Figure 1: YTerm Software Manual

⚠ WARNING

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Under no circumstances should any YASKAWA product be incorporated into any product or design as the exclusive or sole safety control. Without exception, all controls should be designed to detect faults dynamically under all circumstances. All products designed to incorporate a component part manufactured by YASKAWA must be supplied to the end user with appropriate warnings and instructions as to that part's safe use and operation. Any warnings provided by Yaskawa must be promptly provided to the end user.

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Contents

Overview

What's New for Version 7

SMC4000 support

The latest version was modified and tested to work with the recently released SMC-4000 controller.

Syntax Checker

Programs are automatically syntax checked before being transferred to the controller. This will save the programmer considerable time by helping to identify errors that would prevent the program from running. Warnings and recommendations are also given when the program is analyzed. In addition, the syntax check is performed based on the selected controller, allowing it to identify and check for compatibility or command differences from controller to controller.

Variable Tool Tip

When the mouse is held over a highlighted user or internal variable in the program window, the tool tip reports the current value in the controller. This is very helpful for debugging. The variable can be an entire math expression, and it doesn't even need to be in the program currently executing in the controller. This allows programmers to test a calculation of formula live. Any phrase that can be typed into the terminal window by preceding it with the MG command can be updated with a tool tip in the programming window.

Windows Skins (Look & Feel)

A new look has been given to YTerm; the user can select the appearance of the windows and controls on each of the windows. The toolbar has been changed from a vertical toolbar to a more standard, horizontal style. Finally, a standard menu system has been incorporated.

Other visual changes include the addition of a tab system for the Terminal Window, Help, and Syntax Checker.

Performance

Communications have been improved to process data at much higher rates. This allows faster upload and download of programs and faster viewing of graphical data such as during tuning and scope.

Finally, the speed of program formatting to show comments in green has been dramatically increased, and a utility has been added to format the program into an easier to read layout, especially when it has been uploaded from a controller.

Introduction to YTerm

YTerm is a front-end software package for the Yaskawa SMC Series Motion Controller. YTerm provides a user-friendly Windows interface for design, development and debugging of motion control applications. The software package consists of three main sections:

- Programming Section - edit, transfer, and monitor programs for the motion controller.
- Tuning Section - tune the SMC's axis and test the servo system's performance using a four-channel scope to graph performance data.
- Monitoring section - monitor motion and I/O on the controller.

Features of YTerm

YTerm enables full control and programming of the SMC using:

- Text editor with dual edit windows for user programs and array data.
- Find/replace support.
- Multiple step Undo function.
- Selectable program compression and error checking during upload.
- Real-time monitoring of program execution (includes multi-tasking).
- Full screen zoom capability in programming, online manual, and terminal window section.
- Extensive on-screen context sensitive SMC keyword help text.
- Graphical online manual and auto tuning.
- Online scoping of up to four channels of data.
- Quick load/save of SMC parameters in and out of the controller.
- Real-time monitoring speed, position error, position, and torque for all connected motors (numerical and graphical).
- Real-time monitoring of all analog and digital I/O.
- Sigma servo amplifier quick setup (Hardware required: YS-11 cable).
- Context sensitive pop-up menus and standard menus.
- Online ASCII Terminal emulator window.

- Scroll-back buffer for viewing data in the Terminal window.
- Clipboard access to the Terminal window.
- Full text logging of all events in the Terminal window.
- Context sensitive help in all screens, accessible through F1 key.
- Event logging of program status.
- Ethernet communications and support.
- Firmware upgrading.
- Live evaluation of variables and expressions.
- Clipboard access to the Terminal window.
- Scroll-back buffer for viewing data in the Terminal window.
- Full text logging of all events in the Terminal window.
- Find/replace support.
- Multiple step Undo & Redo functions.
- Context sensitive pop-up menus.

Getting Started

Installing YTerm

Software Kit Contents

The YTerm software kit (SMCGUI1) should include the following:

- One CD ROM labeled 'YTerm SMC Development Environment.'
- The YTerm Software Manual, YEA-SIA-SMC-1.1.
- One programming serial cable, SMCCBL7.
- A Software Registration card.

If any of the YTerm items are missing or damaged, contact Customer Service at Yaskawa Electric America for replacement, telephone number 1-800-YASKAWA.

System Requirements

YTerm requires the following minimum PC system configuration:

- A Pentium 233 MHz, 32MB RAM.
- VGA resolution monitor.
- An asynchronous adapter (RS-232 Serial port) on the computer.
- Microsoft Windows 95, 98, NT, 2000, or XP.

Software Installation

Exit other programs as a precaution against a program conflict occurring the first time the software is installed.

All the files required for setup are contained on the CD ROM. Before using YTerm, run the YTerm YTERM.EXE program. This program decompresses and copies the YTerm program and its associated files onto your PC hard disk.

YTERM.EXE does not modify CONFIG.SYS, AUTOEXEC.BAT, WIN.INI or SYSTEM.INI. It may update Windows components.

To run the INSTALL program:

1. Start Microsoft Windows.
2. Insert CD ROM into CD ROM drive.
3. Select the Run option from the Start Menu in Windows 95, 98, NT, 2000 and XP.
4. Type D:\yterm.exe (Your system may use a different letter designation for the CD ROM drive).
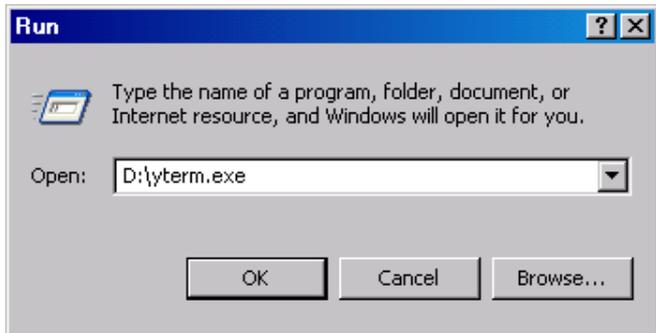
Figure 1: Run Dialog Screen

5. Press **OK**. Click the YTerm Software button under the Install Software heading.
6. Read the instruction screen and press **Next** to proceed.
7. Enter the user name and company name information and press **Next**.
8. Select in the desired folder for copying the YTerm files. Press **Next** to proceed.
9. The "Ready to install the application" window appears. Press **Next** to proceed.
10. The INSTALL program will now copy files from the CD ROM to the selected folder.

Note: At this time, please complete your Yaskawa software registration card found in the YTerm Software kit. This is necessary in order to provide updates and support to registered users.

11. The installation is now complete. Press **Finish** to end the installation program.

Upon completion of a successful installation, the YTerm icon will appear on the PC desktop window:
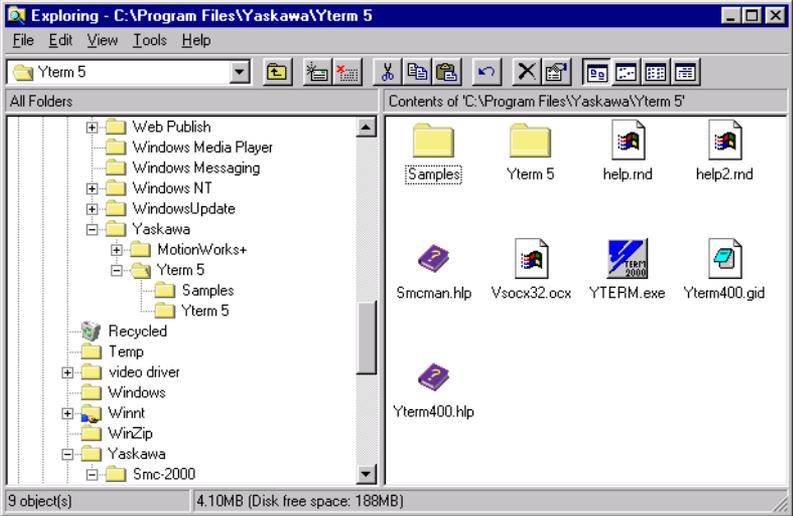
Figure 2: YTerm Program Group in Windows 95
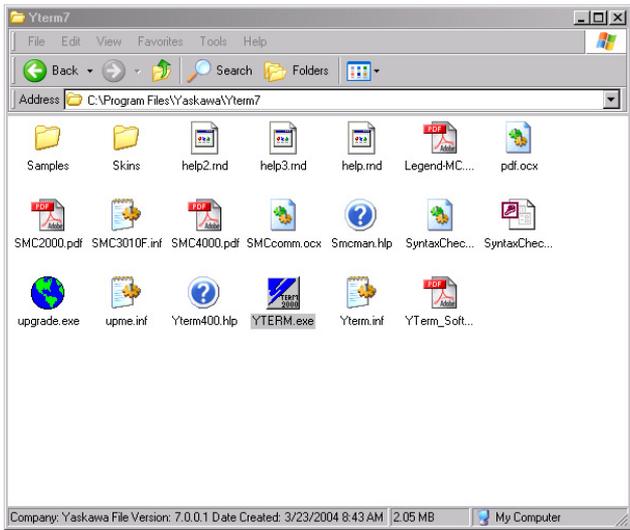
Figure 3: YTerm Program Group in Windows XP

YTerm creates a Windows program group that defaults to Yaskawa Software and creates four program items ("shortcuts"):
1. YTerm (The SMC communication program)

Launching YTerm

To run YTerm, double click on the YTerm icon.

The following screen (Figure 4) will appear, while the application loads indicating the version number and release date, and any user information entered during the installation process.

Figure 4: YTerm Startup Splash Screen

This screen will display for a few seconds while the application loads. When the application is loaded, it will attempt to establish communication with an SMC. The connection will be based on previously saved communication parameters. The first time the program runs, it will use the first free communication port in the computer, and the connection will default to 19200 baud.

If the communication access attempt was successful, the following screen appears:
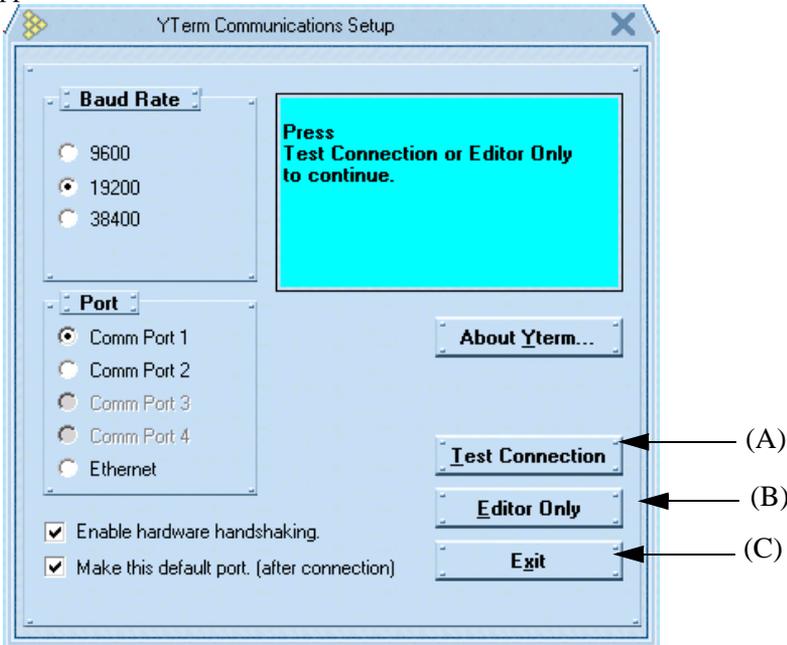
Figure 5: Communication Setup Screen Showing Successful Communication

To enable hardware handshaking, select the **Enable Hardware Handshaking** check box. Press **Continue** to proceed to the first (Programming) screen.

Note: Hardware handshaking is the recommended mode of operation.

The default setting is enabled.

To view the "About YTerm" screen, double click on the **About YTerm** button. Press **Exit** to exit YTerm.

If the communication access attempt failed, this screen will display the "No Connection" message as follows:
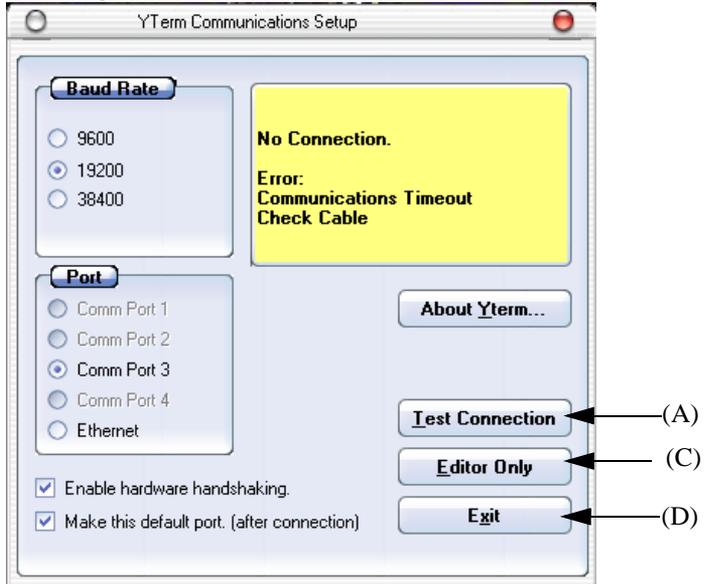
Figure 6: Communication Setup Showing Unsuccessful Communication Attempt.

Figure 7: Communication Setup Showing Ethernet Setup

Baud Rate: Select the baud rate that has been set by either DIP switches or jumpers on the SMC, depending on the controller. For all controllers, the default baud rate is 19200.

Port: Select the port which corresponds to the location on the computer where the serial cable has been connected. If a LEGEND–MC or SMC–4000 controller is used, Ethernet is a communication option. If Ethernet is selected, the controller's IP address must be entered. The window will change display to allow entry of this information as shown in Figure 7. Note: The local IP address setting is shown on the screen. If the number is all zeros or something like 127.0.0.1, this means that the PC's Ethernet settings are not properly set (in Network, TCP/IP settings). Also note that if the cable is properly connected, both the PC's Ethernet status LED and the one on the controller will show a valid connection (Typically via a green LED next to the Ethernet Port). The LEDs should be ON even before the actual software connection is established.

About YTerm: Click to view the "About YTerm" window, including version information. System information can be gathered from this window by pressing the system information button. This information may be helpful to Yaskawa software development should incompatibility issue arise.

Enable Hardware Handshaking: To enable hardware handshaking, check the check box. This is the recommended method for serial communication. The default setting is "enabled".

Default Port: The check box that refers to the default port will send the CF command to the controller after connection. This will cause the controller to redirect unsolicited information to the port that YTerm has just opened. This will allow messages from the controller to be viewed in the terminal window.

Force Connection to Last Handle: If checked, YTerm queries the controller using _IA3 to determine what handle it is on. If it is not on the "P" for LEGEND-MC or "H" for SMC4000, then YTerm sends the HS command to switch handles making the YTerm connection on either "P" or "H." This keeps YTerm out of the way of other devices that the controller might make a connection to later.

Test Connection: Initiates communication with the controller. Once communication has been verified, the status panel at the upper right of the form will turn green, and the controller's serial number, axis count, and the firmware version are displayed. Press **Continue** after the connection window appears. If connection was not verified, the status panel will turn yellow.

Editor Only: If YTerm is to be used for viewing or editing programs while a controller is not present, select Editor Only. This will allow YTerm to operate without using a communications driver. Only the programming window will be accessible in the Editor Only mode.

Note: If the controller is in "monitor mode", a mode where the firmware is not executing, YTerm will detect this and assume that a firmware upgrade attempt has previously failed. If this is the case, YTerm will attempt to download firmware to the controller again if requested. This feature is only applicable if connected to an SMC–3010 or SMC4000 controller.

When establishing communications with an SMC, check all cable and power connections. Make sure that the cable between the computer and motion controller is plugged into the correct computer port. Verify the computer port matches the one selected in YTerm.

Press **Test (A)** to try to establish communication once more and press **Continue (B)** upon seeing the connection screen.

If problems persist, contact technical support.

Press **Editor Only (C)** to work in offline mode if there is no SMC connected. In offline mode, only the Programming screen is available.

Press **Exit (D)** to exit YTerm.

Note: All SMC units are configured for 19200 baud rate by default.

Using YTerm

The Programming Screen
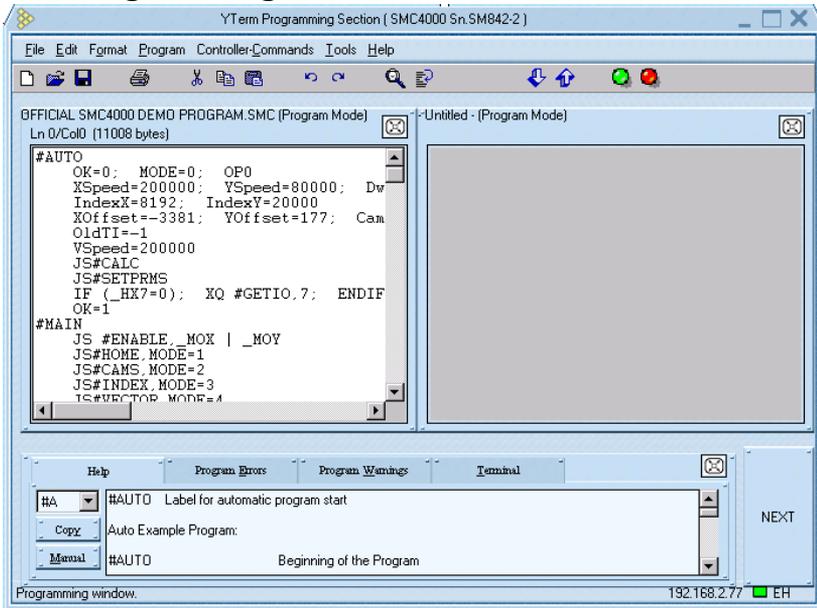
Figure 8: Programming Screen.

After YTerm is running and communication with the SMC has been established, the Programming Screen (Figure 8) is displayed. Use this screen to develop and execute SMC programs.

Navigating Around the Programming Screen

The menus in the menu bar have most of the options from the Edit Toolbar and the pop-up menus found throughout YTerm and are explained where the pop-up menu is explained. The other options are explained here.

- The File menu shows the last 7 programs that were accessed by YTerm to allow quick access to the programs.
- The Format menu contains skin options.
- The Program menu contains the Syntax Check and automatic formatting of the program.

Click on a specific icon on the screen to activate. For example, to select one of the editing windows, move the mouse pointer to the desired working window and click the left mouse button. The title of the active window is highlighted while the title of the other editing window will be gray.

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To edit one of the programs in full screen view, click the full screen button in the upper-right corner of the program window. Click the button again to return to normal viewing.

Key Commands (shortcuts) are available:

> - **Alt+1** moves the cursor to the editing window on the left.
> - **Alt+2** moves the cursor to the editing window on the right.
> - **Alt+3** moves the cursor to the Help pull down menu if the Help tab is active.
> - **Alt+4** moves the cursor to the terminal window if the Terminal tab is active.

The Edit Windows

YTerm provides the ability to add comments to the program. Any program line beginning with a double slash (//) will be ignored as the program is sent to the SMC. Comments can also be placed after a valid command or commands, and once the (//) is found, the remainder of the line will not be uploaded. This makes it possible to add as many comments as needed without overloading the controller's memory with comments.
While holding the Control (Ctrl) key down and highlighting a user or internal variable in the program window with the mouse, the tool tip reports the current value in the controller. The variable can be an entire math expression, and does not need to be in the program currently executing in the controller. This allows a live calculation of a formula. Any phrase that can be typed into the terminal window by preceding it with the MG command can be updated with a tool tip in the programming window.
The Toolbar and the Pop-up menu provide program editing functions.
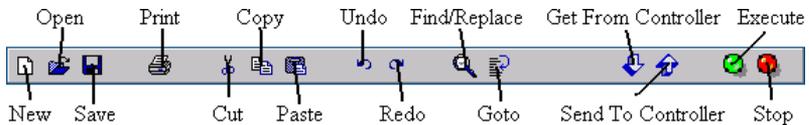
Figure 9: The Edit Toolbar.
Note: The functions accessed through the Toolbar are for the active edit window.

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Most of the tools look like and have the same function as the tools in other Windows programs. The ones that do not are explained as follows:

- Find/Replace: Displays a dialog box for finding and replacing text in a program.
- Goto: Displays a dialog box for jumping to a given line number in a program.
- Switch Window: Exchanges the visible program for the one that is not visible (if the program window is maximized).Get From Controller: Downloads a program or array that is stored in the controller.
- Send To Controller: Uploads a program or array to the controller.
- Execute: (Green light) Sends the EXECUTE ("XQ") command to the controller.
- Stop: (Red light) Sends the STOP ("ST") command to the controller.

The Pop-up Menu is accessed by clicking the mouse's right button while the cursor is located in one of the edit windows. The Active window is highlighted. The pop-up menu is shown below:
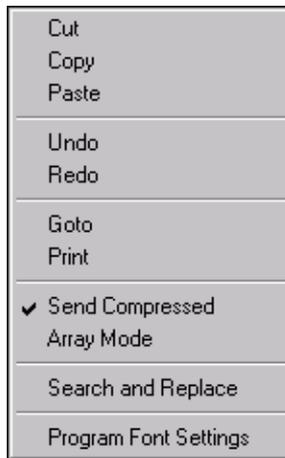
Figure 10: The Edit Pop-up Menu

The pop-up menu has the following options:

- Select **Cut** to transfer the current selection onto the clipboard.
- Select **Copy** to duplicate the current selection onto the clipboard.
- Select **Paste** to insert the contents of the clipboard onto the page at the current cursor position.
- Select **Undo** to cancel the last (or more) edit.
- Select **Goto** to move to a specific line in your program.

- Select **Print** to print out the program or selected text (in the active window) on the default printer. To change the default printer, refer to your operating system manual.
- Mark **Send Compressed** to remove all "//" comments, spaces and to delete empty lines before sending the program to the controller. Select this again to send the program to the "as is" except for changing all "//" comments to native SMC comments ("NO").

Note: Send Compressed is the default setting. A compressed program will execute slightly faster.

- Select **Array Mode** to use the edit window to send, receive, load and save array data. Comments are not allowed in arrays. When the **Array Mode** is selected, **Send Compressed** is disabled. All arrays are compressed before being sent to the controller.
- Select **Find/Replace** to search the program in the active window for text. If text is highlighted before selecting this function, the selected text will be used as the text to seek. This can also be used to replace text in the program.

The Help Window

(B)

(A)
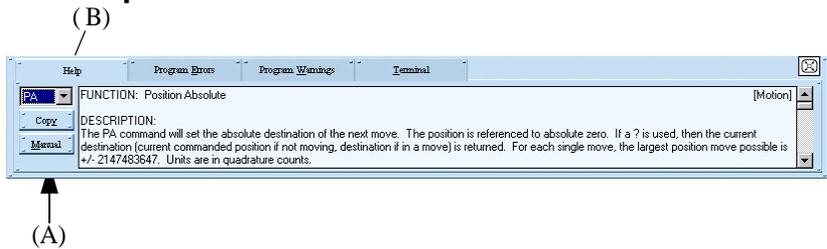
Figure 11: SMC HelpWindow.

The Help window provides descriptions for the SMC programming language. Get descriptions on any command by the use of two methods:

1. When one of the two programming windows is selected, the Help window will update to show descriptions for the command on the current line.
2. A description for any command can be viewed by entering the two letter command in the Keywords box (Figure 11). By clicking on the **down arrow** (located next to the box) a list of available commands will appear. Select the desired command. Scroll up and down the list with the vertical scroll bar (located next to the list) to view keywords.

If detailed descriptions on SMC commands is needed, press the **Manual (A)** button. The SMC Online Manual (if installed) will come up in a separate window.

To copy text from the Help window, select the text to be copied by pressing on the mouse button while dragging the cursor over the text. Release the mouse button and click on **Copy (B)** to duplicate the selected text onto the clipboard.

Double clicking on the Help window or clicking the button in the upper-right corner of the window will display the window in full screen view. Double clicking or hitting the button again will return the window to normal view.

The Program Errors and Program Warnings Windows

The Program Errors and Program Warnings windows display diagnostics after Syntax Check from the Program menu has been selected, after sending the program to the controller has been attempted, or after loading a program from a file. Programs are automatically syntax checked before being sent to the controller. The syntax check is performed based on the selected controller, allowing it to identify and check for compatibility or command differences between different controllers.

The Program Errors Window displays problematic code, the line number that the problem appears, and a diagnosis. These problems must be fixed before the program can be sent to the controller.

The Program Warnings Window displays suggestions to the code. These suggestions do not need to be fulfilled for the program to be sent to the controller, but are recommended.

The Terminal Window

The Terminal window functions as a terminal emulator connected to the SMC. Commands typed here are executed by the motion controller after the (**Enter**) or (**;**) (**semi colon**) key is pressed. Pressing the F3 key will auto repeat the last command.

The Terminal window can also be used (by the SMC) to display controller status information such as I/O, debug messages, input prompts, error messages, etc.

The **Paste** button completes the transfer of the text (from the clipboard) onto the Terminal window.

The Terminal window has a pop-up menu similar to the Editing window that is accessed by clicking the right mouse button while the cursor is on the Terminal window. The pop-up menu provides functions to communicate with the controller such as enabling or disabling servo power, status reporting, and logging features.

When the terminal window pop-up menu is active, the following menu will appear:
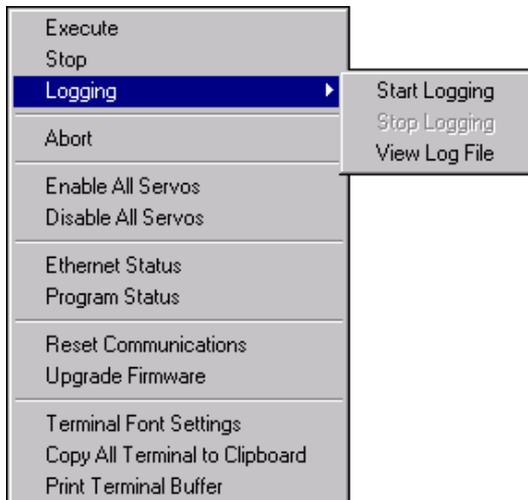
Figure 12: The Communication Pop-up Menu.

The pop-up menu has the following options:

- **Execute:** Starts the current program in the controller.
- **Stop:** Sends an "ST" command to stop any running motors. This command also stops the applicaiton program from running.
- **Logging:** Provides access to the sub-menu for capturing data to a file (SMCLOG.LOG) of communication in the terminal window.
- **Start Logging:** Starts writing all communication to the SMCLOG.LOG file. Once the log file is started it will continue to log the events in the Terminal window. The file size will continue to increase until logging is stopped or YTerm ends.
- **Stop Logging:** Stops writing to the SMCLOG.LOG file.
- **View Log File:** Loads the SMCLOG.LOG file in Microsoft Write for viewing.
- **Abort:** Stops the execution of the current program in the controller.
- **Enable all Servos:** Energizes (enable) all servos.
- **Disable all Servos:** De-energizes (disable) all servos.
- **Ethernet Status:** Displays a form which contains details about the Ethernet communications. See Ethernet Status.
- **Tell Error:** Displays the current position error of all servo motors.
- **Tell Position:** Displays the current position of all the connected servo motors.
- **Program Status:** Allows the observation of the program execution. See Program Monitoring.
- **Reset Communication:** Resets the communication channel between the PC and the SMC. This clears any existing communications by closing the serial port, restarting it again, and verifying that YTerm can communicate with the SMC. It also redetermines the number of axes on the LEGEND–MC controller. If Ethernet communication is selected, connection to the host is reattempted.
- **Firmware Upgrade:** Upgrades the firmware on a LEGEND–MC or SMC–4000 controller via the serial port only. Only the LEGEND-MC and SMC-4000 controllers can have firmware upgraded through YTerm, and upgrading must be done through the serial port. Once initiated, the process must not be interrupted, or the controller may fail to restart. Select the firmware file (*.HEX) from the browser window that will appear, and the firmware will be automatically downloaded to the controller. (The SMC-2000 cannot be upgraded with YTerm; it requires a chip change.)
- **Terminal Font Settings:** Selects custom fonts for text in the Terminal window. The settings will be retained for future sessions.
- **Copy all Terminal to Clipboard:** Copies the contents of the entire Terminal window buffer (up to 50K) to the clipboard.
- **Print Terminal Buffer:** Prints the entire content of the Terminal window buffer or selected text.

The Event Logger

Double clicking on the status bar at the bottom of the YTerm screen shows the Event Logger. The Event Logger timestamps each event that YTerm has executed along with the status of the events and lists them in a window.
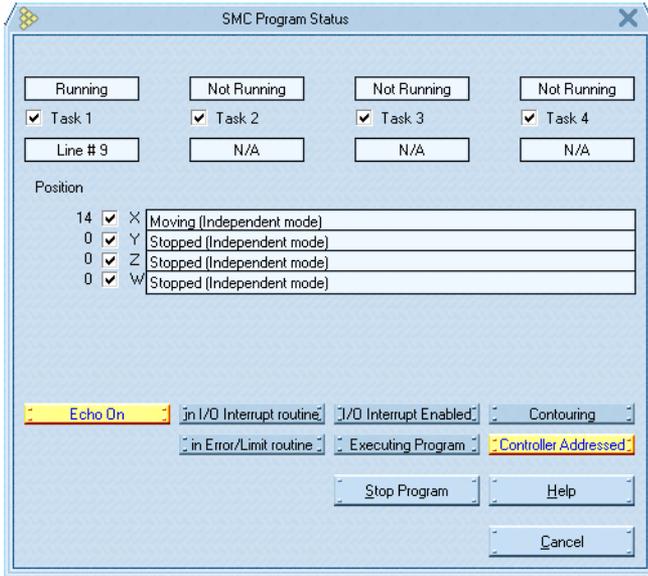
Figure 13: The Event Logger

**Notes: If the log file is started and not stopped, it will continue to log the events in the Terminal window.
The file size will continue to increase until the device is tured OFF or upon exiting YTerm.**

Ethernet Status

The Ethernet Status window will show the connection status of each handle on the controller. Details include TCP/UDP, master or slave, and IP address of the connected devices. The Ethernet Status window is updated in real-time.

Figure 14: Ethernet Status Window

Program Monitoring

Once a program has been created and sent to the controller, it can be monitored with this function. The Program Status window, shown in Figure 15, is accessed through the pop-up menu on the Terminal window or through the Tools menu in the menu bar.
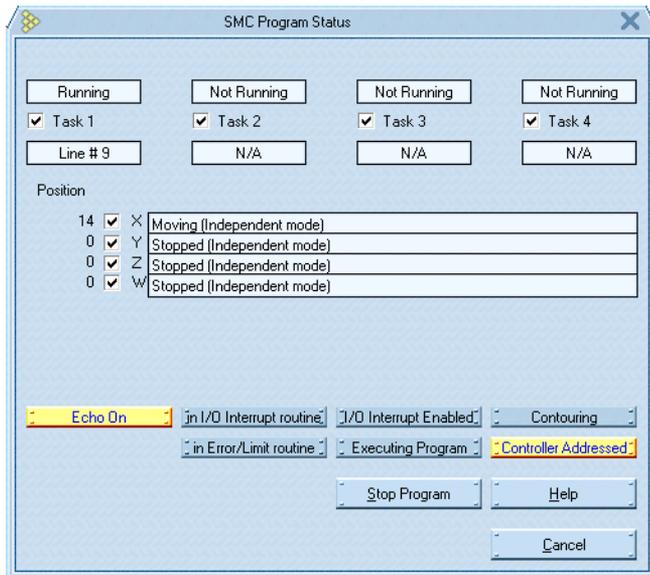
Figure 15: The Program Status Screen.

The current status of each of the four programs is displayed at the top of the window. This includes the state of the program (Running, At Trippoint and Not Running) and the current line being executed. It is possible to execute the controller's program from the Terminal window or the Pop-up menu of the Terminal window, and then view the Program Status.

The middle portion of the window will indicate the state of the axes. Select the axes to monitor using the check boxes.

A status bar at the bottom of the window indicates the SMC status.

Programs are executed by clicking on the left mouse button. When a program is executing, the button text will say "Stop Program", and when the program is halted it will indicate "Execute Program."

Select **Cancel** to stop monitoring and return to the Programming screen.

In the event of a program error, YTerm will display the reported error and the line on which it occurred. This will replace the top portion of the window (which displays the program status) with the Error Report as shown below in Figure 16. Important Note: The line number indicated may not coincide with the line number as viewed in the Programming window. This is due to the program compression that takes place. Use the LS command in the Terminal window to view the line number specified. Example: Line 8 indicates an error, so use the command LS 1,15 in the Terminal window.

Restart the programs by selecting **Execute Program**.
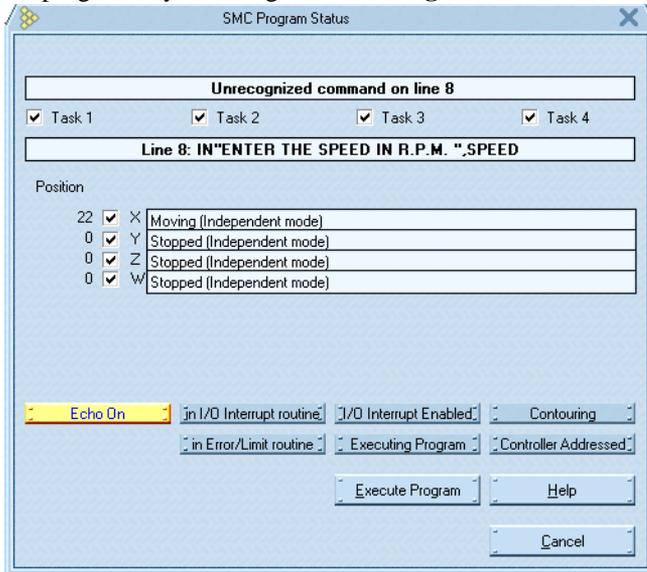
Figure 16: Error reporting in the Program Monitoring Screen.

The Next Button

To switch to the Tuning Screen, click the **Next** button. The **Next** button is also used to advance to the next screen elsewhere in YTerm. The **Next** button icon will appear on each screen located in the lower right corner.

Figure 17: The "Next" Button

The Tuning Screen
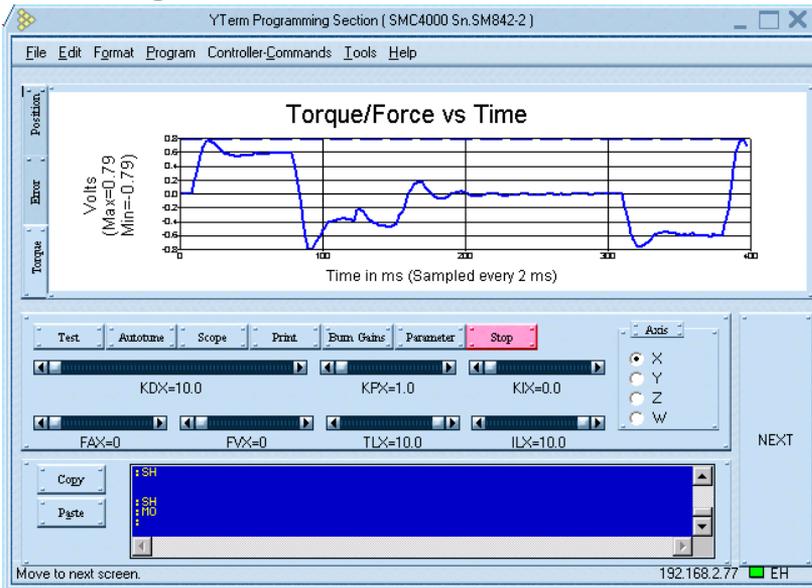
Figure 18: Tuning Screen
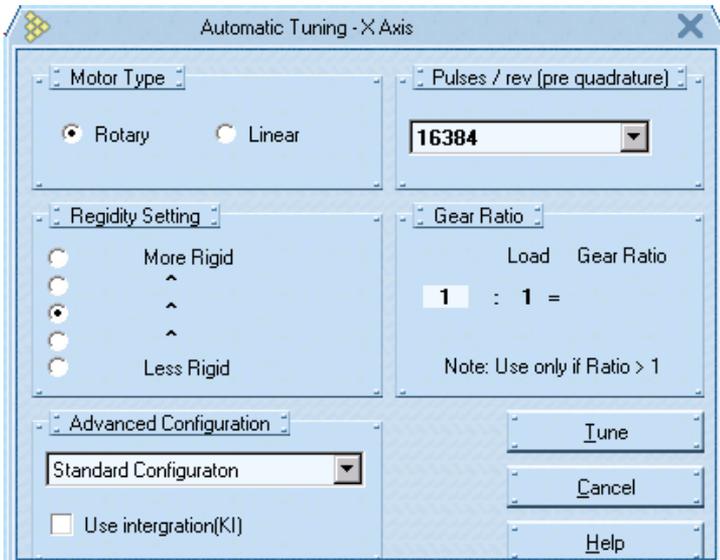
Figure 18A: Tuning Screen (Linear Servo Motor)

The Tuning screens (Figures 14 and 14A), are used to set the gains of the servo motors. See the SMC User's Manual for a detailed explanation about tuning a servo system.
The Terminal screen is not resizable when shown on th etuning screen.

Note: Use the Axis Selection Panel to select the motor to tune. Only one motor can be tuned at a time.

Manual Tuning

See the SMC User's Manual for proper tuning technique.

In order to manually tune a servo system connected to the SMC Controller:

1. Select the axis by clicking on the appropriate radio button on the axis selection panel.
2. Use the terminal window to send the SH* (where * = X, Y, Z, W, E, F, G, H) command to enable the servo motor.
3. Set default values for the gains.
4. Increase KP, KD, KI gains accordingly, by moving the horizontal scroll bars above each gain label. Moving the bar to the right increases the value of the gain, moving it to the left decreases it. It is also possible to type the commands directly into the terminal. THe scroll bar will update when a radio button is pushed.
5. For KI and KP, click inside the bar to change the value by 1. Click the arrow on the bar to change the value by 0.1.
6. For KD, click inside the bar to change value by 10. Click the arrow on the bar to change value by 1.

Autotuning

- YTerm includes a routine that autotunes a connected servo system. This function is able to tune most systems. Systems can be tuned with five levels of rigidity.
- See the Appendix for details on the theory of Autotuning.

In order to Autotune a servo system:

1. Select the axis to be tuned, by clicking on the appropriate icon button in the axis selection panel.
2. Use the terminal window to send the SH* (where * = X, Y, Z, W, E, F, G, H) command to enable the servo motor.
3. Click on the **Autotune** button. The dialog screens shown in Figures 15 and 15A will appear. If Autotuning was previously performed on this axis, previous values used will be loaded.
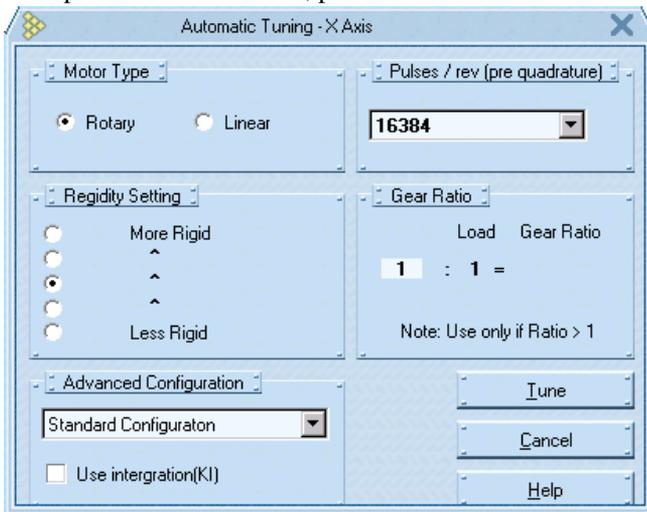
Figure 19: Autotuning Dialog Screen
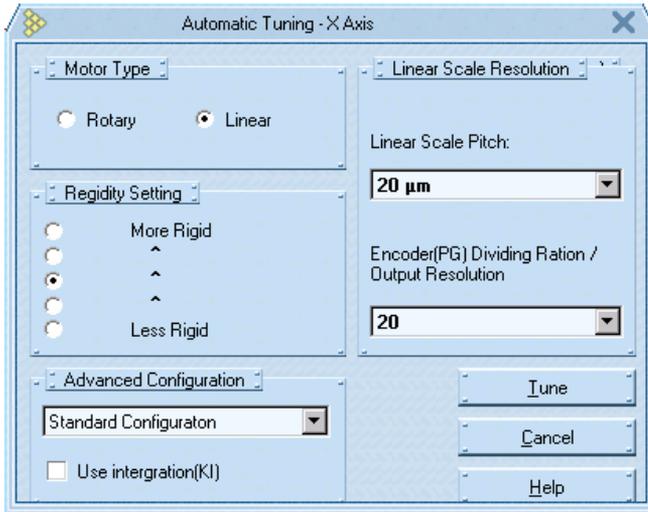
Figure 19A: Autotuning Dialog Screen

4.   Select the desired level of rigidity for tuning the system from the Rigidity Setting panel.
5.   Select the desired machine configuration (appearing in the Advanced Configuration panel) from the available options list.
6.   Enter the motor to load gear ratio.
7.   Check the **Use Integrator** (KI) box to include the integration constant of the PID loop in the autotune calculations.
8.   Select the correct number of Pulse per revolution pre-quadrature for your specific motor or the linear scale resolution if a linear encoder is to be turned.
9.   Click on **Tune** to execute the Autotune program. Click **Cancel** to close the dialog screen and cancel the Autotune operation.

Note: Autotuning does not display a graph.

Testing the Tuning

Once a servo system is tuned, use the "test" tuning function and observe the performance of the system. The test will execute a small program in the controller based on a user-defined motion profile.

In order to run the test program:

1. Select the axis (to which it is connected) by clicking on the appropriate icon button in the axis selection panel.
2. Use the terminal window to send the SH* (where * = X, Y, Z, W, E, F, G, H) command to enable the servo motors
3. Click on **Test**. One of the dialog boxes shown below will appear.
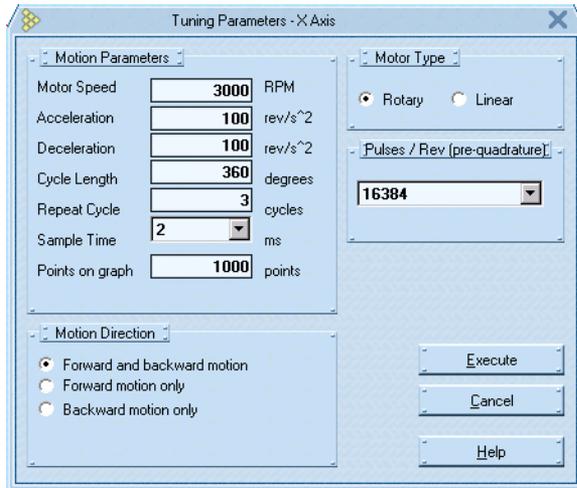
Figure 20: Tune Test Dialog Screen - Servo
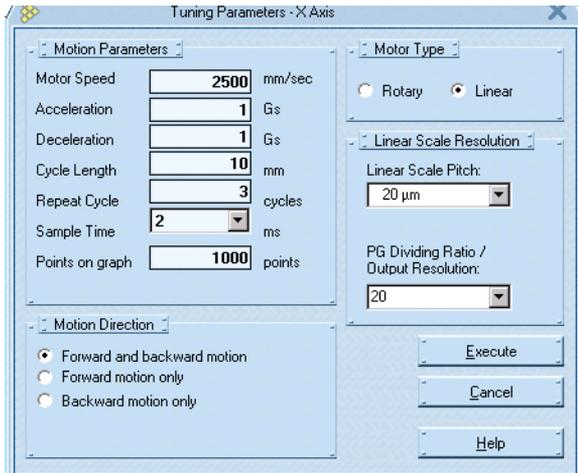
Figure 20A: Tune Test Dialog Screen - Linear

> 4. Define the motion profile by entering the motion parameter fields in the screen's appropriate boxes. Be sure to select the direction of motion and the correct Encoder pulses per rev.
> 5. Click on **Execute** to execute the test program.

Viewing the Tune Test Results

After the controller completes sampling the data, the information is transferred to the PC and displayed as follows:
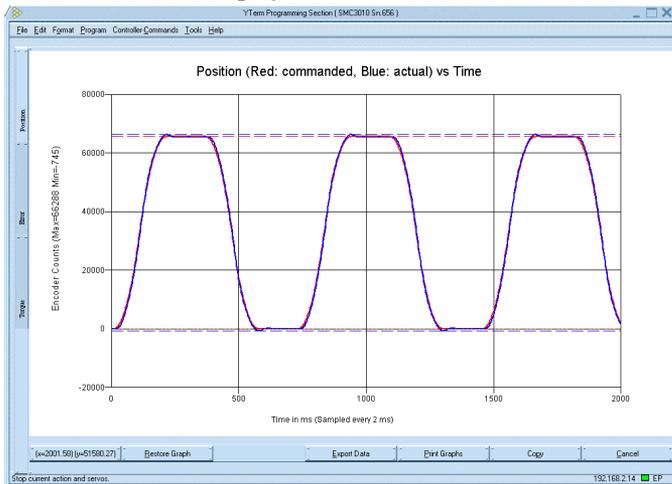
Figure 21: Tune Test Results Window

Double clicking in the graph window will display the window in full screen view. Clicking Cancel will return the window to normal view.

In full screen view, zooming in is available by click-and-dragging the mouse to form a box around the area to zoom into. The coordinates of the cursor are displayed in the first button. The other buttons run functions and are explained below. Some of these functions are available in normal view by right-clicking the graph.

- Restore Graph: Returns the graph scale back to the default scale.
- Adjust Axis: Changes the scale of the axes so that the X and Y scale are the same (if zoomed in). This is only useful when plotting Channel 1 vs. Channel 2 with the Scope.
- Export Data: Outputs graph data points to a text file. The columns are separated by tabs if there is more than one channel being recorded.
- Print Graphs: See Printing The Graphs.
- Copy: Puts the graph image into the Windows Clipboard.
- Cancel: Changes view back to normal.

Printing The Graphs

The graphs of the tuning test or scope with all of the parameters can be printed by clicking on the **Print** button. Yterm will print out the three graphs (Tuning Test) or one graph (Scope) on the default printer. Use Window's Printer Manager Program to change the default printer.

Storage Scope

The storage scope is used to store data. This allows the user to choose the parameters observed and duration. The storage scope has the capability to store up to four parameters (dependent on the type of graph selected).

To run the Storage Scope:

1. Click on **Scope** on the Tuning Screen to display the screen shown below:
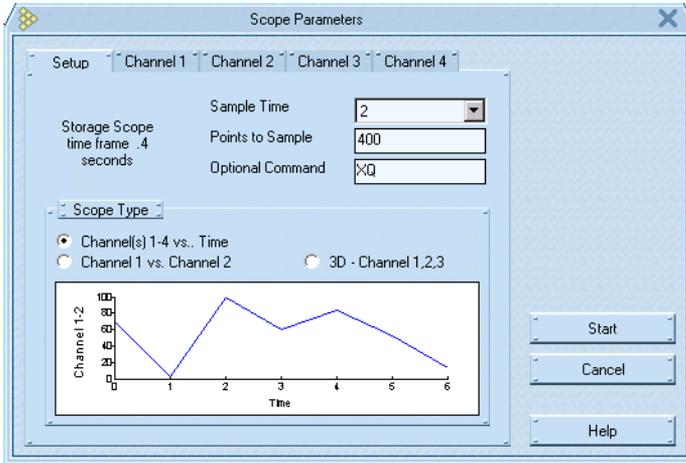
Figure 22: Storage Scope Parameters Screen

2. Determine and select Sample Time (in milliseconds) so the Controller will sample the selected data at the appropriate intervals.
3. Determine number of points to sample and display on the graph.
4. The time frame in which the controller samples the data is a function of: Sample Time x Points to Graph. This number is displayed in Scope Time frame box on the Storage Scope Graph.
5. Enter an optional command to be executed before starting to store the data. Example: Enter the command XQ to execute the program on the controller.

6. Choose the type of graph.

Three graph types are available:

- Time Graph - displays up to four (4) channels of data as a function of time.
- Two Dimensional Data Graph - displays a plotted line as a function of two (2) channels of data.
- Three Dimensional Data Graph - displays a plotted line as a function of three (3) channels of data.

7. Define the data to be sampled. Click on the desired channel tab. The dialog box appears as follows:
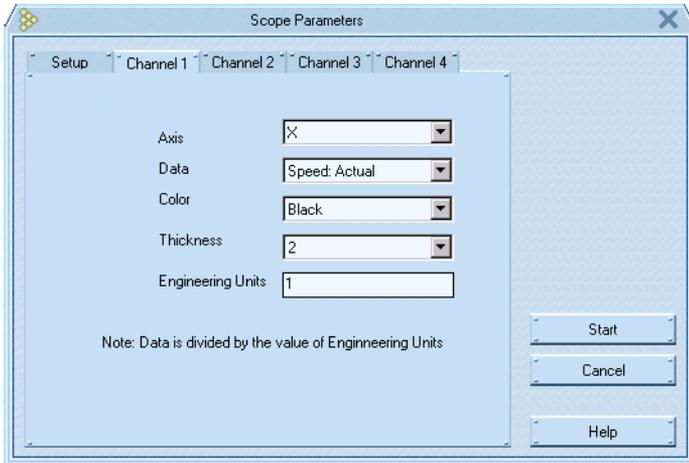
Figure 23: Storage Scope Parameters Channel Screen

8. Select Axis (or I/O) to sample. Select **none** if nothing is to be stored on this channel).
9. Select the **Data** to be stored.
10. Select the **Color** of the line to be plotted.
11. Select the **Thickness** of the line to be plotted.

Note: Two Dimensional and Three Dimensional graphs' line color and thickness is determined by the line color and thickness selected in Channel #1.

12. Enter Engineering Units value.

Note: One (1) is the minimum engineering unit conversion. Use the engineering units field to convert stored data from encoder counts to the desired unit.

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13. Repeat Steps 7 through 11 for other data parameters to be stored.
14. Click **Start** to begin storing data.

Viewing the Scope Results

After the controller completes sampling the data, the information is transferred to the computer and displayed as follows:
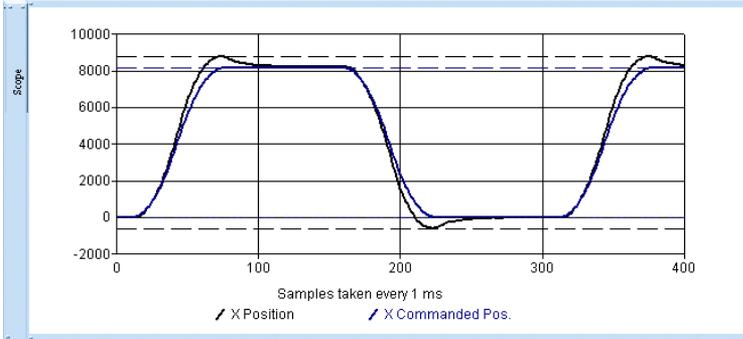
Figure 24: Example of Storage Scope Graph Screen

Saving the Gains on the SMC Controller

To write the gains to the motion controller, click on **Burn Gains** button. After verifying this, the gains are burned onto the SMC's EPROM (This is the equivalent to typing BN in the Terminal window). The gains will now be saved even when the power is disconnected.

Notes: If the gains are not burned, they will be lost after a software or hardware reset of the SMC.
Several parameters not shown on the tuning screen are also saved when burn is executed. Check the BN command page in the SMC manual for a complete list

SMC Parameter Utility
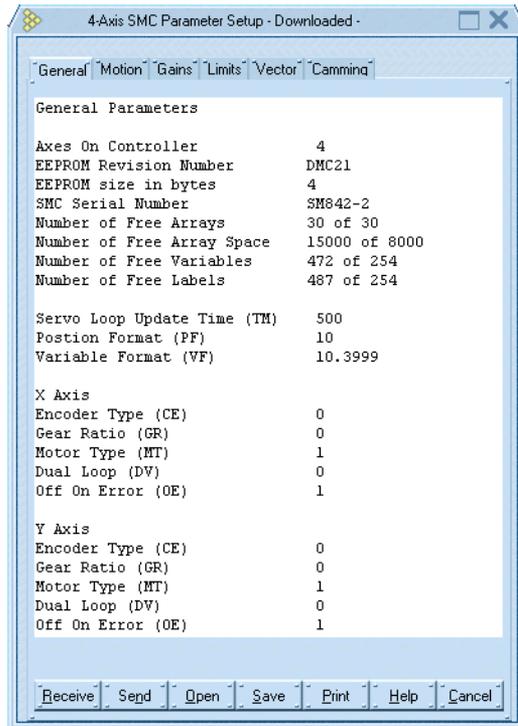
Figure 25: Parameter Setup Screen

The SMC Parameter Setup screen makes it possible to upload, download, save-to- file, and load-from-file parameter sets for the SMC.

Parameters are grouped according to function. By clicking on the desired function's tab, the current parameters of that group are displayed:

- Select **Receive** to download the SMC parameters into YTerm.
- Select **Open** to open a parameter set from a file.
- Select **Send** to send the current parameters set to the SMC.
- Select **Save** to save the current parameter set into a file.
- Select **Print** to print the current parameter set on the default printer. To change the printer, use Window's Printer Manager Program to change the default printer.

Note: Open will open the parameters into YTerm, but will not send them to the SMC.

Sigma Servo Amplifier Setup

The Sigma servo amplifier setup program is designed for configuring the amplifier to work with the SDGA and SDGB only.

Disconnect the serial communications cable from the SMC and connect the Yaskawa YS-11 Serial Communication Cable to the servopack.
Once this is done, run the setup program from YTerm using the Servopack button.

Connection will be established with the Servo amplifier, the result is a return of the servo amplifier's present settings, and should look similar to Figure 26.
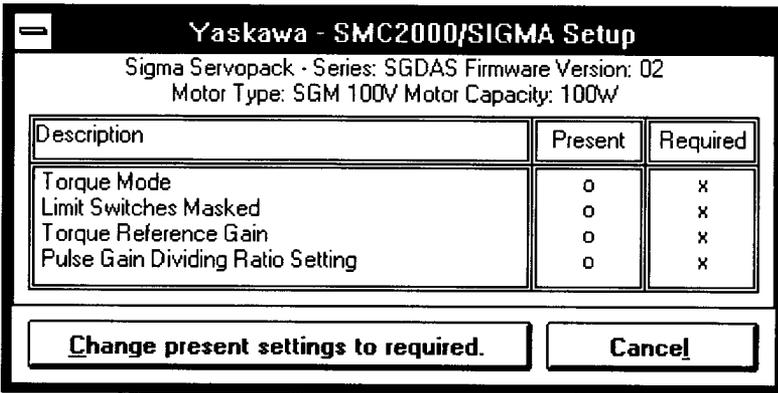
Figure 26: SMC/SIGMA Setup

1. Click on **Cancel** to cancel the current servo amplifier setup.
2. Click on **Change present settings to required** button to change the servo amplifier settings to match the required ones   After this is done, a dialog will appear asking wether an absolute encoder is to be installed. If yes, it will request the selection of the desired pulse gain dividing ratio.

Now your servo amplifier is configured for work with the SMC. The result should now look like Figure 27.
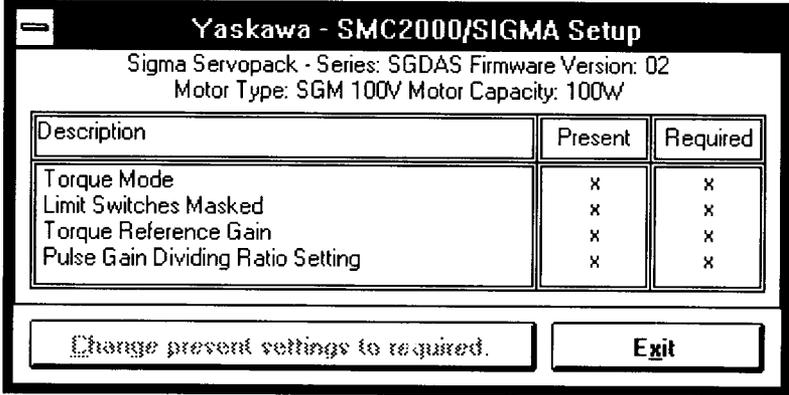
Figure 27: SMC/SIGMA Setup screen (after setup is complete).

Click on **Exit** to return to YTerm. Disconnect the Yaskawa YS-11 Serial communications cable. Reconnect the standard serial communications cable. Resume connection to the SMC via YTerm.

Emergency Stop Button

In the event that it becomes necessary to stop the motion of the attached servo system, click on the **Stop** button. This will issue Abort (AB) and Motor Off (MO) commands to the SMC for the selected axis. While executing Autotune and Tune Test, the stop button will stop the selected axis, and cancel the function, otherwise all axes will be stopped.

Note: The Abort command will stop all program execution. The Motor Off command will turn off the command functions to the selected motor.

The Monitoring Screen
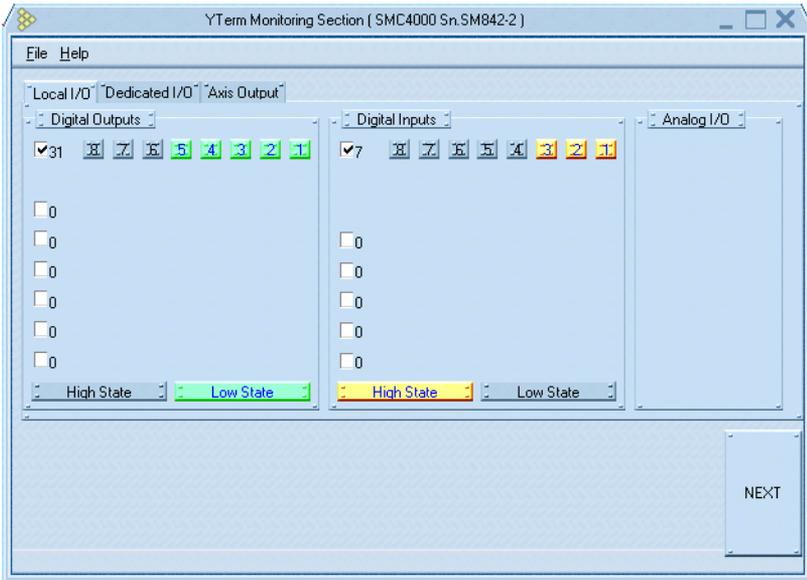
Figure 28: The Monitoring Section Screen.

The Monitoring Section screen, shown in Figure 28, provides the ability to observe the status of selected axes. This screen can be used to track motion parameters, inputs, and outputs.

Choose specific axes to be monitored, and select which parameters are to be returned. There are tabs to select from three screens of SMC status information.

1. Axis Output - Position, Position Error, Speed and Torque.
2. General IO - Digital Inputs, Digital Outputs and Analog Inputs.
3. Dedicated IO - Forward, Backward Limit and Home switches.

Axis Output

Selecting the **Axis Output** tab will display a screen to enable monitoring of any servo system on the SMC's axes. The monitoring consists of returning in real-time, the values of any of the following parameters:

- Position
- Position Error
- Speed
- Torque/Force

Select any combination of the available axes to monitor. This is done by clicking on the button with the letter representing the desired axis in the data monitoring panel. The buttons are labeled X, Y, Z, W, E, F, G, H.

To stop monitoring an axis, press again on the **Axis Selection** button for that axis. To select a parameter for monitoring, click the check box located left of the name label of the desired parameter.

The axis outputs can be displayed in listing or in graphical format as shown in Figures 29-30.

To switch between the two modes of display screen, Press the **Display List/ Display Graph** button on the Axis Output Screen.
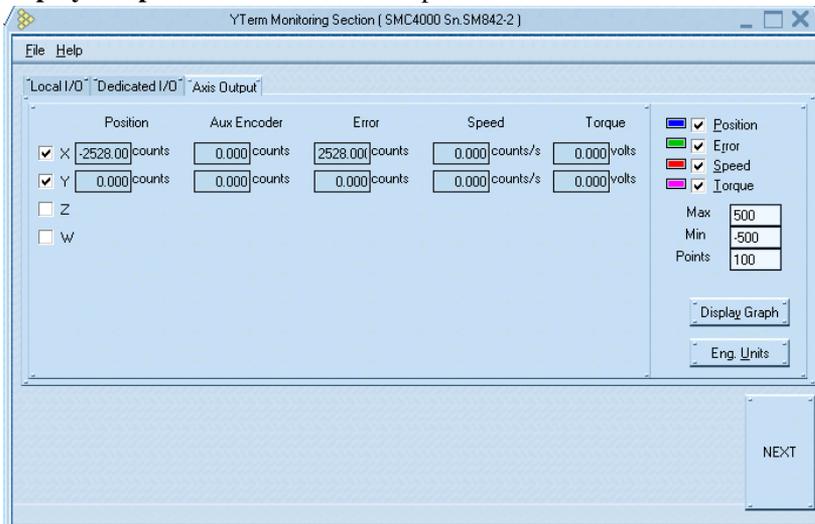
Figure 29: Axis Output Screen - List Display

Figure 30: Axis Output Screen - Graphic Display

The Max. and Min. fields are used to enter the upper and lower range of values to be displayed. The points field will determine how many points of data are displayed on the graph.

Note: Be certain that the Min. and Max. values include the actual range of values that the controller is reporting. This can be verified through the listing mode (see below).
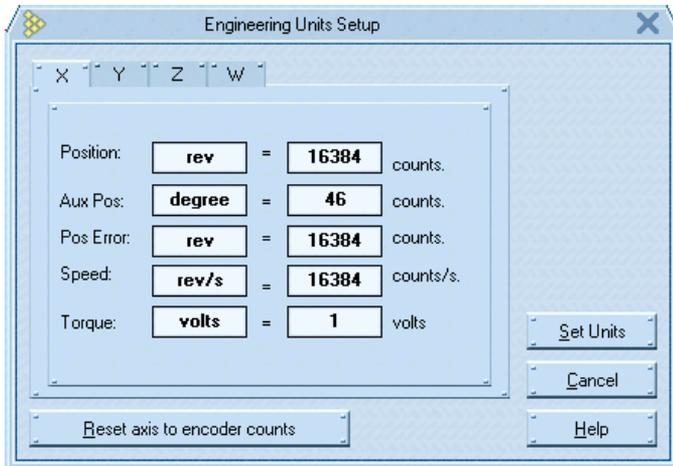
Figure 31: Engineering Unit Setup Screen

The Engineering Unit Setup Screen enables the user to enter pre-determined motions (engineering units) into the controller to be able to retrieve data in the units of measure related to the particular application.

To enter the engineering units for a program:

1. Select the desired Axis.
2. Enter name in the parameter (position, pos. error, speed, torque).
3. Enter the engineering unit factor (counts, counts/s., volts).
4. Select Set Units.

Click on **Reset axis to encoder counts** to restore to default values and continue monitoring with the default (1) engineering units.

Local I/O
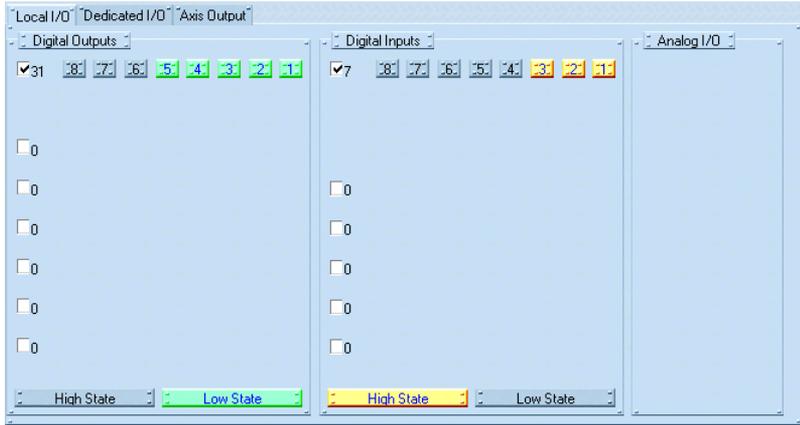
Figure 32: Local IO Monitoring Screen.

Selecting the Local IO tab will enable the monitoring of any I/O connected to the SMC. The monitoring consists of returning in real-time, the values of any of the following parameters:

- Digital Outputs
- Digital Inputs
- Analog Inputs

The digital inputs and outputs are banked. In groups of eight, click on the check box located to the left of the bank to activate. The bank will update in real time as the status on the SMC changes. Check boxes only appear for I/O that exist on the connected SMC.

For digital outputs, green boxes indicate low (i.e. "ON"), dark gray indicate high (i.e. "OFF"), and light gray indicates not available.

For digital inputs, yellow boxes indicate high (i.e. "ON"), dark gray indicates low (i.e. "OFF"), and light gray are not available.

The analog inputs are activated in a similar way, each one with its own check box. The analog value of the input is displayed next to its check box.

It is possible to "force" the status of a digital output by clicking the buttons. After the output is clicked, the status will change from high to low, or low to high, identified by a color change when YTerm reads the output status from the controller.

Dedicated I/O
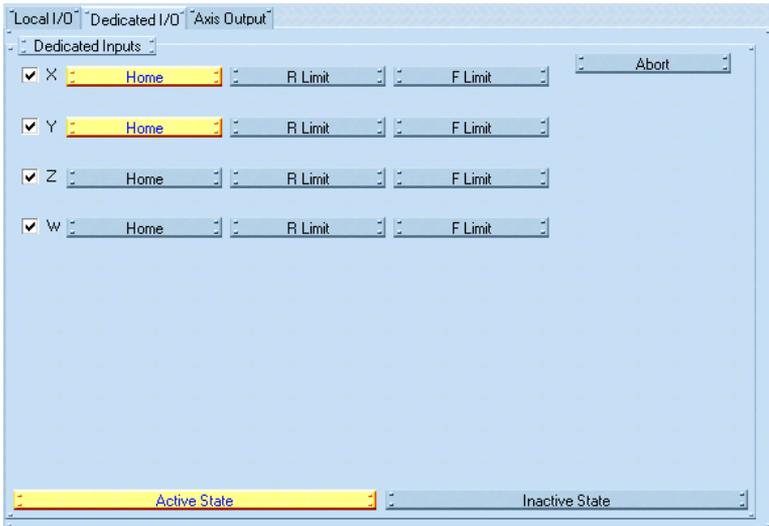
Figure 33: Dedicated IO Monitoring Screen.

Selecting the **Dedicated IO** tab will enables the monitoring of the limits and home inputs on the SMC. The monitoring consists of returning, the values of any of the following parameters in real-time:

- Forward Hardware Limits
- Reverse Hardware Limits
- Home Switches

The dedicated I/O are banked in groups of eight. To make a bank active, click on the check box next to the bank. Check boxes only appear for I/Os that are connected on the SMC.

Green boxes indicate inputs that are active, regardless of their on-state configuration, dark gray indicates the inputs are not active, and light gray indicates not available.

Appendix

SMC to RS-232 Connection (SMCCBL7 cable)

The layout of the connection cable between the SMC and the PC serial port (RS-232) is as follows:

SMC Side   PC (RS232) Side
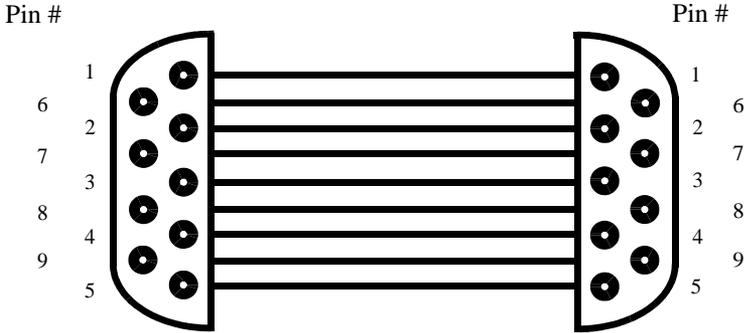
Figure 34: SMC / Personal Computer Connection Cable Layout.

Note: Both connectors are 9 pin female.

Table 1: Pin Descriptions

Pin Number	Pin Name	Function
1	CTS	output
2	Transmit Data	output
3	Receive Data	input
4	RTS	input
5	GND	ground
6	CTS	output
7	RTS	input
8	CTS	output
9	No Connect / 5V	not used

Sigma Servo Amplifier to PC Connection (YS-11 cable)

The layout of the cable, between the PC serial port (RS-232) and the Sigma Servo amplifier is as follows:

Sigma Servopack Side   PC (RS232) Side
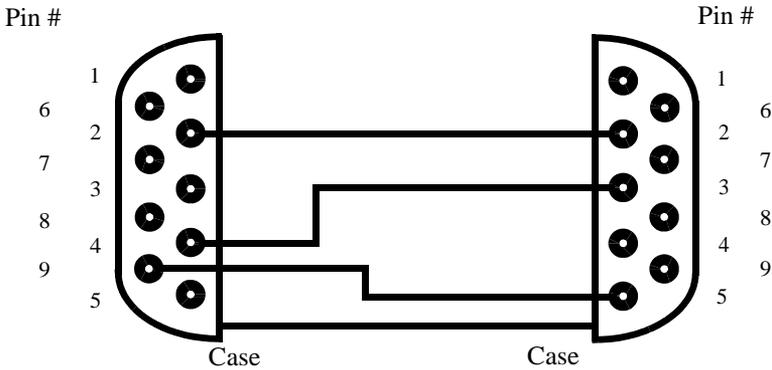
Figure 35: PC /Sigma Servo amplifier Communication Cable Layout.

Table 2: Pin Descriptions (PC Side- 9 PIN Female)

Pin Number	Pin Name	Function
1	n/c	not used
2	Transmit Data	output
3	Receive Data	input
4	n/c	not used
5	GND	ground
6	n/c	not used
7	n/c	not used
8	n/c	not used
9	n/c	not used

Table 3: Pin Description (Servo Amplifier Side - 9 Pin Male)

Pin Number	Pin Name	Function
2	TXD - Transmit Data	output
4	RXD - Receive Data	input
9	GND	ground

Theory of Operation of the Autotuning Algorithm

The motor is jogged in a positive direction at 3.75 R.P.M. while 5000 torque reference values are recorded and averaged. The purpose of this is to get an idea of the torque required to overcome friction. This is done with minimal gains settings of KD=10, KP=1, and KI=0.

The PID loop is shut off (KD=0, KP=0, and KI=0) and a voltage of 1.5 volts is applied to the motor command output for 100 msec. The motor position is recorded before and after this voltage is applied to determinate how far the motor traveled in 100 msec. The farther it moved, the lower the inertia mismatch.

Calculations are made to determinate KD, KP, and KI based on the inertia and selected rigidity level.
The motor is moved backward and forward (approximately 11 degrees for an 1:1 gear ratio, more for higher ratios). The motion is repeated as the gains are increased until an oscillation is detected at the end of the move. When this happens, the gains are decreased. If the rigidity level is other then 1, the process is repeated using less reduction in the gains after oscillation while watching for smaller amounts of oscillation.

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