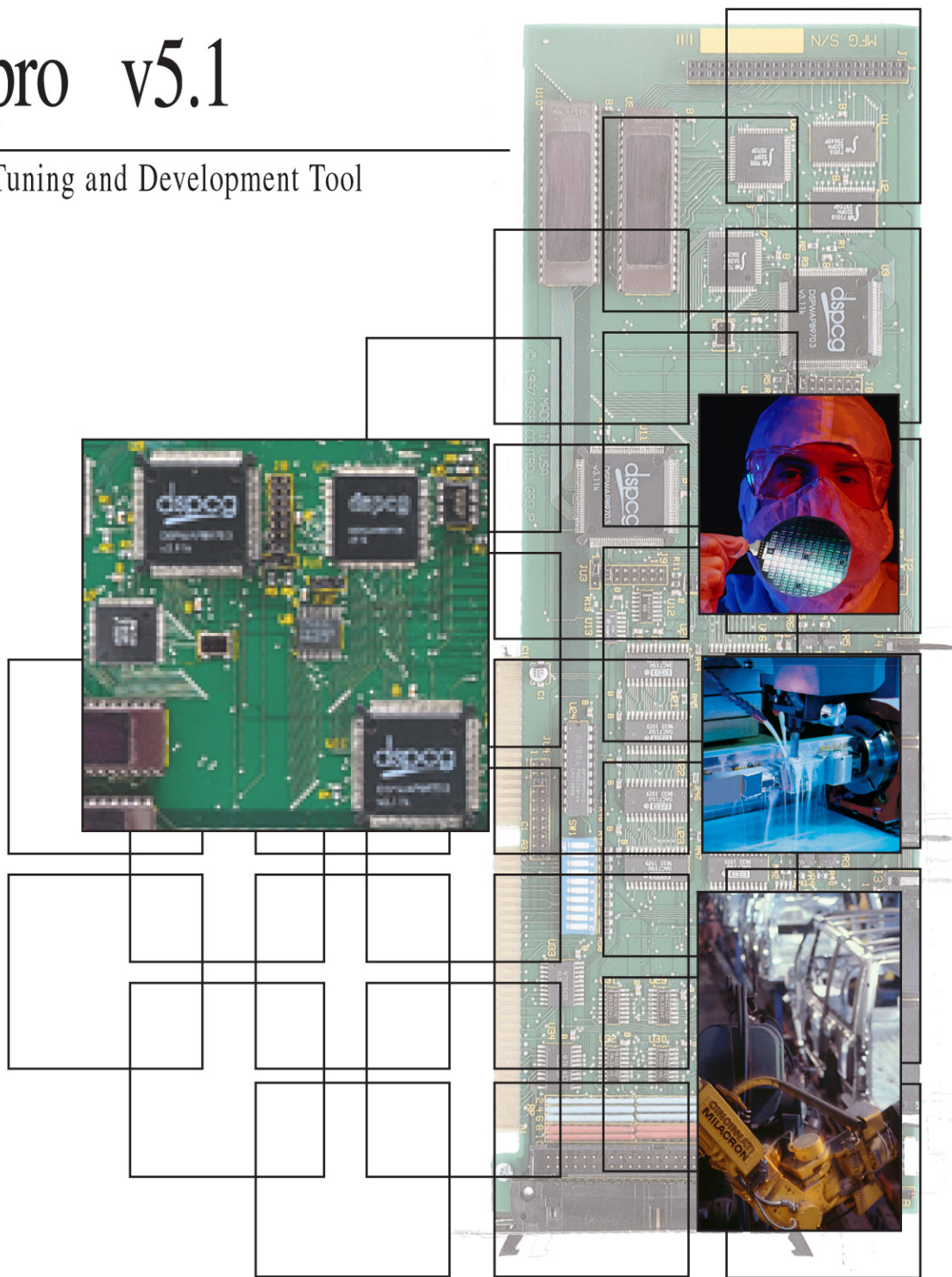


Mx4pro v5.1

An Expert Tuning and Development Tool



DSP Control Group, Inc.

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1 Introduction

The Mx4pro Development Tools is a Windows 95/98/NT/2000-based development platform for Mx4 system tuning, analysis, and program development. The *Mx4pro Development Tools v5.00* manual will assist you in **setting up your hardware and software** needed to use the Mx4pro Development Tools v5.00. The manual includes **illustrated references** for using the powerful features of the development tools such as oscilloscopes, signal generator, gain tools, data viewers, system frequency analyzer, and DSPL programming environment.



Note: Appendix A provides tutorial information on Tuning A System.

What's New in Mx4pro Development Tools

Mx4pro Development Tools takes full advantage of the features offered in the 32-bit Windows operating systems. DSPL development, system tuning, system analyzing, table downloading, and several other tasks may be performed in one easy to use environment. Furthermore, all of the tools may be operating simultaneously. The following is a brief overview of the new and/or improved tools included with the Mx4pro Development Tools:

- DSPL compiler with advanced math functions and macros.
- Internet connectivity, view manuals and application notes.
- DSPL programs may be edited, compiled, downloaded, and controlled (started and/or stopped) from within the DSPL Development Tool.
- Gains for all axes may be changed in real time and then stored in initialization files that can be linked to your DSPL programs for future use.
- The Signal Generator and Oscilloscope will work in both Bus and Serial mode and allow easy tuning and analyzing of your Mx4 applications.
- The Frequency Analyzer allows you to analyze your system performance and models your system with up to a 20th order transfer function.
- G Code programs may be edited, compiled, downloaded, and controlled (started and/or stopped) from within the G Code Development Tools.
- DSPL variables may be monitored and changed in real time.

Introduction

- Inputs may be monitored and outputs changed in real time.
- Interrupts may be monitored, cleared, and disabled in real time.
- Position, Velocity, Cam, and Cubic Spline data tables may be downloaded from within the Mx4pro Development Tools environment.
- All tools (excluding Frequency Analyzer) work in either Bus or Serial communication mode.

About Mx4pro Development Tools v5.00

The *Mx4pro Development Tools v5.00* will assist you in taking full advantage of all included features in the Mx4pro Development Tools v5.00 during development, tuning, and testing of your Mx4 based applications. Each of the chapters are described below.

Chapter 1: Introduction

Summarizes some of the reference materials available through DSP Control Group, Inc. which will assist you, along with the Mx4pro Development Tools, in development, tuning, and testing of all your Mx4 based applications. The new features included with the Mx4pro Development Tools are also discussed.

Chapter 2: Installing Mx4pro

This chapter summarizes the system requirements and describes how to set up your Mx4 hardware and Mx4pro software.

Chapter 3: Licensing

Describes the Mx4pro Development Tools licensing (acquiring a license number) and how to run the Mx4pro in Demo mode for evaluation. Also discussed is how to upgrade from a demo version to a licensed version and/or add new options.

Chapter 4: Internet Features

Describes how to use the Internet Features in the Mx4pro Development Tools to download the latest software, view the application notes, and view the frequently asked question.

Chapter 5: DSPL Program Development

Describes how to use the DSPL Development Tool to open, edit, compile, download, and control the execution of DSPL programs.

Chapter 6: Real Time Command

Describes how to use the Real Time Command Window to send real time commands to the Mx4 or the Mx4 Octavia.

Chapter 7: Frequency Analyzer

Describes how the Frequency Analyzer may be used to graphically analyze the performance, bandwidth, stability, etc. of your system. Also explains how your system may be modeled using the Frequency Analyzer, which displays your modeled system both graphically (Bode plot) and mathematically (up to 20th order transfer function).

Chapter 8: Gain Tool

Describes how to use the Gain Tool to modify the Mx4 position loop gains and notch filter parameters for any axis. Also, the modification of Vx4++ parameters (current loop gains, PWM frequency, current limit, etc.) are described. In addition to explaining these settings, saving Mx4 and Vx4++ parameters and linking them into DSPL programs is described.

Chapter 9: Signal Generator

Shows how to use the Signal Generator Tool to generate trapezoidal and sinusoidal velocity profiles, which are useful for system tuning and optimization.

Chapter 10: Scopes

Describes how to start Time and XY Scopes using the Scope Tool. Also shows how to configure both the Time and XY Scopes to graphically monitor the state variables for any axis in real time.

Chapter 11: Viewers

Explains how to use the DSPL Variable Viewer, Inputs and Outputs Viewer, Interrupts Viewer, and State Variable Viewers to monitor and change variables; monitor inputs and change outputs; monitor, clear, and disable interrupts; and monitor state variables, in real time.

Chapter 12: Tables

Explains how to use the Cubic Spline Table Tool, Cam Tables Tool, Position or Velocity Points Table Tool, and Position and Velocity Compensation Tables Tool to open, edit, download, or clear cubic spline tables; cam tables; position or velocity tables; or position and velocity compensation tables.

Chapter 13: G Code Program Development

Describes how to use the G Code Development Tool to open, edit, compile, download, and control the execution of G Code programs.

Chapter 14: Advanced Topics

This chapter discusses all of the advanced topics of the Mx4pro Development Tools. Explains how to configure an editor to be used by Mx4pro, configure update timers, change the Mx4 card address communication link, and modify resource sharing priorities. Commands for resetting serial communications, resetting timers for graphical displays, and resetting the Mx4 are also covered. Lastly, configuring the communications involved between the Mx4 and Mx4pro using the Windows Registry is explained.

Appendix A: Tuning A System

This appendix provides a thorough reference and procedure for tuning a system in either velocity or torque loop. General familiarity with the Mx4pro Development Tools should be obtained before using this appendix.

In conjunction with this manual you may find the following items of assistance:

Mx4 User's Guide

This manual includes comprehensive information on Mx4's hardware, system tuning, memory organization, trouble shooting and more. The *Mx4's User's Guide* is the focal point for learning the technical details of the Mx4. All other manuals assume that users have already read the *Mx4 User's Guide*.

DSPL Programmer's Guide

This manual will assist you with DSPL, DSPCG's high level programming language for the Mx4. DSPL has its own compiler and downloader, which are included in the Mx4pro Development Tools.

Gcode User's Guide

This manual will provide you comprehensive information on DSPCG's gcode interface. Some of the information the manual includes is using the development tools, gcode programming, a complete list of supported gcodes, and example programs.

Vx4++ User's Guide

This manual includes information on the add-on drive control option, Vx4++. Vx4++ is DSPCG's multi-DSP based drive controller that provides complete drive signal processing for all industrial DC and AC machines. The capabilities of Vx4++ include those normally offered by servo control amplifiers.

Introduction

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2 Installing Mx4pro

This chapter will guide you through the process of installing the Mx4pro Development Tools on a PC running Windows 95/98 or Windows NT/2000. Before beginning the installation procedure, take a moment to read this chapter, there are several prerequisites which must be fulfilled before the installation of the Mx4pro Development Tools can proceed properly.

System Requirements

Before the Mx4pro Development Tools may be installed and used, you must have the following:

- An IBM PC/AT or 100% compatible ISA/EISA based PC
- A RS-232/485 serial communications port, if the Development Tools will be used in Serial Mode
- Microsoft Windows 95/98 or Windows NT/2000
- A minimum of 6 Megabyte of open disk space on the harddrive
- SVGA monitor suggested

Preparing the Hardware

This section explains how to prepare the PC/AT Mx4 and Mx4 Octavia hardware for the Mx4pro Development Tools. The Mx4pro Development Tools can be run in one of three modes, Bus, Serial, or Demo. In Bus mode, the Card Address and IRQ must be configured for ISA/PC bus communication. In Serial Mode, a RS-232/485 Serial Communications port must be used. When running in Demo mode a Mx4 or Mx4 Octavia Card is not required.

Bus Mode Settings

For the Mx4pro Development Tools to operate in Bus mode there must be a card located on a 2K boundary for the Mx4 and on a 8K boundary for the Mx4 Octavia within the ISA base 1Meg address space and the IRQ must be set. Refer to chapter 2, "Installing Your Mx4 Hardware" in the *Mx4 User's Guide* or the

Installing Mx4pro

Mx4 Octavia User's Guide. The 10-position DIP switch SW1 is used to select the start of this boundary (Table 2-1).

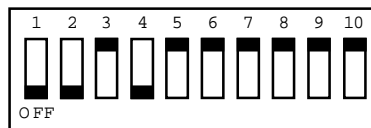


Note: It is important to make sure that the chosen address space of the Mx4 or the Mx4 Octavia card does not interfere with other hardware on the PC Bus.

POSITION	ADDRESS MATCHED	
	SW OFF	SW ON
SW1-1	A19=1	A19=0
SW1-2	A18=1	A18=0
SW1-3	A17=1	A17=0
SW1-4	A16=1	A16=0
SW1-5	A15=1	A15=0
SW1-6	A14=1	A14=0
SW1-7	A13=1	A13=0
SW1-8	(Mx4) A12=1 (Octavia) nc	(Mx4) A12=0 (Octavia) nc
SW1-9	(Mx4) A11=1 (Octavia) nc	(Mx4) A11=0 (Octavia) nc
SW1-10	Nc	Nc

Table 2-1: PC/AT Mx4 2K Boundary Select

For example, setting the card address space to 0xD0000 (i.e. the 64K segment) would require the SW1 DIP switch to be set as follows,



In addition to the card address, the desired IRQ level issued to the host computer must be set. To set the IRQ level, select the proper jumper JU3 (Table 2-2).



Note: When selecting the IRQ level, make sure that this value will not interfere with a previously selected value for other hardware in your PC.

JUMPER POSITION	INTERRUPT SELECTED
JU3-1	IRQ15
JU3-2	IRQ14
JU3-3	IRQ12
JU3-4	IRQ11
JU3-5	IRQ10
JU3-6	IRQ9
JU3-7	IRQ7
JU3-8	IRQ6
JU3-9	IRQ5
JU3-10	IRQ4
JU3-11	IRQ3

Table 2-2: PC/AT Mx4 Host Bus Interrupt Select

Serial Mode Settings

For the Mx4pro Development Tools to operate in Serial mode there must be a Mx4 card connected to the RS-232/485 serial communications port (1 through 4). Furthermore, if RS-485 serial communication is being used, the Slave Node Address of the Serial Adapter Card must be set. Refer to the *Acc4 User's Guide* or *Acc8 User's Guide* for more information.

Demo Mode Settings

If the Mx4pro Development Tools are being used in Demo mode, then a Mx4 card is NOT required. Furthermore, if a Mx4 card is located on the PC BUS or connected to a serial port, the Mx4pro Development Tools will not affect the card. That is, all operations in the Mx4pro Development Tools will NOT be transmitted to the Mx4 card while in Demo mode.

Installing the Mx4pro Development Tools

Installing Mx4pro

This section explains how to install the Mx4pro Development Tools software. The Mx4 card address, IRQ, Serial Port number, and/or Slave Node Address (described above) will need to be specified during the setup procedure, these values are used to configure the Mx4pro Development Tools.



Note: If a previous version of Mx4pro Development Tools exists on your PC it is recommended that you first uninstall the previous version before installing the new version. See the section “Removing Previous Versions of Mx4pro Development Tools” at the end of this chapter.

To start the installation procedure of the Mx4pro Development Tools while using Windows 95/98, select **Run** under the **Start** button and enter SETUP (with the path to the Mx4pro media, CD or diskette), then press the Enter button. You may also double click on the icon that represents the drive and/or folder where the Mx4pro installation media is located (under **My Computer**) and double click on the Setup icon.

To start the setup procedure within Windows NT/2000, select **Run** under the **File** menu of the “Program Manager Window” and enter SETUP (with the path to the Mx4pro media, CD or diskette), then press the Enter button. You may also double click on SETUP.EXE from within the **File Manager** focusing on the drive and/or folder where the Mx4pro installation media is located.

When the setup process begins, several files will first be copied to your PC to assist you through the remainder of the setup process. After these files have been copied successfully, you must specify the drive and path where you would like the Mx4pro Development Tools to be installed (or use the default path). After the drive and path have been specified, click on the indicated button to proceed with the setup. The setup process will prompt you for each disk as it is needed. After all of the files have been installed, you will be prompted with the following configuration windows:

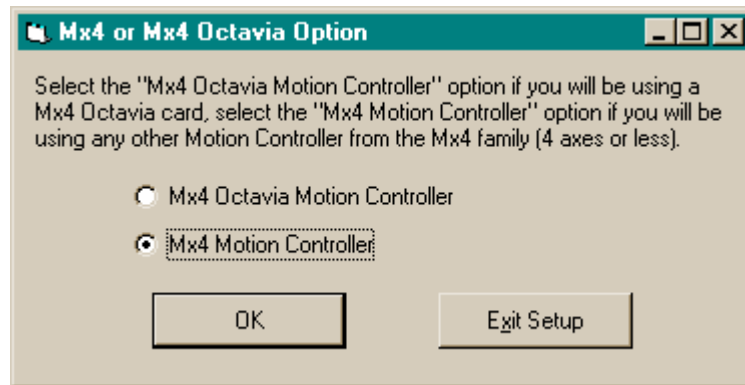


Fig. 2-1: Card Selection window

Select the type of controller which you have installed, either Mx4 Octavia (5-8 axes) or Mx4 (4 axes).



Note: The remaining sections of this manual are presented from the perspective of a 4-axis Mx4 controller installed. If you have installed a 5-8 axis Mx4 Octavia, the descriptions herein are still useful (simply, axes 1-4 descriptions for Mx4 may be expanded to axes 1-8 for Mx4 Octavia).

Installing Mx4pro

The next window configuration window is the Expansion Option Window.

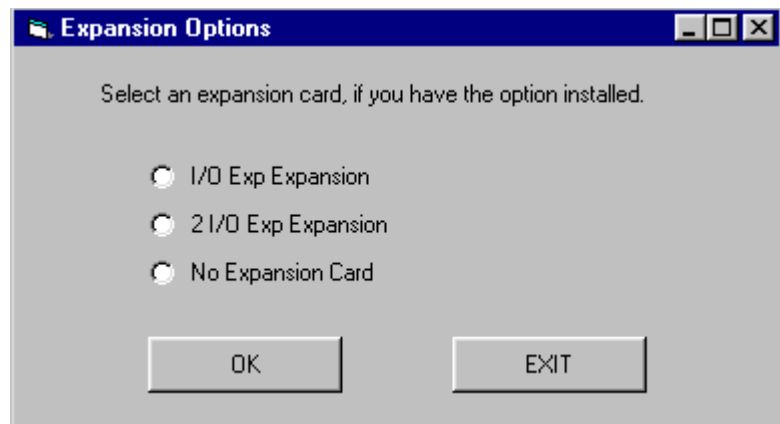


Fig: 2-2: Expansion Option Window for Octavia

The **Expansion Option** window lets you select some of the options available for the Mx4 family. If you have one of the listed options installed select the correct radio button, if you have an option that is not listed or you have no options installed select *No Expansion Card*.

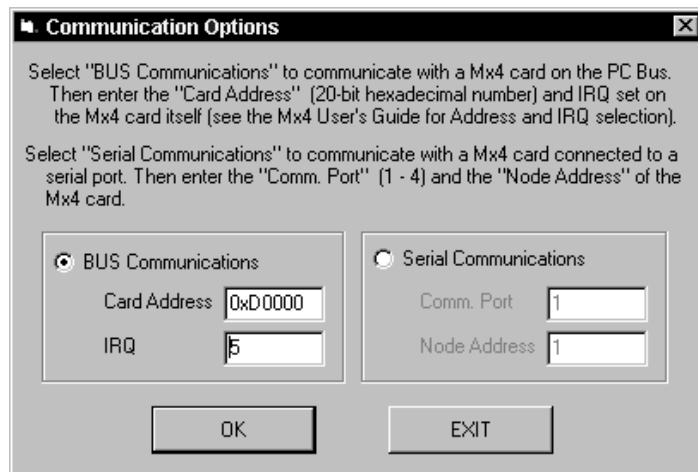


Fig. 2-3: Communication Options window

From within the **Communications Options** window the mode of operation must be selected (BUS or Serial), that is the communication path between the Mx4pro Development Tools and the underlying Mx4 card must be specified. If the Mx4pro Development Tools will be used in Demo mode, just click on the **OK** button.

For Bus mode select the **Bus Communications** option and enter the values of the Mx4 **Card Address** and **IRQ** you selected during the hardware setup. For Serial Mode, select the **Serial Communications** option and enter the **Communications Port** the serial Mx4 card will be connected to and the **Slave Node Address** selected during hardware setup. If you are using RS-232 communications, leave the Slave Node Address as 1. Now click on the **OK** button and the Mx4pro Development Tools will be configured for your hardware specification. The configuration parameters for Mx4pro are stored in the Registry, for more information on these configuration parameters refer to Chapter 14, Advanced Topics. At this point, the Mx4pro Development Tools have been installed.

After the setup procedure has completed, you will find three directories placed inside the root directory you had installed the Mx4pro Development Tools into: HLL, DAT, and GCODE. The HLL and DAT directories contain several tutorial DSPL and data files, respectively. These files will assist you in learning and mastering the DSPL high level language. The GCODE directory contains a sample GCODE tutorial file and a README file to assist you in programming with G Code. Also, for your convenience, a shortcut to Mx4pro Development Tools is placed on your “Desk top” if you are using Windows 95/98.

Removing Previous Versions of Mx4pro Development Tools

There are several ways of removing the previous version of the Mx4pro Development Tools. From within Windows 95/98, this can be done by selecting **Add/Remove Programs** in the **Control Panel**, then selecting the “Mx4pro vx.xx” text in the **installed components list** and clicking on the **Add/Remove** button. To uninstall the previous version of Mx4pro Development Tools from within Windows NT/2000, open the **Mx4pro vx.xx** window under the Program manager, then double click on the **Remove Mx4pro vx.xx** icon.

Installing Mx4pro



Note: If uninstalling the files in either fashion described above, all of the files that were copied to your PC during the previous installation will be removed. Therefore, if you made changes to the installed tutorial DSPL files, data files, or G Code files, they must be copied to another directory if you would like to preserve the changes. Any files you may have created in these directories will not be affected during either the uninstall process or the new installation



Note: Previous DOS versions of Mx4pro (v3.xx) do not need to be removed.

Starting the Mx4pro Development Tools

After you have finished the hardware (not needed if running in Demo mode) and software setup procedures, the Mx4pro Development Tools may be started. If you have installed Mx4pro on a computer using Windows 95/98, then the Mx4pro Development Tools may be started by either clicking on the **Start** button and then selecting **Mx4pro v5.00** under the **Mx4pro v5.00** group within the **Programs** main group, or by double clicking on the **Mx4pro v5.00** shortcut on the desktop. If installed in Windows NT, double click on the **Mx4pro v5.00** icon inside the **Mx4pro v5.00** group within the **Program Manager**.

The first time that the Mx4pro Development Tools are started you will be prompted with a Licensing window, refer to chapter 3 on Licensing. After you have finished entering your licensing information, the following toolbar will appear:

Installing Mx4pro

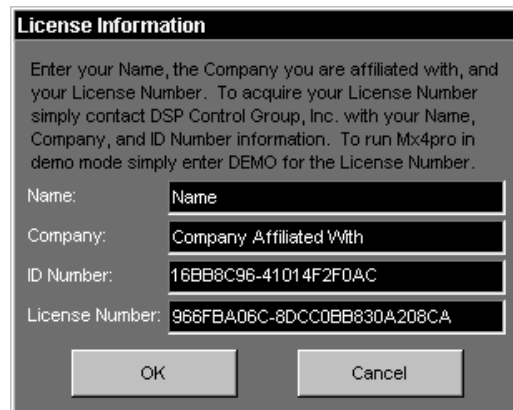


Installing Mx4pro

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3 Licensing

To start using the Mx4pro Development Tools, you must either acquire a license number or run in Demo mode. After Mx4pro Development Tools have been properly setup and started for the first time, you will be prompted to enter your Name, the name of your Company and a License Number. The following window will prompt you for this information:

A screenshot of a Windows-style dialog box titled "License Information". The dialog has a dark gray background with white text. It contains a paragraph of instructions: "Enter your Name, the Company you are affiliated with, and your License Number. To acquire your License Number simply contact DSP Control Group, Inc. with your Name, Company, and ID Number information. To run Mx4pro in demo mode simply enter DEMO for the License Number." Below this text are four input fields. The first is labeled "Name:" and contains the text "Name". The second is labeled "Company:" and contains the text "Company Affiliated With". The third is labeled "ID Number:" and contains the text "16BB8C96-41014F2F0AC". The fourth is labeled "License Number:" and contains the text "966FBA06C-8DCC0BB830A208CA". At the bottom of the dialog are two buttons: "OK" and "Cancel".

License Information

Enter your Name, the Company you are affiliated with, and your License Number. To acquire your License Number simply contact DSP Control Group, Inc. with your Name, Company, and ID Number information. To run Mx4pro in demo mode simply enter DEMO for the License Number.

Name: Name

Company: Company Affiliated With

ID Number: 16BB8C96-41014F2F0AC

License Number: 966FBA06C-8DCC0BB830A208CA

OK Cancel

Fig. 3-1: License Information window

All of the Licensing information should be entered, begin by entering your **Name** and your **Company**, then enter your **License Number**. To acquire your License Number you must contact DSP Control Group, Inc. by fax or email with your name, company and the generated **ID Number**. The License Number enables Mx4pro Development Tools to execute and allows you to use the options you have specified to be included in your License.



Note: The License Number is unique for all computers, that is a License Number from Mx4pro on one computer will not work with Mx4pro on a different computer.

Licensing

Alternatively, Mx4pro Development Tools may be run in Demo mode by entering DEMO (in upper case) for the License Number. When Mx4pro Development Tools is run in Demo mode, all options with the Mx4pro Development Tools may be viewed; however, no communication with Mx4 is established.



Note: An Mx4 card is NOT needed while in Demo mode. If a Mx4 card does reside on the computer running Mx4pro in Demo mode, the Mx4 will NOT be used.

Changing the License Number

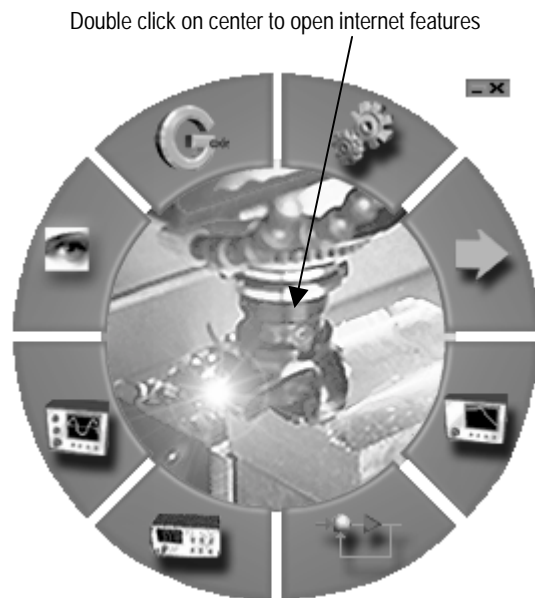
After initially entering a License number or running Mx4pro Development Tools in Demo mode, the License Number may be updated to either allow the Mx4pro Development Tools to run in normal mode (as opposed to Demo) or to update your currently licensed options. From the Start Menu select **Run...**, type *regedit* into the command window and press Enter. This will start the registry editor.



Note: Use caution when editing the registry, deleting or editing values could result in program failures or lockups.

Select **HKEY_CURRENT_USER**. Next, select **Software\MX4PRO\License**. This will open the Mx4 License values. Double click on the value labeled **LicenseNumber**. Type the new license number in the **Value data** window. Click on the **OK** button. Exit the registry editor.

4 Internet Features



Double clicking on the center on the Mx4pro window will bring up the online options for the Mx4pro Tools. This opens the homepage for the DSPCG website, <http://www.dspcg.com> see Fig. 4-1.

Internet Options

The majority of the technical assistance is under the **Support** and **Download** buttons. Under the support page the available choices are to view the frequently asked questions (FAQ), and view the application notes. Under the download page one can download the latest software versions, the application notes, and the user manuals. The frequently asked questions are sorted by product, and the application notes have a short description for each topic. The download page allows one to get the latest software. Some of the software available for download is multiple versions of the DSPL compiler, multiple versions of the Windows DLL, and the latest version of the Mx4pro Development Tools.

Internet Features

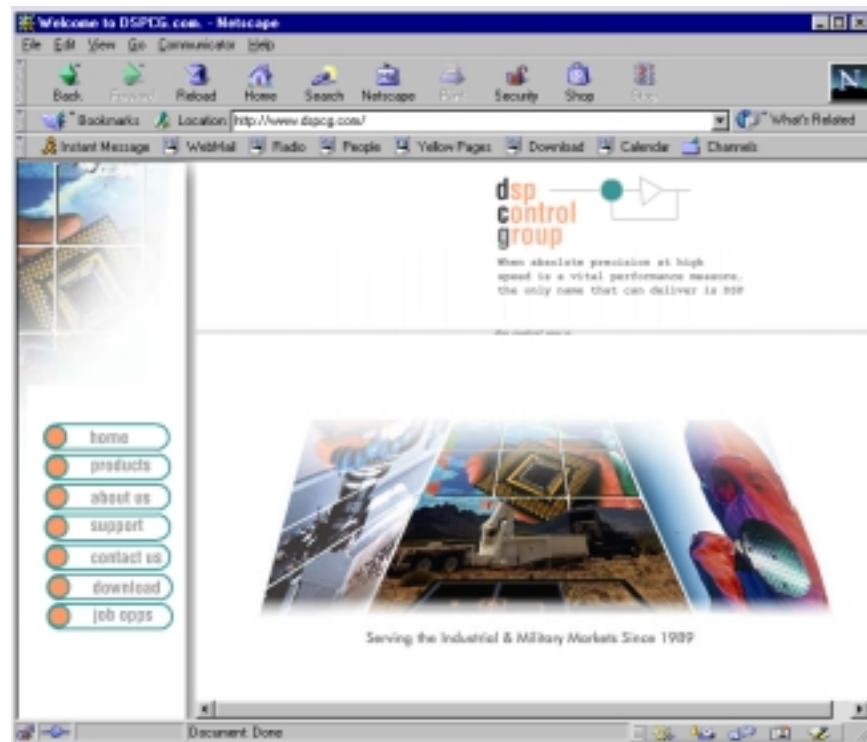


Fig. 4-1: DSPCG Homepage

5 DSPL Program Development

Click button to open DSPL Program Development Tool



The DSPL programming language is a high-level language resembling C which allows complete motion control programs to be written for the Mx4. The DSPL Program Development Tool allows you to create, modify, compile, download, and execute DSPL programs. The DSPL Development Tool may be opened by clicking on the **DSPL** button on the Mx4pro Development. Now the following window will appear:

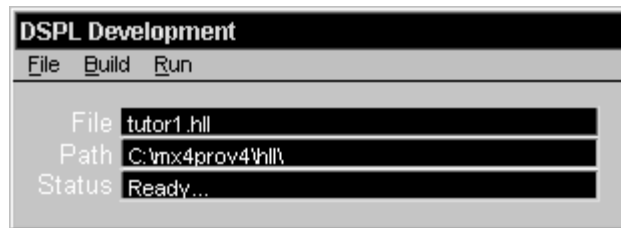


Fig. 5-1: DSPL Development Tool

The DSPL Development tool displays the name of the open DSPL **File**, the **Path** for the open file, and the **Status** of a compile and/or download performed on the file. The following sections describe how to utilize the different features of the DSPL Development Tool.

Opening DSPL Files

Before a DSPL program can be edited, compiled, or downloaded, it must be opened by the user. To open a DSPL program:

1. **Open the DSPL Selection window.** This can be achieved by selecting **Open...** under the **File** menu or in the popup menu (right click in the DSPL Development window). Double-clicking inside one of the three black areas (File, Path, or Status text boxes) inside the DSPL Development window (Figure 5-1) will also open the DSPL Selection window.
2. **Select the DSPL File.** To open a file, browse your harddrive to the path where your project will exist or does exist, then click on the filename or enter the file name in the **File Name** text box. Note, there is a **File Type** filter. After your file has been selected, click on the **OK** button to accept your selection or the **Cancel** button to disregard (Figure 5-2).

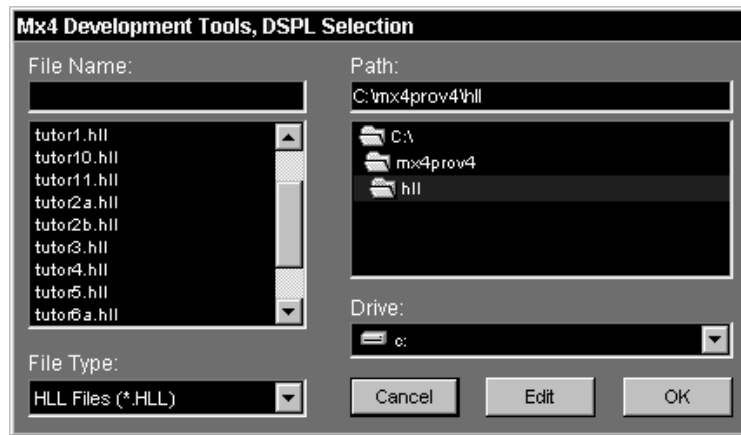


Fig. 5-2: DSPL Selection window

Editing Files

After a file has been opened, it may be edited. This can be achieved by selecting **Edit** under the **File** menu or in the popup menu. The opened file will then be placed into a text editor, to select the editor used for editing the DSPL programs, refer to “Selecting an Editor” in Chapter 14 Advanced Topics.

A file which has not been opened may also be edited via the DSPL Selection window. Follow steps 1 and 2 above, then select the **Edit** button instead of the **OK** button (Figure 5-2). The file will then be opened with the editor, but not into the DSPL Development tool. This feature is useful when an “include” file needs to be edited or created.

Compiling Files

An opened DSPL file can be compiled using the DSPL Development tool, but make sure you save the file first, if it has been edited. To compile the DSPL file, select **Compile** under the **Build** menu or in the popup menu. For example, by selecting **Compile** from within the popup menu, the DSPL compiler will compile the opened DSPL program (Figure 5-3).

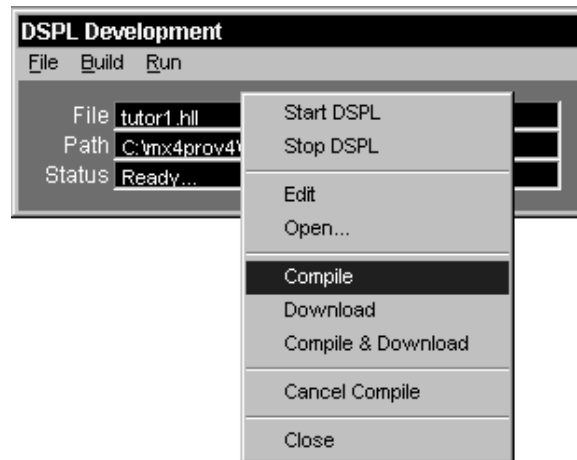


Fig. 5-3 Compiling DSPL Program

After the compile has started, it may be canceled by selecting **Cancel Compile** under the **Build** menu.

If the DSPL compiler detects any warnings or errors during the compilation of the opened file, the **Status** box in the DSPL Development Tool will display a warning/error message and an edit session displaying the warnings and/or errors will appear.

Downloading Files

If the opened file has been compiled successfully, it can be downloaded to the Mx4 card by selecting **Download** under the **Build** menu or in the popup menu.

The opened DSPL file may also be compiled and downloaded if **Compile and Download** is selected under the **Build** menu or in the popup menu.



Note: If **Compile and Download** was used and any warning(s) and/or error(s) occurred, then the file will NOT be downloaded. If only warnings were issued the file may still be downloaded, but **Download** must be used instead of **Compile and Download**.

Executing DSPL Programs

There are several commands that may be issued to control the execution of a downloaded DSPL program. The following commands may be issued to the Mx4 via the DSPL Development Tool by selecting the appropriate command under the **Run** menu,

- **Start DSPL** - Starts the DSPL program execution
- **Stop DSPL** - Stops the DSPL program execution
- **Signal DSPL** - Signals the DSPL program, breaks out of a WAIT_UNTIL_RTC command in a DSPL program.
- **AutoStart DSPL** - Select **AutoStart On** or **AutoStart Off** to turn the autostart option on or off, respectively.

A DSPL program may also be started or stopped by selecting **Start DSPL** or **Stop DSPL**, respectively, from within the popup menu. Furthermore, the function keys F1 through F3 may be used to issue the **Start DSPL** (F1), **Stop DSPL** (F2), and **Signal DSPL** (F3) commands when the DSPL Development Window is active.

Refer to the *Mx4 User's Guide* and the *DSPL Programmer's Guide* for more information on these commands.

Closing the DSPL Development Tool

To close the Mx4pro Development Tool, select **Close** under either the **File** menu or in the popup menu. The opened DSPL file and path along with the window dimensions and position are saved, when the window is started again the same DSPL file will be opened and the window will appear in the same location as when it was closed.

DSPL Programming Notes

- For further information on programming with DSPL, refer to the *DSPL Programmer's Guide*.
- For further information on the Mx4 and its RTC's refer to the *Mx4 User's Guide*.
- In order to work properly, all DSPL programs must be compiled and downloaded using the compiler and downloader that are a part of the Mx4pro Development Tools package.

6 Real Time Command

Click on button to open RTC command window



The Real Time Command Window allows one to send real time commands (RTC) to the Mx4. RTCs can be used to set parameters and execute simple moves. The Real Time Command Window may be opened by clicking on the **RTC** button on the Mx4pro Development Tools main window. Now the following window will appear:

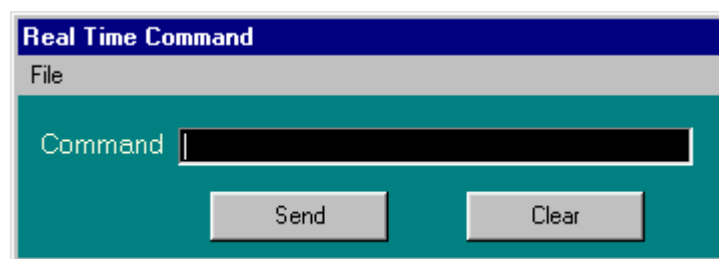


Fig. 6-1: Real Time Command Window

RTC Commands

To send a RTC, type the command into the window then press **Send**. The RTCs are in DSPL format. For example here is an axmove command for axis 3:

```
axmove(0x4, 0.05, 10000, 10)
```

For complete description of the arguments and usage of RTC commands consult the *DSPL Programmer's Guide*.



Note: All of the available Mx4 RTC commands are NOT supported by the Real Time Command Window.

The text will remain in the command window, and will not be cleared. To send the same RTC again all that is required is to press the **Send** button. It is also possible to edit the RTC in the command window, and send the same RTC with different arguments. To send a different RTC press the **Clear** button.

The commands available in the Real Time Command Window are:

autostart_dspl	disabl2_int
axmove	en_bufbrk
axmove_s	en_encflt
axmove_t	en_err
cam_off	en_errhlt
cam_off_acc	en_index
crtl_ka	en_motcp
crtl	en_posbrk
cubic_int	encode_mag
cubic_rate	estop_acc
cubic_scale	flux_current
curr_limit	gear_off_acc
curr_offset	gear_off_acc
curr_pid	gear_probe
ddac	gear_off
disabl_int	inp_state
int5ms	posbrk_out

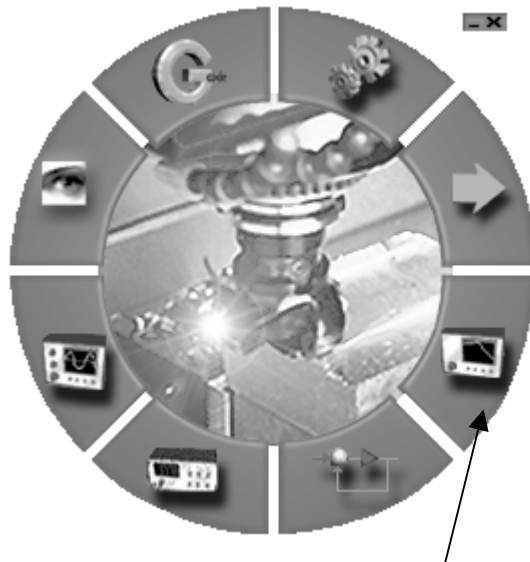
Real Time Command

kilimit	pwm_freq
low_pass	rel_axmove
maxacc	rel_axmove_s
motor_par	rel_axmove_t
motor_tech	signal_dspl
notch	start_dspl
offset	stepper_on
outgain	stop_dspl
outp_off	sync
outp_on	table_sel
override	trq_limit
pos_preset	vector4_block
pos_shift	velmode

Real Time Command

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7 Frequency Analyzer



Click button to open the Frequency Analyzer Tool

An important tool included with the Mx4pro Development Tools is the Frequency Analyzer or Bode plot. The Frequency Analyzer allows the system performance, bandwidth, stability, and modeling transfer function, to be viewed graphically. This chapter will explain how to use all of the features supported by the Frequency Analyzer Tool.

Frequency Analyzer Tool

The Frequency Analyzer Tool allows the frequency analysis for each axis to be configured and executed. It also allows the modeling transfer function to be configured and viewed. To open the Frequency Analyzer Tool click on the Frequency Analyzer Tool button on the main Mx4pro Development Tools. The following window will appear:

Frequency Analyzer

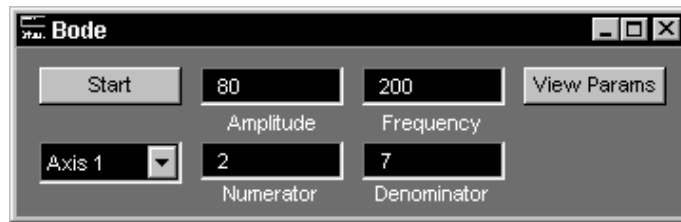


Fig. 7-1: Frequency Analyzer Tool

Besides the main window, two graphs for magnitude and phase will appear. These windows will look as follows (these windows display the analysis results):

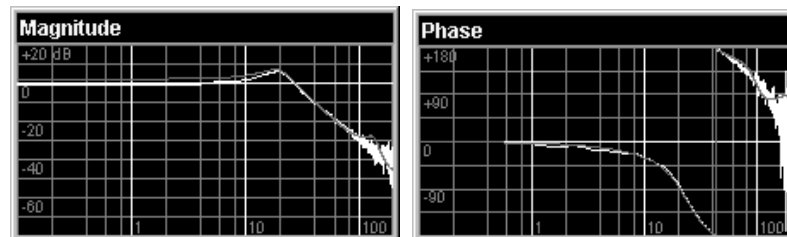


Fig. 7-2: Frequency Analyzer Magnitude and Phase plots

Before a system may be analyzed, the Frequency Analyzer must be configured for the desired axis to analyze. To choose the axis, select the desired axis from the drop box located under the Start/Stop button. Now the **Amplitude** and **Frequency** must be specified, the **Amplitude** is the magnitude of the excitation signal in counts (50 count minimum) and the **Frequency** is the maximum frequency (between 20 and 200 Hz) of the excitation signal (Figure 7-1).

To start the analysis click on the **Start** button, the button will now display Stop and the analysis will begin. When the analysis routine completes, the Magnitude and Phase plots will be updated and the button will display Start again. To stop the analysis prematurely, click on the **Stop** button.

Frequency Analyzer



Note: It is the responsibility of the user to set the control gains for the axis being analyzed before the frequency analyzer will run for that axis.



Note: The frequency analyzer uses a DSPL program, therefore any existing DSPL program loaded on the Mx4 card will be overwritten.



Note: Right clicking in the Magnitude or Phase windows will display the Main Window for the Frequency Analyzer and the Parameters windows.

System Modeling

The Frequency Analyzer Tool allows the system to be modeled with a transfer function in the z-domain. To model the system set the **Numerator** and **Denominator** to the desired powers of z and then start the analysis as explained above (Figure 7-1). The powers may range from 0 to 20, where powers of 0 will turn the modeling feature off.

After the analysis has completed the modeled transfer function will be displayed in the Magnitude and Phase plots (red trace). Furthermore, the coefficients for the transfer function may be viewed by clicking on the **View Params** button. A window similar to the following will appear:

Frequency Analyzer

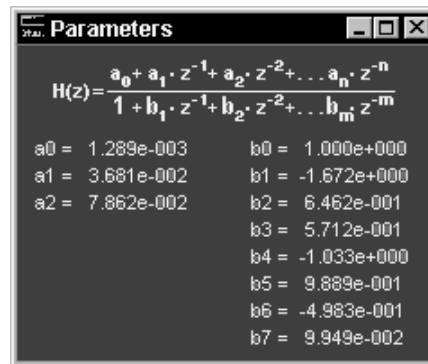
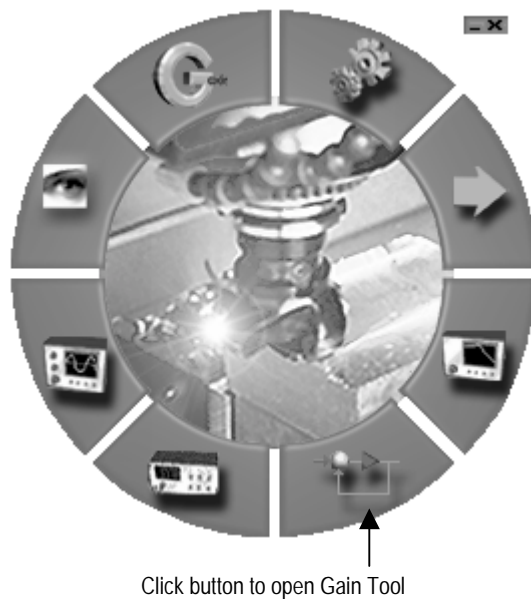


Fig. 7-3: System Model Parameters

If this window is already open, the coefficients will be updated automatically.

8 Gain Tool



The Gain Tool included with the Mx4pro Development Tools allows you to manipulate all of the position loop gains and the notch filter frequency for all axes of the Mx4. Also, with the Vx4++ commutation controller option card, the drive control parameters (for all axes) may be modified in real time. There are three windows associated with the Gain Tool, one is dedicated to the Mx4 controller (Mx4 Gains window) and the other two are dedicated to the optional Vx4++ controller (Vx4++ Gains and Vx4++ Parameter Settings windows).



Note: *Appendix A: Tuning A System* contains a thorough step-by-step tutorial on the process of tuning a system in either velocity or torque loop.

Mx4 Gains Window

The Mx4 Gains window may be opened by clicking on the **Gain Tool** button on the Mx4pro Development Tools. The Mx4 Gains window appears as follows:

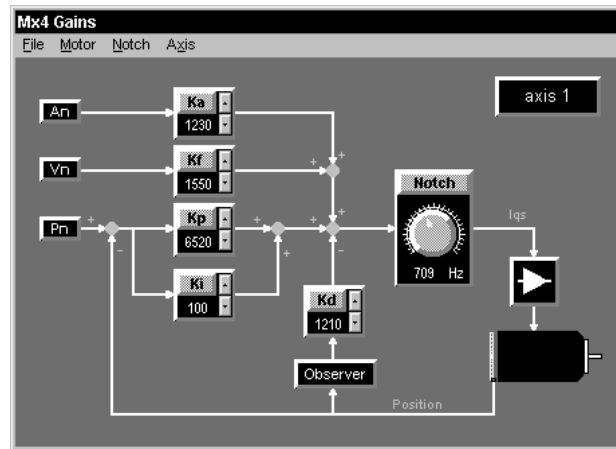


Fig. 8-1: Mx4 Gains window in Gain Tool

The Mx4 Gains window displays the position loop gains, notch filter frequency, and current axis of focus. From within this window these values can be modified in real-time for all axes. Furthermore, the values for the position loop gains may be saved to an initialization file for future use.

Axis Selection

The current axis which the Mx4 Gains window is focusing on is displayed in the upper right corner of the window. That is, all changes and updates to the position loop gains and notch filter frequency values will be for the current axis which has focus. To change the values of the other axes, the axis of focus must be changed to the desired axis.

There are three methods available for changing the current axis, the first method is to select the desired axis from the list of axes **Axis 1**, **Axis 2**, **Axis 3**, **Axis 4**, **Axis 5**, **Axis 6**, **Axis 7**, and **Axis 8** under the **Axis** menu. The Mx4 has four axis and the Octavia has up to eight axis. The second method is to select the desired axis from the list of axes, **Axis 1**, **Axis 2**, **Axis 3**, **Axis 4**, **Axis 5**, **Axis 6**, **Axis 7**, and **Axis 8** inside the popup menu (right click inside the Mx4 Gains window).

The third method is to select the function key which represents each axis, that is, F1 will switch to axis 1, F2 to axis 2, F3 to axis 3, F4 to axis 4, F5 to axis 5, F6 to axis 6, F7 to axis 7 and F8 to axis 8. Notice that inside the **Axis** menu and popup menu, the axis which currently has focus will have a check mark beside it.



Note: Changing the axis of focus inside the Mx4 Gain window will cause the focus of the Vx4++ Gains window to be on the same selected axis.

Updating Current Mx4 Gains and Notch Frequency Values

When the Mx4pro Development Tools are initially started the position loop gains, notch filter frequency, and notch filter Q factor value are read from the Mx4 and updated to the Mx4 Gain window. In addition, every time the axis of focus is changed as described in the previous section, these values are also updated from the Mx4 to the Mx4 Gain window. When it is necessary to refresh the gains from the Mx4 to the Mx4 Gain window (for example if the gains are changed outside the Mx4pro Development Tools), they can easily be refreshed by reselecting the current axis of focus (see section above on axis selection) or select **Refresh** under the **Axis** menu or popup menu. Pressing the F5 function key for the Mx4 and F9 for the Mx4 Octavia will also refresh the windows.



Note: If the position loop gains or notch filter frequency values on the Mx4 have been changed outside the Mx4pro Development Tools (for example if a DSPL program changes the gains) they will not be automatically updated inside the Mx4 Gain window.

Changing the Position Loop Gains

The position loop gains of the Mx4 may be changed in real time using the scroll bar next to each of the individual gains, to scroll up or down in increments of 10. This method of gain selection is useful for tuning your system in real time. The gains may also be changed by entering a new gain value into the corresponding text box. The enter key does not need to be pressed, since the Gain Tool will notice the change in the keyed or scrolled value, this current value (if it is valid) will be issued to the Mx4 card as a new gain.



Note: If the entered value for the gain is too large, then the previous gain value will be placed into the text box and used as the new gain to be issued to the Mx4.

Changing the Notch Filter Frequency and Q Factor

The Notch filter frequency and Q factor of the Mx4 may be changed in real time using two methods. To change the notch filter frequency, the knob in the Notch box may be used to rotate left or right to change the frequency. In addition to the knob, the frequency (in Hz) may be entered into the text box. As with changing the gains, the enter key does not need to be pressed, since the Gain Tool will notice the change in the keyed value. This current value will be issued to the Mx4 card as a new notch frequency.

To change the Q factor, select the new Q factor from the list under the **Notch** menu or inside the popup menu (right click on the top of the Notch box). Notice that the current Q factor has a check mark beside it in both of these lists.



Note: If the entered value for the notch frequency is too large, the maximum notch frequency value will be placed into the text box and used as the notch frequency to be issued to the Mx4.

Saving Gains and Linking into DSPL Programs

The current position loop gains from the Mx4 Gain window can be saved to a DSPL initialization file and then linked into any DSPL file for future use. To save the gains, select **Save Gains** under the **File** menu. The gains will be saved to the file called MX4_INIT.HLL, which will be located in the directory containing the Mx4pro Development Tools program. After the file has been saved, it can be linked to any DSPL file by using the DSPL directive **#include**. For more information on include files and the DSPL language refer to the *DSPL Programmer's Guide*.

The following simple example shows how to include the saved initialization file and how to call it from within a motion program,

```
#include "C:\Mx4proV5\init_mx4.hll" ; Assumes Mx4pro v5 exists
                                   ; in C:\Mx4proV5 directory
```

```
      :  
      :  
MOTION_PROGRAM:  
      :  
      :  
      call(INIT_MX4) ;Calls the saved gains initialization file  
      :  
      :  
END
```




Note: Only the Ki, Kp, Kf, and Kd gains will be saved for all axes. Before using the INIT_MX4.HLL file in an application, review the HLL file first.

Closing Mx4 Gains Window

To close the Mx4 Gains Window, select **Close** under the **File** menu or in the popup menu. Upon closing the window dimensions and position are saved, so that the next time the Mx4 Gain window is opened it appears in the same location as before it was closed.

Vx4++ Gains Window

After starting the GainTool to acquire the Mx4 Gains Window, the Vx4++ Gains window may be opened. To open the window either select **Vx4++ Gains** under the **File** menu or click on the  image.

The Vx4++ Gains window displays the loop gains, PWM frequency, field current, current offset, and axis of focus. From within this window these values can be modified in real-time. Furthermore, all of the Vx4++ values may be saved to an initialization file for future use.

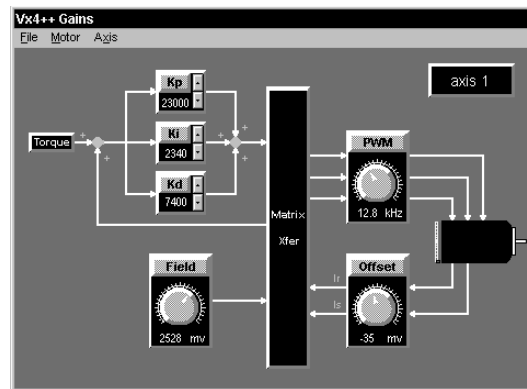


Fig. 8-2: Vx4++ Gains window in Gain Tool

Axis Selection

The axis which the Vx4++ Gains window is focusing on is displayed in the upper right corner of the window. That is, all changes and updates to the loop gains, PWM frequency, field current, current offset, and motor type will be for the axis which has focus. To change the values of the other axes, the axis of focus must be changed to the desired axis.

There are three methods available for changing the current axis, the first method is to select the desired axis from the list of axes, **Axis 1**, **Axis 2**, **Axis 3**, and **Axis 4** under the **Axis** menu. The second method is to select the desired axis from the list of axes, **Axis 1**, **Axis 2**, **Axis 3**, and **Axis 4** inside the popup menu (right click inside the Vx4++ Gains window). The third method is to select the function key which represents each axis, that is F1 will switch to axis 1, F2 to axis 2, F3 to axis 3, and F4 to axis 4. Notice that inside the **Axis** menu and popup menu, the axis which currently has focus will have a check mark beside it.



Note: Changing the axis of focus inside the Vx4++ Gain window will cause the focus of the Mx4 Gains window to be on the same selected axis.

Updating Current Vx4++ Gains, PWM Frequency, Field Current, Current Offset and Motor Type

When the Mx4pro Development Tools are initially started, the loop gains, PWM frequency, field current, current offset, and motor type values are read from the Mx4 and updated to the Vx4++ Gain window. Also, every time the axis of focus is changed (described in the previous section) these values are also updated from the Vx4++ to the Vx4++ Gain window. When it is necessary to update any of the values from the Vx4++ to the Vx4++ Gain window (for example if the loop gains are changed outside the Mx4pro Development Tools), they can be refreshed by reselecting the current axis of focus (see section above on axis selection) or select **Refresh** under the **Axis** menu or popup menu. Selecting the F5 function key will also refresh the loop gains, PWM frequency, field current, current offset, and motor type values.



Note: If the loop gains, PWM frequency, field current, current offset, and motor type values on the Vx4++ have been changed outside the Mx4pro Development Tools (for example if a DSPL program changes the loop gains) they will not be automatically updated inside the Vx4++ Gain window.

Changing the Loop Gains

The loop gains of the Vx4++ may be changed in real time using the scroll bar next to each of the individual gains to scroll up or down in increments of 10. This method of gain modification is useful for tuning your system in real time. The gains may also be changed by entering a new gain value into the text box. The Enter key does not need to be pressed, since the Gain Tool will notice the change in the keyed or scrolled value, this current value (if it is valid) will be issued to the Vx4++ as a new gain.



Note: If the entered value for the gain is too large, then the previous gain value will be replaced into the text box and used as the new gain to be issued to the Vx4++.

Changing the PWM Frequency

The PWM (Pulse Width Modulation) frequency of the Vx4++ may be changed in real time by rotating the knob in the PWM box left or right to change

Gain Tool

frequency. In addition to the knob, the frequency may be entered into the text box. As with changing the gains, the Enter key does not need to be pressed, since the Gain Tool will notice the change in the keyed value. This current value will be issued to the Vx4++ card as a new frequency.



Note: If the entered value for the PWM frequency is too large, the maximum frequency value will be placed into the text box and used as the new PWM to be issued to the Vx4++.

Changing the Field Current

The field current of the Vx4++ may also be changed in real time using the knob in the Field box to rotate left or right, thus changing the field current. In addition to the knob, the field current may be entered into the text box. As with changing the gains, the Enter key does not need to be pressed, since the Gain Tool will notice the change in the keyed value. This current value will be issued to the Vx4++ card as a new field current. The field current values have different ranges for different motor types, if the motor type of BRUSHTYPE DC is used, the field current has no effect and therefore is disabled for this motor type.



Note: If the entered value for the field current is too large, the maximum value will be placed into the text box and used as the new field current to be issued to the Vx4++.


Changing the Current Offset

The current offset of the Vx4++ may be changed in real time using the knob in the Offset box to rotate left or right, modifying the current offset. In addition to the knob, the current offset may be entered into the text box. Again, the enter key does not need to be pressed, since the Gain Tool will notice the change in the keyed value. This current value will be issued to the Vx4++ card as a new current offset.



Note: If the entered value for the current offset is too large, the maximum value will be placed into the text box and used as the new current offset to be issued to the Vx4++.

Changing the Motor Type

There are two simple methods available for changing the current motor type used with the Vx4++. First the motor type may be selected under the **Motor** menu, selections are **BrushType DC**, **Brushless DC**, and **AC Induction**. It may also be changed by right clicking on the motor image  and selecting the desired motor type from the list. Notice that inside the **Motor** menu and popup menu, the motor type currently selected will have a check mark beside it.

Saving Vx4++ Parameter Values and Linking into DSPL Programs

The values from the Vx4++ Gain window and Vx4++ Settings window (discussed below) can be saved to a DSPL initialization file and then linked into any DSPL program for future use. To save the values, select **Save** under the **File** menu. The values will be saved to the file called INIT_VX4.HLL, which will be located in the directory containing the Mx4pro Development Tools program. After the file has been saved, it can be linked to any DSPL file by using the DSPL directive **#include**. For more information on include files and the DSPL language refer to the *DSPL Programmer's Guide*. The following simple example shows how to include the saved initialization file and how to call it from within a motion program:

```
#include "C:\Mx4proV5\init_vx4.hll"    ; Assumes Mx4pro V5 exists
                                      ; in C:\Mx4proV5 directory
:
:
MOTION PROGRAM:
:
:
call(INIT_VX4)      ;Calls the saved gains initialization file
:
:
END
```



Note: All Vx4++ parameters and the Kp, Ki, Kf, and Kd gains from the Mx4 will be saved. Before using the INIT_VX4.HLL file in an application, review the file first.

Closing Vx4++ Gains Window

To close the Vx4++ Gains Window, select **Close** under the **File** menu or in the popup menu. The window position and dimensions will be saved when the window is closed, then next time the Vx4++ Gains window is opened it will appear in the same location.

Vx4++ Fixed Parameter Settings Window

From within the Vx4++ Gains window, the Vx4++ Fixed Parameter Settings window may be opened. To open the window either select **Setup** under the **File** menu or from within the popup menu.

The Vx4++ Settings window displays the encoder lines per revolution, number of motor poles, commutation option, current limit, and motor parameter for the current axis of focus. From within this window all of these values may be modified. The Settings window appears as follows:

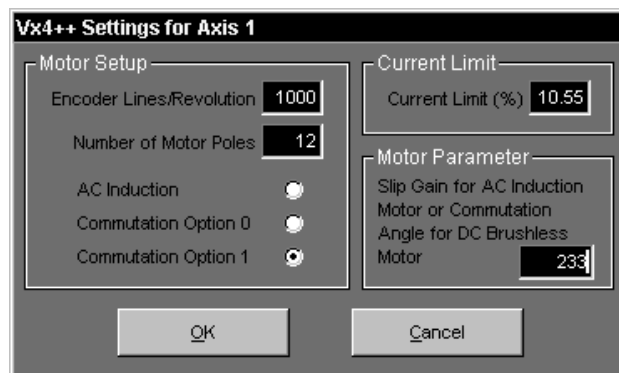


Fig. 8-3: Vx4++ Settings window in Gain Tool

Motor Setup

From within the Motor Setup group, the encoder lines per revolution, number of motor poles, and commutation option may be programmed. To set the desired values enter the values in the text boxes (don't need to press enter) and click on

Gain Tool

the desired commutation option. The range for the encoder lines per revolution is 1 to 8191. The range for the poles is 0 to 256.



Note: If the entered value for either the encoder lines per revolution or number of motor poles are outside the range of allowable values, the Setting window will not close after selecting **OK** and a message will appear noting the source of the problem.

Current Limit

From within the Current Limit group, the current limit may be selected. To set the desired value enter the percentage of current limit (0 to 100%) in the text box, the Enter key does not need to be pressed.

Motor Parameter

From within the Motor Parameter group, the slip gain (AC Induction motor) or commutation angle (DC Brushless motor) may be selected. To set the desired value enter the motor parameter (-32768 to 32767) in the text box. The Enter key doesn't need to be pressed.



Note: If the entered value for motor parameter is outside the range of allowable values, the Setting window will not close after selecting **OK** and a message will appear noting the source of the problem.

Transmitting the Settings to the Vx4++

After selecting the encoder lines per revolution, number of motor poles, commutation option, current limit, and/or motor parameter, these values may be issued to the Vx4++ by clicking on the **OK** button. To cancel the Settings, that is not issue the currently selected values to the Vx4++, select the **Cancel** button.

9 Signal Generator



Click button to open Signal Generator Tool

The Mx4pro Development Tools contain a signal generator which is useful for optimizing your system. The signal generator is able to generate either trapezoidal or sinusoidal velocity profiles. This chapter will explain how to start and use the Signal Generator Tool.

Signal Generator Tool

The Signal Generator Tool allows trapezoidal and sinusoidal velocity profiles to be configured, started, and stopped for all axes. To open the Signal Generator Tool click on the Signal Generator Tool button on the main Mx4pro Development Tools. The following window will appear:

Signal Generator

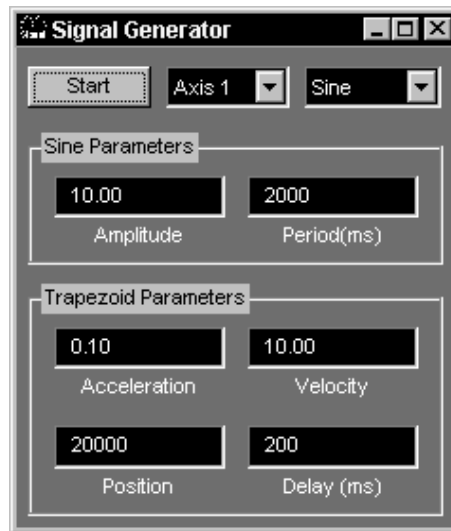


Fig. 9-1: Signal Generator Tool

To start the signal generation click on the **Start** button, the start button will now display **Stop**. After the motion has started, clicking on the **Stop** button will stop the motion. The axis on which the motion should occur can be selected from the drop box next to the **Start/Stop** button, scroll down the list and select the desired axis. To select the desired velocity motion profile, trapezoidal or sinusoidal, simply select **Trapezoid** or **Sine** from the dropdown box. Before starting the motion you must also configure the profile, described below.



Note: It is the responsibility of the user to set the control gains for an axis before the signal generator is run for that axis. If the control gains are not set by the user, the signal generator may not generate axis motion as expected.



Note: When the signal generator starts, the MAXACC value for the specified axis is changed to 1.0 counts per $(200 \mu\text{sec})^2$.

Sinusoidal Profile

There are two parameter fields for the Sinusoidal velocity profile. The first is the **Amplitude**, this controls the amplitude of the velocity for the sinusoidal signal and has units of counts per 200 μsec . The other parameter field is **Period**, this field controls the period of the sinusoidal signal in units of milliseconds.

Trapezoidal Profile

The trapezoidal profile, which is generated using an Mx4 AXMOVE command, contains four parameter fields for customizing the Trapezoidal velocity profile. The first field is **Acceleration**, which is the value (in counts per $(200 \mu\text{sec})^2$) used to accelerate from the current velocity to a new target velocity. Another field is **Velocity**, this value is (in counts per 200 μsec) the target velocity for the motion. The Velocity corresponds to the amplitude of the trapezoidal velocity profile. The third parameter is **Position**, which is the value of the target position for a motion. That is, the motion will oscillate between 0 and the target position. The final parameter, **Delay**, specifies the amount of delay in milliseconds between the positive and negative direction of the motion.



Note: The signal generator makes use of the DSPL programming language, therefore any existing DSPL program loaded on the Mx4 card will be overwritten.



Note: The signal generator will turn off automatically whenever the sine or trapezoid parameters are modified, or when the type of signal is changed.

Signal Generator

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10 Scopes



The Mx4pro Development Tools supports three separate real-time scopes while in Bus mode and a single real-time scope while in Serial mode. The scopes allow the state variables of the Mx4 to be viewed graphically as they change with time. The Mx4 state variables are position, velocity and error of each axis. Two different types of scopes are available, a Time Scope and a XY Scope. This chapter will explain how to start and use all of the supported scopes.

Scope Tool

The Scope Tool allows the Time and XY scopes to be started. To open the Scope Tool click on the Scope Tool button on the main Mx4pro Development Tools. The following window will appear:

Scopes

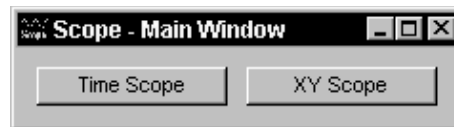


Fig. 10-1: Main Scope window in Scope Tool

To start a Time scope simply select the **Time Scope** button and to start an XY Scope select the **XY Scope** button. Again, in Bus mode a maximum of three scopes may be running simultaneously, of these three only one can be a XY Scope. In Serial mode one scope, either Time or XY may be running.



Note: Only one instance of the Main Scope Window may be executing at any time. If another Main Scope Window is commanded to open, an error message (“Could not run Scope”) will appear.



Note: Only one XY Scope can be executing at a time, if a second XY Scope is commanded to open, an error message (“An XY Scope already exists.”) will be displayed.



Note: While Mx4pro is in Serial mode and a Time or XY Scope is open, then other computationally intensive tools will operate slowly. Also, you may get error messages that certain commands were not transmitted to the Mx4. These can be partially avoided by turning one of the channels off while opening other tools.

Clicking on either of the buttons in the main scope window will cause two additional windows to appear, a **Scope Settings Window** and a **Scope Display Window** (discussed below). The two windows are paired with one another, so the Scope Settings Window titled “Scope Settings 1” controls the Scope Display window titled “Scope 1”. At any time, the Scope Settings Window for a particular Scope Display Window can be displayed by clicking the right mouse button while the pointer is inside the particular Scope display window.



Note: The Scope Tool shares resources with other Mx4 Development Tools (such as the Frequency Analyzer), therefore you may not always be able to start three scopes. An error message (“Could not open a scope. Insufficient resources. Refer to documentation.”) will be displayed if additional scopes are unable to open.

Time Scope

The Time Scope displays up to two separate Mx4 state variables (vertical axis) against time (horizontal axis). The units per division in both the vertical and the horizontal directions can be adjusted and an offset value may be specified in real-time causing the display to be “shifted” up or down as desired. Triggering options are also available when using a Time Scope. After opening a Time scope, the following two windows will appear:

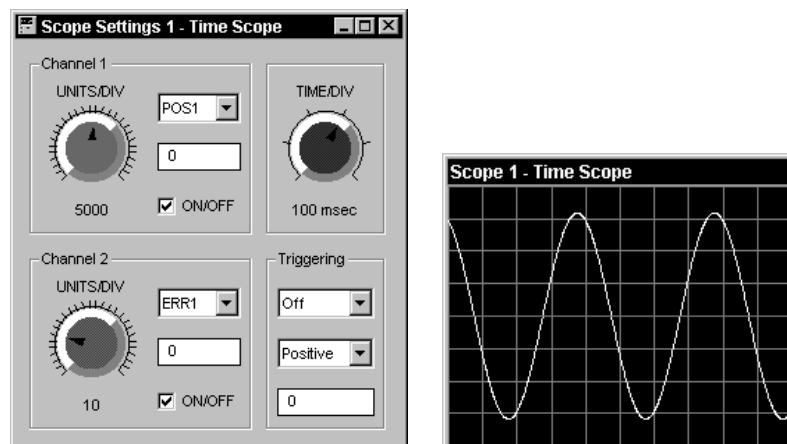


Fig. 10-2: Time Scope windows

Time Scope Channel and Time Scale Settings

From within the Time Scope Settings window, the Time Scope may be easily customized for the desired state variables to be monitored. The Channel 1 and Channel 2 groups allow the units per division, state variable being monitored, and origin offset to be selected. The channel may also be turned off and on (Figure 10-2). The following list explains each of the functions for the Channel group,

- **UNITS/DIV:** This knob controls the number of units displayed in each vertical division of the corresponding Scope Display window. The UNITS/DIV knob for Channel 1 is green and corresponds to the green trace on the Scope display window, the Channel 2 UNITS/DIV knob is red and sets the scale for the red trace. The units of each division depend on the selected state variable.
- **State Variable Selection:** One of the twelve Mx4 state variables can be displayed by either or both channels by selecting the appropriate state variable from the drop box. The current state variable is displayed in the top of the drop box. The state variables are abbreviated with the following format, **state_variable:axis_number**, for example VEL2 is the velocity state variable for axis 2. If the state variable for a channel is displaying either a POS or ERR value, then the UNITS/DIV knob specifies the number of encoder counts displayed in each division. If a VEL state variable is being displayed the UNITS/DIV specifies the number of counts per 200 μ sec are being displayed in each vertical division.
- **Origin Offset:** An offset value can be entered by the user in order to shift the corresponding trace upwards or downwards. The offset entered indicates the value of the horizontal white line (origin) for that channel in the Scope Display Window. The entered offset units correspond to the units of the selected state variable for that channel.
- **ON/OFF:** Turns the scope trace for that channel in the Scope Display window on or off. A check inside the box to the left of the ON/OFF label indicates that the corresponding trace is being displayed.
- **TIME/DIV:** This knob controls the units of time (in milli-seconds) for each horizontal division of the corresponding scope. The value selected is used as the horizontal units per division for both channels.

Triggering for Time Scopes

From within the Time Scope Settings window, the triggering for the Time Scope may be configured. First the triggering for the scope must be enabled, this is achieved by selecting **Ch.1** inside the appropriate list box (this will set the scope to trigger off state variable selected for Channel 1). To turn the triggering off, simply select **Off** in the same list box (Figure 10-2).

The Triggering can occur on either the positive or negative slope of the trace. The slope may be selected from the second list box in the Trigger Group by selecting **Positive** for a positive slope trigger and **Negative** for a negative slope trigger. The trigger offset can be set by entering the offset into the edit box in the Trigger Group, the units of offset are the same as the selected state variable for channel 1. After the triggering has been enabled the trigger slope and offset will take effect.

XY Scope

The XY Scope plots one value of the Mx4 state variable against another as the variables change with time. The units per division and offset for the scope channels may also be selected. After opening a Time scope, the following two windows will appear:

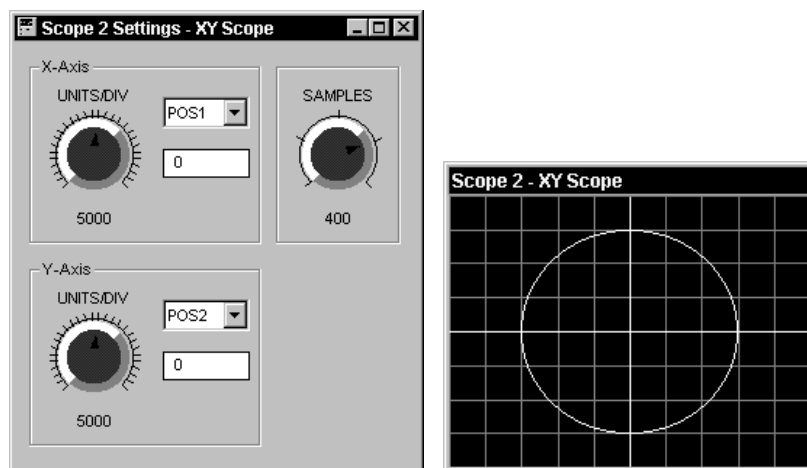


Fig. 10-3: XY Scope windows

XY Scope Axis and Sample Settings

From within the XY Scope Settings window, the XY Scope may be customized for the desired state variables being monitored. The X-Axis and Y-Axis groups allow the units per division, state variable being monitored, and origin offset to be selected. The following list explains each of the functions for the XY Scope Settings window,

- **UNITS/DIV:** This knob controls the number of units displayed in each division of the corresponding Scope Display window. The UNITS/DIV knob for the X-Axis controls the units per division for the horizontal axis and UNITS/DIV knob for the Y-Axis controls the units per division for the vertical axis on the Scope display window. The units of each division depend on the selected state variable.
- **State Variable Selection:** One of the twelve Mx4 state variables can be displayed by either or both axes by selecting the appropriate state variable from the drop box. The current state variable is displayed in the top of the drop box. The state variables are abbreviated with the following format, **state_variable:axis_number**, for example VEL2 is the velocity state variable for axis 2.
If the state variable for a channel is displaying either a POS or ERR value, then the UNITS/DIV knob specifies the number of encoder counts displayed in each division. If a VEL state variable is being displayed the UNITS/DIV specifies the number of counts per 200 μ sec are being displayed in each vertical division.
- **Origin Offset:** An offset value can be entered by the user in order to shift the corresponding axis origin. The offset entered indicates the value of the corresponding white line (origin) for the axis in the Scope Display Window. The entered offset units correspond to the units of the selected state variable for that channel.
- **SAMPLES:** This knob controls the number of samples which will be displayed on the scope. The number of samples corresponds to the number of 5ms samples in Bus mode and 10ms samples in Serial mode.

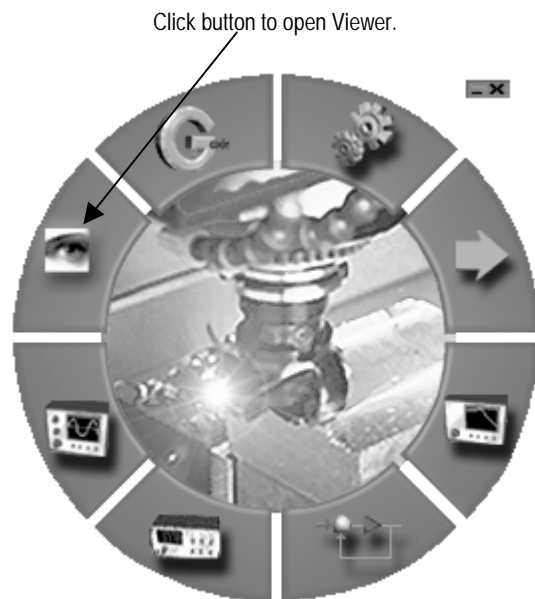
Closing Scopes

All opened scopes and the Main Scope window may be closed by closing the Main Scope window, or the individual scopes may first be closed, then the Main Scope window can be closed. If the Main Scope window is closed while scope windows are open, the next time the Main Scope window is opened the scopes which were open prior to the closing of the Main Scope window will also be opened and their previous settings will be restored. If each of the individual scope windows are closed and then the Main Scope window is closed, then all of the setting for these closed scope windows will be lost.

Scopes

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11 Viewers



After clicking on the Viewer button, the Viewer menu opens it has all the viewers for Mx4pro, a reset button, and the table downloaders in the options menu.

Viewer

The Mx4pro Development Tools supports four real-time viewers, a DSPL Variable Viewer, Inputs and Outputs Viewer, Interrupts Viewer, and State Variable Viewer. These viewers monitor the DSPL variables, Mx4 inputs, Mx4 interrupts, and the state variables in real-time. They also allow the DSPL variables to be changed, outputs to be set/cleared, and interrupts to be cleared and/or disabled. This chapter will explain how to use all of the viewers supported by the Mx4pro Development Tools.

Viewers

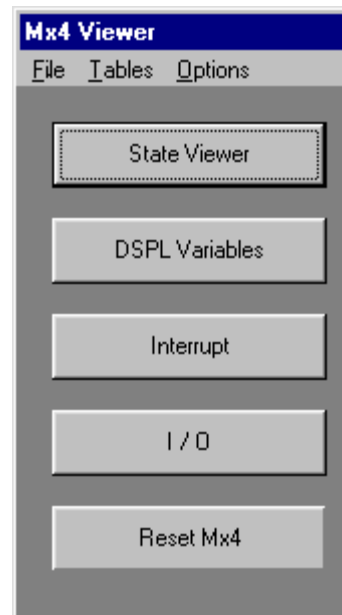


Fig. 11-1: Viewer

State Variable Viewer

The State Variable Viewer allows the position, velocity, and following error state variables for all axes to be monitored in real-time. To open the State Variable Viewer click on the State Viewer Tool button on the Mx4 Viewer. The State Variable Viewer looks as follows:

State Variable Viewer				
File				
	Axis 1	Axis 2	Axis 3	Axis 4
Position	2073	-126	80000	89999
Velocity	0.769	-2.923	0.000	0.000
Error	8	-1	0	1

Fig. 11-2: State Variable Viewer for Mx4

Viewing State Variables

The position, velocity, and following error state variables for all axes may be viewed simultaneously, the state variable names are listed down the left column and the corresponding axis for each state variable is listed across the top row. The units for the state variables are in counts for the position and following error and in counts/(200µsec) for velocity.

Pausing Updates

Updating of the state variables may be paused at any time. This can be done either by selecting **Pause Updating** under the **File** menu or in the popup menu. When the update timer is paused, a check mark will appear next to the **Pause Updating** menu item. To resume the updating, reselect **Pause Updating**. Pausing the updates to the window is a simple way to get better response time in other opened windows during serial communication.

Closing the Viewer

To close the State Variable Viewer either select **Close** under either the **File** menu or the popup menu. When the window is closed the window dimensions and window position are saved, so next time the State Variable Viewer is started it will appear in the same location as when it was closed. Also, the **Pause Updating** flag is removed when the window is closed, so next time it is opened the updating will occur.

DSPL Variable Viewer

To open the DSPL Variable Viewer click on the DSPL Variables button on the Viewer window. The DSPL Variable Viewer appears as follows:

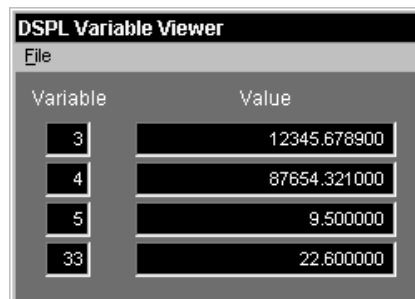


Fig. 11-3: DSPL Variable Viewer

The DSPL Variable Viewer allows all DSPL variables to be monitored and changed in real-time.

Viewing Variables

Four DSPL variables may be viewed simultaneously, the variable number in the **Variable** column corresponds to the value displayed in the **Value** column. To view a different variable, change the variable number in the **Variable** column to the desired variable number to monitor. The DSPL variables 1 through 64 may be monitored (Figure 11-3).



Note: If a MONITOR_VAR RTC is issued outside the Mx4pro Development Tools environment, then the variable numbers in the **Variable** column will NOT match the value in the **Value** column. To get them to match you must re-enter the variable numbers in the **Variable** column.

Changing Variables

To change the value of the variable itself, select the variable's corresponding **Value** column location, the value will be highlighted once it is selected. The variable value may be selected by either tabbing to the value or by clicking on the value itself. While the value is highlighted it is not updated to the DSPL Variable Viewer, at this point the new value may be entered. To make the change take effect, the value box **must** be unhighlighted. This can be done by pressing the tab key or by clicking on a different location inside the DSPL Variable Viewer window (Figure 11-3).

Pausing Updates

Updating of the variables may be paused at any time, this can be done either by selecting **Pause Updating** under either the **File** menu or the popup menu. When the update timer is paused a check mark will appear next to the **Pause Updating** menu item. To resume the updating, reselect **Pause Updating**. Pausing the updates to the window is a simple way to get better response time in other open tools during serial communication.

Closing the Viewer

To close the DSPL Variable Viewer either select **Close** under the **File** menu or in the popup menu. When the window is closed the window dimensions, window position, and selected variables are saved. The next time the DSPL Variable

Viewer is started it will appear in the same location with the same settings for the variables as when it was closed. Also, the **Pause Updating** flag is removed when the window is closed, so next time it is opened the updating will occur.

Interrupts Viewer

The Interrupts Viewer allows all the interrupts to be monitored in real-time. To open the click on the Interrupts button on the Mx4 Viewer. The Interrupts Viewer appears as follows:

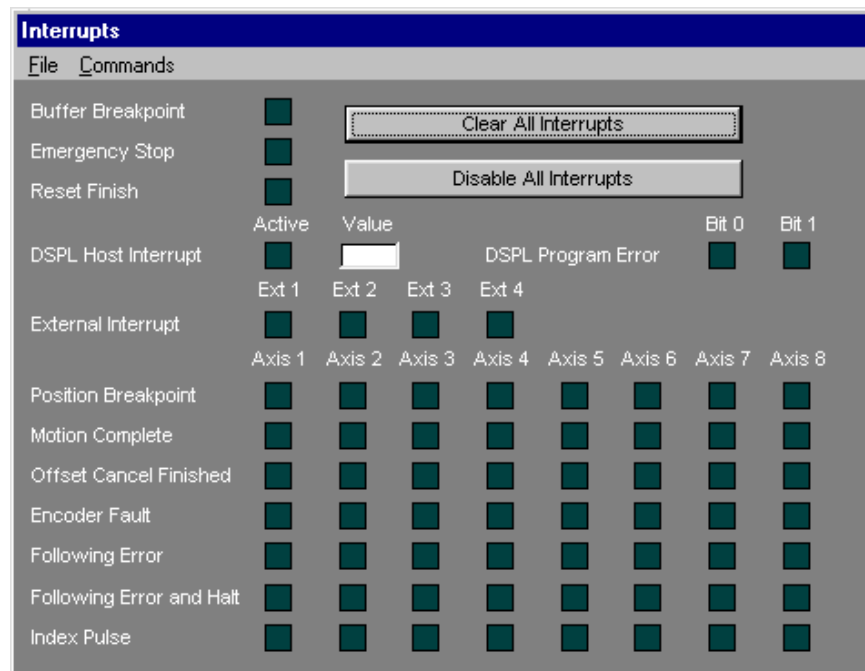


Fig. 11-4: Interrupts Viewer for Octavia

Viewing Interrupts

The Buffer Breakpoint, Emergency Stop, Reset Finished, DSPL Host, DSPL Program Error, External Int, Position Breakpoint, Motion Complete, Offset Cancel Finished, Encoder Fault, Following Error, Following Error & Halt, and Index Pulse interrupts are all monitored in real-time. When an interrupt has become active the box to the immediate right of the indicated interrupt value will

Viewers

be set (red). If the interrupt is not active, the box will be cleared (dark green). For the Position Breakpoint, Motion Complete, Offset Cancel Finished, Encoder Fault, Following Error, Following Error & Halt, and Index Pulse interrupts there are columns, one for each axis, (Figure 11-3).

Clearing and Disabling Interrupts

All interrupts may be cleared or disabled from within the Interrupts Viewer. To clear all interrupts click on the **Clear All Interrupts** button or select **Clear All Interrupts** under the **File** menu or in the popup menu.

To disable all of the interrupts, click on the **Disable All Interrupts** button or select **Disable All Interrupts** under either the **File** menu or in the popup menu.

Closing the Viewer

To close the Interrupts Viewer either select **Close** under the **File** menu or in the popup menu. When the window is closed the window dimensions and window position are saved, so next time the Interrupts Viewer is started it will appear in the same location as when it was closed.

Inputs and Outputs Viewer

The Inputs and Outputs Viewer allows all inputs and outputs to be monitored and changed, respectively, in real-time. To open the click on the I/O button on the Mx4 Viewer. The Inputs and Outputs Viewer appears as follows:

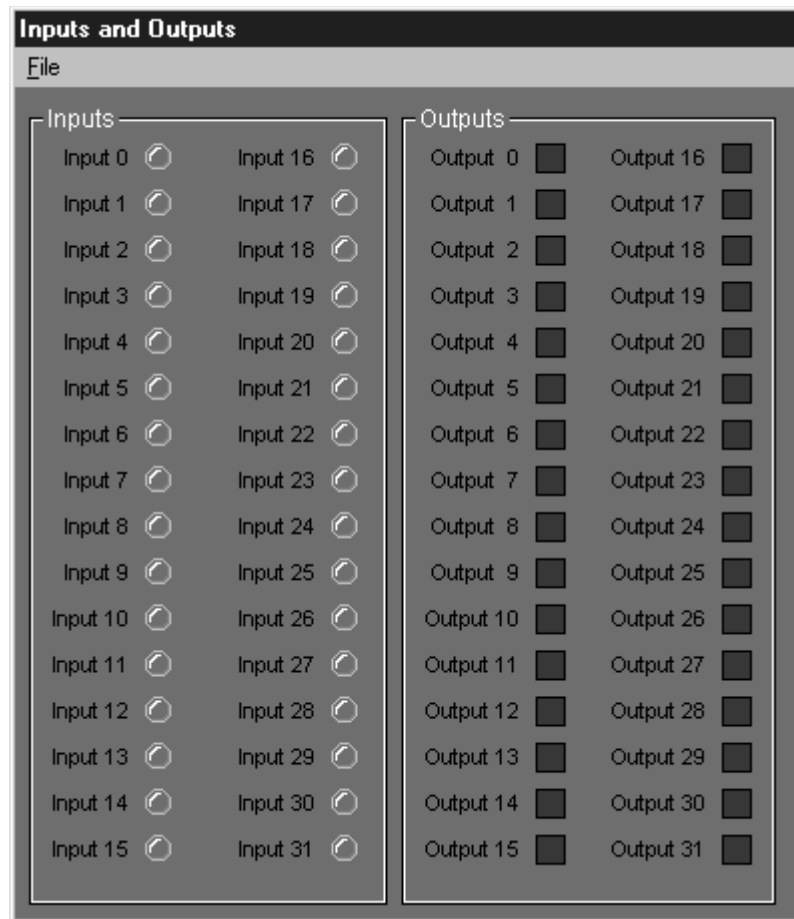


Fig. 11-5: Inputs and Outputs Viewer for Mx4 Octavia

Viewing Inputs

All standard inputs, 32 for the Mx4 Octavia and 22 for the Mx4, are monitored simultaneously. When an input is active (on) the “light” beside the input number will light up (displays red). When the input is inactive or off the “light” will turn off (displays dark green) (Figure 11-5).

Setting Output States

All standard inputs, 32 for the Mx4 Octavia and 13 for the Mx4, may be set to either an active or inactive state and they are monitored simultaneously. To set the state of an output to active click on the square box to the right of the desired output number, now the box will light up as red indicating the output has been activated. To set an output state to inactive, click on the box to the right of the desired output number, the box will then become dark green indicating that the output state is inactive (Figure 11-5).

Closing the Viewer

To close the Inputs and Outputs Viewer either select **Close** under the **File** menu or in the popup menu. When the window is closed the window dimensions and window position are saved, so next time the Inputs and Outputs Viewer is opened it will appear in the same location as when it was closed.

12 Tables

Mx4pro Development Tools allows you to manipulate four major table formats, Cubic Spline Tables; Cam Tables; Position or Velocity End Point Tables; and Position or Velocity Compensation Tables. This chapter explains how to edit and download these four tables.

Cubic Spline Table

The Cubic Spline Table Tool allows you to create, modify, and download Cubic Spline data tables. The Cubic Spline Table Tool may be opened by selecting **Cubic Spline...** under the Tables menu in the Mx4 Viewer. Now the following window will appear:

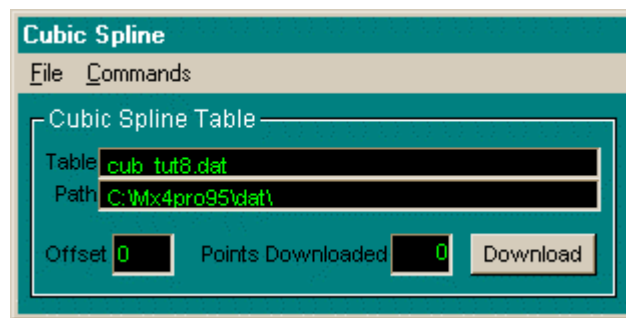


Fig. 12-1: Cubic Spline Table Tool

The Cubic Spline Table Tool displays the name and path of the opened table and the number of points that were downloaded. Furthermore, the offset starting table index download location can be set. The following sections describe how to utilize the different features of the Cubic Spline Table Tool.

Opening a Cubic Spline Table

Before a Cubic Spline data table can be edited or downloaded, it must be opened by the user. Opening a Cubic Spline table is the same as opening a DSPL program, follow this method:

1. **Open the Cubic Spline Selection window.** This can be achieved by selecting **Open...** under either the **File** menu or the popup menu (right click in the Cubic Spline Tool window), or by double-clicking inside one of the two black areas (File or Path text boxes) inside the Cubic Spline Tool window (Figure 12-2).
2. **Select the Cubic Spline Table File.** To open a file, browse your hard drive to the path where your table will exist or does exist, then click on the filename or enter the file name in the **File Name** text box. Notice, there is a **File Type** filter. After your file has been selected, click on the **OK** button to accept your selection or the **Cancel** button to disregard your selection (Figure 4-2).

Editing a Cubic Spline Data File

After a Cubic Spline table has been opened, it can be edited by either selecting **Edit Table** under the **File** menu or in the popup menu (right clicking in the Cubic Spline Table window).

The Cubic Spline Tables can have one of the following formats (for a 4-axis table):

Position Point 1	⇐ Axis 1
Position Point 1	⇐ Axis 2
Position Point 1	⇐ Axis 3
Position Point 1	⇐ Axis 4
Position Point 2	⇐ Axis 1
Position Point 2	⇐ Axis 2
Position Point 2	⇐ Axis 3
Position Point 2	⇐ Axis 4
⋮	

or:

Axis 1 Position P1	Axis 2 Position P1	Axis 3 Position P1	Axis 4 Position P1
Axis 1 Position P2	Axis 2 Position P2	Axis 3 Position P2	Axis 4 Position P2
...

The Position Points must be entered in units of counts and scaled between -2147483648 and 2147483647 counts.



Note: The data points are read from left to right and top to bottom.



Note: There should be no blank lines in the data file, a blank line will cause the next expected value to be inferred as a value of zero.

Downloading the Cubic Spline Table

Before an opened Cubic Spline Table may be downloaded, the offset starting index for the download must be set (Figure 12-1).

The offset is the position in the Mx4's Cubic Table where the opened Cubic Spline data file will begin to be downloaded to. If the opened Cubic Spline data file is too large for the area between the chosen offset and the end of the Mx4 Cubic Spline table, an error message will appear. To select an offset, simply enter an offset value between 0 and 4095 into the **Offset** text box.

Now the opened Cubic Spline table may be downloaded to the Mx4 card. This can be achieved by clicking on the **Download** button or by selecting **Download Cubic Table** under the **Commands** menu or in the popup menu (right click in the Cubic Spline Table Tool window). Once the table download has completed, the number of points actually downloaded to the Mx4 Cubic Spline table is displayed in the **Points Downloaded** box.

Clearing Cubic Spline Table

All entries in the Mx4 Cubic Spline table may be set to 0 (i.e. cleared) by selecting **Clear Cubic** under the **Commands** menu.

Closing Cubic Spline Table Tool

To close the Cubic Spline Table Tool, select **Close** under the **File** menu or the popup menu. The opened table name and path, window position, and window dimensions will be saved. Next time the Cubic Spline Table Tool is opened, the saved table will be opened and the window will appear as it did before it was closed.

Cam Tables

The Cam Table Tool allows you to create, modify, and download a table of Cam master/slave position points. The Cam Table Tool may be opened by selecting **Cam Tables...** under the Tables menu in the Mx4 Viewer. Now the following window will appear:

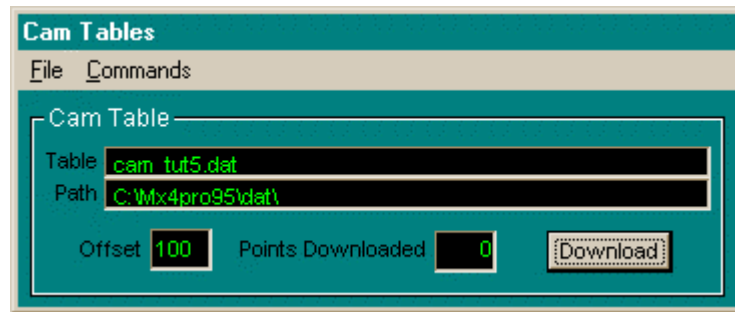


Fig. 12-2: Cam Table Tool

The Cam Table Tool displays the name and path of the opened table and the number of points that were downloaded. Furthermore, the offset starting table index download location can be set.

Opening a Cam Table

Before a Cam data table can be edited or downloaded, it must be opened by the user. Opening a Cam table is the same as opening a Cubic Spline table, follow this method:

1. **Open the Cam Data File Selection window.** This can be achieved by selecting **Open...** under either the **File** or the popup menu (right click in the Cam Table Tool window), or by double-clicking inside one of the two black areas (File or Path text boxes) inside the Cam Table Tool window (Figure 12-2).
2. **Select the Cam Table File.** To open a file, browse your hard drive to the path where your table will exist or does exist, then click on the filename or enter the file name in the **File Name** text box. Notice, there is a **File Type** filter. After your file has been selected click on the **OK** button to accept your selection or the **Cancel** button to disregard your selection (Figure 4-2).

Editing a Cam Data File

After a Cam table has been opened, it can be edited by either selecting **Edit Table** under the **File** menu or in the popup menu.

The Cam Tables must have the following format:

Master axis position	Slave axis position	1
Master axis position	Slave axis position	2
Master axis position	Slave axis position	3
Master axis position	Slave axis position	4
⋮		

The Cam Master and Slave Position Points must be entered in units of counts and scaled between -2147483648 and 2147483647 counts (see *DSPL Programmer's Guide* or *Mx4 User's Guide* manuals for descriptions of the CAM command for further description on Cam operation).



Note: The data points are read from left to right and top to bottom.



Note: There should be no blank lines in the data file, a blank line will cause the next expected value to be inferred as a value of zero.

Downloading the Cam Table

Before an opened Cam Table may be downloaded, the offset starting index for the download must be set (Figure 12-2).

The offset is the position in the Mx4's Cam Table where the opened Cam data file will begin to be downloaded to. If the opened Cam data file is too large for the area between the chosen offset and the end of the Mx4 Cam table, an error message will appear. To select an offset, simply enter an offset value between 0 and 1600 into the **Offset** text box.

Now the opened Cam table may be downloaded to the Mx4 card. This can be achieved by clicking on the **Download** button or by selecting **Download Cam**

Tables

Table under the **Commands** menu or in the popup menu. Once the table download has completed the number of points actually downloaded to the selected Mx4 Cam table is displayed in the **Points Downloaded** box.

Clearing Cam Tables

All entries in the Mx4 Cam tables may be set to 0 (i.e. cleared) by selecting **Clear Cam Table** (clears the currently selected table only) or **Clear All Tables** (clears both Cam tables) under the **Commands** menu.

Closing Cam Table Tool

To close the Cam Table Tool, select **Close** under the **File** menu or in the popup menu. The opened table name and path, window position, and dimensions will be saved. Next time the Cam Table Tool is opened, the saved table name will be re-opened and the window will appear as it did before it was closed.

Position and Velocity Compensation Tables

The Position and Velocity Compensation Tables Tool allows you to create, modify, and download tables of Position or Velocity compensation points. The Position and Velocity Compensation Tables Tool may be opened by selecting **Position/Velocity Tables...** under the Tables menu in the Mx4 Viewer. Now the following window will appear:

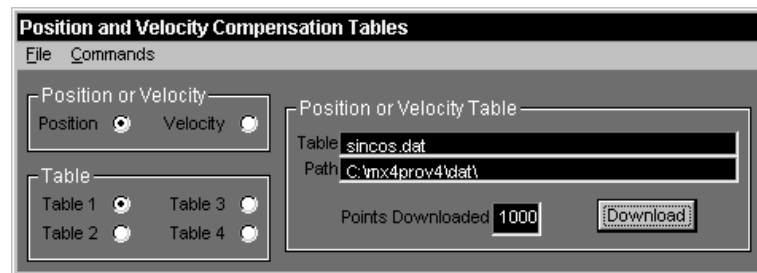


Fig. 12-4: Position and Velocity Compensation Tables Tool

The Position and Velocity Compensation Tables Tool displays the name and path of the opened table and the number of points that were downloaded. Furthermore, the table number and type of table to download to can be set. The following sections describe how to utilize the different features of the Position and Velocity Compensation Tables Tool.

Opening a Position or Velocity Compensation Table

Before a Position or Velocity Compensation data table can be edited or downloaded, it must be opened by the user. Opening a Position or Velocity Compensation table is the same as opening a Cubic Spline table, follow this method:

1. **Open the Position and Velocity Compensation Data File Selection window.** This can be achieved by selecting **Open...** under either the **File** menu or in the popup menu (right click in the Position and Velocity Compensation Tables Tool window), or by double-clicking inside one of the two black areas (File or Path text boxes) inside the Position and Velocity Compensation Tables Tool window (Figure 12-4).
2. **Select the Position or Velocity Compensation Table File.** To open a file, browse your hard drive to the path where your project will exist or does exist, then click on the filename or enter the file name in the **File Name** text box. Notice, there is a **File Type** filter. After your file has been selected, click on the **OK** button to accept your selection or the **Cancel** button to disregard your selection (Figure 4-2).

Editing a Position or Velocity Compensation Data File

After a Position or Velocity Compensation table has been opened, it can be edited by selecting **Edit Table** under the **File** menu or in the popup menu.

The Position or Velocity Compensation tables must have the following format:

Compensation Point 1
 Compensation Point 2
 Compensation Point 3
 Compensation Point 4

⋮

The Compensation Points, which must be all Position or all Velocity Compensation values, are 16-bit two's complement numbers. The Compensation Points may be represented in exponential form (i.e. 0.12345e+002) or in floating point form (i.e. 12.345).

Tables



Note: The data points are read from left to right and top to bottom.



Note: There should be no blank lines in the data file, a blank line will cause the next expected value to be inferred as a value of zero.

Downloading a Position or Velocity Compensation Table

Before an opened Position or Velocity Compensation Table may be downloaded the position or velocity table number and type of table (position or velocity) to download to must be set (Figure 12-4).

The Mx4 contains four tables for each the position and velocity compensation points. The tables are referred to as table 1 through table 4. To select which table to download to, simply click on **Table 1**, **Table 2**, **Table 3**, or **Table 4** (representing tables 1, 2, 3, and 4 respectively in the Mx4) in the **Table** group.

The table type must also be specified so the downloader will download the opened Position or Velocity Compensation table to the correct table in the Mx4. To download the opened Position or Velocity table to a Position table, select **Position** in the **Position or Velocity** group, to download to a velocity table select **Velocity**.

Now the opened Position or Velocity Compensation table may be downloaded to the Mx4 card. This can be achieved by clicking on the **Download** button or by selecting **Download Table** under the **Commands** menu or in the popup menu. Once the table download has completed, the number of points actually downloaded to the selected Mx4 Position or Velocity Compensation table is displayed in the **Points Downloaded** box.

Clearing Position and Velocity Compensation Tables

All entries in the Mx4 Position and Velocity Compensation tables may be set to 0 (i.e. cleared) by selecting **Clear Table** (clears the currently selected position or velocity table only) or **Clear All Tables** (clears all Position and Velocity Compensation tables) under the **Commands** menu.

Closing Position and Velocity Compensation Tables Tool

To close the Position and Velocity Compensation Table Tool, select **Close** under the **File** menu or in the popup menu. The opened table name and path, and the window position and dimensions will be saved. Next time the Position and Velocity Compensation Tables Tool is started the saved table name will be reopened and the window will appear as it did before it was closed.

Tables

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13 GCode Development Tools



The Mx4pro GCode Developer is a complete GCode development tool including a graphical interface along with a powerful GCode to DSPL cross-compiler. This chapter will give a brief introduction to the GCode Developer for a more complete explanation consult the *GCode User's Guide*.

GCode Interface

The graphical interface is used to control gcode execution. In addition to Mx4 GCode's many features, it may be used in conjunction with the Mx4pro development tools to provide the user with an unparalleled motion control development platform. To open the Gcode Development Interface click on the

GCode button on the main Mx4pro Development Tools. The following window will appear:

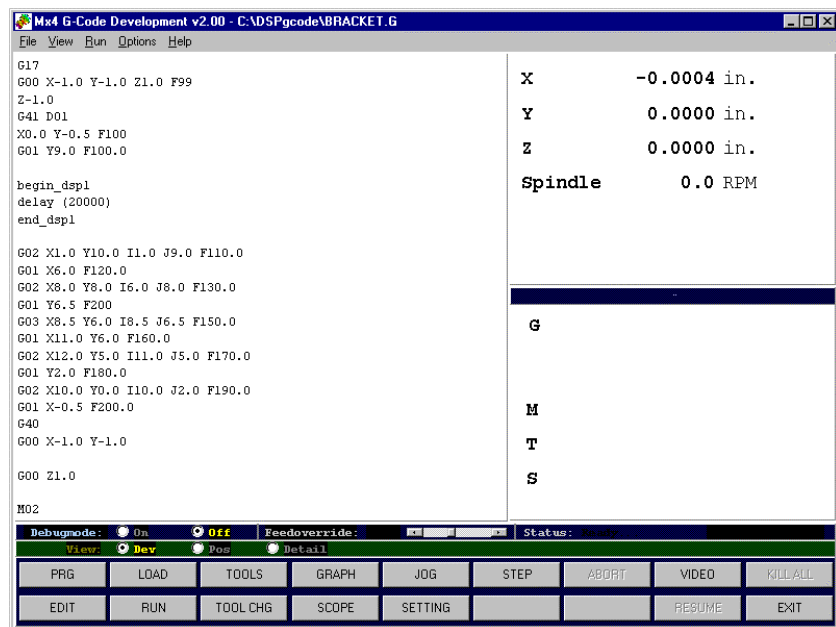


Fig. 13-1: Mx4 GCode Interface

Using the GCode Interface

A simple explanation of the major features is below, consult the *GCode User's Guide* for a complete explanation.

Open GCode

Once a file has been opened, it may be edited, compiled, run, etc. You may open a G-Code ASCII file by either selecting Open G Code in the file menu or pressing PRG key in the main display window. Assuming that the GRAPH window is opened, opening a pre-loaded program will also open its' graphic file. Otherwise to see the graph program file must first be loaded.

Edit GCode

The EDIT button is used to invoke the editor on the G code file which is opened in the development tool. The editor may be selected by the options Select Editor command. After a file has been edited, it must be refreshed (see Refresh Gcode) in order for the updated file to be loaded into the development tool.

Load GCode

The LOAD button invokes the cross-compiler which converts the G code file into a DSPL (the Mx4's native language) file and downloads this file to the Mx4 controller. This function also generates the XY/YZ/ZX plane view display. Any errors and/or warnings which occur during the compile will be displayed. The download will not be executed.

Run GCode

The RUN button is used to initiate the execution of a G code file which has been compiled (in run mode) and downloaded to Mx4. Again, note that the development tool must be in run mode before the Run GCode command can be used. As the G code file is being executed, the 'active' G code line is hi-lighted in the file text window.

Gcode Development Tools

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14 Advanced Topics

This chapter discusses the advanced topics of the Mx4pro Development Tools. The Mx4pro Development Tools may be configured in several different ways. For example, Mx4pro can use Serial or Bus communications. Some of Mxpro's configuration parameters must be modified inside the Windows Registry, while others can be modified within the Mx4pro Development Tools. The following is a list of the configurations which must be altered within the Windows Registry (discussed later in this chapter):

- Initial Mx4 Card Address
- Mx4 IRQ level
- Communication type (Serial communications port)
- Slave Node Address
- Other communication specifics (baudrate, timeouts, etc.)

The configurations that may be specified within Mx4pro Development Tools are as follows:

- The editor used for editing files
- The update intervals for the Viewers
- The current Mx4 card address on the PC Bus
- The priorities of the critical sections used to share resources

Besides these configurations, several commands may be executed to control the communications between the Mx4pro Development Tools and the Mx4 itself. The following is a list of such commands:

- Reset Serial communications (only if in Serial mode)
- Reset the update timer for the sampling routines for all Scopes
- Reset the Mx4 card itself

All of the above mentioned features are discussed below.

Selecting an Editor

Throughout the Mx4pro Development Tools editor is used to edit DSPL, G Code, Tables, etc. Mx4pro Development Tools defaults to the **C:\WINDOWS\notepad.exe** editor, if this editor is not found, an error message stating that an editor must be selected will appear. The editor used to edit these files can be any text editor that can take a filename to edit as a command line argument.

To select a different editor simply select the **Select Editor...** item under the **Options** menu in the Mx4 Viewer. The file selection window (refer to chapter 4: DSPL Development) will appear. Using this selection window, browse to the drive and path containing the desired editor, then select the editor from the file list box and click **OK**. Now, during the current execution and all future executions of the Mx4pro Development Tools, the selected editor will be used for all editing within the Mx4pro Development Tools environment.

Setting Update Timer, Mx4 Address and Priorities

The update timer, current Mx4 card address, and critical sections for resource sharing can be configured from within the **Settings** window. To open the Settings window select **Custom...** under the **Options** menu in the Mx4 Viewer. The Settings window appears as follows:

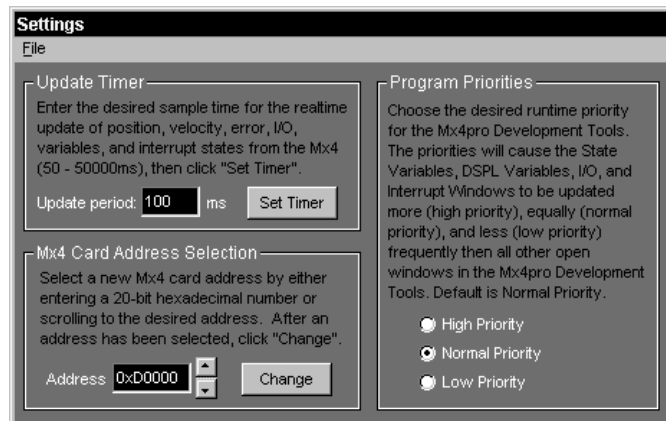


Fig. 14-1: Settings

There are three major sections to the Settings window, **Update Timer**, **Mx4 Card Address Selection**, and **Program Priorities**. Each of these three sections are discussed below.

Update Timer

The update timer specifies the interval of time between the real-time updates of the Viewer windows (DSPL Variable Viewer, Inputs and Outputs Viewer, Interrupts Viewer, and the State Variable Viewer). The default time is 100msec.

To set the timer, enter the amount of time (between 50 and 50000msec) into the **Update period** box and then click on the **Set Timer** button. This will be the value for the current and future executions of the Mx4pro Development Tool.

Mx4 Card Address Selection

The Mx4 Card Address Selection group allows the Mx4pro Development Tools communication link to be changed from the initial Mx4 address link to another Mx4 located on the PC BUS. This option does not effect Mx4pro if in Serial mode. All operations performed by Mx4pro Development Tools will then be on the newly selected Mx4 card. That is, all commands issued through the Mx4pro Development Tools will be issued to the newly specified Mx4 and all updates will come from the newly specified Mx4 card.



Note: Setting the Mx4 card address from the Settings window only effects the currently executing Mx4pro Development Tools. To set the Mx4 Card Address permanently it must be changed in the Windows Registry.

To set the Mx4 card address, enter the new Mx4 address into the **Address** selection box, the card address must be a 20-bit hexadecimal number, 0x does not have to proceed the number, i.e. 0xD0000 and D0000 will be treated the same. Besides entering the address, the scroll bar next to the **Address** edit box may be used to scroll to the desired address. After the desired address has been entered or scrolled to, click on the **Change** button to issue the change of address.



Note: If a Mx4 card is not found at the newly specified address, then the previous Mx4 address will be used.

Program Priorities

To handle resource sharing, Mx4pro Development Tools uses critical sections during all Mx4pro to Mx4 communications. The Program Priorities group allows the priority level for certain tools in the Mx4pro Development Tools to have a higher, equivalent, or lower priority than other tools. Setting the priority levels effect the tools in the following manner, the Viewer Tools (DSPL Variables, Inputs and Outputs, Interrupts, and State Variables), Gain Tool (Mx4 and Vx4++), Development Tools (DSPL and G Code), and Table Tools (Cubic Spline, CAM, Points Data, and Position/Velocity) will be allowed to update more frequently (**High Priority**), equally frequent (**Normal Priority**), or less frequently (**Low Priority**) than all other Mx4pro Development Tools.

To set the priority levels, click on the desired level, **High Priority**, **Normal Priority**, or **Low Priority**.



Note: Setting the Priorities in the Settings window only effects the currently executing Mx4pro Development Tools.



Note: Any of the graphical displays (Scope or Frequency Analyzer) will make all other open tools less responsive, while operating in Serial mode.

Resetting Serial Communications

If the communication in Serial Mode is interrupted, Mx4pro Development Tools will try to reconnect the communications in real-time. If Mx4pro is unable to reconnect the communications then the serial communications may be explicitly reset.

To reset the serial communications, select **Reset Serial Communications** under the **Options** menu or the popup menu (right click on the Mx4pro toolbar). If Mx4pro is not in serial mode, a message will appear stating that Mx4pro is not using the serial communications.

Resetting the Update Timer

During the use of the Scope Tool or Frequency Analyzer Tool in the Mx4pro Development Tools, while in BUS mode, it is possible for the interrupt supplied by the Mx4 to cease if, for example, the Mx4 is reset from the outside of the Mx4pro Development Tools environment. If the interrupt from the Mx4 is not enabled, then the Scopes and Frequency Analyzer graphical displays will not update. If this occurs, the interrupt can be reinstated by resetting the update timer.

To reset the update timer simply select **Reset Timer** under the **Options** menu or the popup menu (right click on the Mx4pro toolbar).

Resetting the Mx4

The Mx4 may be reset while using the Mx4pro Development Tools, it is suggested that the Mx4 is only reset from within the Mx4pro Development Tools. If the Mx4 is not reset from within the Mx4pro Development Tools environment while any of the Mx4pro Development Tools are executing, then certain tools will either quit updating or display incorrect information.

Resetting the Mx4 from within the Mx4pro Development Tools will reset the Mx4 and then handle all of the updating needed for the tools in the Mx4pro Development Tools. To reset the Mx4, select **Reset Mx4** under the **Options** menu or in the popup menu (right click in Mx4pro toolbar).

Advanced Topics



Note: All tools in the Mx4pro Development Tools will be unresponsive until the Mx4 has finished its reset routines.



Note: If the Mx4 card address has been changed in the Card Address selection in the Settings window described above, then that is the Mx4 which will be reset.

Configuring Communication Parameters using Registry

All of the permanent Mx4pro configuration parameters are stored in the Windows Registry. These parameters are stored under the following two keys for Windows 95/98:

HKEY_CURRENT_USER\Software\MX4
HKEY_CURRENT_USER\Software\MX4PRO

The parameters are stored under the following keys for Windows NT/2000:

HKEY_CURRENT_USER\Software\MX4
HKEY_CURRENT_USER\System\CurrentControlSet-
\Services\DspcgNT\Parameters
HKEY_CURRENT_USER\Software\MX4PRO

The keys, HKEY_CURRENT_USER\Software\MX4 and HKEY_CURRENT_USER\System\CurrentControlSet\Services\DspcgNT\Parameters contains all of the Mx4pro to Mx4 communication configuration parameters. The other key, HKEY_CURRENT_USER\Software\MX4PRO contains all of the configuration parameters which are modified from within the Mx4pro Development Tools environment.

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Note: It is suggested that only the communication parameters (HKEY_CURRENT_USER\Software\MX4) should be modified from within the Windows Registry.

Communication Configuration

There are several entries within the key HKEY_CURRENT_USER\Software\MX4 for Windows 95/98 which control the Mx4pro to Mx4 communications. The following is a list of the entries as they appear in the registry and a short description of each:

- **Address** - Represents the initial 20-bit card address. This must be a valid address, otherwise the Mx4pro Development Tools will not execute.
- **BaudRate** - Baud Rate while using serial communications (don't change).
- **Communication** - Type of communications to use, 0 for Bus, non zero for serial. If using Serial, then this number represents the port number (1-4).
- **IRQ** - Interrupt level generated by Mx4 card at address specified above.
- **Mutex_TimeOut** - Time out for critical sections (don't change).
- **Read_Back_TimeOut** - Time out for reading information back from the Mx4 (don't change).
- **Serial_TimeOut** - Time out for Serial Communications. This value is used so Mx4pro Development Tools will not "lock up" if the Serial Communications are lost.
- **SlaveNodeAddress** - Slave node address used for RS-485 communications.

There are several entries within the key HKEY_CURRENT_USER\System\CurrentControlSet\Services\DspcgNT-\Parameters for WindowsNT/2000 which control the Mx4pro to Mx4 communications. The following is a list of the entries as they appear in the registry and a short description of each:

- **Address** - Represents the initial 20-bit card address. This must be a valid address, otherwise the Mx4pro Development Tools will not execute. (Windows NT/2000)
- **Communication** - Type of communications to use, 0 for Bus, non zero for serial. If using Serial, then this number represents the port number (1-4). (Windows NT/2000)
- **IRQ** - Interrupt level generated by Mx4 card at address specified above. (Windows NT/2000)
- **NumberAxes** - The number of axes on the Mx4 card.(Windows NT/2000)

Advanced Topics

If the Mx4pro Development Tools are configured for Bus Communications then the BaudRate, Serial_TimeOut, and SlaveNodeAddress entries are ignored. If configured for Serial Communications, then the Address and IRQ entries are ignored.



Note: All of these values above are stored as double words, NOT integers.

Advanced Topics

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APPENDIX A

Tuning A System

This tuning appendix describes how the Mx4 gains are set with servo amplifier either in velocity or torque loop. The Mx4pro tools that help us in system tuning are the Gain Tool, Signal Generator and Oscilloscope. We will first overview the setting of the tools and then proceed with tuning.

Set A Gain Value

Choosing the Gain Tool allows you to set the control gains. The control block diagram for one of the 8 motors is selected by pressing the right mouse button on the Gain Tool window. You may then set the gains by either typing the values in the numerical field or using the arrow keys on the gain boxes. For example, set the proportional gain, K_p , to 1000.

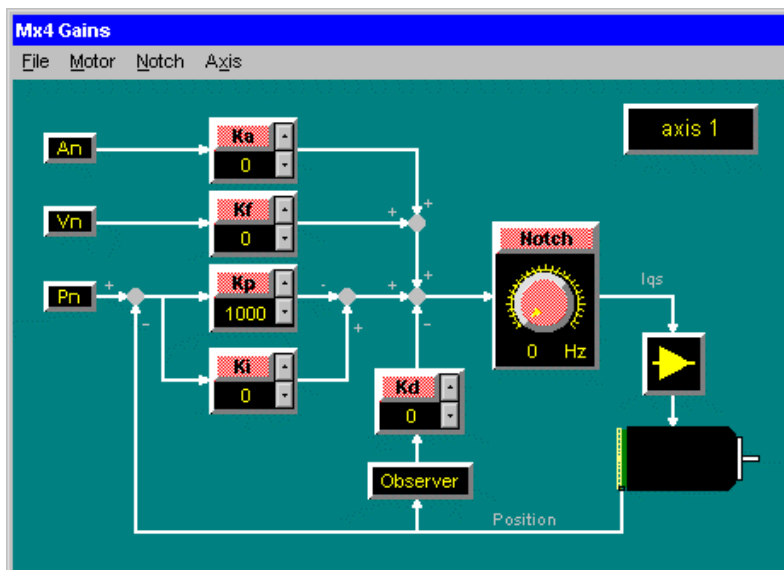


Fig. A-1: Gain Tool, K_p set to 1000

Start Signal Generator

Select Signal Generator. This option allows you to program the parameters of a short (back and forth) move along a trapezoidal, or sinusoidal trajectory.

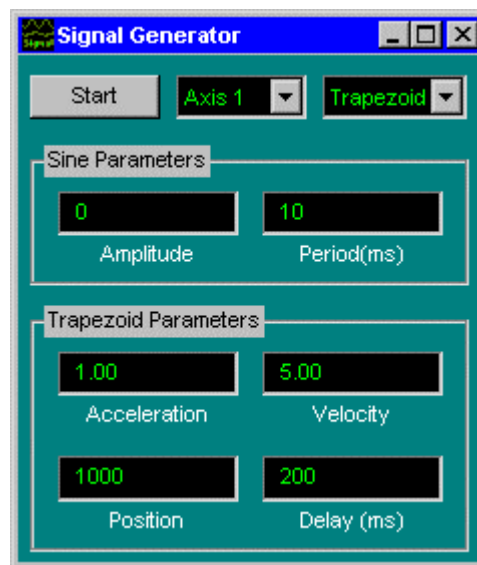


Fig. A-2: Signal Generator

The following is an example of Signal Generator motion parameters:

Acc = 1 (encoder count per 200 μ sec²)
 Pos = 1000 (encoder counts)
 Vel = 5 (encoder counts per 200 μ sec)

Delay Time = 200 msec

Start Oscilloscope

Select the Time Scope and set its Channel 1 and 2 parameters for Velocity and Position error (in this example both for motor 1)

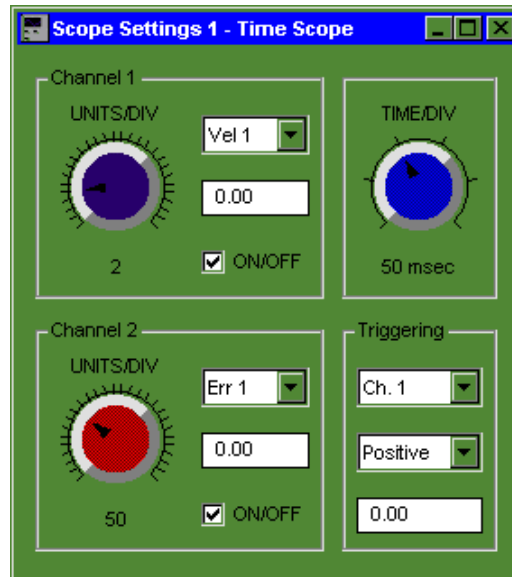


Fig. A-4: Oscilloscope Controls

The figure below illustrates real-time display of velocity and position error for motor one with 50 msec/div. time setting. To stabilize the signal trace on the scope, you may trigger the signal on its positive edge.

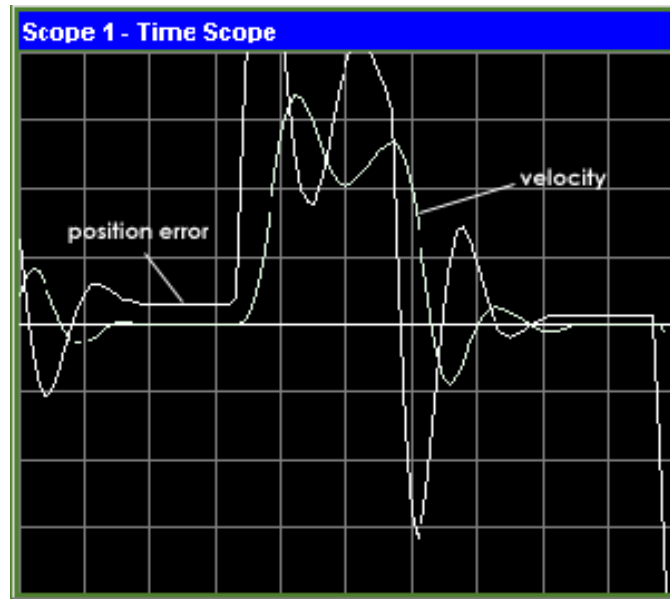


Fig. A-5: Axis 1 velocity/position error display

Proceed With Tuning

There are two methods to tune your system: *analytical* and *practical*.

Analytical method is for those who want to do things right the first time.

Proper tuning of any system requires the knowledge of its electromechanical model. This knowledge, embodied in a transfer function, helps system engineers design a control law that satisfies their application needs. For example, a punch press application requires minimum time control performance whereas machine tools demands a zero (or near zero) transient error. If your machine's mathematical model is known, using a simulation software such as Matlab, you may proceed with the control design. You can find information on the Mx4's control gains (CTRL instruction) and their scaling in Chapter 8 of the *DSPL Programmer's Guide*.

Practical method is for those who feel compelled to try things their own way.

In absence of a mathematical model for your machine, you may use the following simple steps to fine-tune your system.

Tuning A System with Servo Amplifier in Velocity Loop

Step 1: Set Feed Forward Gain, K_f

Since most servo amplifiers are already in a closed velocity loop, K_f (velocity feed-forward gain) must be set such that the velocity command is perfectly followed. In this step, you set K_f while all other gains are zero. The K_f scaling factor (see CTRL RTC in the *Mx4 User's Guide*), motor speed/volt and the encoder lines/rev., help you compute this gain accurately.

$$K_f = 9.836e + 005 \cdot \left(\frac{v/krpm}{epr} \right)$$

Where: $v/krpm$: the amplifier command volts per thousand rpm
 epr : encoder pulses per mechanical revolution

Example:

Find the K_f value for a system in which a 1v command turns motor shaft at 1,000 rpm and has a 1024-pulse (per mech. rev.) incremental encoder.

Solution:

$$v/krpm = \frac{1(\text{volts})}{1(\text{k rpm})} = 1.0$$

$$epr = 1024$$

$$K_f = 9.836e + 005 \left(\frac{1.0}{1024} \right)$$

$$K_f = 960$$

Tuning A System

This K_f setting calibrates your motor, amplifier and control combination.

Step 2: Tune proportional gain, K_p

Increasing K_p increases the position loop bandwidth and reduces the transient error. You may continue to increase K_p until velocity overshoot reaches its maximum acceptable limit. To visualize the impact of K_p on a step response, you must look at the position error and velocity signals simultaneously. Notice that the transient and steady state errors are decreased as K_p is increased.

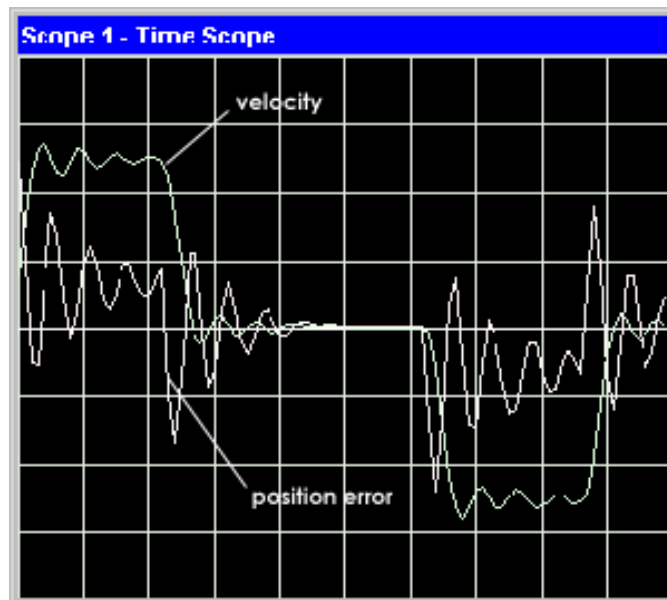


Fig. A-6: Tuning K_p

Proportional gain, K_p provides a stiffer servo performance but results in too much overshoot.

Step 3: Tune K_d Gain to Reduce Overshoot

This step is necessary only if the velocity loop damping is less than adequate. Increasing K_d provides an additional damping and reduces overshoot.

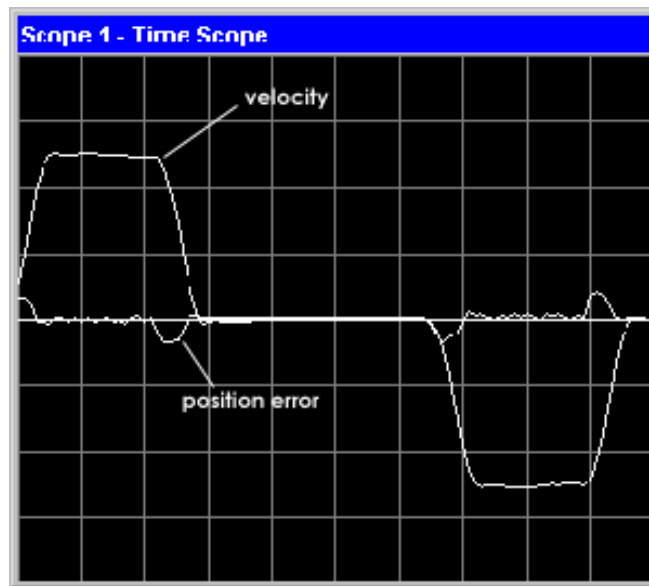


Fig. A-7: Tuning K_d to reduce overshoot

Step 4: Tuning K_i , Integral Gain, To Zero Steady-State Position Error

Systems with static friction and a need for zero steady state position error can benefit from the integral gain. Since integration effect is only desirable when a system approaches its target position, it is desirable to activate this gain only when error is small. Also, you may use $K_{i\text{limit}}$ to reduce integral channel's activity to a few bits and therefore prevents the control signal from going into saturation.

Tuning A System With Servo Amplifier In Torque Loop

Step 1: Use K_p to Close the Position Loop

Zero all the gains but K_p . Start with a relatively small K_p value (e.g. 1000). Increase K_p to reduce position error until you see large velocity overshoots.

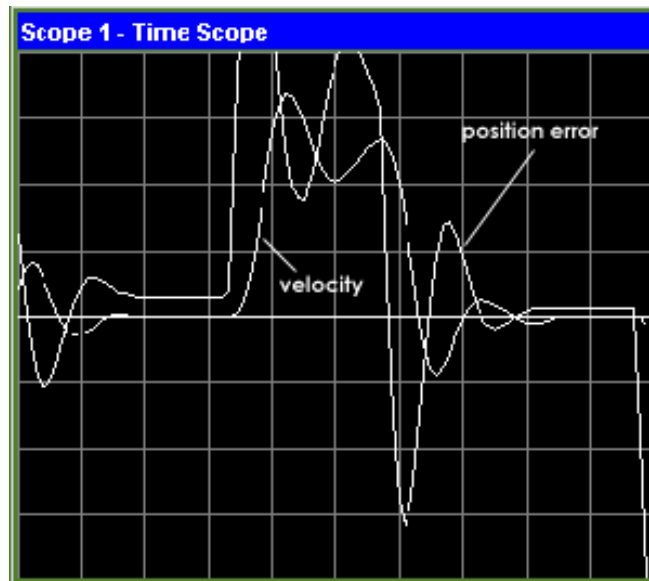


Fig. A-8: Start Tuning by Adjusting K_p to 1000

Step2: Increase K_d to reduce overshoot

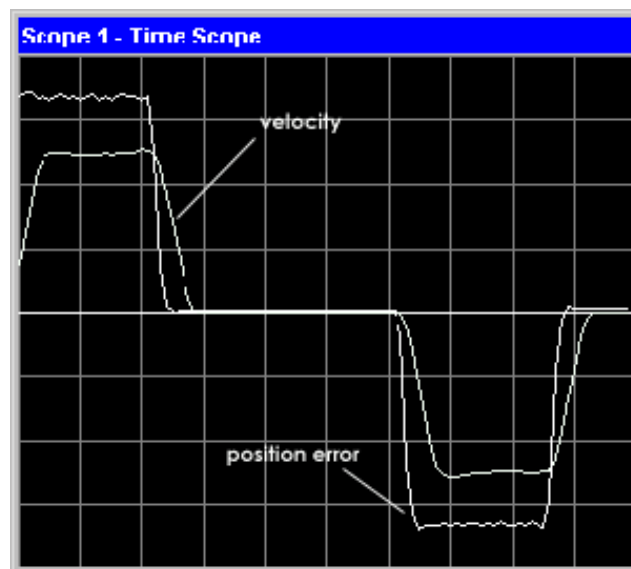


Fig. A-9: Tuning K_d to reduce overshoot

Notice that while overshoot is eliminated, the transient error is increased

Step 3: Increase K_f to reduce Transient error

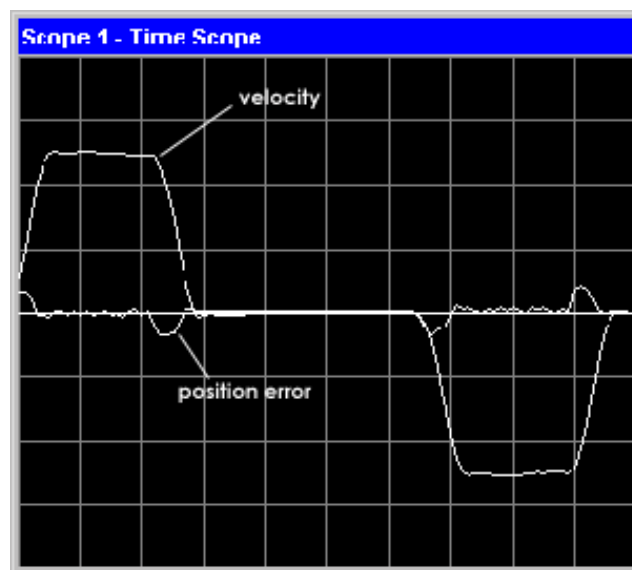


Fig. A-10: Tuning K_f to reduce transient error