Windows Servo Design Kit

WSDK

Galil Motion Control

Contents

Chapter 1 - Overview

The Windows Servo Design Kit software has been designed to help the user setup and analyze your motion controller. Windows Servo Design Kit will walk you through set-up and configuration, tuning, testing, and analysis.

The Windows Servo Design Kit software was designed for use with the following Galil Motion Controllers: DMC-1000 series, DMC-1400 series, DMC-1500 series, and DMC-1700 series. There are two versions of the Windows Servo Design Kit. WSDK16 has been designed for use with the operating systems, Windows 3.1 and Windows 3.11. WSDK32 has been designed for use with the operating systems, Windows 95 and Windows NT.

WSDK (Windows Servo Design Kit) has a number of functions that simplify the task of setting up a complete servo system. Each step of the servo system assembly process is addressed:

- Setting up communications
- Connecting the system components
- Automatic tuning of the servo motors
- Evaluation of the systems performance

Chapter 2 - Getting Started

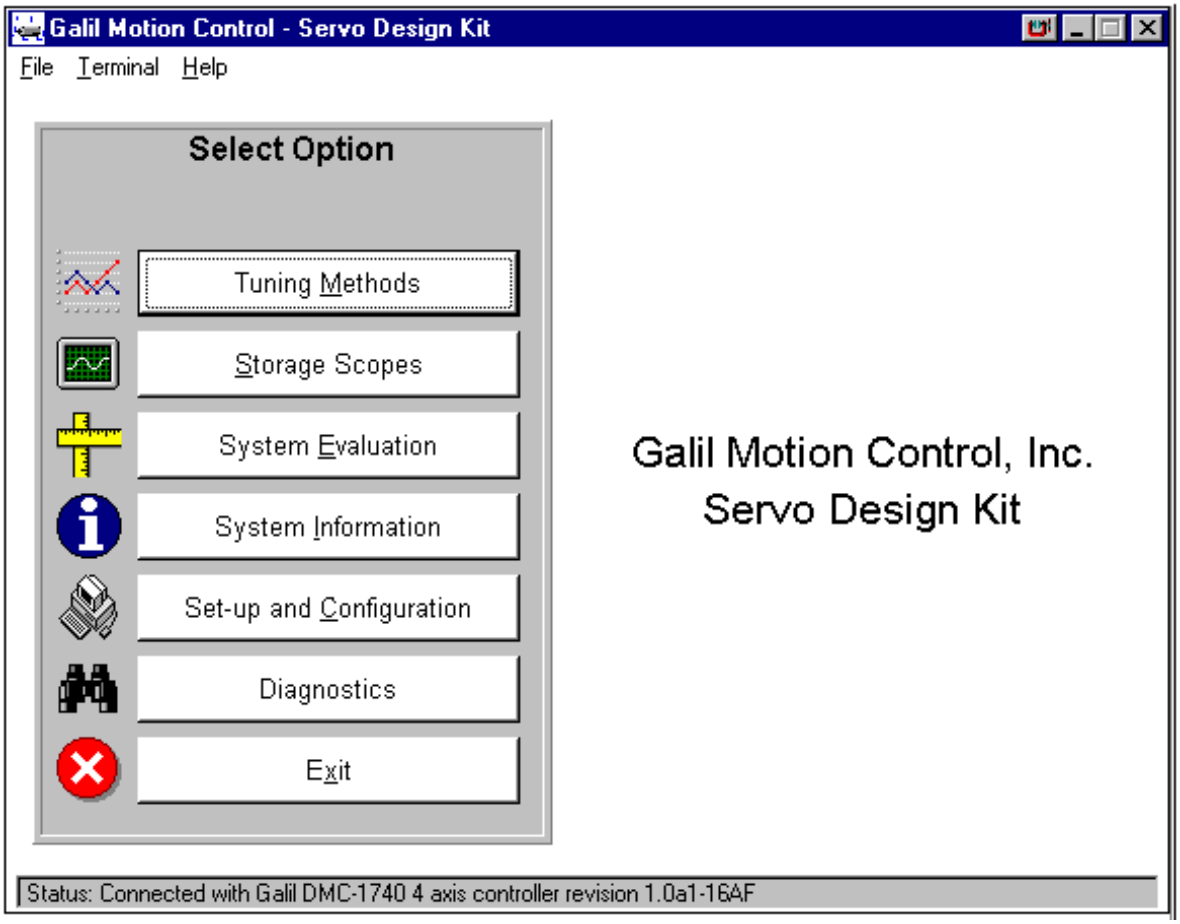
Software Installation

This software must be installed under Windows. From the Program Manager select the 'File' menu then the 'Run' option. \setup" to install the software from the b: floppy drive. WSDK will be installed and a program group created with the WSDK icon.

Note: If you are running Windows 3.1, Windows 3.11, or Windows for Workgroups 3.11 you should be installing the 16-bit version of WSDK or WSDK16. If you are running Windows 95 or Windows NT, you should be installing the 32-bit version of WSDK or WSDK32.

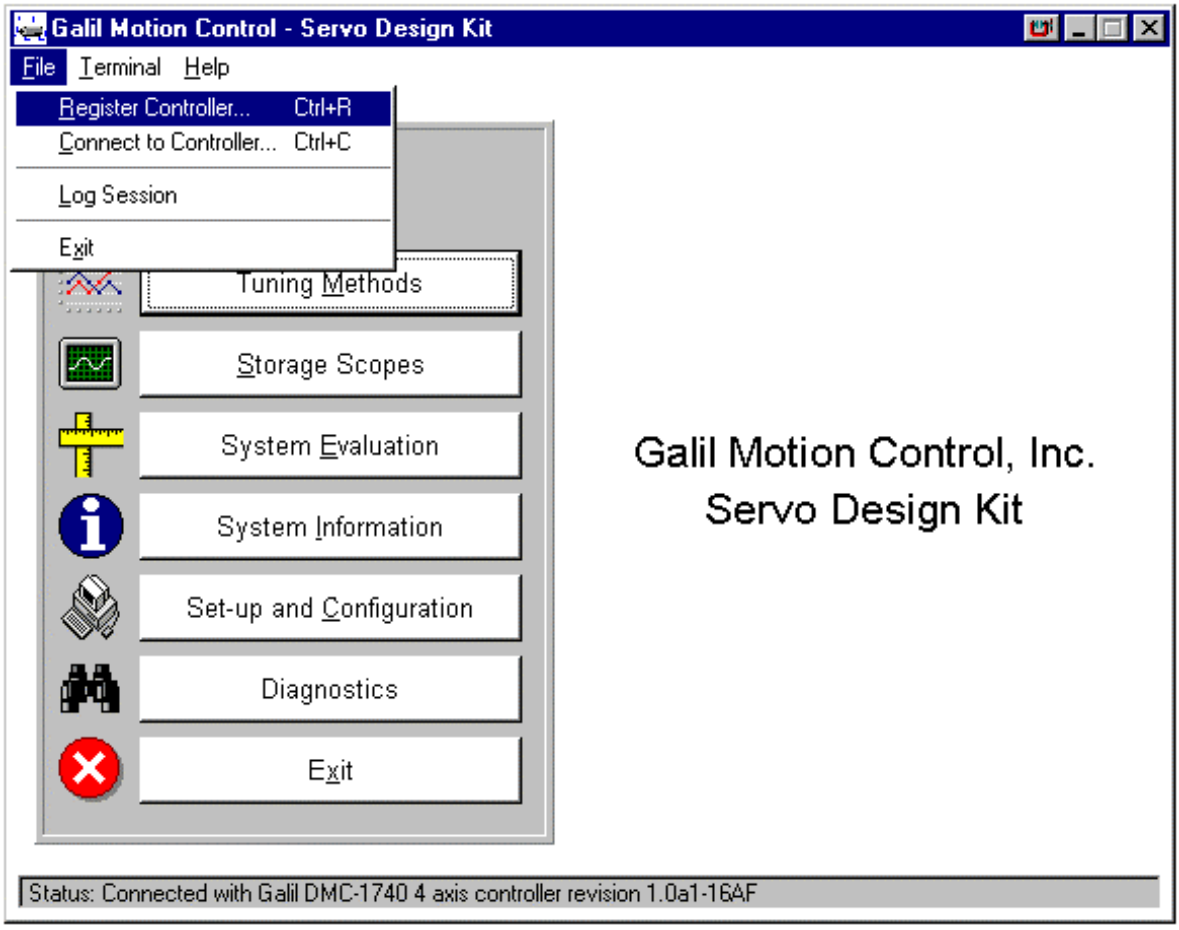
Running WSDK

Double click on the WSDK icon created during the installation process. The main window will appear. Use this window as a starting point to all the functions within WSDK. Refer to this picture in the following descriptions:



Registering the Controller and Setting Up Communications

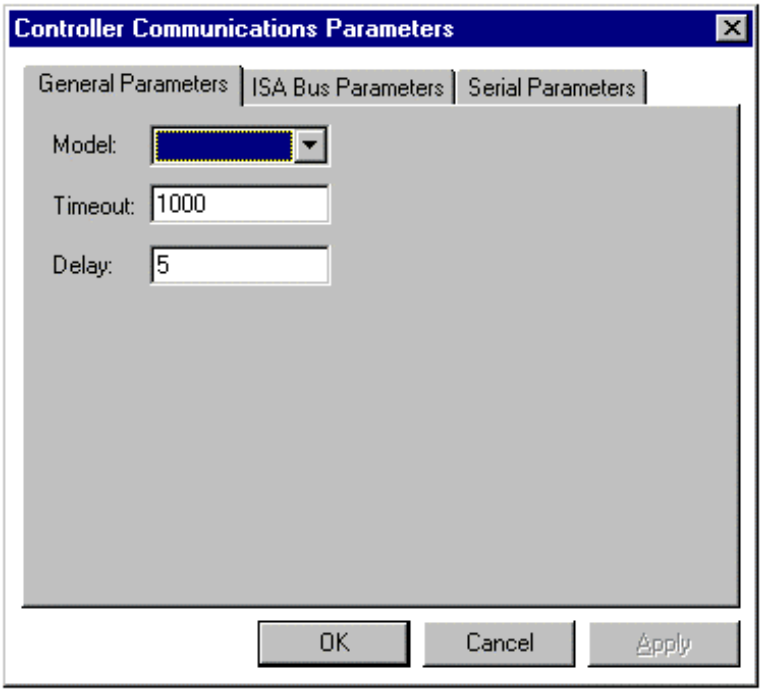
If you have not already registered your controller with Windows, you must do so before you can communicate with it. The menu item File | Register Controller (located on the main form only) will allow you to register your controller.



In order to communicate with your Galil controller, you must first register it in the Windows registry. The Windows registry is a central repository of information concerning all hardware installed on your system. To register your controller, select the "Getting Started" button on the main window, then from the Getting S
Galil Controller" button. When you click the "Add" button on the Edit Galil Registry window, the follow window will appear:

All configuration information pertaining to your motion controller is stored in the Windows registry. Once registered, the Servo Design Kit program can then communicate with the controller. To register your controller, first select the model of your controller. Then, select the relevant parameters for the type of controller you have. You only need to register your controller one time as the information is stored in permanent memory.

You may need to close the Servo Design Kit program and re-boot your system in order for the changes to the configuration to be recognized by the system.



The first action is to select the model of Galil motion controller installed. Once you have selected a model, you must then enter the appropriate parameters for that controller. For example, for a DMC-1000, you must select an I/O port address and optionally an interrupt (IRQ). For a DMC-1500, you must select the comm port and comm speed.

> *Note: Hardware handshake should always be enabled for the DMC-1500. Make sure the handshake parameter is set to hardware on this screen as well as the dip switch setting on the DMC-1500.*

Unless otherwise instructed by Galil, leave the Timeout and Delay parameters set to their default values.

Once you have entered all the necessary parameters, click the "OK" button to register your controller.

Connect to Controller

The menu item File | Connect to Controller will allow you to open a communications session with your controller.

Once you have registered your controller in the Windows registry, you may communicate with it.. If you have more than one controller registered, the Servo Design Kit program will display a window from which you may select a controller. Highlight the controller in the list box you wish to connect to with the mouse or keyboard, then click the OK button. You may also double-click on the controller in the list box.

Once your controller has been registered, you may communicate with it by selecting the "Communicate with Galil Controller" option on the Getting Started window.

> *Note: You may have to reboot your Windows system in order for the system to recognize changes made to the Windows registry. If you are unable to communicate with your controller after registering it, reboot your system.*

If you have more than one Galil controller registered in the Windows registry, you will be prompted for the controller to communicate with.

Once you have registered your controller and are connected with it, the following options are available from the main form:

Chapter 3 - Tuning Methods

From the main screen select the “Tuning” button. There are a number of tuning routines available; at least one will provide adequate tuning parameters. If one type of tuning does not provide acceptable performance try another one. If any routine provides suitable values there is no need to continue with further auto-tuning routines.

> *Note: Most routines will produce tuning parameters that are not optimal. Some manual adjustments may be required to create desired results.*

Listed below are the routines currently offered in WSDK:

- **General Tuning:** This routine will work for systems with various types of drives and amplifiers. This routine tunes the system by increasing the gain until instability occurs , then backs the gain down.
- **Conservative Tuning:** This routine tunes the system by increasing the gain until instability occurs , then backs the gain down. As the name suggests, the resulting parameters are very conservative but will provide an operational system.
- **Manual Tuning:** Unlike the other tuning methods, this is not an auto-tuning routine. All tuning parameters can be adjusted with the sliders. Whenever the values are changed they are sent to the controller giving instant feedback as to the effect those changes made to the stability of the system.

- **Crossover Frequency:** This routine produces PID parameter values that will provide the best system response at the frequency (in rads/s) specified. The crossover frequency value should be set to the bandwidth of the system for best results.
- **Automatic Crossover Frequency:** Uses the same basic tuning routines as the standard crossover but will try a number of frequencies and select the one that gives the best system response. Use this routine if the bandwidth of the system is unknown.

Tuning Methods

This form allows you to choose from one of five tuning routines by clicking on the Tuning Method combo box. The Crossover Frequency routine will let you define a crossover frequency, and then attempt to tune the axis. The Auto Crossover Frequency routine attempts to find the 'best' crossover frequency, and then tune the axis. The General Tuning routine is best suited for velocity mode amplifiers, although it will work with most any type of system. It is more 'aggressive' than the Conservative Compensation routine. The Conservative Compensation routine will try to find a gain setting that won't cause 'buzzing' or overdrive your system. The Manual Method will let you choose the gain and damping on your system.. You can tune any axis on your system by clicking on the Axis combo box.

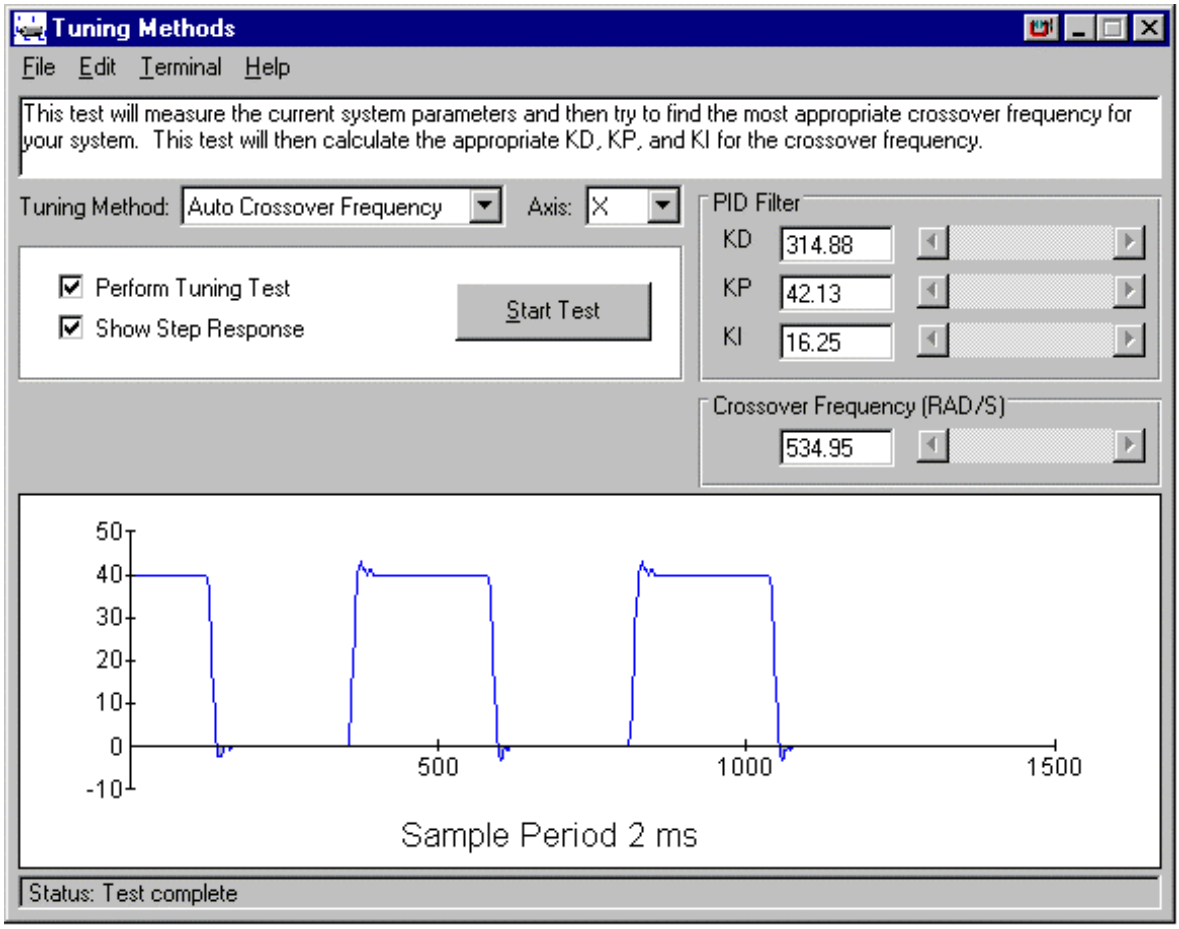
For each of the tuning methods, you may optionally display a step response based on the current PID filter settings. The step response provides a visual indication of how well your system is tuned.

Tuning Methods

Auto Crossover Frequency
Crossover Frequency

General Tuning
Conservative Compensation
Manual Method

Parameters



Auto Crossover Frequency Tuning

This test will try to tune your system for a crossover frequency that the software judges as best.

Parameters

Crossover Frequency Tuning Parameters

Crossover Frequency Tuning Parameters

This window is where you can select the auto-crossover frequency and crossover frequency tuning parameters.. Both of these tests start by sending a pulse or offset to the axis at a specified voltage and duration. You can change the values for Pulse Magnitude in volts and Pulse Duration in milliseconds. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Crossover Frequency Tuning

This test will try to tune your system for a crossover frequency that you specify. You can choose a frequency between 5 and 650 rads/sec.. The lower the frequency, the slower and more sluggish the response of your system. The higher the frequency, the faster and more responsive your system will be. The problem with lower frequencies is that your system tends to be over-damped and sluggish. The problem with higher frequencies is that your system tends to be under-damped and produces overshoots.

Parameters

Crossover Frequency Tuning Parameters

Crossover Frequency Tuning Parameters

This window is where you can select the auto-crossover frequency and crossover frequency tuning parameters.. Both of these tests start by sending a pulse or offset to the axis at a specified voltage and duration. You can change the values for Pulse Magnitude in volts and Pulse Duration in milliseconds. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

General Tuning

This test is called general tuning because it will work for systems with various types of drives and amplifiers. In this test, the system attempts to find the best value for KP while holding KD constant. Once the best KP is found for a given KD, KD is increased and the test continues. Eventually, KD can not be increased any further without causing instability and it is backed down. Then the final values for KD and KP are set. As a last step, the test finds the best value for KI.

Conservative Compensation Tuning

This is a two-part test. The first part is a "static" test, and the second part is a "dynamic" test. In the static test, the system gain is increased, while being excited with a small impulse. Once the system looses stability, the gain is backed down and the results are shown. In the dynamic test, the system gain is increased while movement is occurring. Once the system looses stability, the movement is stopped, and the gain is backed down.

Manual Method Tuning

Manual tuning provides a means of testing the responsiveness of your system. This tuning method uses the step response , which is displayed on the window, as a means of showing changes made to the PID filter. You can change the system gain and damping by clicking on the sliders or by typing in new values in the appropriate box. You can change the step response parameters by clicking on the Step Response Parameters menu item. To try out new values for KP, KD, and KI, click on the Start Test button.

Step Response Parameters

This window is where you can change the values used for displaying the step response. You can change any of the following items: Dwell Time, Step Size, Acceleration, Deceleration, and Maximum Speed, as well as some display options. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Set-up and Configuration

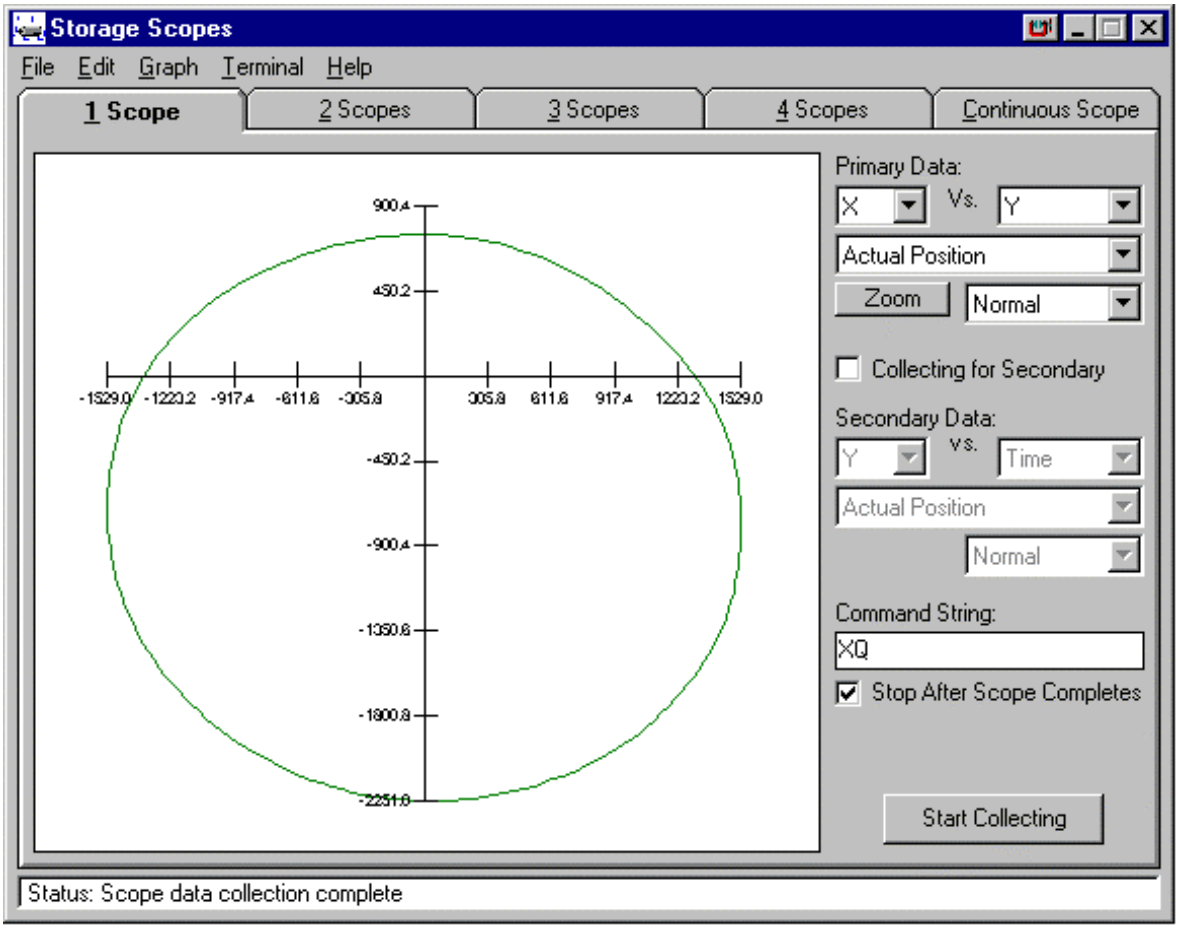
The Set Up and Configuration form is intended to be used to display and/or edit the set up parameters for your motion controller. The set up parameters are those variables which are saved in the non-volatile memory (EEPROM) of the controller when the burn (BN) command is executed. The following menu items are available.

Servo Design Kit Options

Tuning Methods
Storage Scopes
System Evalutation
System Information
Set-up and Configuration

Each of the Servo Design Kit options will display a different form. The available menu items will vary from one form to the next. Every form has a Terminal menu item from which you may communicate directly with the controller. Every form also has an Exit menu item ,which when clicked, will return you to the main form.

Chapter 4 - Storage Scopes



This form provides several emulation s of a storage scope. A storage scope can record the actions of your controller and display them on the screen. To record the controller's actions, you must first select what type of data you want to record. This is done with the various combo-boxes. It is also possible to display a derivative of the data you have recorded. For example, if you want to see velocity, you could select Actual Position as the data type and then select Derivative. It defaults to Normal. If you wish, you can save or print the storage scope data.

You may customize the appearance of the storage scope in various ways: turning grid lines on or off, showing or not showing data values, showing minimum and maximum values, and changing Data Colors.

To switch between storage scope options, click on the desired tab at the top of the screen just below the menu bar.

Storage Scope Options

Single Scope

Multiple Scopes
Continuous Scope
Scope Zoom

Storage Scope Parameters

Storage Scope Parameters

Storage Scope Data Colors

This window allows you to change the color of any of the four scope traces. The only time you will see four traces at the same time will be in the Storage Scope with 4 windows. Most of the time, you will see 1 or maybe 2 traces. Be sure to set the trace colors to something that will be easy to see.

Storage Scope (Single Scope)

This screen provides a single storage scope which is able to display two traces. To record the controller's actions, you must first select what type of data you want to record. This is done with the combo-boxes. The data type defaults to Actual Position. If you want to record two axes in coordinated motion, select which two axes to record. The axis selection combo-box is near the upper right corner. It defaults to X Axis Vs. Time.

It is also possible to display a derivative of the data you have recorded. For example, if you want to see velocity, you could select Actual Position as the data type and then select Derivative. It defaults to Normal.

If you want to have two traces on the screen, select Collecting for Secondary, then select the axis and data type. When you have set up all the collecting combo-boxes, make sure the Command String has the correct starting command for the program loaded in the controller. Click the Start Collecting button to get the data into the scope.

Storage Scope (Multiple Scopes)

These screens provide two, three, or four storage scopes. To record the controller's actions, you must first select what type of data you want to record. This is done with the combo-boxes. The data type defaults to Actual Position. Each scope is capable of recording and displaying a different type of data.

It is also possible to display a derivative of the data you have recorded. If you wanted to see velocity, you could select Actual Position as the data type and then select Derivative. It defaults to Normal.

Storage Scope (Continuous)

This screen provides a continuous storage scope. Although not quite real-time, the continuous storage scope does provide continuous recording and displaying of data. On slower systems, the scope period may have to be set higher than 4 milliseconds or else data points may be lost.

To record the controller's actions, you must first select what type of data you want to record. This is done with the combo-boxes. The data type defaults to Actual Position.

It is also possible to display a derivative of the data you have recorded. For example, if you want to see velocity, you could select Actual Position as the data type and then select Derivative. It defaults to Normal.

The minimum and maximum values to display on the graph can be adjusted at any time (even when the scope is active) by typing in new values or by using the spin buttons.

A trigger may be set by clicking on the Trigger On check box and adjusting the minimum and maximum trigger values. The continuous storage scope will stop whenever a recorded value is less than or equal to the minimum trigger value or greater than or equal to the maximum trigger value. When the continuous storage scope stops due to a trigger condition, the trigger value is high-lighted by means of a vertical line on the graph.

Storage Scope Zoom

This form allows you zoom-in on a portion of the storage scope graph. As you move the mouse over the graph, you will notice that the actual X and Y coordinates are tracked and displayed above the graph. To zoom in on a portion of the graph, hold down the left mouse button and drag the mouse. As you drag the mouse, you will notice a rectangular area will form (denoted by a dotted line). The area inside this rectangle will be expanded to the size of the entire graph when you release the left mouse button. To zoom out from a position, click the Zoom Out button. To restore the graph to its original perspective, click the Fit Data button.

Storage Scope Parameters

This window is where you can change the values used for generating the storage scopes. You can change the number of data points collected and the period between collection points. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Chapter 5 - System Evaluation

Evaluation of System Performance

Once the tuning is complete the system should be ready for operation. Checking the response characteristics of the system can be done in two ways; use the autographing feature contained in each tuning procedure, or use the storage scope functions to design a custom test.

Storage scopes can be used to graph data from the card to the PC screen. Data can be presented versus time or some other axis. To use the scopes follow these simple steps:

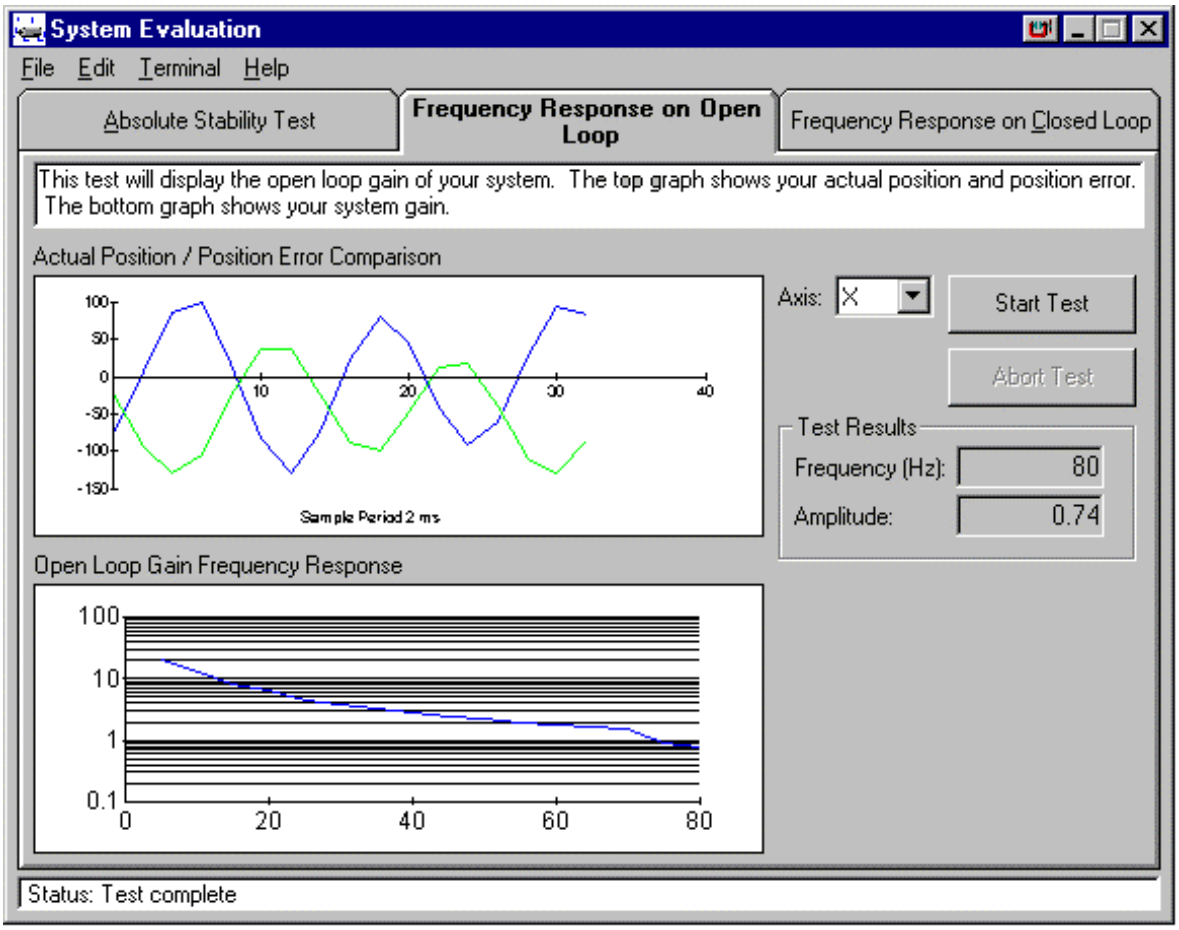
- Select “Storage Scope” from the main screen
- Select the number of scopes to display
- From the lists provided, set the data to be displayed

- Bring up the terminal (under the File menu)
- From the terminal type in a single move or entire program (see using the Terminal, below)
- Return to the storage scope and type in the command string. This string is sent at the same time data collection begins, making sure data collection is synchronized to the start of the motion.
- Select the “Start Collecting” button the gather and display the information

Other features of the scope under the ‘Collection’ menu include:

- Number of Sample Points: Increase this value to see more data on the graph
- Sample Period: Sets the period between consecutive data points

You have four types of system evaluations that you can perform. The Absolute Stability test is a good place to start. Follow that with the Step Response test (accessible from the Tuning Methods form). Then you can try the frequency response on either the open-loop or closed loop response. The Absolute Stability test will make sure you have connected all the wires in your system properly. It does not check for gain/damping problems. The Step Response test attempts to find out the gain of your system. It will also point out any errors in your gain/damping. The Frequency Response (closed and open-loop) will give you a graphical look at the responsiveness of your system.



The Step Response test can be found on the Tuning Methods form. To perform a Step Response test without changing the tuning parameters of your system, make sure the Perform Tuning Test check box is unchecked.

To switch between System Evaluation options. click on the desired tab located at the top of the screen just below the menu bar.

System Evaluation Options

Absolute Stability
Step Response
Closed-loop Frequency Response
Open-loop Frequency Response

Absolute Stability Test

This test will subject your system to an impulse response. The impulse response tends to saturate your system, and will be a good indicator of whether or not your system is truly stable. You can change the parameters of the test by clicking on the Edit | Absolute Stability Test Parameters menu item.

Parameters

Absolute Stability Test Parameters

This window is where you can change the parameters used by the Absolute Stability test. You can change the Pulse Size and the Pulse Time (duration). You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Frequency Response on Closed-Loop

This test will perform an analysis of the closed-loop frequency response of your system. As the test is in progress, the last frequency and response amplitude is displayed in the upper right box. You can select which axis to test by clicking on the Axis combo box. You can change the starting and ending frequency by clicking the Edit | Frequency Response Parameter menu item..

Parameters

Closed-Loop Frequency Parameters

Frequency Response Parameters

This window is where you can change the parameters used by the Frequency Response tests. You can change the Starting Frequency, Ending Frequency, Amplitude, and Frequency Step. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Frequency Response on Open-Loop

This test will perform an analysis of the open-loop frequency response of your system. As the test is in progress, the last frequency and response amplitude is displayed in the upper right box. You can select which axis to test by clicking on the Axis combo box. You can change the starting and ending frequency by clicking the Edit | Frequency Response Parameter menu item..

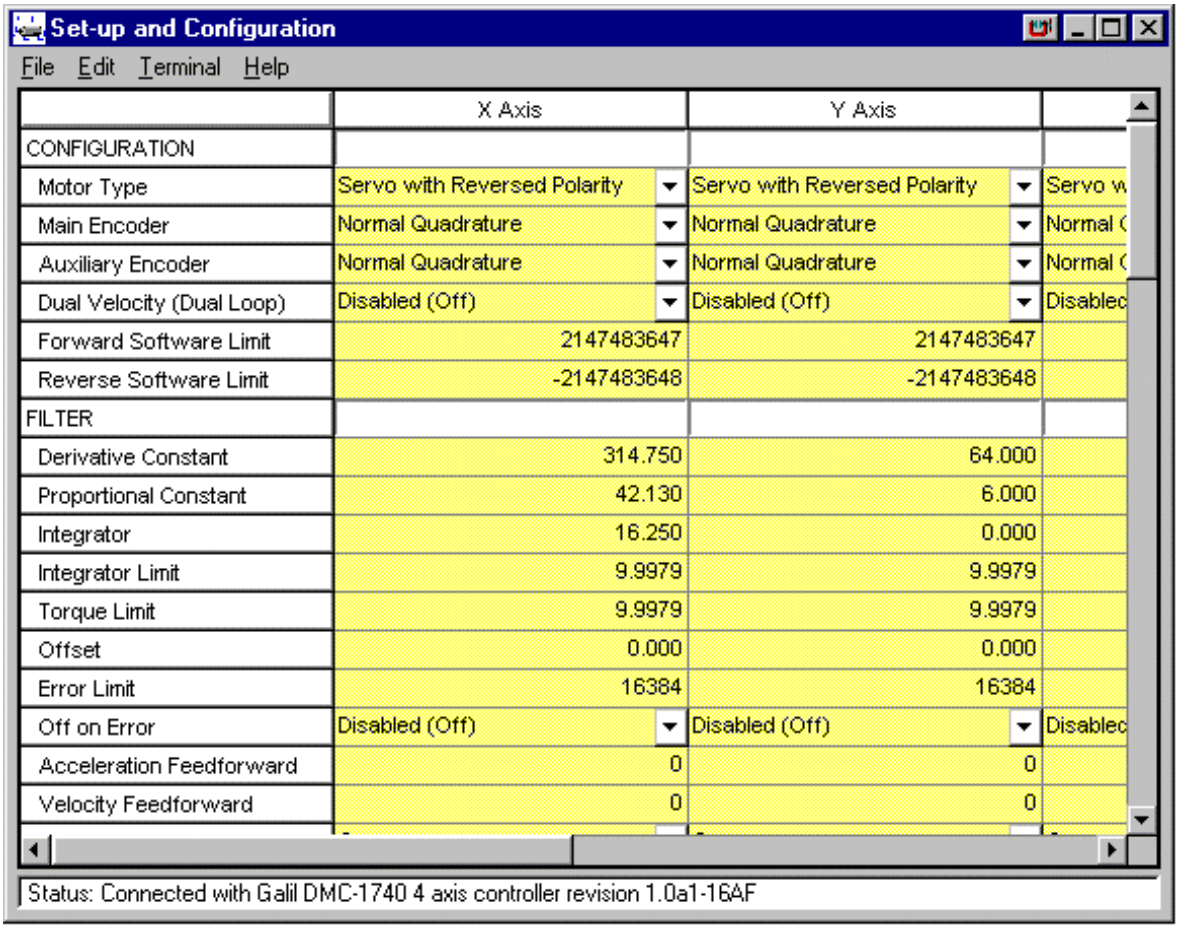
Parameters

Open Loop Frequency Parameters

Frequency Response Parameters

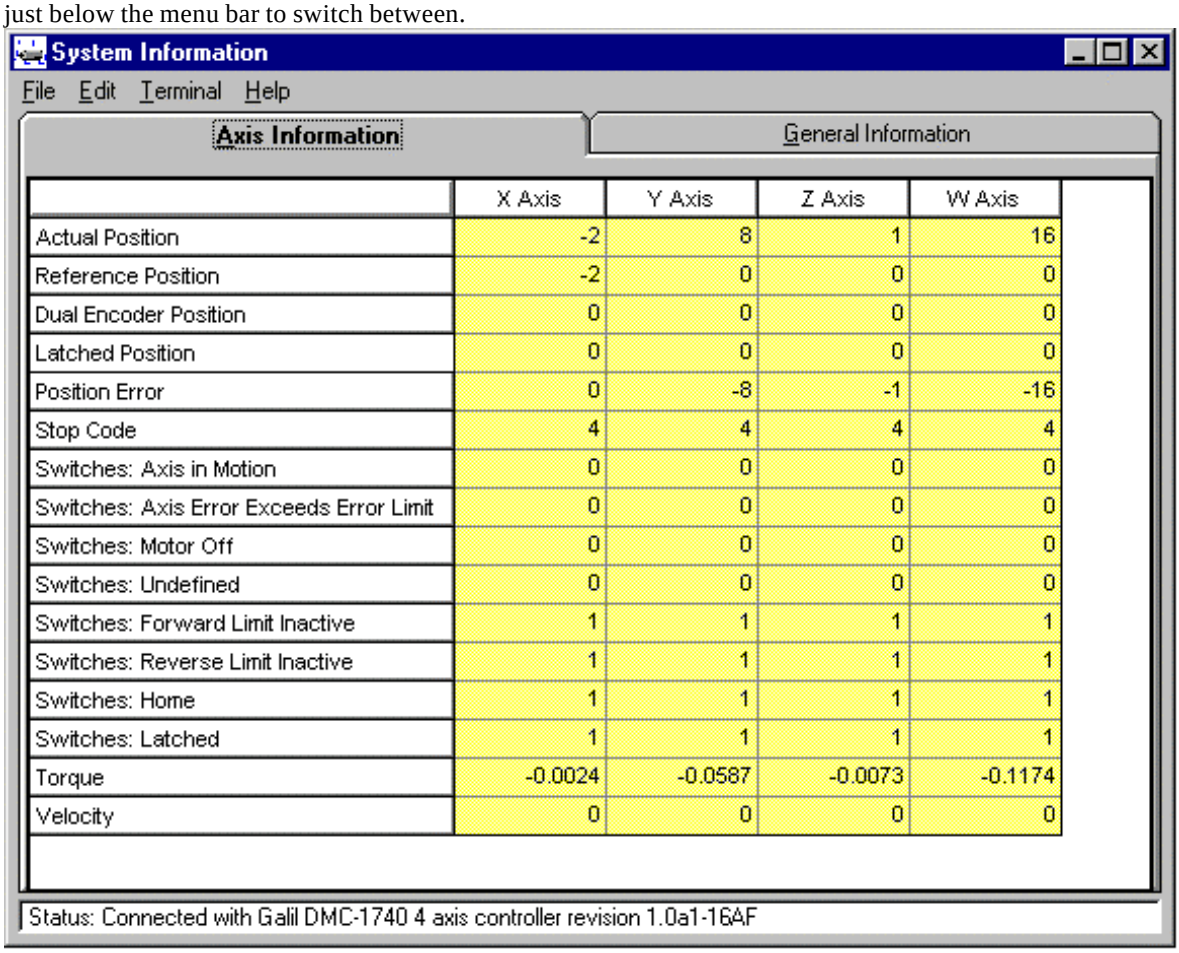
This window is where you can change the parameters used by the Frequency Response tests. You can change the Starting Frequency, Ending Frequency, Amplitude, and Frequency Step. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Chapter 6 - System Setup



Chapter 7 - System Information

This form displays controller status information such as current position, error, and state of the inputs and outputs. The information is organized by Axis information and General information. Click the tab on located at the top of the screen just below the menu bar to switch between.



	X Axis	Y Axis	Z Axis	W Axis
Actual Position	-2	8	1	16
Reference Position	-2	0	0	0
Dual Encoder Position	0	0	0	0
Latched Position	0	0	0	0
Position Error	0	-8	-1	-16
Stop Code	4	4	4	4
Switches: Axis in Motion	0	0	0	0
Switches: Axis Error Exceeds Error Limit	0	0	0	0
Switches: Motor Off	0	0	0	0
Switches: Undefined	0	0	0	0
Switches: Forward Limit Inactive	1	1	1	1
Switches: Reverse Limit Inactive	1	1	1	1
Switches: Home	1	1	1	1
Switches: Latched	1	1	1	1
Torque	-0.0024	-0.0587	-0.0073	-0.1174
Velocity	0	0	0	0

To update the information displayed, click the Edit | Refresh Display menu item. To update the information continuously (approximately every 100 milliseconds), click the Edit | Continuous Refresh menu item (the menu item will appear checked). To stop the continuous display, click the Edit | Continuous Refresh menu item again (the menu item will appear unchecked).

System Information Parameters

This window is where you can change the parameters used by the System Information form. You can change the Refresh Rate used by the Continuous Refresh menu item. You can either type in new values or use the sliders to change the values. When you are done, click the OK button to return you to the previous screen. If you wish to save these values

permanently, click the Save button. If you wish to restore the values to their defaults, click the Defaults button. If you don't want to keep the changes you made, click the Cancel button.

Menu Items

File
- Open Parameters
- Save Parameters
- Save Parameters As
- Create DMC File
- Print
- Exit

Edit
- Get Parameters
- Set Parameters
- Clear Values
- Reset Controller
- Master Reset Controller

Open Parameters

This command will allow you open a previously saved parameter file. Parameter files have the extension .BRN.

Save Parameters

This command will save the set up parameters to the current parameters file. The current parameters file is set by the Open Parameters command. If no current parameters file exists, you will be prompted to supply a file name. Parameter files have the extension .BRN.

Save Parameters As

This command will save the set up parameters to a parameters file. You will be prompted to supply a file name. Parameters files have the extension .BRN.

Create DMC File As

This command will save the set up parameters to a DMC file. That is, all the parameters will be saved as a series of DMC commands which can be sent to the controller at any time. You will be prompted to supply a file name. DMC files have the extension .DMC.

Print

The print command will print the current display.

Exit

This command will exit the current form and return you to the main form. If you are already on the main form, this command will exit the Servo Design Kit.

Get Parameters

This command will retrieve all the set up parameters from the controller. This command is executed automatically when the Set Up and Configuration form is first displayed, and after the Reset Controller and Master Reset Controller commands have been executed.

Set Parameters

This command will send all the set up parameters displayed on the screen to the controller and then will execute the burn (BN) command to save the set up parameters in the non-volatile memory (EEPROM) of the controller.

Clear

This command clears the set up parameters display. To view the current set up parameters, use the Get Parameters command.

Reset Controller

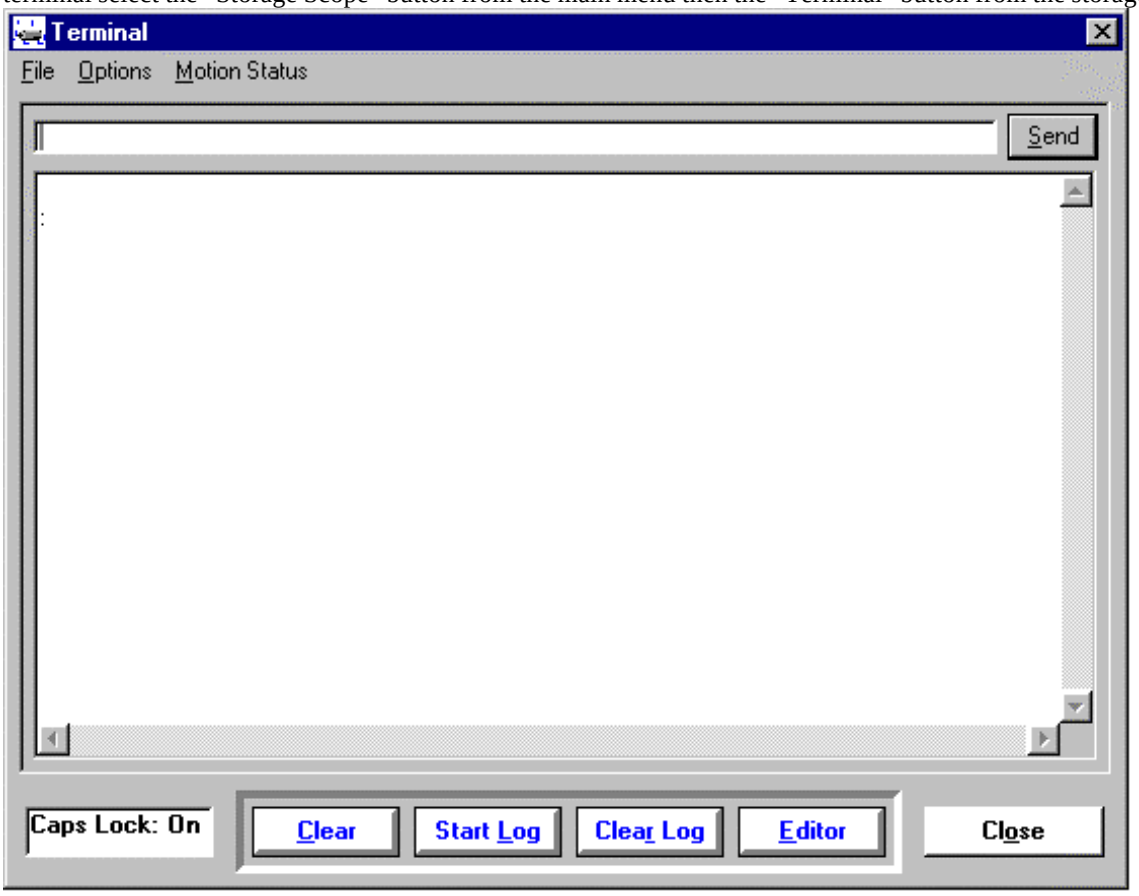
The reset controller command resets the state of the controller to its power-on condition. The previously saved state of the controller, along with the set up parameter values and saved sequences are restored.

Master Reset Controller

The master reset command resets the set up parameters of the controller to the factory default settings and erases the non-volatile memory (EEPROM).

Chapter 8 - Terminal and Program Editor

Included in the WSDK program is a terminal screen used to send commands to the controller and display any response. This tool provides a direct link to the system- allowing simple programming and status interrogation. To open the terminal select the “Storage Scope” button from the main menu then the “Terminal” button from the storage scope screen.



Functions available in the terminal include a status polling windows located under the “Motion Status” menu, sending a master reset under the “Options” menu and viewing the version of the controllers firmware by selecting the “Version” button.

Program Editor

To bring up the editor select the “Editor” button or type “ED” in the command line section of the terminal. This brings up a simple text editor best suited for smaller programs (under 500 lines).

Once a program is created it can be downloaded to the controller using the “Download” selection under the “File” menu. Likewise a file existing in the controller can be displayed by selecting “Upload File” from the same menu. Hitting the escape button on the keyboard will remove the editor from view, but the text information is not lost until WSDK is shut down.

Glossary of Terms

Index

Error! No index entries found.