USER GUIDE

PLC WorkShop for Siemens 505

Version 4.9x

FasTrak
SoftWorks, Inc.

www.fast-soft.com
262.238.8088

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14. REGISTRATION FORM. The Registration Form is a part of this Agreement and is incorporated herein by reference. This Agreement will not take effect, and Licensee will have no rights whatsoever with respect of the Software, unless and until the Registration Form is duly executed and returned to the Licensor and is accepted by Licensor.

Table of Contents

Chapter 1 – Welcome

Introduction

505 WorkShop is a powerful Windows-based tool for programming programmable logic controllers (PLCs). Whether you are a novice or an experienced programmer, this manual has been constructed to help you begin using 505 WorkShop quickly. We at FasTrak SoftWorks, Inc. have tried to assume little about you, the user, except that when you have a question regarding this software, you will want it answered by using this manual and the on-line help.

Using This Manual

Chapter titles use names that point you quickly to the specific information you want to find. Chapter titles are listed below, along with a brief description.

Chapter Titles	Description
Introduction	Outlines manual contents, Customer Support numbers, and necessary hardware and software to run 505 WorkShop.
505 WorkShop Quick Start Guide	Short, concise tips to get you started with PLC WorkShop quickly and easily.
Installation	Guides you through the installation procedures for the software.
Basics	Describes 505 WorkShop features and helps you move through the Windows environment.
Setup	Provides specific guidelines in setting up and customizing the software.
PLC Memory & I/O Configuration	Provides directions for configuring your processor, I/O modules, and Profibus slave devices to work with 505 WorkShop.
Programming	Gives a you solid understanding of the 505 WorkShop easy-to-use programming features.

Chapter Titles	Description
Documentation	Shows you how to add description to your logic programs.
Analog Alarms	Details the 505 WorkShop easy-to-use programming of analog alarms.
PID Loops	Details the 505 WorkShop easy-to-use programming of PID Loops.
RLL Instructions	Gives detailed information about the various RLL PLC instructions.
Special Function Instructions	Gives detailed information about the various Special Function PLC instructions.
Auditing	Outlines options for tracking program and setting changes.
FasTrak Authentication and NT Security	Provides instructions for establishing and using a Password Security Mode.

What is PLC WorkShop?

PLC WorkShop™ for Siemens 505™ is one of the most powerful and exciting programmable logic controller (PLC) programming software packages in the world, and is quickly becoming *the* universal PLC programming solution with its time-and money-saving features. PLC WorkShop is the software of choice for Simatic® 505 and CTI 2500 Series processors, and the only software on the market to support the full functionality of the CTI 2500 Series PLC System.

PLC WorkShop is easy to use, has built-in data acquisition and monitoring capabilities, provides the ability to track program changes (Activity Audit Trail), and offers powerful NT security management (Windows Authentication) with password protection. PLC WorkShop is a full 32-bit product, and the only 505 software product available that fully supports all Windows operating systems, from Windows 95 through Windows 7.

Features and Benefits

PLC WorkShop for Siemens 505 is:

Functional and Comprehensive

- Has the ability to open several online and / or offline programs simultaneously, track addresses through cross referencing, and track program changes (Activity Audit Trail)

- Offers built-in data acquisition & monitoring capabilities, Cut, Copy, and Paste commands, and complete support of RLL, Special Function Programs and Subroutines, Alarms and Loops including Power Math functions in 555 and 575 TI PLCs

- Provides comprehensive Profibus-DP master and slave configuration tools

- Provides online Help, and an instruction toolbar and mnemonics

Flexible

- Offers flexible program setup and full support of all Windows® operating systems, from Windows 95 through Windows 7.

- Provides the option to use familiar TISOFT™ hotkeys
- Provides multiple documentation and print options, and choice of communications including Serial, TCP/IP, H1, FMS, TIWAY, Modem, AutoBaud, and NITP

Secure

- Offers NT Security incorporating one-time, server-based security configuration, complete administrator control of all editing, save and load functions, documentation, program setup, and auditing of all user operations

Technical Specifications

PLC WorkShop for Siemens 505 supports:

PLC Compatibility

Supports the entire line of Siemens Simatic / TI PLCs including:

500 SERIES

- 520 1101
- 520C 1101, 1102
- 525 1102, 1104
- 530 1102, 1004, 1008
- 530C/T 1104, 1108, 1112
- 535 1104, 1108, 1112
- 560 2120
- 565 2120

- 560T 2820
- 565T 2820

505 Series

- 545 1101 - 1106
- 555 1101 - 1106
- 575 2102 - 2106

Supports the entire line of CTI 2500 PLCs:

- CTI 2500 Series: 2500-C100; C200; C300; C400

Windows Compatibility

- Designed and tested under Windows® 95, 98, Millennium, NT, 2000, XP, Vista, and Windows 7

Communications Support

- Supports all methods of communications including Serial with modem support (COM1 – COM4), TCP/IP, H1, FMS, and Serial TIWAY

TISOFT Conversion

- To ease your transition from TISOFT, TISOFT files can be loaded and familiar TI-SOFT hot keys and mnemonics can be used

SoftShop Conversion

- To ease your transition from SoftShop, SoftShop files can be loaded and used

COM Profibus Conversion

- To ease your transition from COM Profibus, COM Profibus configuration files can be merged into your I/O configuration

Customer Support

It's our goal that customers become proficient users of our software as quickly and easily as possible. With that in mind, FasTrak makes available a number of support options. Commonly asked questions can usually be answered with this manual, online help, or by visiting our website at www.fast-soft.com. Our website features easy-to-access FAQs, technical resources, and system documentation.

For real-time how-to help and advanced troubleshooting, contact FasTrak's customer support center and speak directly with a technical support representative. Our trained experts offer convenient, accurate and prompt assistance.

Customer Support	262.238.8088
Customer Support Fax	262.238.8080
Email	support@fast-soft.com
Website	www.fast-soft.com

You can also send questions, comments and suggestions to:

FasTrak SoftWorks, Inc.

PO Box 240065

Milwaukee, WI 53224-9003

For detailed information on Siemens 505 CPUs and Instructions set, refer to the following manuals:

Manual Name	Part Number
505 System Manual	PPX:505-8201-X
505 Programming Reference Manual	PPX:505-8204-X
ET200 Distributed I/O Manual	PPX:505-8206-X

Updating Software License Key

This FasTrak product is protected by a security key or site license.

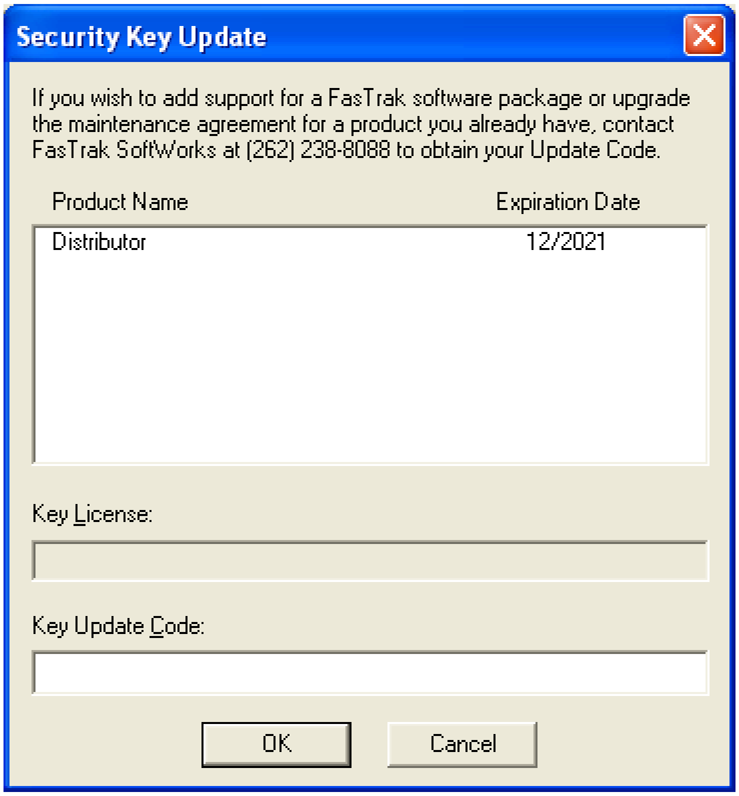
Security of keyed WorkShop products are protected by use of a security key. This key may be a parallel port or USB connector (the FasTrak-KEY) that is provided when a new purchase is made of the product. For keyless site license users, security is built in to the product. For more information on site licenses, please contact your WorkShop distributor or sales representative.

For users with a security key, a license code is provided per each maintenance agreement by FasTrak SoftWorks, Inc. Upon renewal of a maintenance agreement, a new license code may be obtained by contacting your distributor or sales representative.

To obtain the Key Update Code by email:

1. Connect your hardware key to your computer (parallel or USB port).

2. Select the **Help \ Update Key** WorkShop menu item. The **Security Key Update** dialog appears.



Security Key Update

If you wish to add support for a FasTrak software package or upgrade the maintenance agreement for a product you already have, contact FasTrak SoftWorks at (262) 238-8088 to obtain your Update Code.

Product Name	Expiration Date
Distributor	12/2021

Key License:

Key Update Code:

3. Copy the contents of the **Key License** text box. Paste it into an email message. Note that the key license may be longer than the displayed part of the field. Repeat for each key, and write the key number(s) found on the label on your key(s) (4 digits and a letter) near the key license number(s).

4. Send the message to support@fast-soft.com.

5. FasTrak SoftWorks will reply with a new license code.

6. Enter the new license code in the **Key Update Code** text box. Click **OK** when finished. The security key is now updated.

To obtain the Key Update Code by telephone:

1. Connect your hardware key to your computer (parallel or USB port).

2. Call FasTrak SoftWorks at **262.238.8088**. Ask for a key update.

3. Select the **Help \ Update Key** WorkShop menu item. The **Security Key Update** dialog appears.

4. Read the contents of the **Key License** text box to the representative. Note that the key license may be longer than the displayed part of the field.

5. Enter the new license code in the **Key Update Code** text box. Click **OK** when finished. The security key is now updated.

System Requirements

Hardware Requirements

To install PLC WorkShop on your computer, you need the following hardware:

- A personal computer with an Intel Pentium 100 processor or higher
- 32 Mb or more of RAM
- An 800 X 600 VGA monitor with at least 256 colors
- 100 Mb free disk space on your hard drive
- A mouse is recommended, but not required

WorkShop may not function properly on systems that are not 100% Intel compatible. Certain other hardware components and peripherals can create incompatibility problems.

Compatible PLCs

This version of PLC WorkShop supports the following PLC types and revisions:

500 Series	
PLC Type	**Revisions**
520	1101
520C	1101, 1102
525	1102, 1104
530	1102, 1004, 1008
530 C/T	1104, 1108, 1112
535	1104, 1108, 1112
560	2120
565	2120
560T	2820

505 Series	
PLC Type	**Revisions**
545	1101-1106
555	1101-1106
575	2102-2106

CTI 2500 Series	
PLC Type	**Revisions**
2500	C100 – C400

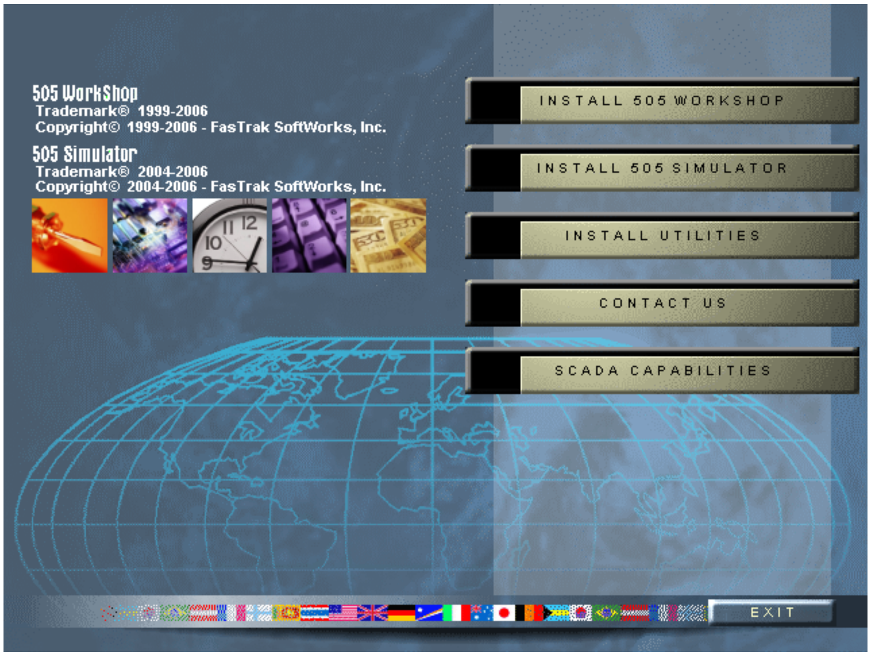
Chapter 2 – Installation

Installing the Software

Before you begin installation, you should review WorkShop's System Requirements.

To install PLC WorkShop for Siemens 505, turn on the computer and start Windows. A user name and password may be required to log in to a computer network. If unsure, contact your company's System Administrator or IT representative. Follow these steps to install the software:

1. Insert the PLC WorkShop for Siemens 505 installation CD in your computer's CD-ROM drive.
2. The CD should start automatically. If not, click the Windows **Start** button. Then click **Run**, and type `x:\setup.exe`, where x is the letter for the CD-ROM drive. The **PLC WorkShop CD Browser** dialog box appears.



505 WorkShop
Trademark® 1999-2006
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505 Simulator
Trademark® 2004-2006
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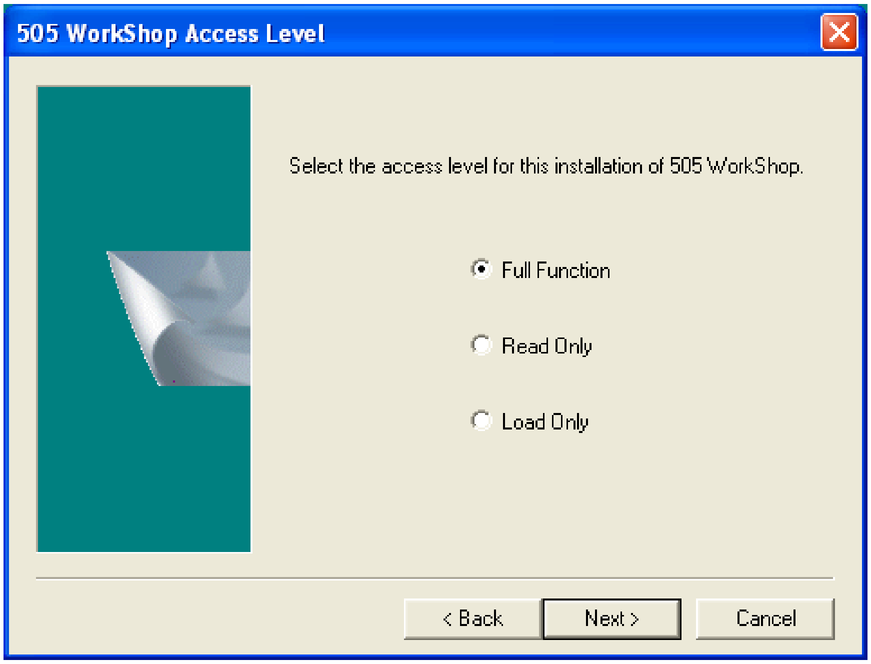
3. Click **Install 505 WorkShop** to begin installation. Follow the instructions that appear on the screen.
4. After clicking **Next**, the **Access Level** dialog appears. Select **Full-function**, **Read-only**, or **Load-only** install. See Access Level for further details.
5. After making your selection, click **Next**. Installation begins and a message appears telling you that the **505 WorkShop Installation Utility** is loading. Follow the instructions on the screen to complete installation.

Access Level



505 WorkShop Access Level

Select the access level for this installation of 505 WorkShop.

● Full Function

○ Read Only

○ Load Only

A **Full Function** installation allows full access to all features of WorkShop.

A **Read Only** installation will not allow the user to access the following:

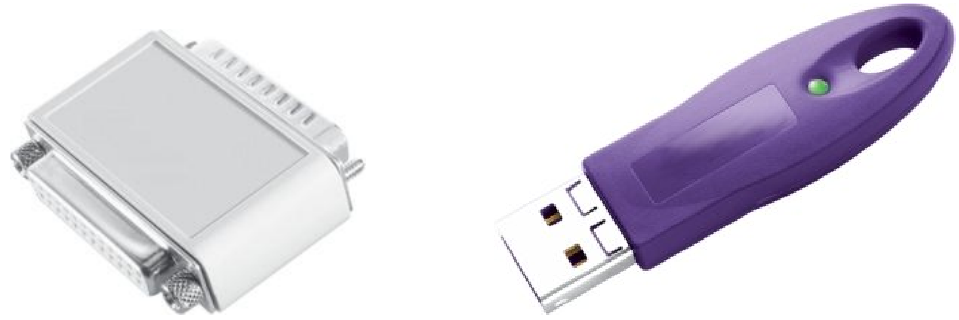
- **File Menu operations** - New, Open (Online), Save, Save As, Import, Export, and Merge.
- **Edit Menu** - Undo, Cut, Copy, Paste, Clear, Delete, Insert, Append, and Select All.
- **View Menu** - Ladder Editor, Special Function Editor, PID Loops, Alarms, Documentation Window, Symbol Library, and Data Window are all view only.
- **Program Menu** - New Network, Select Instruction, and Validate and Enter.
- **Configuration Editing** - Memory configuration editing, set PLC Scan Time, 505 I/O Edit, Profibus I/O Edit, Watchdog Timer Edit, and Time of Day edit.
- **Utilities Menu** - PLC Operations modes (PG/RUN etc.), Profibus Operations, Diagnostics on base, Task Codes per scan, Port Lockout, Password, Clear Memory, and Clear Memory.

A **Load Only** installation will not allow the user to access the following:

- **File Menu operations** - New, Save, Save As, Import, Export, and Merge.
- **Edit Menu** - Undo, Cut, Copy, Paste, Clear, Delete, Insert, Append, and Select All.
- **View Menu** - Ladder Editor, Special Function Editor, PID Loops, Alarms, Documentation Window, Symbol Library, and Data Window are all view only.
- **Program Menu** - New Network, Select Instruction, and Validate and Enter.
- **Configuration Editing** - Memory configuration editing, set PLC Scan Time, 505 I/O Edit, Profibus I/O Edit, Watchdog Timer Edit, and Time of Day edit.
- **Utilities Menu** - Diagnostics on bases, Task Codes per scan, Port Lockout, Clear U Memory, and Password.

FasTrak-KEY

Attaching the FasTrak-KEY?



The WorkShop software is copy-protected with a device called the FasTrak-KEY, which is included in your shipment. The FasTrak-KEY will be used for one of two purposes, depending on your licensing agreement with FasTrak SoftWorks, Inc:

- **Single-user keyed license** - Under this agreement, each FasTrak-KEY represents one single-user license. The FasTrak-KEY must be attached to your computer before you launch WorkShop. Otherwise, if a FasTrak-KEY is not detected, WorkShop will run in Demo mode with limited functionality.

- **Multi-user key on install only site license** - Under this agreement, one FasTrak-KEY is issued for your company. This key allows a certain number of installations of WorkShop based on your site license agreement. The FasTrak-KEY must be attached to your computer before you can install WorkShop, but can be removed once WorkShop is installed.

To attach the FasTrak-KEY to your computer, connect the key to a parallel port (LPT1-LPT3) or USB port on your computer, following the steps below. The FasTrak-KEY will not interfere with normal port data transmissions, nor will it prevent you from creating backup copies of the software.

Connecting the FasTrak-KEY

To attach the FasTrak-KEY to your computer:

1. Determine which parallel or USB port to connect the FasTrak-KEY to.
2. Disconnect other security devices or cables attached to that port.
3. Connect the FasTrak-KEY to the port.

4. Attach other cables to the FasTrak-KEY, if necessary. If the device attached to the FasTrak-KEY is a parallel printer, make sure the printer is turned on before starting 505 WorkShop.

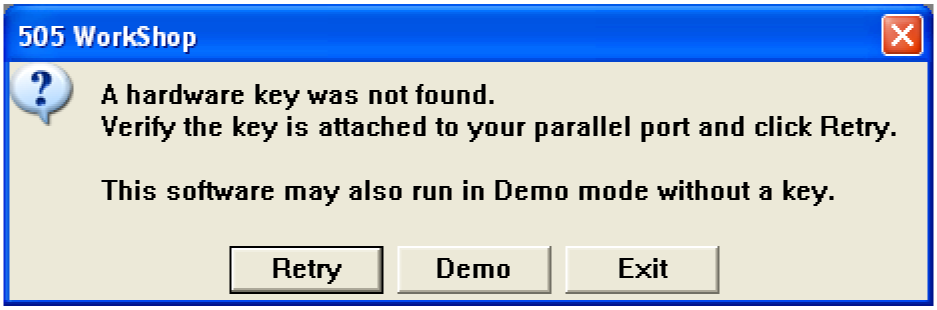
> **NOTE:** The FasTrak-KEY must be the first device attached to the parallel port. Other devices or cables can subsequently be attached to the FasTrak-KEY.

See Troubleshooting the FasTrak-KEY if you are receiving error messages or having any other problems relating to the FasTrak-KEY.

Troubleshooting the FasTrak-KEY

Following are error messages associated with the FasTrak-KEY, possible causes, and solutions.

Message



A hardware key was not found.
Verify the key is attached to your parallel port and click Retry.

This software may also run in Demo mode without a key.

Possible Causes

- WorkShop was started without the FasTrak-KEY attached to a valid parallel or USB port.
- The FT-Key port driver may be missing or corrupt.
- If running Windows NT, the NT driver may not be loaded.

Solution

Check to see that:

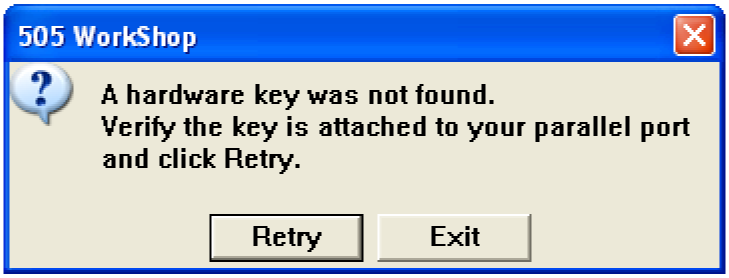
- The FasTrak-KEY is connected to a valid parallel or USB port.
- The FasTrak-KEY is the first device attached to the computer.
- Any parallel printers attached to parallel ports are turned on.

Reinstall the port driver :

1. Download the latest FT-Key driver from FasTrak at **www.fast-soft.com**.
2. Uninstall the existing driver by running the driver file and selecting the **Remove**radio button from the **Program Maintenance** dialog and following the prompts in the install program.
3. Remove any attached FasTrak-KEYs from the computer.
4. Reinstall the driver by running the driver file again and following the prompts in the install program.

NOTE: If WorkShop is being installed on a laptop that uses a docking station, do not attach the key to the docking station. If the laptop is removed from the docking station, the key will not be found. Instead, remove the port driver using the steps above and reinstall the key driver with the laptop undocked. WorkShop will then recognize the key whether or not the laptop is docked.

Message



505 WorkShop

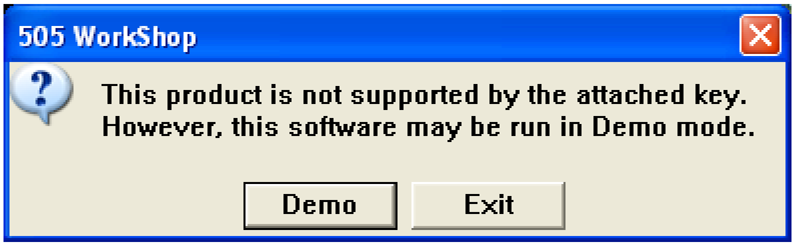
A hardware key was not found.
Verify the key is attached to your parallel port
and click Retry.

Solution

Check to see that:

- The FasTrak-KEY is connected to a valid port.
- The FasTrak-KEY is the first device attached to the computer.

Message


505 WorkShop

This product is not supported by the attached key.
However, this software may be run in Demo mode.

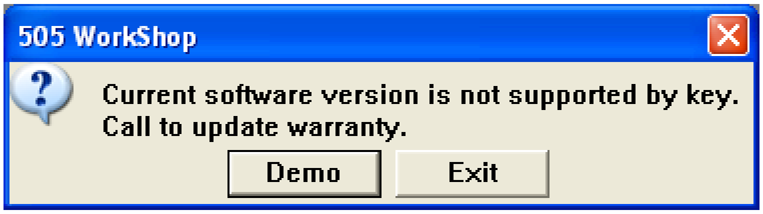
Possible Cause

The attached key is not authorized for use with 505 WorkShop.

Solutions

- Check to see that the correct FasTrak-KEY has been attached to the parallel or USB port.
- Call FasTrak Technical Support (262.238.8088).

Message


505 WorkShop

Current software version is not supported by key.
Call to update warranty.

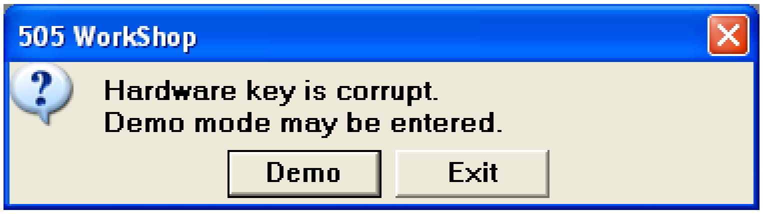
Possible Causes

The key date does not support the current software version.

Solution

Call FasTrak Technical Support (262.238.8088).

Message



505 WorkShop

Hardware key is corrupt.
Demo mode may be entered.

Possible Cause

You purchased a partial software package, and the partial package information cannot be read from the FasTrak-KEY.

Solution

Call FasTrak Technical Support (262.238.8088).

Communications Cable

Connect the Communications Cable

The communications cable connects a serial port of the computer to the PLC. This enables programs and data to be transferred between the computer and the PLC. This cable has a 25-pin or 9-pin connector (computer end) and a 9-pin connector (PLC end).

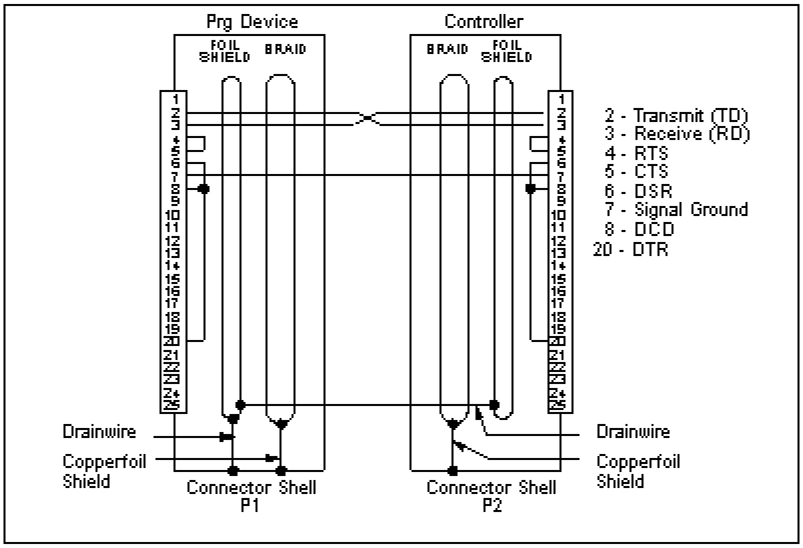
If your computer has a 9-pin COM port, and you have a 25-pin cable, you can use a 9 to 25-pin converter to connect the communications cable to the processor. If your computer has a 25-pin COM port, this converter is not necessary.

The pin-outs for the communications cable are shown in the following figures.

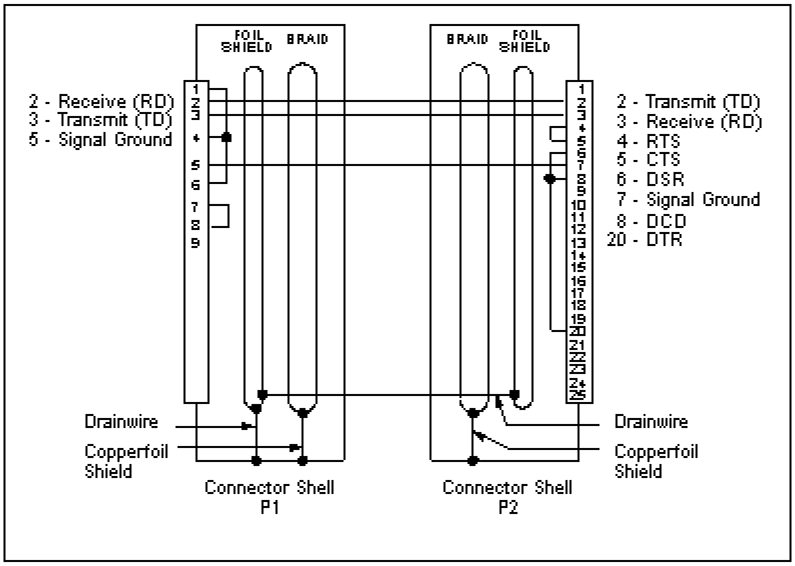
- Cable Pin-Outs for RS-232-C Ports
- Cable Pin-Outs for RS-422 Ports
- **Ethernet Connection**

Cable Pin-Outs for RS-232-C Ports

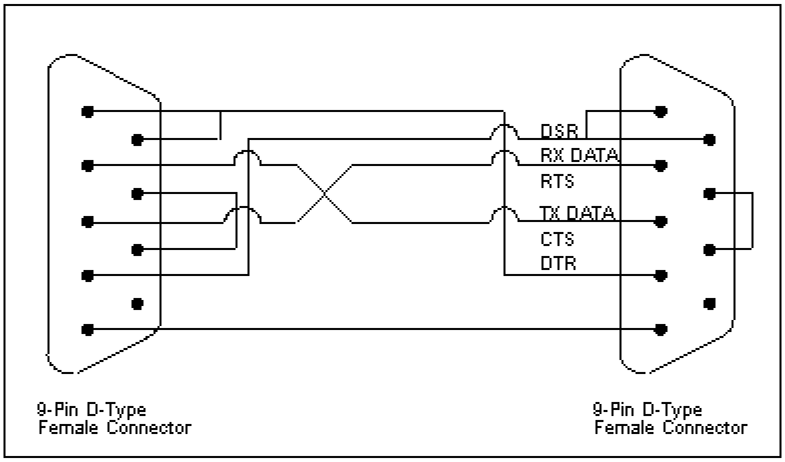
Connect your programming device to the controller with a double-shielded null modem RS-232-C cable. The following illustrations show pin-outs for the RS-232-C cables.



25-Pin to 25-Pin Cable



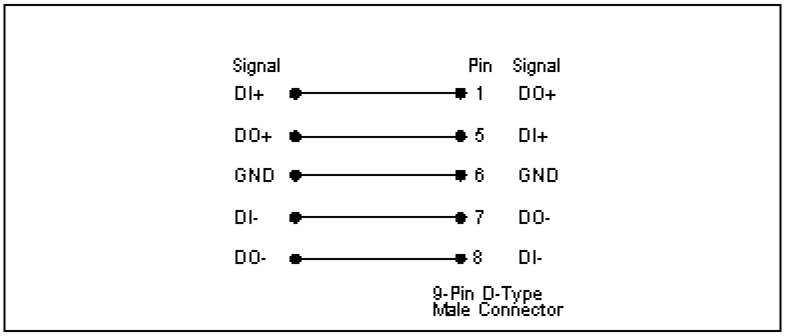
9-Pin to 25-Pin Cable



9-Pin to 9-Pin Cable

Cable Pin-Outs for RS-422 Ports

If your controller has an RS-422 port, you can connect through the RS-422 port on your programming device. Use the pin-out values shown below for the RS-422 cable.



Ethernet Connection

For Ethernet connection, you need a compatible Network Interface Card (NIC) in your computer, a Siemens PPX:505-cp2572 TCP/IP Ethernet card installed in your 505 system, and the appropriate cabling.

For more information on setting up your Ethernet connection, refer to the **Simatic Ethernet TCP/IP Communication Processor (505-CP2572) User Manual,** order number PPX:505-8132-1, or the **CTI 2572 Ethernet TCP/IP Adapter Installation and Operation Guide**, order number 062-00146.

Chapter 3 – PLC WorkShop Basics

Software Features

This chapter will get you started using PLC WorkShop. Although you should progress at a rate comfortable for you, we recommend following the manual outline in your approach to programming. Advancing through the remaining sections in this order will help ensure a more efficient use of the software. These sections, in order, include:

- PLC WorkShop Basics
- Setup
- PLC Memory & I/O Configuration
- Programming
- Documentation
- Analog Alarms
- PID Loops
- RLL Instructions
- Special Function Instructions
- Auditing
- FasTrak Authentication and NT Security
- 505 Simulator
- FTLogger
- FTTrender
- FTVersionTrak

Approaching the software in this order will also help you discover 505 WorkShop's powerful features that include:

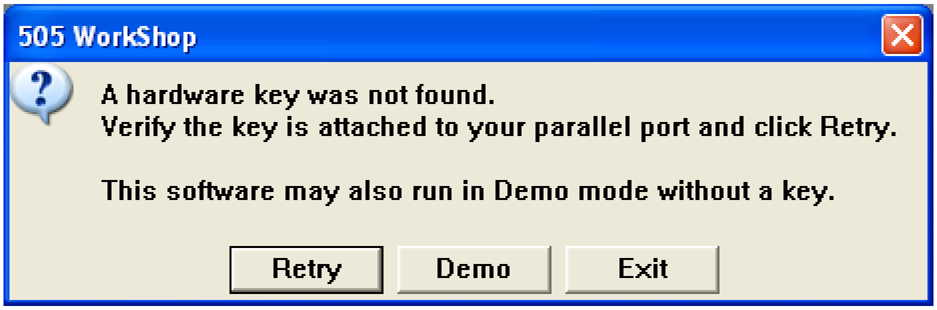
- Multiple windows view and edit
- Flexible program setup
- Access to ladder logic through cross-reference
- Write, read, and force addresses from the Data Window
- Multiple documentation options
- Keyboard support for every function and command

Starting PLC WorkShop

After installing PLC WorkShop, start WorkShop by doing one of the following actions:

- Double-click the **WorkShop** icon.
- Click **Start**, point to **All Programs**, click **FasTrak SoftWorks**and then click **505 WorkShop**.

While 505 WorkShop loads, the 505 WorkShop copyright screen appears. If your license requires the FasTrak-KEY for WorkShop to function and 505 WorkShop does not detect a key, an error message appears.



A hardware key was not found.
Verify the key is attached to your parallel port and click Retry.

This software may also run in Demo mode without a key.

If you see this message, check to see that the FasTrak-KEY is:

- Connected to a USB or parallel port
- If connected to a parallel port, connected before printers or other devices
- See Attaching the FasTrak-KEY for more information

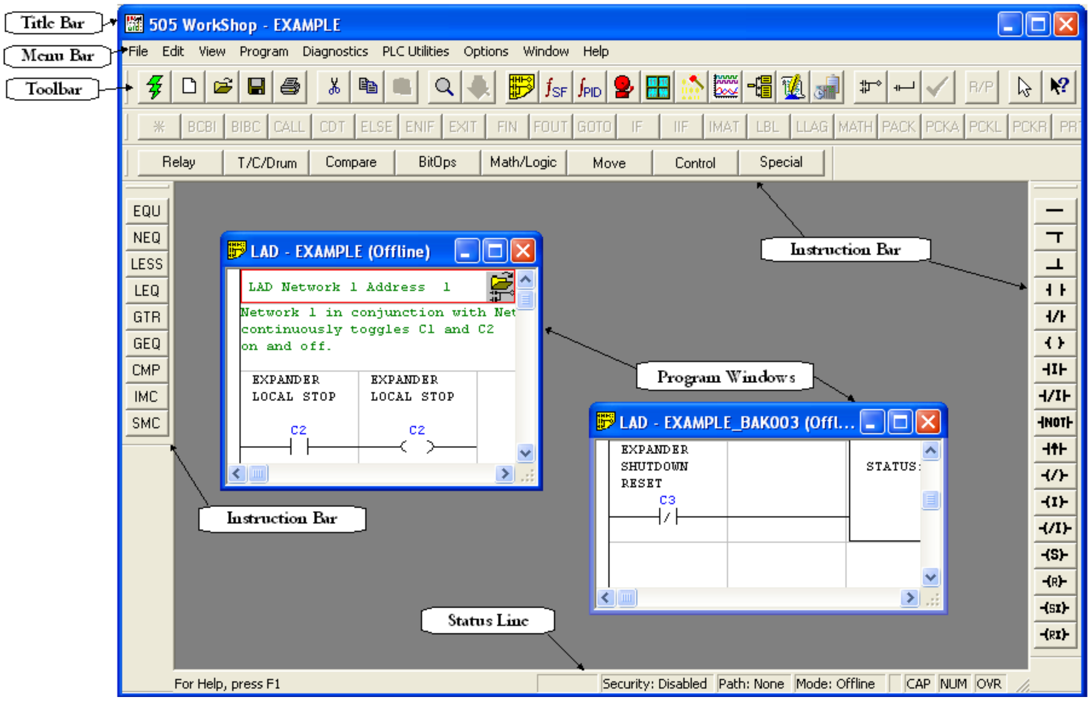
After you have checked the key's installation, load PLC WorkShop from the icon. If PLC WorkShop continues to not detect the FasTrak-KEY, please call FasTrak Customer Support at 262-238-8088 immediately.

When 505 WorkShop has loaded completely, the 505 WorkShop window appears.

Main Window

Main Window

The PLC WorkShop window is the starting point for all your work. The key features of the window are designated with arrows on the sample illustrated below. Definitions of each feature are next, followed by more detailed information.


Title Bar
Menu Bar
Toolbar
505 WorkShop - EXAMPLE
File Edit View Program Diagnostics PLC Utilities Options Window Help
R/P
BCBI BIBC CALL CDT ELSE ENIF EXIT FIN FOUT GOTO IF IIF IMAT LBL LLAG MATH PACK PCKA PCKL PCKR PR
Relay T/C/Drum Compare BitOps Math/Logic Move Control Special
EQU NEQ LESS LEQ GTR GEQ CMP IMC SMC
Instruction Bar
LAD - EXAMPLE (Offline)
LAD - EXAMPLE_BAK003 (Offl...
Program Windows
Instruction Bar
Status Line
NOT
S R SI RI

LAD Network 1 Address 1

Network 1 in conjunction with Net continuously toggles C1 and C2 on and off.

EXPANDER LOCAL STOP C2 | EXPANDER LOCAL STOP C2

EXPANDER SHUTDOWN RESET C3 | STATUS:

For Help, press F1 | Security: Disabled | Path: None | Mode: Offline | CAP | NUM | OVR

Window Description

The key features of the **505 WorkShop window** are defined below. More detailed descriptions follow.

Window Feature	Function
Instruction Bars	Use to add instructions, new rows, and new networks/addresses to a logic program.
Menu Bar	Use to select 505 WorkShop functions.

Window Feature	Function
Multiple Program Windows	Displays view and edit windows of multiple logic programs at the same time, limited only by the size of your computer's memory.
Status Line	Displays information about the operation in progress.
Title Bar	Displays the name of the application. Buttons in the upper right corners change the window's size and position.
Main Toolbar	Use to quickly access frequently used menu options.

Instruction Bars

Instruction Bars

The instruction bars appear along the sides and the top of the **WorkShop window** when you are programming ladder logic.

Instructions are divided into groups. To display the instructions for a group, click the group button. For example, to display the math instructions click the **Math/Logic** button. The instructions for that button appear and you can move the window anywhere on the screen. The Math group button remains selected until another group button is pressed.

Inserting an Instruction Bar Item in a Program

1. Click an instruction group button on the upper half of the Instruction Bar.
   Result: Instructions for that group appear on the lower half of the bar.

2. Click the button showing the item you want to insert in the program.
   Result: The item attaches to the pointer when you move to the ladder editing area.

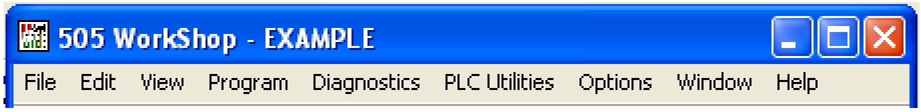
3. Move the pointer to the item insertion point on the ladder editing area and click the left mouse button.
   Result: The instruction is dropped into place.

4. Repeat Step 3 each time you want to add the same item.

5. Click on the arrow button in the middle of the Instruction Bar to return the pointer to an arrow.

Menu Bar

The menu bar, located just below the title bar, identifies the names of the available 505 WorkShop functions. To display the menu options for each function, click on the function name. The menu options displayed may change depending upon the operation in progress.



The **Restore Down** button appears on the Menu Bar when a program window is maximized. Use the **Restore Down** button to control the size of the program window.

Multiple Program Windows

505 WorkShop displays more than one logic program window at a time. You can open as many logic program windows as your computer's memory permits.

For example, you may wish to copy part of a logic program to another program. This saves you programming time by not having to retype similar logic statements for each program. To copy a part of one logic program to another, use the following procedure:

1. Open both programs offline.

2. Arrange the logic program windows by clicking **Tile** or **Cascade** from the **Window** menu.

3. Select the data you want to copy to the other program.

4. Click **Copy** from the toolbar or from the **Edit** menu.

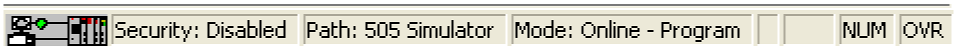
5. Move the pointer to the place you want to insert the data in the other program. Click **Paste** from the toolbar or from the **Edit** menu.

Status Line

The Status Line spans the bottom of the 505 WorkShop window. Information about the menu item or button under the mouse cursor appears at the left end of the status bar.

The right side of the Status Line displays the information listed below.

Status line	Function
Security	Indicates whether the security system is enabled or disabled. See **Security Setup** for details.
PLC Path	Describes the active program's connection to the PLC.
Logic Mode	Indicates whether you are programming online or offline.
CAP	When the indicator **CAP** is shown, the caps-lock mode is active. Characters typed will be CAPITALS, unless the **SHIFT** key is pressed.
NUM	When the indicator **NUM** is shown, the num-lock mode is active. The keypad will be interpreted as numbers instead of cursor motion.
OVR	When the indicator OVR is shown, the overwrite mode is active. Characters typed in text fields will overwrite any existing text, rather than being inserted.

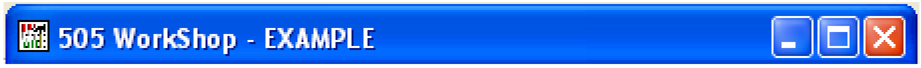

Security: Disabled | Path: 505 Simulator | Mode: Online - Program | NUM | OVR

Title Bar

The Title Bar spans the top of the 505 WorkShop window.

Use the Title Bar to:

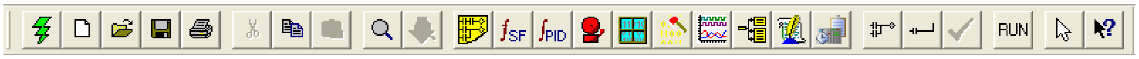
- Identify the application you are using. In this example, the application is 505 WorkShop
- Move the window. Click the title bar with the pointer and drag to the desired location to move the window.
- Change the size or position of the window. The following buttons appear in the corner of the title bar:



Button Title	Location	Function
Minimize	Left box	Click the dash button to reduce window to an icon.
Maximize	Middle box	Click the window button to enlarge the entire screen.
Close	Right box	Click the X button to exit WorkShop.

Main Toolbar

The main toolbar displays a row of icons that represent frequently used options. Select the option by clicking on its button, saving you the steps of selecting several options from a series of menus. Notice that when you click on the button, its purpose appears on the Status Line at the bottom of the window.



Click	To
⚡	Fast PLC Connection
🗋	Create a new program
📂	Open an existing program
💾	Save the active program

Click	To
🖨	Print
✂	Cut the highlighted section to the clipboard
⧉	Copy the highlighted section to the clipboard
📋	Paste a section from the clipboard
🔍	Find a network, address, or tag
⬇	Find the next occurrence of the found address or tag
⊣⊢	Display Ladder Editor
*f*SF	Display Special Functions Editor
*f*PID	Display PID Loop Directory
🔔	Display Analog Alarm Directory
⊞	Display the Data Window
✎	Display FTLogger
📈	Display FTTrender
⊣▤	Display the Cross Reference
📝	Display the Documentation Window
▦	Display 505 Simulator
⊣⊢⇢	Add a new network to a program
⊣⊢↵	Add a new row to a program

Click	To
PRG	Puts the PLC in program mode
RUN	Puts the PLC in run mode
✓	Enter and validate the active program.

Logic Programs

Working With Logic Programs

505 WorkShop provides you with a number of different ways of editing programs. These include:

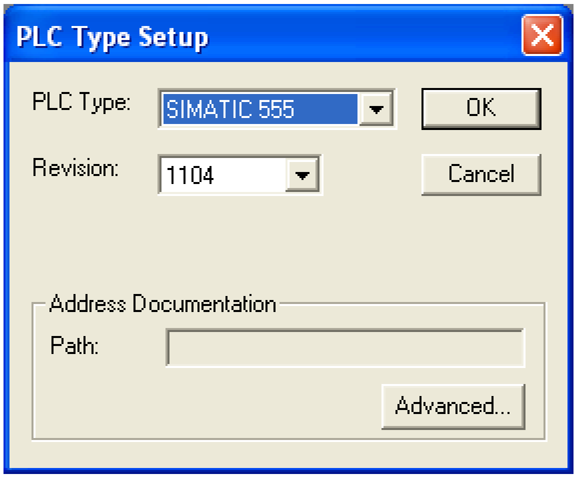
- Connecting to a PLC to view logic stored in the PLC
- Creating a new program offline
- Loading a file online
- Loading a file offline
- Attaching documentation to an online program

Before you can perform any editing, you must first open a logic program.

Creating a New Logic Program

New programs are created in offline mode only. To create a new logic program and begin programming:

1. Click **New** from the **File** menu, click the 🗋 toolbar icon, or press **CTRL+N**. The **PLC Type Setup** dialog box appears.



PLC Type Setup

PLC Type: SIMATIC 555

Revision: 1104

Address Documentation

Path:

2. Select the **PLC Type** and **Revision** corresponding to the PLC to be used. Selecting a **PLC Type** of **CTI 2500** and a **Revision** of **C400 >= 8.01** enables the use of additional control relay bits (56,320 instead of 32,768). A CTI 2500 C400 with a firmware revision of at least 8.01 is required.

3. By default, documentation is saved with logic, data, and configuration in the same *.FSS file. However, documentation can be shared with other applications and programs by saving it in a separate database file. Click the **Advanced** button to display the **Shared Address Documentation** dialogs and specify the separate database file.

NOTE: Programs cannot be saved in demo mode.

Fast PLC Connection - Connecting to a PLC

With 505 WorkShop, you can connect to a PLC with a click of the mouse. You can then view and edit existing logic in the PLC.

Prior to connecting the first time, you need to set up the PLC connection. Refer to Fast PLC Setup for more details.

NOTE: Remember, you cannot load a file with Fast PLC Connection. To load a file Online, use Open Program.

To connect to a PLC online click ⚡ on the Toolbar or select **Fast PLC Connection** from the **File** menu. You are set to begin programming.

NOTE: If your controller is a 575, refer to Connecting Online to a 575 in this chapter for information on selecting Application ID and configuring ports.

Open an Existing Logic Program Offline or Online

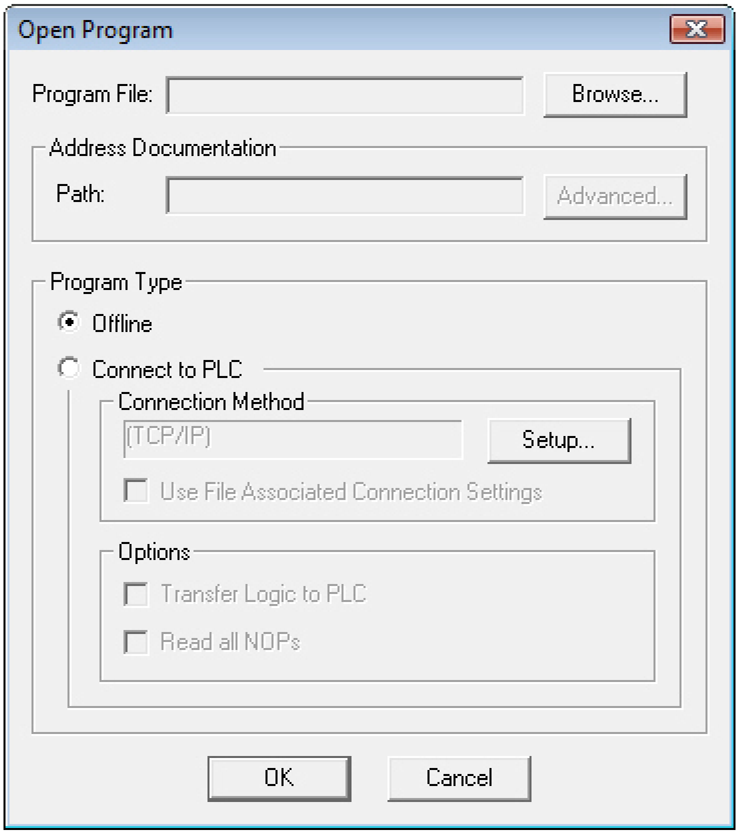
You can open an existing logic file to edit or update program information in either online or offline mode. Logic programs may contain one or more of the following: logic and data, tags, headers, and descriptions and comments. Several programs may be open at one time without losing memory contents.

⚠ **Warning**	Editing or modifying a program online may produce unexpected or hazardous results.

To open an existing program:

1. Click 📂 on the Toolbar, click **Open Program** from the **File** menu, or press **CTRL+O**.
   Result: The Open Program dialog box appears.

> **NOTE:** The last four files that were opened are saved and listed at the bottom of the File menu. When you select one of these files, the Open Program dialog box automatically opens with the file you selected.



2. Click **Browse**.
   Result: The Open dialog box appears.

3. Select the program you want to open or type the program name in the **File name** box and click **Open**. Change drives and/or directories, if necessary, to find the program you wish to open. You can open *.FSS (505 WorkShop 32 bit files), *.FTK (505 WorkShop 16 bit files) or *.VP5 (TISOFT V5.0 files).

> **NOTE:** For TISOFT V5.0 (*.vp5) loads, a new offline program is created with the logic and documentation always imported. Synonyms for JMP, GTS, and SBY are not imported. However, their associated comments are imported as Headers.

4. Result: The name of the program appears in the **Program File** box of the Open Program dialog box.

The selected program's file name is put into the Address Documentation Path. If a different documentation program is desired, it must be linked via Share Address Documentation. When a file is configured you can specify a database file that holds and sorts all documentation. Multiple users can simultaneously modify documentation for the same file thus regular updates can be scheduled to get the latest documentation within the database.

Documentation can be imported from *.FSS (505 WorkShop 32 bit files), comma or tab separated. Conversely you can export from the database file into a text file or a *.VP5 file (TISOFT V5.0 files with Headers and Tags).

5. To set up shared documentation, click the **Advanced** button on the Open Program dialog box.
   Result: The Share Address Documentation dialog box appears.
6. Enter the share address documentation program name in the **Shared File and Path** line or select **Browse** to locate an existing file.
7. Click **Next** and enter the refresh rate (time lag between updates from other users of the database). Valid times are from 1 – 1440 minutes.
8. Click **Next** and **Finish**.
9. In the Program Type area, select **Offline** or **Connect to PLC**. If you select **Connect to PLC**, you can use the previously-saved communication method or select a new communication method by clicking the **Setup** button. If you select **Connect to PLC**, you can check other options such as:

- **Use File Associated Connection Settings**. If connection settings have been saved with the program file, selecting this check box will automatically set up communication settings associated with the file.

- **Transfer Logic to PLC**. Transfers all blocks and data areas to the PLC, and loads documentation.

> **NOTE:** To avoid overwriting the online ladder with the version stored on file and associating documentation with the online ladder; do not select **Transfer Logic to PLC**.

- **Read All NOPs.** Reads 30 consecutive NOP instructions and assumes the end of program logic. This can substantially increase the time to connect online to a 520, 525, 530, 535, 560, or 565 controller when selected.

> **NOTE:** If you select **Read All NOPS** and have more than 30 NOP instructions separating user logic, all logic past the 30 NOPS will not be read.

10. Click **OK** or press **ENTER** to open your program.

> **NOTE:** If your controller is a 575, refer to Connecting Online to a 575 for information on selecting Application ID and configuring ports.

Address/Network Mode

11. If there is no file transferred online when the program first opens then the ladder rungs are referenced in the old TISOFT Address Mode. When the complete program has been loaded, the program can be converted over to network mode. To accomplish this, select **Switch to Network Display** from the **Options** Menu.

    The rungs are now displayed in Network and Address Mode. Once rungs have been converted to Network/Address mode they cannot be converted back to Address Mode only.

Loading Parts of an Existing Logic Program Online

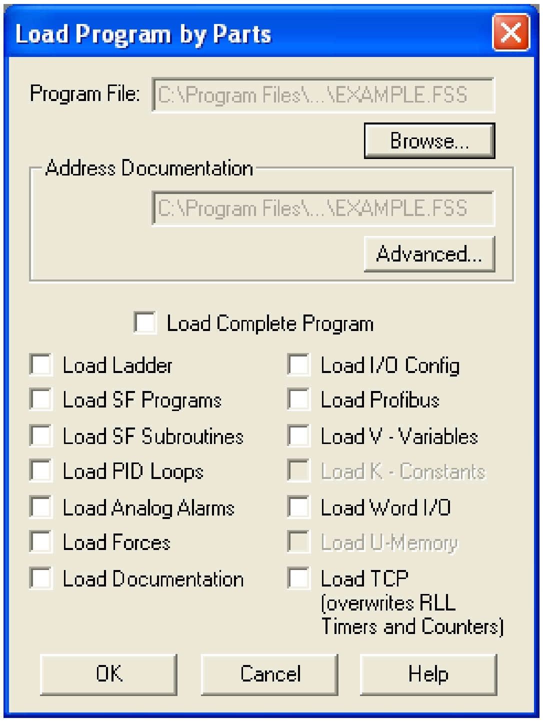
505 WorkShop allows you to load parts of an existing logic file to an online 505 controller. One or more of the following parts can be loaded:

- Ladder
- Special Function Programs
- Special Function Subroutines
- PID Loops
- Analog Alarms
- Force States
- Documentation (Tags, Descriptions, Comments and Headers
- I/O Configuration
- Profibus
- V-Variables
- K-Constants
- Word I/O
- U-Memory
- TCP values

⚠ **Warning**	Editing or modifying a program online may produce unexpected or hazardous results.

To Load parts of an existing program:

1. Establish an online connection with the PLC (see Fast PLC Connection - Connecting to a PLC or Open an existing logic program online).
2. Click **Load By Parts** from the **File** menu or press **CTRL+B**.



Program File: C:\Program Files\...\EXAMPLE.FSS

Address Documentation: C:\Program Files\...\EXAMPLE.FSS

☐ Load Complete Program

☐ Load Ladder
☐ Load SF Programs
☐ Load SF Subroutines
☐ Load PID Loops
☐ Load Analog Alarms
☐ Load Forces
☐ Load Documentation
☐ Load I/O Config
☐ Load Profibus
☐ Load V - Variables
☐ Load K - Constants
☐ Load Word I/O
☐ Load U-Memory
☐ Load TCP (overwrites RLL Timers and Counters)

3. To enter a different file name click the **Browse** button.
4. Check the boxes for the parts of the program you wish to load, or check the **Load Complete Program** box to load all parts.
5. To set up shared documentation:

    a. Enter the shared documentation database file name in the or click the **Browse** button to locate an existing file.

    b. Click the **Advanced** button.

    c. Click the **Next** button and enter the refresh rate (time lag between updates from other users of the database). Valid times are from 1 – 1440 minutes.

    d. Click **Next** and **Finish**.

6. Click the **OK** button to load.

> **NOTE:** If your controller is a 575, refer to Connecting Online to a 575 in this chapter for information on selecting Application ID and configuring ports.

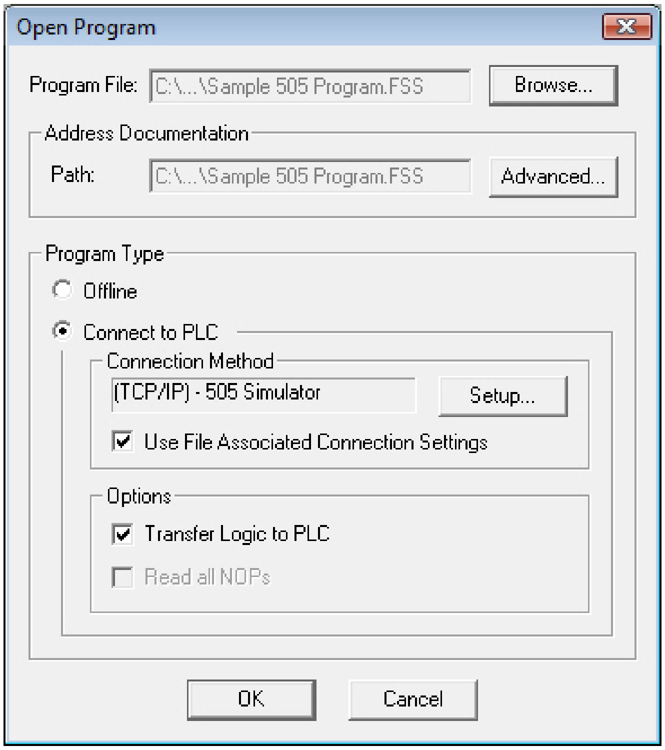
Transfer Offline Program to Online

505 WorkShop allows you to transfer an existing offline logic file to an online 505 controller.

⚠ **Warning**	Editing or modifying a program online may produce unexpected or hazardous results.

To transfer an existing offline program to online:

1. **Click Transfer –> Online** from the **File** menu or press **CTRL+B**.
   Result: The Open Program dialog box appears.



Open Program

Program File: C:\...\Sample 505 Program.FSS

Address Documentation

Path: C:\...\Sample 505 Program.FSS

Program Type

○ Offline

● Connect to PLC

Connection Method

(TCP/IP) - 505 Simulator

☑ Use File Associated Connection Settings

Options

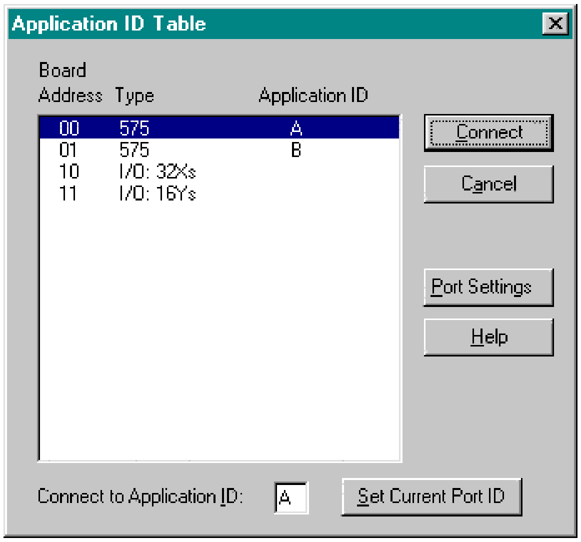
☑ Transfer Logic to PLC

□ Read all NOPs

2. Select **OK** to Transfer.

Connecting Online to a 575

When connecting to a 575 controller either from Fast PLC Connect or the Open Program window, configure the Application ID and Port Settings before the online connection is made.



Board Address	Type	Application ID
00	575	A
01	575	B
10	I/O: 32Xs	
11	I/O: 16Ys	

Connect to Application ID: A

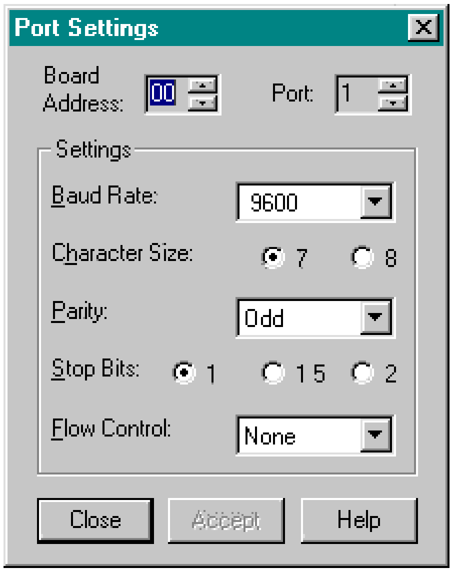
To connect to a 575 online:

1. Type the letter (A to Z) of the application you want to connect to in the **Connect to Application ID** box.
2. Click **Set Current Port ID** and then click **Connect** to go online, or double-click on the selected **Application ID** in the list box to go online.

If a file is being loaded from disk to the controller and the disk file Application ID is different than the connecting PLC's ID; a warning appears describing that the loading file ID is different. Select **OK** to continue the load or **Cancel** to abort.

Reading or Writing 575 Port Configuration

To read or write the 575 port configuration, click the **Port Settings** in the Application ID Table dialog box. The Port Settings Dialog box appears.



Port Settings

Board Address: 00 Port: 1

Settings

Baud Rate: 9600

Character Size: ● 7 ○ 8

Parity: Odd

Stop Bits: ● 1 ○ 1.5 ○ 2

Flow Control: None

To make changes to the port settings:

1. Click on the item to be changed and either type in the change or click on the spin, radio button, or combo box.
2. Click **Accept** to send changes to the controller, or click **Cancel** to make no changes and return to the Applications ID Table dialog box.

NOTE: If the port you are changing is the port 505 WorkShop is connected to, but the settings are not what 505 WorkShop uses, when you press **Accept** the following prompt appears to confirm your action:

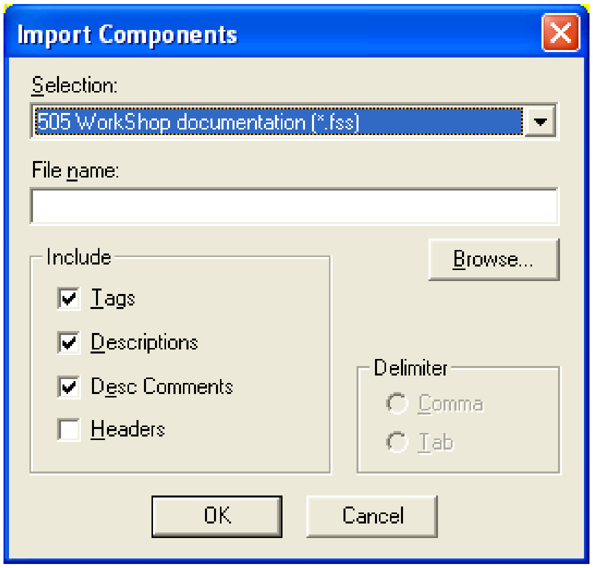
```
505 WORKSHOP IS ATTACHED TO THE PROC-
ESSOR THROUGH THIS PORT. THERE MAY BE
A SHORT DELAY AS THE PORT IS RE-
CONNECTED. DO YOU WANT TO CHANGE
THESE PORT SETTINGS?
```

Select **YES** to change the port configuration and 505 WorkShop may or may not continue to communicate with the controller.
Select **NO** to abort the operation.

Importing Documentation

Use the following procedure to import documentation, RAMP/SOAK steps, or V and K register values.

1. Click **Import** from the **File** menu.



Import Components

Selection: 505 WorkShop documentation (*.fss)

File name:

Include
☑ Tags
☑ Descriptions
☑ Desc Comments
☐ Headers

Delimiter
○ Comma
○ Tab

2. Select the type of import from the **Selection** list. The options are:

- **505 WorkShop documentation (.fss)**: Import the documentation information directly from another 505 WorkShop logic program file.
- **Documentation to delimited text file (*.txt, *.csv)**: Import documentation from a text file. See Address Documentation Text File Format for details.
- **RAMP/SOAK Steps to delimited text file (*.txt, *.csv)**: Import RAMP/SOAK information from a text file. See Ramp/Soak Text File Format for details. Information can only be exported for one loop at a time, but information for many loops can be imported in one step.
- **V & K Register values from delimited text file (*.txt, *.csv)**: Import V and K register values from a text file. See Register Value Text File Format for details.

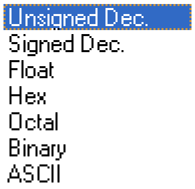
3. Type the name of the file to import in the **File Name** box or click **Browse** to browse for the file to import.

4. Under **Include**, select the components to import.

5. Under **Delimiter**, select the type of delimiter used in the file.

Items that can be imported:

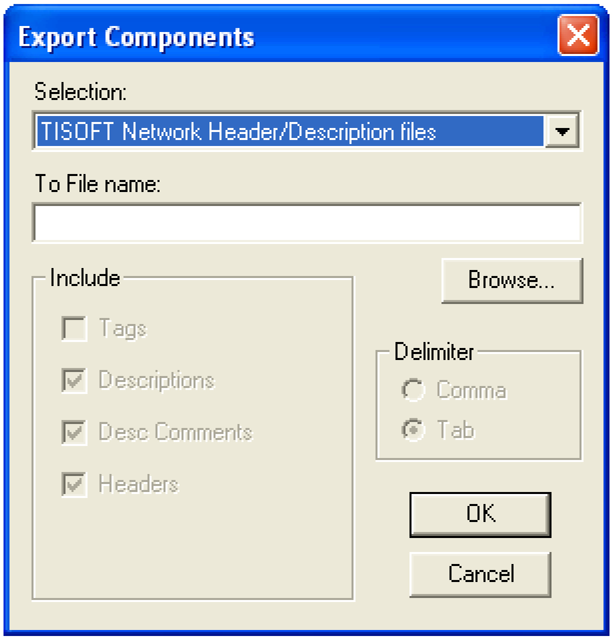
- **Tags**: May be checked or cleared when importing documentation. Not shown for other import operations. Address documentation tags
- **Descriptions**: May be checked or cleared when importing documentation. Not shown for other import operations. Address documentation comments
- **Desc Comments**: May be checked or cleared when importing documentation. Not shown for other import operations. Address documentation description comments
- **Headers:** May be checked or cleared when importing documentation from **505 WorkShop documentation (.fss)** or **Documentation to delimited text file (*.txt, *.csv)**. Not shown for other import operations. Network headers.
- **V Registers**: Available only when importing V & K register values. Check the box to import V registers.
- **K Registers**: Available only when importing V & K register values. Check the box to import K registers.
- **Size**: Available only when importing V & K register values. Select the size (16 or 32 bit) of the data values.
- **Format**: Available only when importing V & K register values. Select the format of the data values.



Exporting Documentation

Use the following procedure to export documentation, RAMP/SOAK steps, or V and K register values.

1. Click **Export** from the **File** menu.



Export Components

Selection: TISOFT Network Header/Description files

To File name:

Include

- ☐ Tags
- ☑ Descriptions
- ☑ Desc Comments
- ☑ Headers

Delimiter

- ○ Comma
- ● Tab

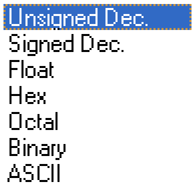
2. Select the type of export from the **Selection** list. The options are:

- **TISOFT NetworkHeader/Description files**: Export to a file for import to TI-SOFT.
- **Address Documentation to delimited text file (*.txt, *.csv)**: Export address documentation to a text file. See Address Documentation Text File Format for details.
- **Header Documentation to delimited text file (*.txt, *.csv)**: Export header documentation to a text file. See Header Documentation Text File Format for details.
- **RAMP/SOAK Steps to delimited text file (*.txt, *.csv)**: Export RAMP/SOAK information to a text file. See Ramp/Soak Text File Format for details. Information can only be exported for one loop at a time, but information for many loops can be imported in one step.
- **V & K Register values to delimited text file (*.txt, *.csv)**: Export V and K register values to a text file. See Register Value Text File Format for details.

3. Type the name of the file to export to in the **To File name** box or click **Browse** to browse for the file.
4. Under **Include**, select the components to export.
5. Under **Delimiter**, select the delimiter (tab or comma) to use. Excel, and most other software, can import files delimited with either.

Fields that can be exported:

- **Tags**: Display only when exporting documentation to TISOFT or text files. Not shown for other export operations. Address documentation tags
- **Descriptions**: Display only when exporting documentation to TISOFT or text files. Not shown for other export operations. Address documentation comments
- **Desc Comments**: May be checked or cleared when exporting documentation to text files. Display only when exporting documentation to TISOFT. Not shown for other export operations. Address documentation description comments
- **Headers:** Display only when exporting documentation to TISOFT or text files. Network headers.
- **Loop Number**: Available only when exporting RAMP/SOAK information. Enter the number of the loop to be exported.
- **V Registers**: Available only when exporting V & K register values. Check the box to export V registers. Edit the **From** and **to** boxes to select the registers to be exported, or leave them at the default values to export all the registers.
- **K Registers**: Available only when exporting V & K register values. Check the box to export K registers. Edit the **From** and **to** boxes to select the registers to be exported, or leave them at the default values to export all the registers.
- **Size**: Available only when exporting V & K register values. Select the size (16 or 32 bit) of the data values.
- **Format**: Available only when exporting V & K register values. Select the format of the data values.



Address Documentation Text File Format

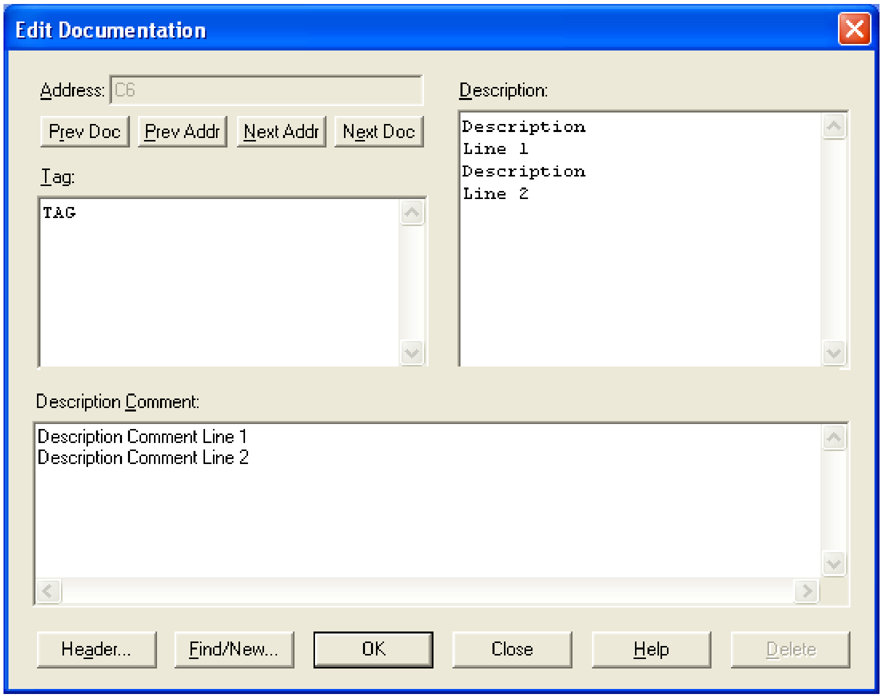
Address documentation that is exported is saved in the following format. When importing address documentation, the software expects the same format. Fields are separated by either tab characters or commas, at user option.

Address	Tag	Description	Description Comment
The first field contains the PLC address being documented.	The second field contains the tag. If there is no tag, the field is empty.	The third field contains the first line of the description. If there is no description, the field is empty. If the description contains multiple lines, each line is stored in a following field. The second line of the description would be in the fourth field, and so on. This applies only when there are hard line breaks -if the text is wrapped automatically because it is too long to display in one line, it is stored in one wide field.	If there is a description comment, the field after the last description field contains a marker: +++DescCom+++ Each line of the description comment occupies a following field.

For example, the text file line

```
C6,TAG,Description Line 1,Description Line 2,+++DescCom+++,Description Comment
Line 1,Description Comment Line 2
```

describes the following documentation:



Address: C6

Tag: TAG

Description:

Description
Line 1
Description
Line 2

Description Comment:

Description Comment Line 1
Description Comment Line 2

Header Documentation Text File Format

Headers are exported and imported independently from tags, descriptions, and comments. Header documentation is comprised of headers from alarms, loops, special function programs (SFP), special function subroutines (SFS), ladder, networks, and print title page.

The table below lists the file format for each header section. Header text may occupy multiple lines. Any text between two header types (Alarm, Loop, SFS, and so on.) will be associated with the header type above the text.

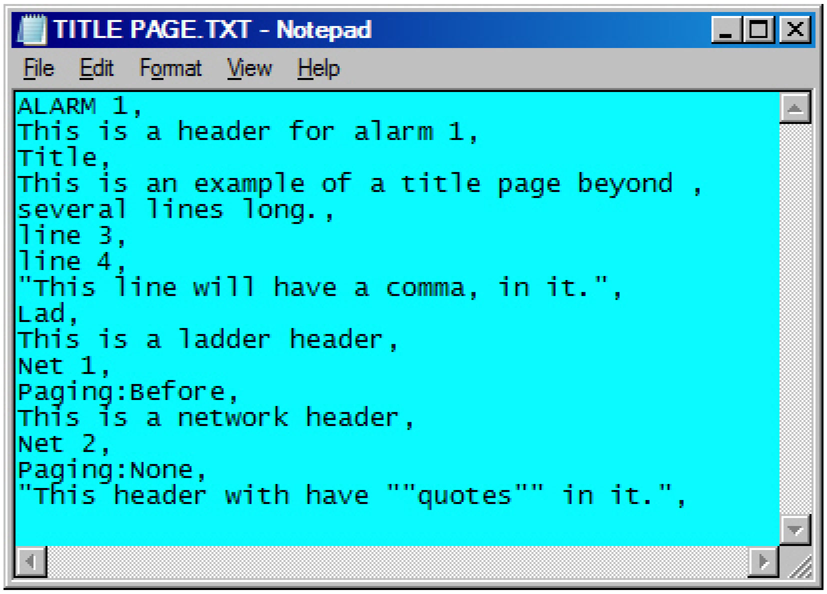
Header Type	Header Format
Alarm (Alarm)	Alarm [alarm number]<delimiter><alarm header text><delimiter>
Loop (PID Loop)	Loop [loop number]<delimiter><loop header text><delimiter>
SFS (Special Function Subroutine)	SFS [SFS number]<delimiter>< SFS header text><delimiter>
SFP (Special Function Program)	SFP [SFP number]<delimiter>< SFP header text><delimiter>

Header Type	Header Format
Lad (Ladder – OB1)	Lad<delimiter>< ladder header text><delimiter>
Net (Rung Comment)	Net [network number]<delimiter>Paging:[None | Before | Odd]<delimiter><network header text><-delimiter>
Title (Print Title)	Title<delimiter>< Title header text><delimiter>

If a header contains a carriage return, double quote characters, or commas, it is surrounded by double quotes. A header with no special characters will be stored without double quotes and read to the end of its line.

Example

The figure below shows an example of exported headers with double quote characters, commas and carriage returns.



```
ALARM 1,
This is a header for alarm 1,
Title,
This is an example of a title page beyond ,
several lines long.,
line 3,
line 4,
"This line will have a comma, in it.",
Lad,
This is a ladder header,
Net 1,
Paging:Before,
This is a network header,
Net 2,
Paging:None,
"This header with have ""quotes"" in it.",
```

Register Value Text File Format

Register values that are exported are saved in the following format. When importing register values, the software expects the same format. Fields are separated by either tab characters or commas, at user option.

Address	Value
The first field contains the PLC address of the register.	The second field contains the value.

For example, the text file line

```
K1251,12
```

means that the address K1251 contains the value 12.

> **NOTE:** No information about the size or format of the data values is stored in the file. When importing, be sure to select the correct size and format. For example, if you export register values as octal, and then import them as decimal, the results will be incorrect.

Ramp/Soak Text File Format

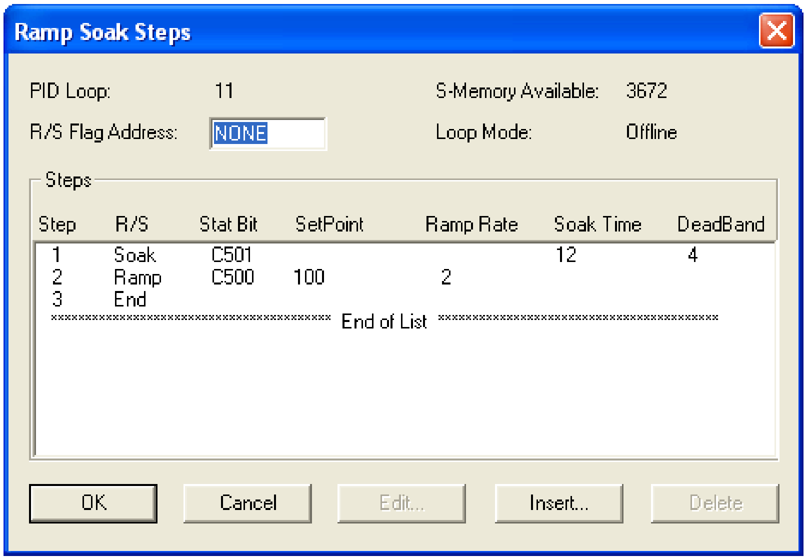
Ramp/Soak information that is exported is saved in the following format. When importing Ramp/Soak information, the software expects the same format. Fields may separated by either tab characters or commas.

- The first line contains the loop number and flag address. Both are labeled. For example:
  Loop 11,Flag Address None
- The second line contains headers:
  Step, Ramp/Soak/End, Status Bit, Set Point, Ramp Rate, Soak Time, Dead Band
- The lines starting with the third contain information for each step, in the format indicated by the second line.

For example, the text file:

```
Loop 11,Flag Address None
Step,Ramp/Soak/End,Status Bit,Set Point,Ramp Rate,Soak Time,Dead Band
1,Soak,C501,,,12,4
2,Ramp,C500,100,2,,
3,End,,,,,
```

describes the following Ramp Soak steps:



PID Loop: 11

S-Memory Available: 3672

R/S Flag Address: NONE

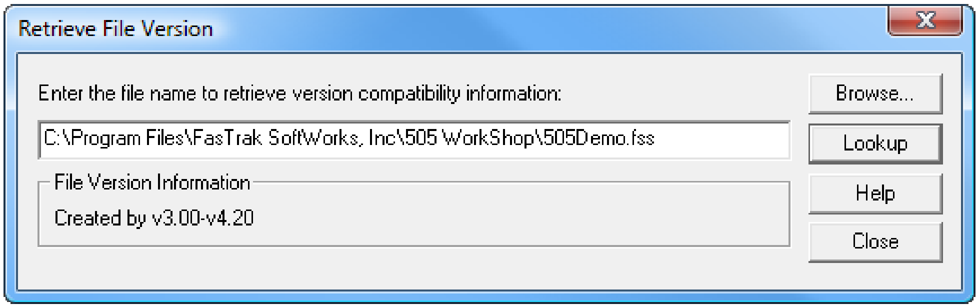
Loop Mode: Offline

Step	R/S	Stat Bit	SetPoint	Ramp Rate	Soak Time	DeadBand
1	Soak	C501			12	4
2	Ramp	C500	100	2		
3	End					

** End of List **

Retrieving Version Information

WorkShop 505 is able to provide information about the version of previously-saved logic programs. This is done using the **Retrieve File Version** command.



Enter the file name to retrieve version compatibility information:

C:\Program Files\FasTrak SoftWorks, Inc\505 WorkShop\505Demo.fss

File Version Information

Created by v3.00-v4.20

To retrieve the file version information of a previously-saved 505 WorkShop logic program:

1. Click **Retreive File Version** from the **File** menu.

2. Do one of the following:
   - In the text box, type the full path and name of the logic program whose file version information you want to view, and then click **Lookup**.

     For example, type `C:\Program Files\FasTrak SoftWorks, Inc\505 WorkShop\505demo.fss`

- Click **Browse** and then browse to the logic program whose file version information you want to view.

File version information about the selected logic program is displayed in the **File Version Information** area. The information might reflect a range, such as v3.00 – v4.20, instead of a specific version.

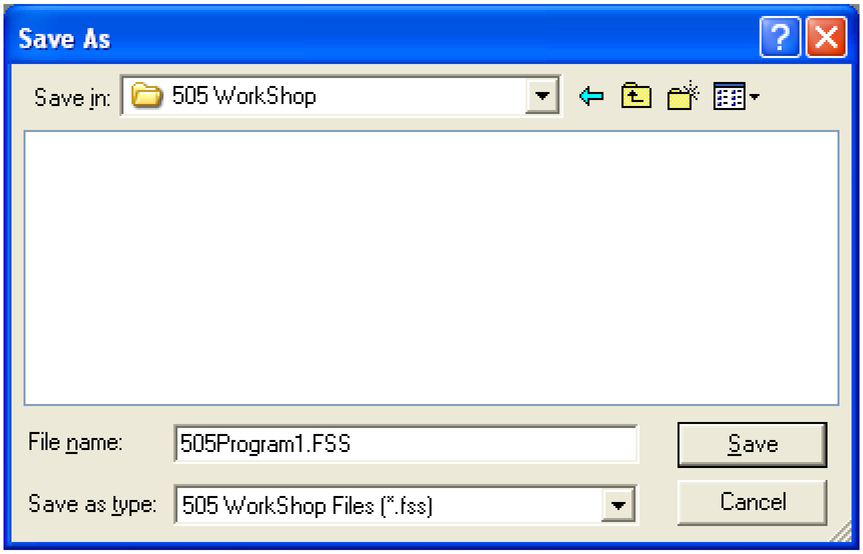
If an invalid path and/or program name is entered, an error message is displayed. Make sure to specify a valid path and correct program name, or browse to the program file you want to use.

Saving Logic Programs

Saving Offline

Use the Save Program command to save the active program contents with its existing name. To save the active logic program:

1. Click on the Toolbar, click **Save Program** from the **File** menu, or press **CTRL+S**, and a previously-saved logic program is saved.
2. If the program has not been previously saved, the Save As dialog box appears. Select where the program will be saved in the **Save in** box and type a name for the program in the **File name** box.



Save in: 505 WorkShop

File name: 505Program1.FSS

Save as type: 505 WorkShop Files (*.fss)

3. Click **Save** or press **ENTER** to save the program.
4. If you select a file name that already exists in that directory, a message appears with options. Select from the following options:

- **YES** saves the updated program with the current name, overwriting the previous version.
- **NO** cancels the save procedure.

NOTE: You must validate logic before saving. If you have not done so, a message appears stating changes to logic have not been validated or entered. Changes cannot be saved until logic has been validated and entered. Click the **Validate Logic** ✓ toolbar icon or click **Validate and Enter Logic** from the **Program** menu. Complete necessary changes to logic and try to save the program again.

Save/Save As Online

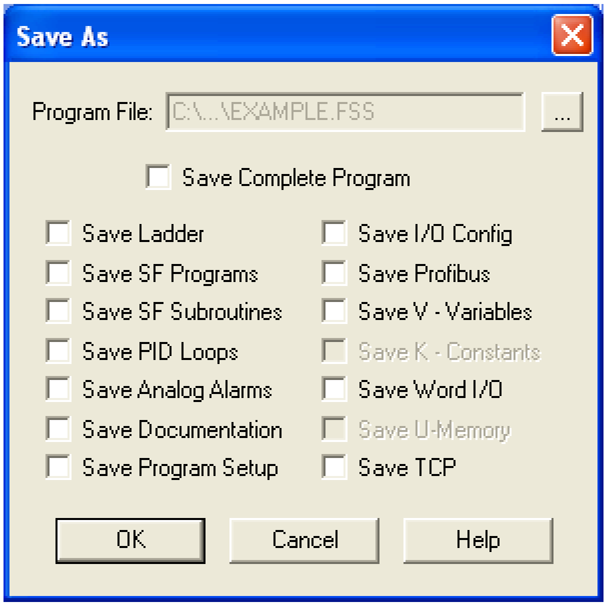
Use the **Save** or **Save As** while online to save all the active program contents with its existing name or parts of an existing logic program. One or more of the following parts can be saved:

- Ladder
- Special Function Programs
- Special Function Subroutines
- PID Loops
- Analog Alarms
- Force States
- Documentation (Tags, Descriptions, Comments and Headers)
- I/O Configuration
- Profibus
- V-Variables
- K-Constants
- Word I/O

- U-Memory
- TCP values

To save the active logic program:

1. To save to the current file name, click 💾 on the Toolbar, click **Save** from the **File**menu, or press **CTRL+S**. To save to a new file name, click **Save As** from the **File** menu.

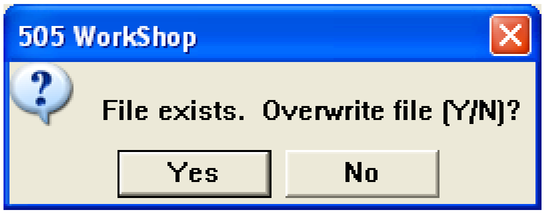


Program File: C:\...\EXAMPLE.FSS

☐ Save Complete Program

☐ Save Ladder
☐ Save SF Programs
☐ Save SF Subroutines
☐ Save PID Loops
☐ Save Analog Alarms
☐ Save Documentation
☐ Save Program Setup
☐ Save I/O Config
☐ Save Profibus
☐ Save V - Variables
☐ Save K - Constants
☐ Save Word I/O
☐ Save U-Memory
☐ Save TCP

2. Select the boxes of the parts of the program to save or select the **Save Complete Program** check box to save all parts. If this is a new file, the **Save Complete Program** check box is automatically selected and it cannot be cleared.
3. If the program has not been previously saved, or to change the file name, click the browse button, and select the location and name for the program.
4. Click **OK** to save the program.
5. If the file name already exists in that directory, a dialog box appears with these options:



File exists. Overwrite file (Y/N)?

- **YES**: saves the updated program with the current name, overwriting the previous version.
- **NO**: cancels the save procedure.

NOTE: You must validate logic before saving. If you have not done so, a message appears stating changes to logic have not been validated or entered. Changes cannot be saved until logic has been validated and entered. Click the **Validate Logic** toolbar icon ✓ or click **Validate and Enter** from the **Program** menu. Complete necessary changes to logic and try to save the program again.

⚠ **Warning**	Editing or modifying a program online may produce unexpected or hazardous results.

Save Program As Offline

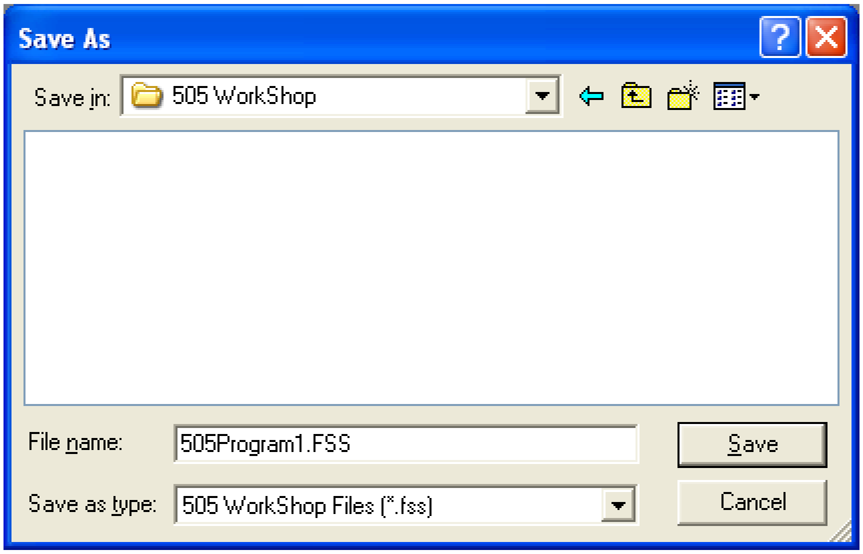
Use **Save Program As** to save the active logic program with a different program name. This is useful when maintaining the original without changes. For example, open file ABC.FTK, make changes, select **Save Program As**, and save the program as *DEF.FTK*. Now you have two files, *ABC.FTK* retained its same condition before you opened it, and *DEF.FTK* that contains changes made to ABC.FTK.

NOTE: You must validate logic before saving. If you have not done so, a message appears stating changes to logic have not been validated or entered. Changes cannot be saved until logic has been validated and entered.

Click the **Validate Logic** toolbar icon ✓ or click **Validate and Enter Logic** from the **Program** menu. Complete necessary changes to logic and try to save the program again.

To save a logic program with a new file name:

1. Click **Save As** from the **File** menu.
   Result: The Save As dialog box appears.



Save in: 505 WorkShop

File name: 505Program1.FSS

Save as type: 505 WorkShop Files (*.fss)

2. Select where you want to save the program in the **Save in** box and type the name the file in the **File name** box.

3. Click **Save** or press **ENTER**.
   Result: Your file is saved with its new name.

4. If you select a file name that already exists in that directory, a message appears with options. Select from the following options:

- **YES** saves the updated program with the current name, overwriting the previous version.
- **NO** cancels the save procedure.

> **NOTE:** If you are saving documentation to an online program, please see Saving Online under Saving Logic Programs on the preceding pages.

Printing Logic Programs

Printing Logic Programs

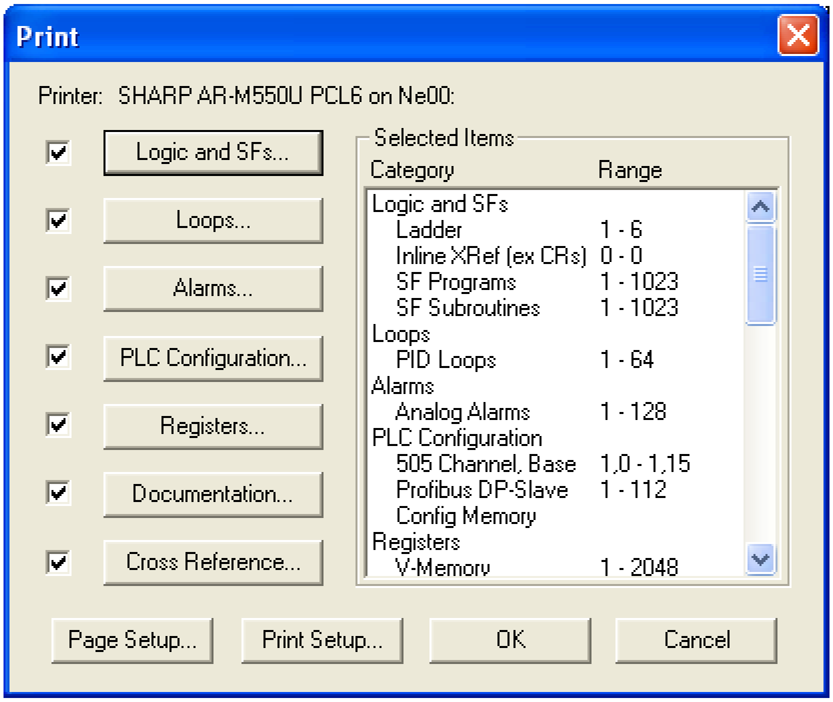
505 WorkShop provides you with a number of print features that allow customization of your printouts. These include:

- Tags and Documentation
- Cross Reference
- Network/Address Range
- Margins and Starting Page Number

Before you can print, open a logic program. Make certain that you have loaded the correct print drivers for your printer through the Windows Control Panel. If you have questions regarding loading print drivers, consult your printer's user's manual and the Windows User's Guide.

To print logic programs and/or documentation:

1. Click on the toolbar, click **Print** from the **File** menu, or press **CTRL+P**.
   Result: The Print dialog box appears.



Printer: SHARP AR-M550U PCL6 on Ne00:

Selected Items

Category	Range
Logic and SFs	
Ladder	1 - 6
Inline XRef (ex CRs)	0 - 0
SF Programs	1 - 1023
SF Subroutines	1 - 1023
Loops	
PID Loops	1 - 64
Alarms	
Analog Alarms	1 - 128
PLC Configuration	
505 Channel, Base	1,0 - 1,15
Profibus DP-Slave	1 - 112
Config Memory	
Registers	
V-Memory	1 - 2048

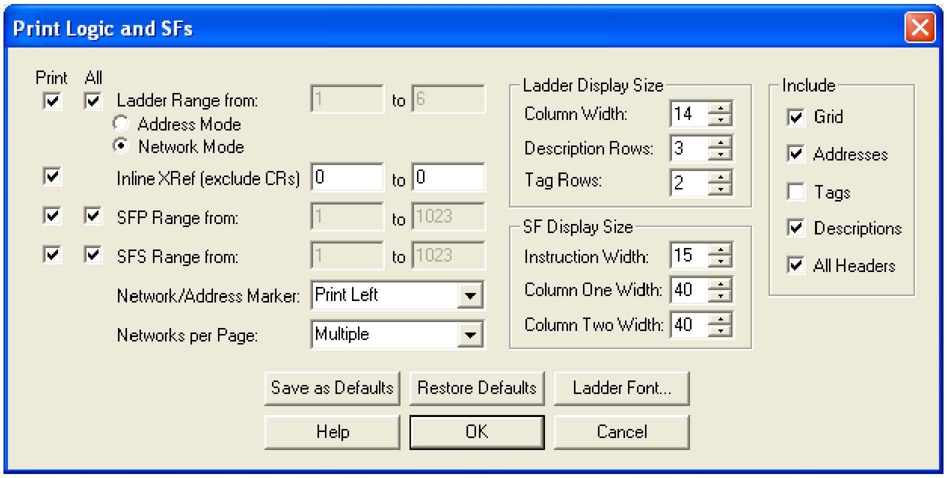
2. Select the check boxes that correspond to the items you want to print. For each item selected, you can choose sort options and the information you want to include for reports. The print range of each print item to be printed is displayed under **Selected Items**.

Print Logic and SFs

Click the Logic and SFs button to print the following:

- All logic, ladder, SFS and SFP
- Selected logic ladder, SFS or SFP
- Selected ladder in address or network mode
- Selected Special Function lines
- Inline Xref
- Ladder with Addresses, Tags, Descriptions, or Headers
- Multiple or single networks/addresses per page

The Print Logic and SFs dialog box determines which items are printed.



Print Logic and SFs

Print All
☑ ☑ Ladder Range from: 1 to 6
○ Address Mode
● Network Mode
☑ Inline XRef (exclude CRs) 0 to 0
☑ ☑ SFP Range from: 1 to 1023
☑ ☑ SFS Range from: 1 to 1023
Network/Address Marker: Print Left
Networks per Page: Multiple

Ladder Display Size
Column Width: 14
Description Rows: 3
Tag Rows: 2

SF Display Size
Instruction Width: 15
Column One Width: 40
Column Two Width: 40

Include
☑ Grid
☑ Addresses
□ Tags
☑ Descriptions
☑ All Headers

Select the **All** check box to print the entire range of the item selected. To print a selection, clear the **All** check box and enter a range in the associated edit box.

If you selected to print ladder logic, the ladder reference numbering can be either **PLC memory address mode** or **network address mode**. The selected radio button below ladder range determines which mode is printed. The Network Address or PLC Memory Address is printed on the top left or right of ladder and can be disabled to not print at all. The selection is made in the **Network/Address Marker** field.

When selecting **Networks/Addresses per Page** as **Single** or **Multiple**, use the following information. When printing **Single Networks/addresses per Page**, each network begins on a new page. When printing **Multiple Networks/Addresses per Page**, as many networks/addresses that can fit on a single page will be printed. However, if the network is not the first network on the page and the network is broken across more than one page but can fit on a page and if it would start a new page, then the network begins on a new page. The intent is to keep the entire network on one page whenever possible.

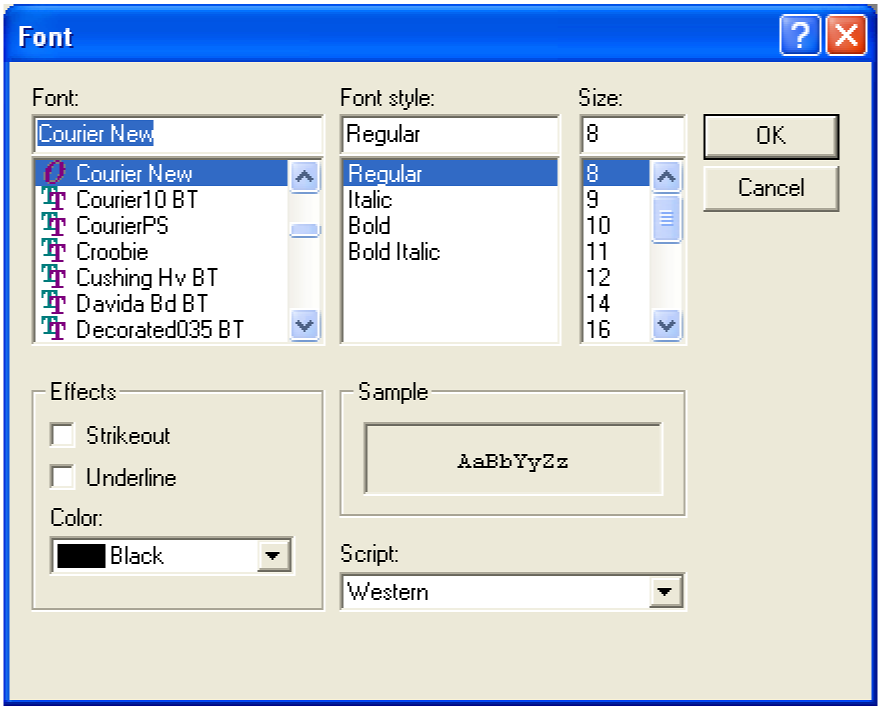
The **Ladder Display Size** determines the **Column width**, **Description rows**, and **Tag row size**. **Column Width** adjusts the size of the ladder grid. Click the up or down arrow or enter a value between 7 – 24. **Description Rows** determines the number of character rows displayed for each description. Click the up or down arrow or type in a value between 1 – 12. **Tag Rows** determines the number of character rows displayed for each tag. Click the up or down arrow or type in a value between 1 – 4.

The **SF Display Size** determines the **Instruction width**, **Column One width** and **Column Two width**. **Instruction Width** determines the width allocated for display of Special Function instructions on each line. Click the up or down arrow or type in a value between 1 – 80. **Column One Width** determines the width allocated for display of SF first column variables after the instruction. Click the up or down arrow or type in a value between 1 – 300. **Column Two** determines the width allocated for display of SF second column variables after the instruction. Click the up or down arrow or type in a value between 1 – 300.

The ladder grid, addresses, tags, descriptions and headers can all individually be turned on or off to be included with ladder printout. To include with the ladder print out, select the appropriate check box under Include.

Ladder Font changes the font displayed in the active program. Any active Window's font can be selected. To change the font:

1. Click the **Ladder Font** button.
   Result: The Font dialog box is displayed.



Font: Courier New
Font style: Regular
Size: 8
□ Strikeout
□ Underline
Color: Black
Script: Western

2. Choose a font, font style, and font size. Notice that you can see a sample of the font in the Sample box.

3. Click **OK** to save your changes or **Cancel** to cancel your changes.
   Result: The Print Logic and SFs dialog box appears.

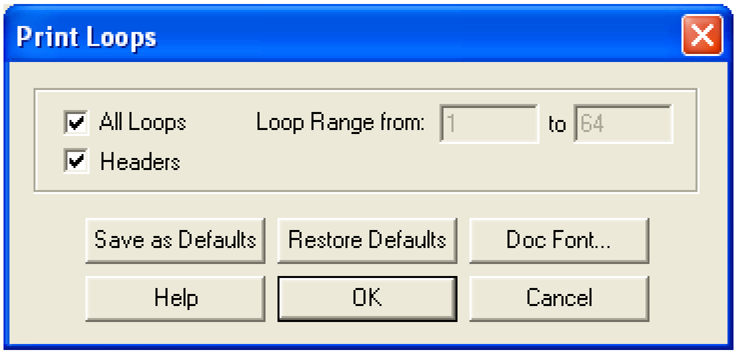
NOTE: The print selection options are stored when saving a program.

Print Loops

Select the **Loops** check box from the Print dialog box to print the following:

- All PID Loops
- PID Loops and Headers

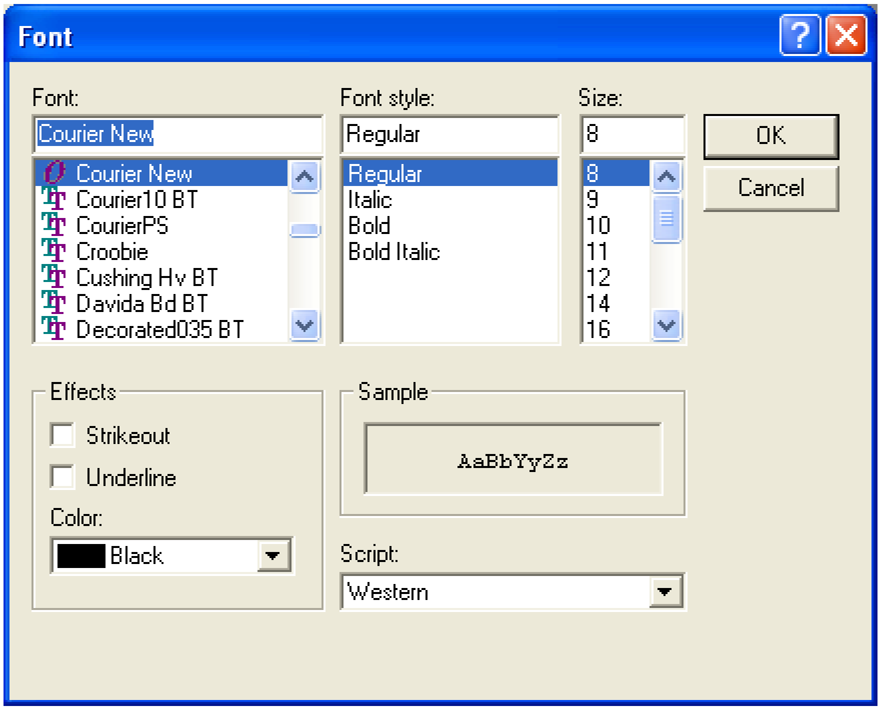
To change the PID Loops properties click the **Loops** button on the Print dialog box. The Print Loops dialog box appears.



☑ All Loops Loop Range from: 1 to 64
☑ Headers

Select the **All Loops** check box to print the entire range loops. To print a selection, clear the **All Loops** check box and enter a range in the associated edit box. To include loop headers with the printout, click the **Headers** check box.

1. Click the **Doc Font** button to change the Header font in the active program.
   Result: The Font dialog box appears.



Font: Courier New

Font style: Regular

Size: 8

□ Strikeout

□ Underline

Color: Black

Sample: AaBbYyZz

Script: Western

2. Choose a new font, font style, or font size. Notice that you can see a sample of the font in the Sample box.

3. Click **OK** to save your changes or **Cancel** to cancel changes.
 Result: The Print Loops dialog box appears.

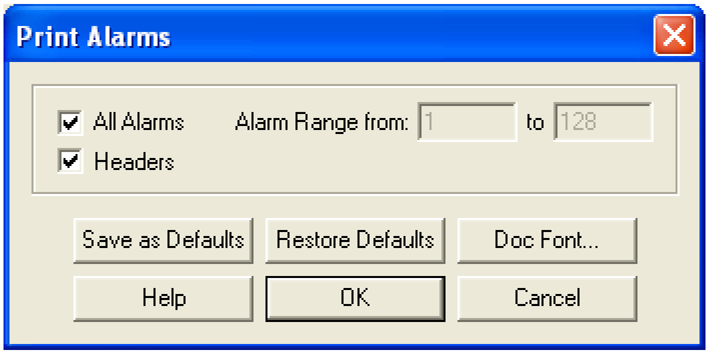
> **NOTE:** The print selection options are stored when saving a program.

Print Alarms

Click the Alarms check box from the Print dialog box to print the following:

- All Alarms
- Alarms and Headers

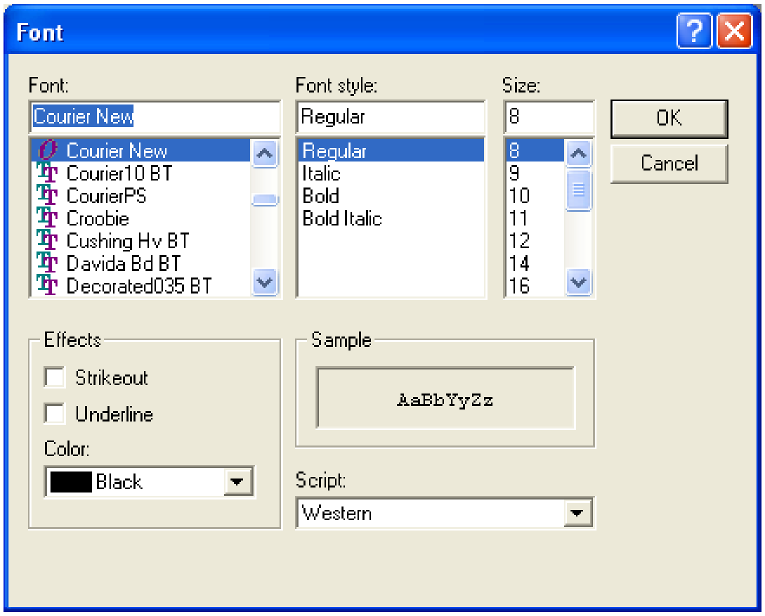
To change the Alarms properties, click the **Alarms** button on the Print dialog box. The Print Alarms dialog box appears.



☑ All Alarms Alarm Range from: 1 to 128
☑ Headers

Select the **All Alarms** check box to print the entire range of alarms. To print a selection, clear the **All Alarms** check box and enter a range in the associated edit box. To include loop headers with the printout, click the **Headers** check box.

1. Click the **Doc Font** button to change the Header font in the active program.
   Result: The Font dialog box appears.



Font: Courier New
Font style: Regular
Size: 8
□ Strikeout
□ Underline
Color: Black
Script: Western

2. Choose a font size. Notice that you can see a sample of the font in the Sample box.
3. Click **OK** to save your changes or **Cancel** to cancel changes.
   Result: The All Alarms dialog box appears.

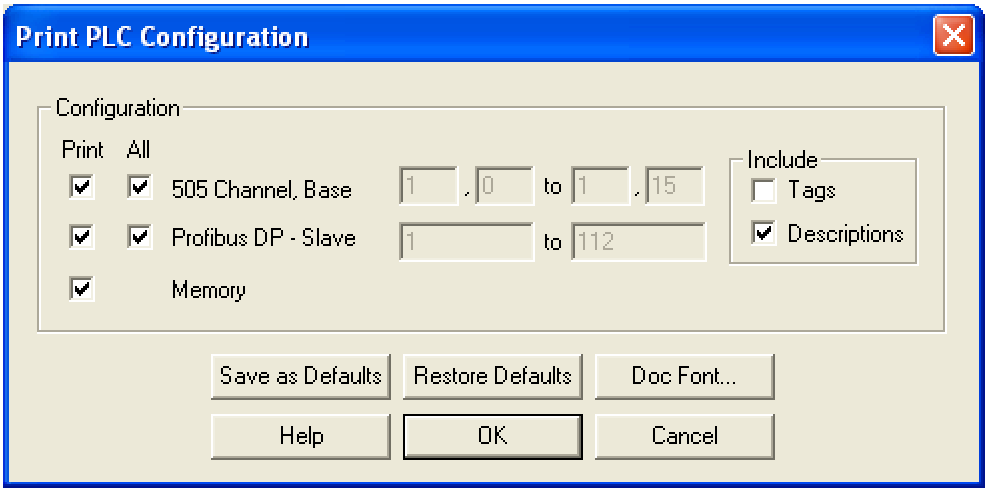
NOTE: The print selection options are stored when saving a program.

Print PLC Configuration

Click the PLC Configuration check box from the Print dialog to print the following:

- 505 Channel Base
- Profibus DP – Slave I/O
- PLC Memory Configuration
- I/O Tags and Descriptions

To change the PLC Configuration properties click the **PLC Configuration** button on the Print dialog box. The Print PLC Configuration dialog box appears.



Print PLC Configuration

Configuration

Print	All			
☑	☑	505 Channel, Base	1 , 0	to 1 , 15
☑	☑	Profibus DP - Slave	1	to 112
☑		Memory		

Include
☐ Tags
☑ Descriptions

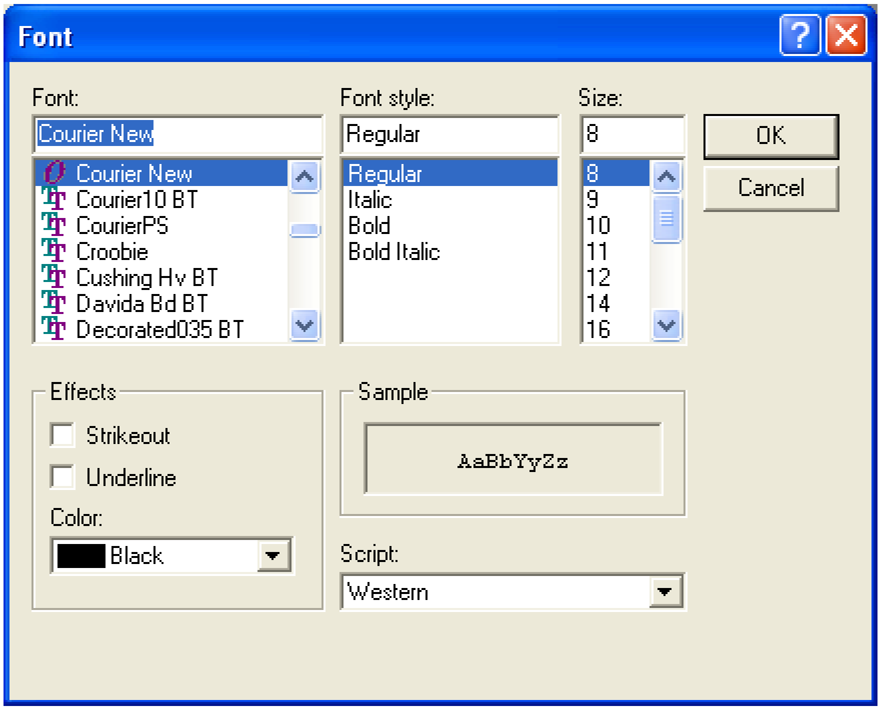
Select the **All** check box to print the entire range of items. To print a selection, clear the **All** check box and enter a range in the associated edit box.

When entering a range for channel and base numbers, the first entry before the comma is the channel number. The second entry after the channel number and comma is the base number.

For example: In the preceding figure, the printout would start at channel 1 Base 0 and end at channel 1 Base 15.

The tags and descriptions can be individually turned on or off. To include with the PLC Configuration printout, select the appropriate check box under Include.

1. Click the **Doc Font** button to change the Tag and Description printout font in the active program.
   Result: The Font dialog box appears.



Font: Courier New

Font style: Regular

Size: 8

Color: Black

Script: Western

2. Choose a new font, font style, or font size. Notice that you can see a sample of the font in the **Sample** box.

3. Click **OK** to save your changes.

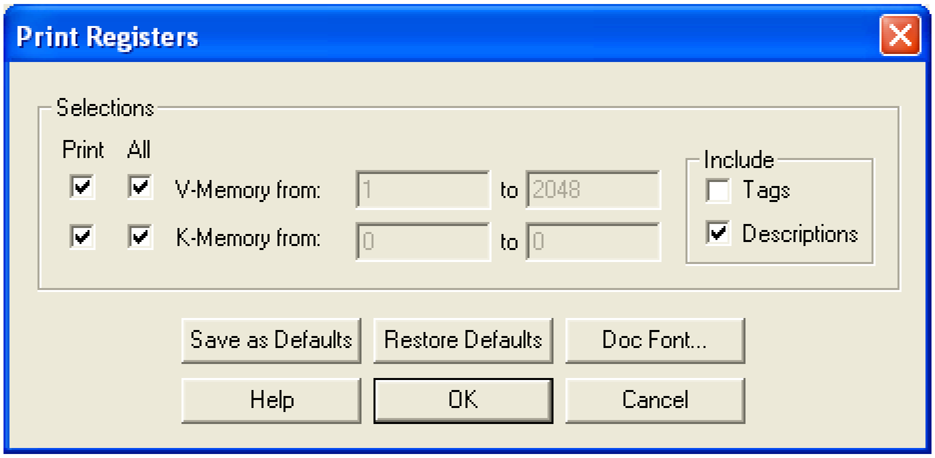
> **NOTE:** The print selection options are stored when saving a program.

Print Registers

Click the **Register** check box from the Print dialog box to print the following:

- V-Memory
- K-Memory
- Register Tags and Descriptions

To change the Register properties click the **Register** button on the Print dialog box. The Print Register dialog box appears.



Print Registers

Selections

Print All

☑ ☑ V-Memory from: 1 to 2048

☑ ☑ K-Memory from: 0 to 0

Include

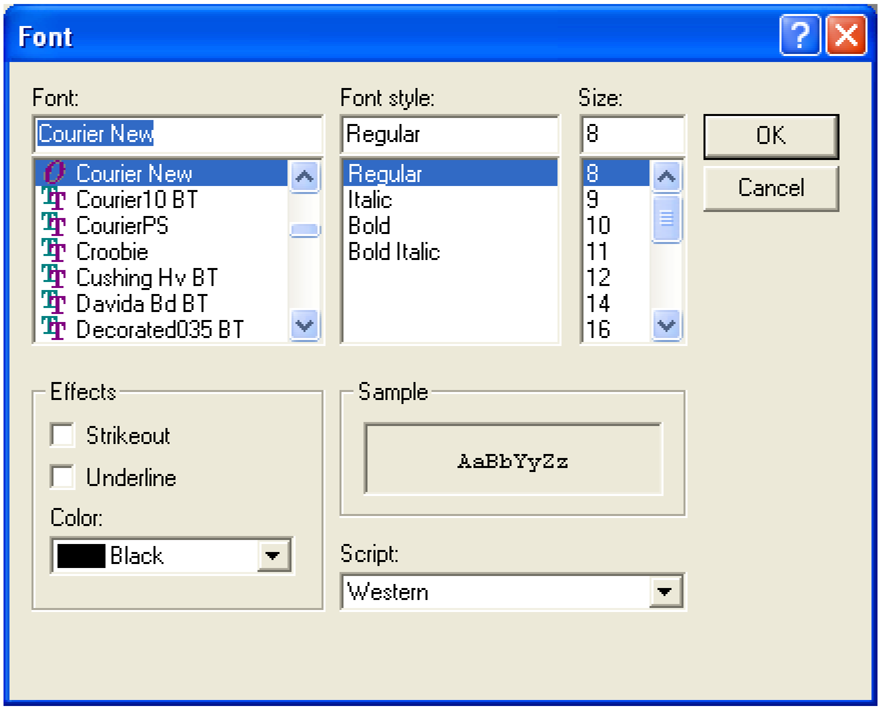
□ Tags

☑ Descriptions

Select the **All** check box to print the entire range of items. To print a selection, clear the **All** check box and enter a range in the associated edit box.

The tags and descriptions can be individually turned on or off. To include with the Register print out select the appropriate check box under Include.

1. Click the **Doc Font** button to change the Tag and Description printout font of the active program.
   Result: The Font dialog box appears.



Font

Font: Courier New

Courier New
Courier10 BT
CourierPS
Croobie
Cushing Hv BT
Davida Bd BT
Decorated035 BT

Font style: Regular

Regular
Italic
Bold
Bold Italic

Size: 8

8
9
10
11
12
14
16

Effects

□ Strikeout

□ Underline

Color: Black

Sample

AaBbYyZz

Script: Western

2. Choose a new font, font style, or font size. Notice that you can see a sample of the font in the **Sample** box.
3. Click **OK** in the Font dialog box to save your changes.

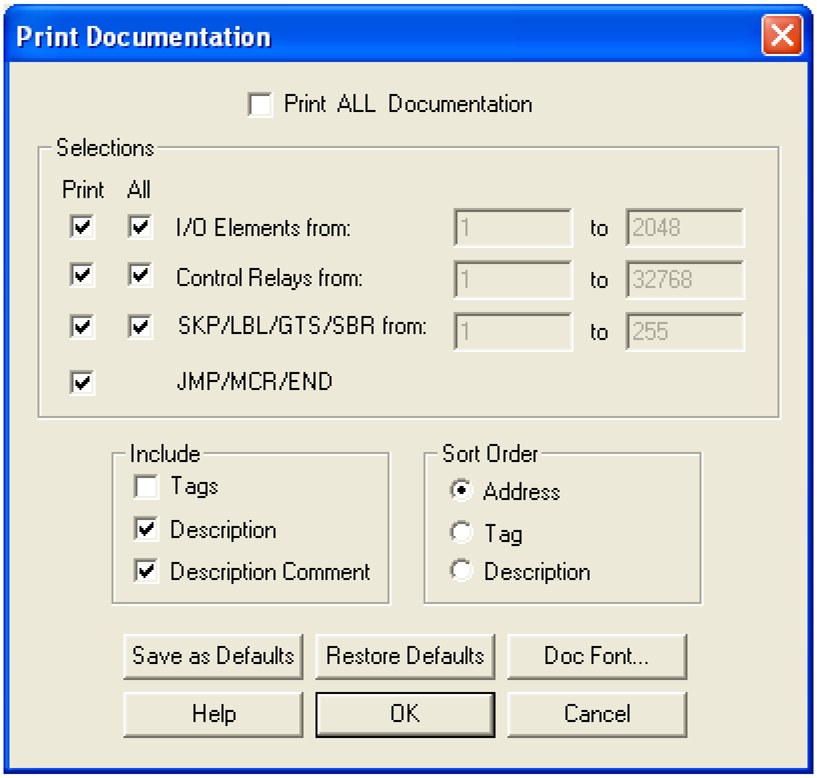
> **NOTE:** The print selection options are stored when saving a program.

Print Documentation

Select the **Documentation** check box from the Print dialog box to print the following:

- I/O Elements (X, Y, WX and WY)
- Control Relays (C)
- SKP, LBL, GTS, SBR, JMP, MCR and END
- Register Tags, Descriptions and Comments

To change the Documentation properties click the **Documentation** button on the Print dialog box. The Print Documentation dialog box appears.



Print Documentation

□ Print ALL Documentation

Selections

Print	All				
☑	☑	I/O Elements from:	1	to	2048
☑	☑	Control Relays from:	1	to	32768
☑	☑	SKP/LBL/GTS/SBR from:	1	to	255
☑		JMP/MCR/END			

Include
□ Tags
☑ Description
☑ Description Comment

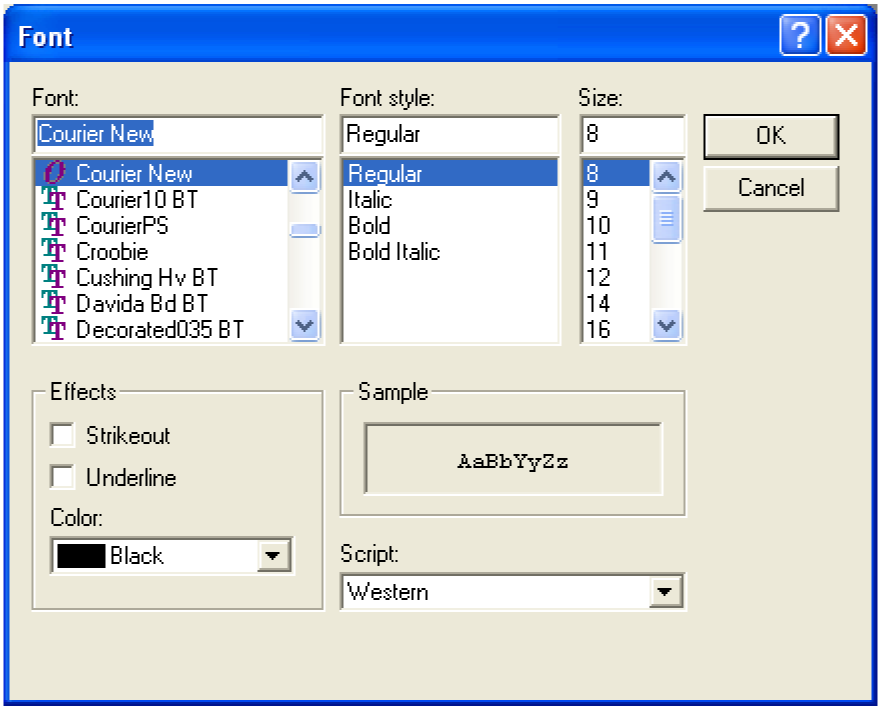
Sort Order
● Address
○ Tag
○ Description

Select the **All** check box to print the entire range of items. To print a selection, clear the **All** check box and enter a range in the associated edit box.

The Register Tags, Descriptions and Comments can be individually turned on and off. To include with the Documentation print out select the appropriate check box under Include.

The sort order for documentation print can be based on address, Tag, or Description. To change the Documentation print sort orders select the appropriate check box under **Sort Order**.

1. Click the **Doc Font** button to change the Tag, Description, and Comments printout font of the active program.
   Result: The Font dialog box appears.



Font

Font: Courier New

Font style: Regular

Size: 8

Effects

□ Strikeout

□ Underline

Color: Black

Sample

AaBbYyZz

Script: Western

2. Choose a new font, font style, or font size. Notice that you can see a sample of the font in the **Sample** box.

3. Click **OK** in the Font dialog box to save your changes or Cancel to cancel your changes.
   Result: The Print Documentation dialog box appears.

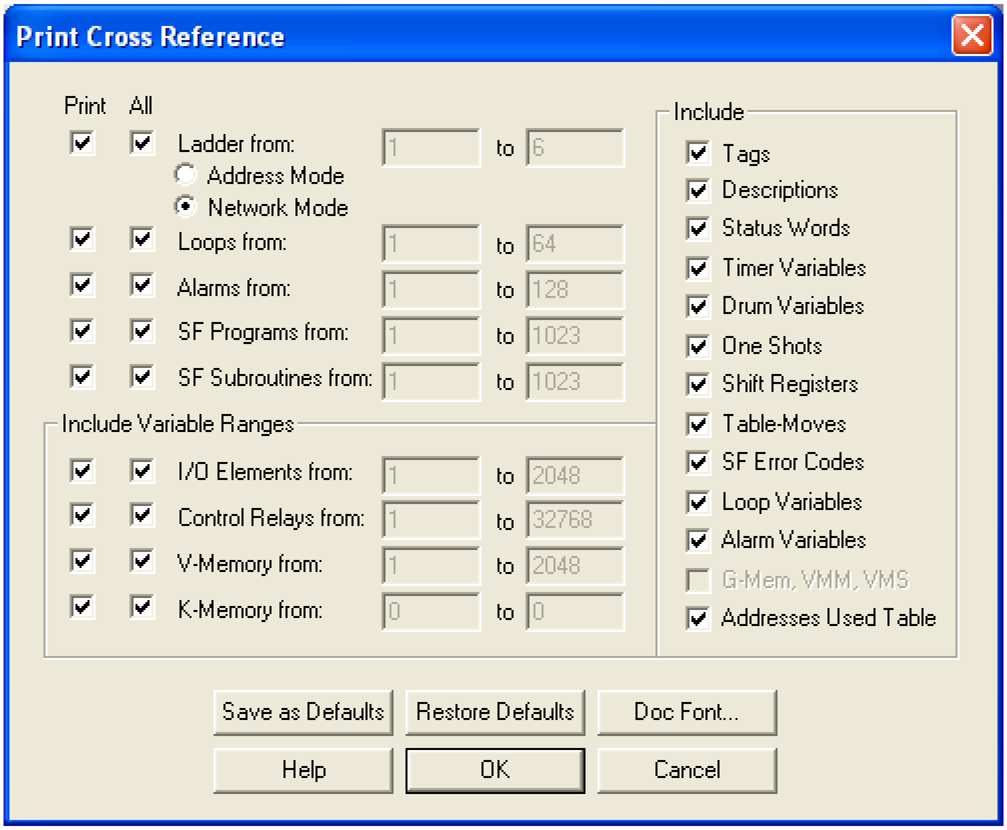
NOTE: The print selection options are stored when saving a program.

Print Cross Reference

Select the **Cross-reference** check box from the Print dialog box to print the following.

- All logic, ladder, SFS and SFP
- Selected logic ladder, SFS or SFP
- Selected ladder in address or network mode
- Selected Special Function lines
- Alarms
- Loops
- I/O Elements (X, Y, WX and WY)
- Control Relays (C)
- V-Memory
- K-Memory
- I/O Elements (X, Y, WX and WY)
- Control Relays (C)
- Tags Descriptions and Comments

To change the Cross-reference properties click the **Cross-reference** button on the **Print** dialog box. The Print Cross Reference dialog box appears.



Print Cross Reference

Print	All				
☑	☑	Ladder from:	1	to	6
		○ Address Mode			
		● Network Mode			
☑	☑	Loops from:	1	to	64
☑	☑	Alarms from:	1	to	128
☑	☑	SF Programs from:	1	to	1023
☑	☑	SF Subroutines from:	1	to	1023

Include Variable Ranges

☑	☑	I/O Elements from:	1	to	2048
☑	☑	Control Relays from:	1	to	32768
☑	☑	V-Memory from:	1	to	2048
☑	☑	K-Memory from:	0	to	0

Include

☑ Tags
☑ Descriptions
☑ Status Words
☑ Timer Variables
☑ Drum Variables
☑ One Shots
☑ Shift Registers
☑ Table-Moves
☑ SF Error Codes
☑ Loop Variables
☑ Alarm Variables
□ G-Mem, VMM, VMS
☑ Addresses Used Table

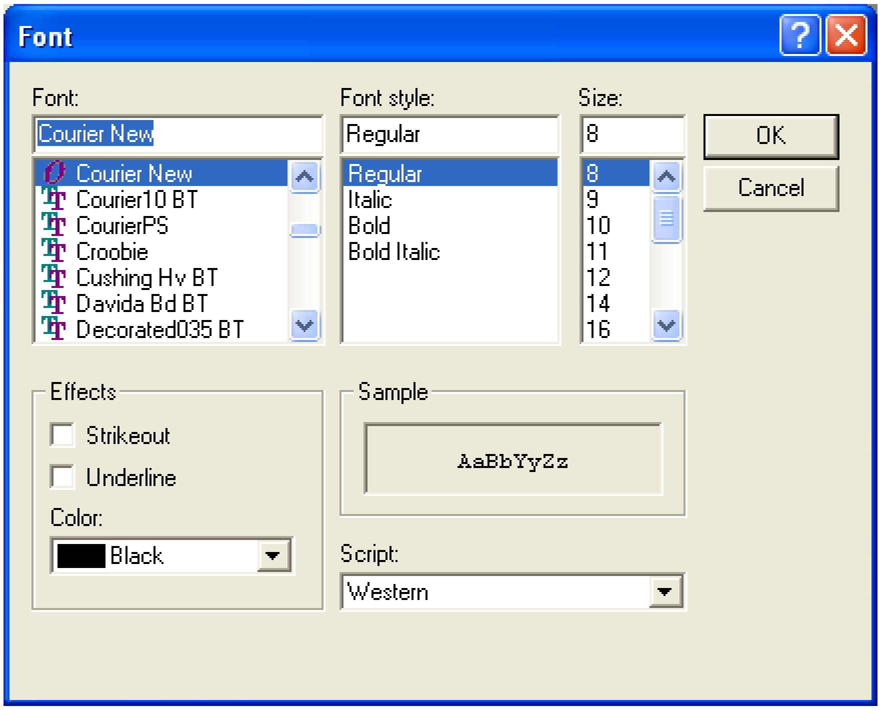
Select the **All** check box to print the entire range of items. To print a selection, clear the **All** check box and enter a range in the associated edit box.

The following can be individually turned on and off to be included with Cross reference printout:

- Tags
- Descriptions Status Words
- Timer Variable
- Drum Variables
- One Shots Shift Registers
- Tables-Moves
- SF Error Codes
- Loop Variables
- Alarm Variables
- G-Mem/VMM/VMS

To include Addresses Used Table with the Cross-reference print out select the appropriate check box under **Include**.

1. Click on the **Doc Font** button to change the Tag, Description, and Comments print-out font of the active program.
   Result: The Font dialog box appears.



Font: Courier New

Font style: Regular

Size: 8

☐ Strikeout

☐ Underline

Color: Black

Script: Western

2. Choose a new font, font style, or font size. Notice that you can see a sample of the font in the **Sample** box.

3. Click **OK** in the Font dialog box to save your changes or click **Cancel** to cancel changes.
   Result: The Print Cross-reference dialog box appears.

> **NOTE:** The print selection options are stored when saving a program.

Print Data Window

The contents of the Data Window can be printed by clicking **Print** from the **Data** menu or by right-clicking the Data Window and selecting **Print** from the shortcut menu.

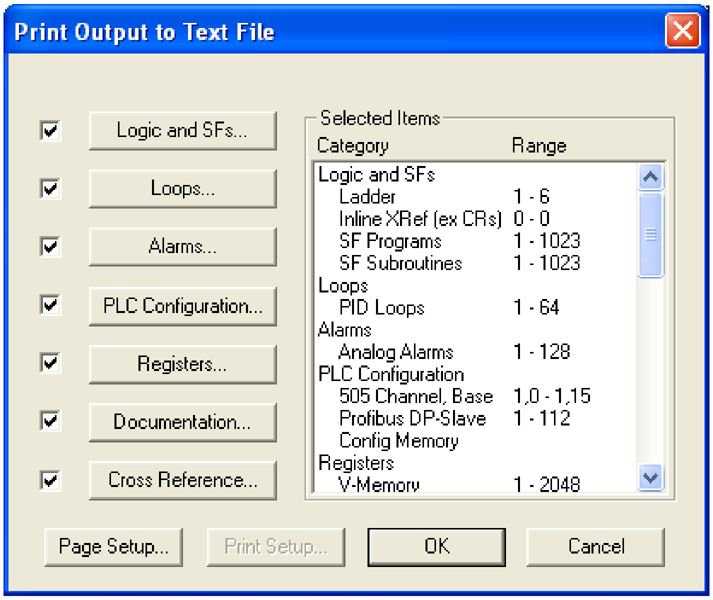
Print to a Text File

1. To print to a text file click **Output To Text File** from the **File** menu.

   Result: The Print Output to Text File dialog box appears. *See* **Printing Logic Programs**for dialog box selections.

2. Once selections are made click **OK**.

3. Enter a file name to save to and click **OK**.



☑ Logic and SFs...
☑ Loops...
☑ Alarms...
☑ PLC Configuration...
☑ Registers...
☑ Documentation...
☑ Cross Reference...

Selected Items

Category	Range
Logic and SFs	
Ladder	1 - 6
Inline XRef (ex CRs)	0 - 0
SF Programs	1 - 1023
SF Subroutines	1 - 1023
Loops	
PID Loops	1 - 64
Alarms	
Analog Alarms	1 - 128
PLC Configuration	
505 Channel, Base	1,0 - 1,15
Profibus DP-Slave	1 - 112
Config Memory	
Registers	
V-Memory	1 - 2048

Editing

Editing Features

505 WorkShop uses a number of timesaving editing features to help you complete your programming tasks. These include:

- Cut
- Copy
- Paste
- Paste With Rewire
- Undo
- Clear
- Delete
- Insert

The most frequently used editing features are **Cut**, **Copy**, and **Paste**. Use these commands to quickly copy logic and documentation to either another location in the same program or another program. The list below describes Cut, Copy, and Paste differences.

Window Feature	Function
Cut	Removes the selection from the program and places it on the clipboard.
Copy	Copies the selection and places it on the clipboard.
Paste	Inserts clipboard contents into the program at the cursor location.
Paste With Rewire	Inserts clipboard contents into the program at the cursor location and allows the user to re-address any addressable items contained in the clipboard.
Undo	Resets the networks/addresses in a segment to their original data.

The clipboard referred to is the standard Windows clipboard. Refer to your Windows User's Guide for more information.

To select the information you want to cut or copy, click, hold and drag the pointer over the desired area. Selected items are highlighted with a different color than your normal workspace color.

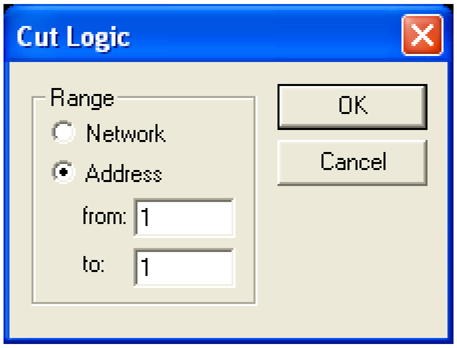
If you want to select all logic in the current window, click **Select All** from the **Edit** menu.

Each of these editing commands, described in detail in the following paragraphs, can be accessed several ways.

Cut

To use the cut feature:

1. Select the instructions, networks/addresses, or special function (SF) lines you want to cut.
2. Cut your selection to the clipboard by either clicking the ✂ toolbar button or clicking **Cut** from the **Edit** menu.



Cut Logic

Range
○ Network
● Address
from: 1
to: 1

The ladder logic or SF rows that have been cut can be **pasted**.

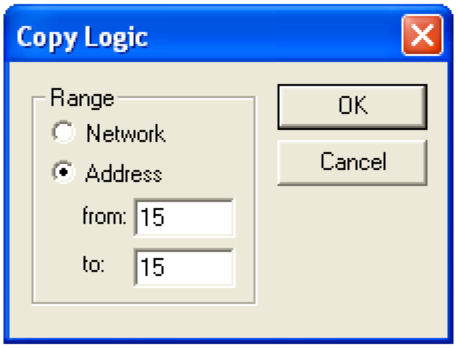
> **NOTE:** If the start and ending networks/addresses or (SF) lines are known, then the cut from and cut to range can be entered directly into the Cut Range dialog box. If a partial network is selected, the Cut Range dialog box is not displayed. The items selected are cut without warning.

Copy

To use the copy feature:

1. Select the instructions, networks/addresses, or special function (SF) lines you want to copy.

2. Copy your selection to the clipboard by either clicking the toolbar button or clicking **Copy** from the **Edit** menu.



Copy Logic

Range

○ Network

● Address

from: 15

to: 15

The range of networks/addresses or (SF) lines displayed are copied and placed into the clipboard.

NOTE: If the start and ending networks/addresses or (SF) lines are known, then the copy from and copy to range can be entered directly into the Copy Range dialog box. If a partial network is selected, the Copy Range dialog box is not displayed. The items selected are copied without warning.

Paste

To access the paste feature:

1. Move the pointer to the location in your program where you want to paste the contents of the clipboard.

2. Click on the toolbar, click **Paste** on the **Edit** menu, or press **CRTL+V**.

Paste With Rewire

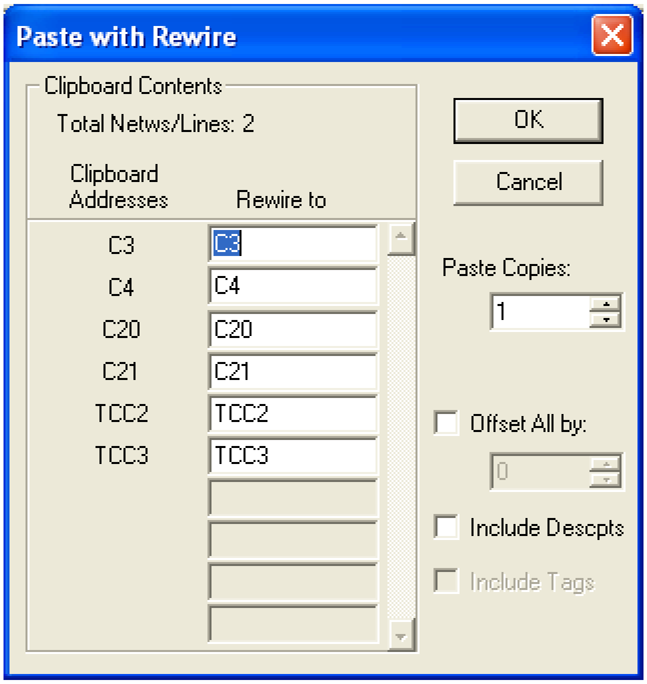
Paste With Rewire provides you with a number of timesaving editing features. These include:

- Paste multiple copies
- Paste with address offset
- Include tags and descriptions in the paste
- The ability to Rewire (change address) on an individual basis

NOTE: The Paste With Rewire feature is available offline only.

To access the rewire feature:

1. Move the pointer to the desired location.
2. Paste clipboard contents into the new location by clicking **Paste with Rewire** from the **Edit** menu. The Paste With Rewire dialog box appears.
3. Choose the appropriate options.
4. Click **OK**.



Paste with Rewire

Clipboard Contents

Total Netws/Lines: 2

Clipboard Addresses	Rewire to
C3	C3
C4	C4
C20	C20
C21	C21
TCC2	TCC2
TCC3	TCC3

Paste Copies: 1

□ Offset All by: 0

□ Include Descpts

□ Include Tags

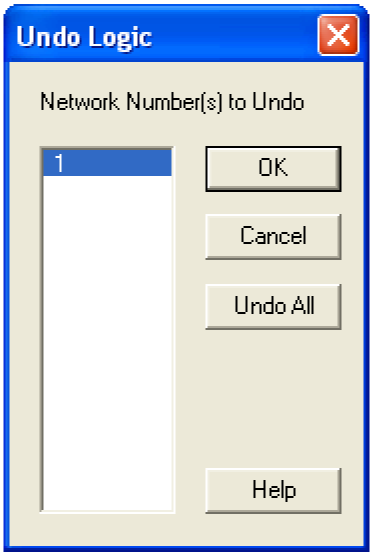
NOTE: When pasting, clipboard contents are inserted before existing items. For example, if you are pasting a network and the cursor is positioned at Network 002, click paste and the clipboard contents become Network 002. The previous Network 002 becomes Network 003.

Undo

Use Undo to reset networks/addresses in a segment to their original data. Any modified or inserted rung can be reset. Deleted rungs cannot be reset.

To access the Undo feature:

1. Click **Undo** from the **Edit** menu or press **CTRL+Z**.
   Result: The Undo Logic window appears.
2. Select the segments to reset and click **OK**, or click **Undo All** to reset all networks/addresses displayed.
3. Click **Cancel** to close the window.



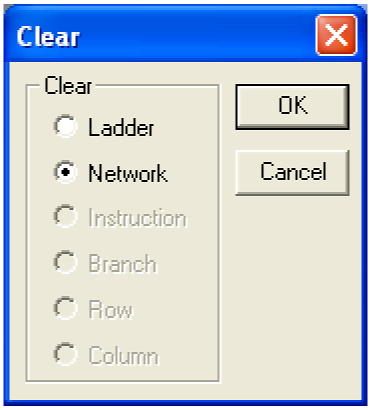
Clear

Clear

Use Clear to clear an item without removing the space it occupies. Clear can be accessed from the Logic Editor in either offline or online mode.

To clear items:

1. Select the item or items you want to clear.
2. Click **Clear** from the **Edit** menu or press the **DELETE** key.
   Result: The Clear dialog box appears.
3. Click the items you want to clear.
4. Click **OK** or press **ENTER**.
   Result: The selected items are cleared.



Clear

○ Ladder
● Network
○ Instruction
○ Branch
○ Row
○ Column

The following table describes the clearing items.

Item	Description
Ladder	Removes all networks/addresses from the block displayed.
Network	Removes all logic from the network at the cursor position.

Item	Description
Instruction	This option is available if the cursor is positioned at an instruction. When cleared, the instruction is removed; however, attached branches are not affected.
Branch	This option is available if there is a branch to the right of the instruction with the cursor. Clearing removes the branch to the right of the cursor.
Row	This option is available when an instruction is selected. Clearing removes instructions from the row where the cursor is positioned. Branches in this row are cleared only if the resulting logic contains branches unconnected to logic at one or both ends.
Column	This option is available when an instruction is selected. Clearing removes instructions and branches from the current column.

Logic Editor - Online

Using Clear in the Logic Editor while online works the same as in offline mode. However, row and column cannot be cleared while online.

Delete

Delete

Use Delete to delete an item and remove the space it occupies. Access Delete using the Logic Editor in either offline or online mode. Delete can also be accessed from the Data Window.

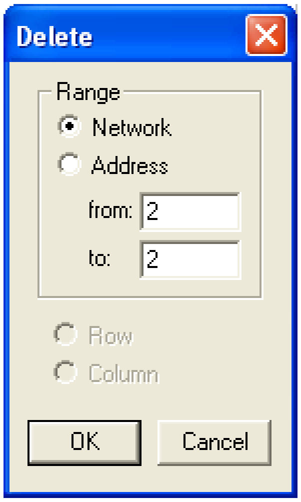
To delete:

1. Select the item or items you wish to delete.

2. Select **Delete** from the **Edit** menu.
   Result: The Delete box appears.

3. Click the items you want to delete.

4. Click **OK** or press **ENTER**.



Delete

Range

● Network

○ Address

from: 2

to: 2

○ Row

○ Column

The following table describes the deletion items.

Item	Description
Network	Deletes a network or a range of networks/addresses. To delete a range of networks/addresses, enter the number of the first network to delete in the From box. Then enter the number of last network to delete in the To box.
Row/Line	In Ladder, selecting a row deletes all instructions and branches from the row where the cursor is positioned. Logic below the deleted row(s) moves up. When box instructions prevent a deletion, an error message appears.

Item	Description
Column	Deletes instructions and branches from the column where the cursor is positioned. Logic to the right of the deleted column(s) moves left. When box instructions prevent a deletion, an error message appears.

Logic Editor - Online

Using Delete in the Logic Editor while online works the same as in offline mode. However, a row or column cannot be deleted unless it is empty.

Data Window

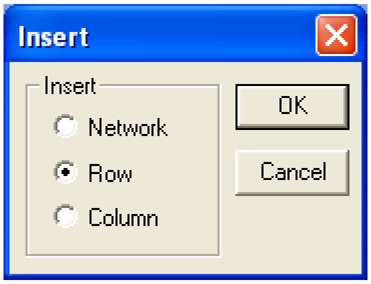
While working in the Data Window, you can use Delete to clear all rows or one row at a time. Delete is accessed through the Edit menu.

Insert

Use **Insert** to insert a selected object (network, instruction, row, or column) at the point of the current cursor position. Access **Insert** from the **Edit** menu using the Logic Editor in either offline or online mode.

To insert an object:

1. Select **Insert** from the **Edit** menu.
   Result: The Insert dialog box appears.
2. Click on the object you want to insert.
3. Click **OK** or press **ENTER**.



Logic Editor - Offline

Item	Function
Network/Address	Adds a new network before the current network or address where the cursor is positioned.
Row/Line	Adds a new row is before the row where the cursor is positioned. If box instructions prevent insertion, an error message appears.
Column	Adds a new column before the column where the cursor is positioned. If box instructions prevent insertion, an error message appears.

Logic Editor - Online

Insert is accessed in the same manner online as offline. However, only a network or column can be inserted while working online.

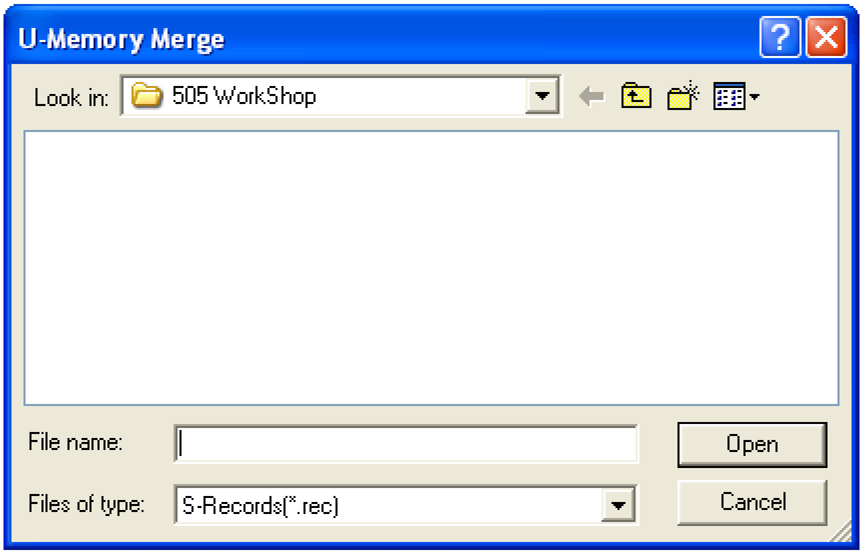
Item	Function
Network	With the cursor positioned at a network, Insert places a new network before the current network.
Column	A new column is inserted before the column where the cursor is positioned. If box instructions prevent insertion, an error message appears.

Merge Memory

Merge allows you to merge externally developed subroutine programs into User Memory. For example, you can merge compiled C, Pascal, assembly language, and other programs into U-Memory.

Follow these steps to prepare the external subroutine for use in the controller.

1. Compile/assemble the subroutines and header to create object modules.
2. Link the object modules for the header and subroutines to create the load module. The file name must have the extension ".rec". The output must have the header at zero, followed by the code and data constants, then the variables, and finally the stack.
3. Select **Merge** from the **File** menu and **U-Memory** from the list Window.
   Result: The Merge dialog box appears.
4. Type the program name in the **File name** box, or browse to search from valid program names.
5. Click **Open** to merge the program.



WorkShop and FTVersionTrak

Using WorkShop with FTVersionTrak

505 WorkShop integrates seamlessly with FTVersionTrak, FasTrak's powerful file change management software.

FTVersionTrak safeguards your valuable work in progress, preserves previous versions of files, and stores files in a safe place. If for some reason you lose a file or it becomes corrupt, you can retrieve a previous version of the file from the FTVersionTrak repository. FTVersionTrak also details version histories, allows electronic signatures, organizes files, and more.

You can be sure no one else is editing a file when you store it in FTVersionTrak because only one person at a time can check out the file, making it read-only to other users. You can view checked out copies of files by getting them from FTVersionTrak.

FTVersionTrak recognizes whether or not a file is being edited and by whom, so team members can work on a program concurrently without overwriting each others' work. As long as each programmer is using the same FTVersionTrak database, all team members can see each other's changes in a program.

Programmers in a single-user environment can also benefit from using FTVersionTrak. Using FTVersionTrak is beneficial for single users who want to centralize their programs onto a secure server. FTVersionTrak also provides revision tracking and file state transitioning throughout the life of the program, which is beneficial to both single-user and team programming environments.

If you are not currently using FTVersionTrak to safeguard your PLC programs, visit **www.fast-soft.com** to download a demo or contact **Sales at sales@fast-soft.com** for more information.

Getting Started with FTVersionTrak

If you are using FTVersionTrak to protect and manage your WorkShop files for the first time, follow these steps to begin.

To get started using FTVersionTrak with WorkShop:

1. Check with your network or systems administrator to address issues such as access rights, user accounts, and so on. If you are the network or systems administrator,

review the *Administrator Guide* in the *FTVersionTrak* manual.

2. One user adds an existing program (or creates a new program and adds it) to the FTVersionTrak repository by clicking the icon on the FTVersionTrak toolbar.

3. Other users get the file from the repository by launching FTVersionTrak, highlighting the file, and clicking **Get Version** from the **Version** menu or by clicking the toolbar button.

4. If multiple programmers will be working on the same programs at the same time, see Tips and Strategies for Team Programming. These strategies will help everyone involved use FTVersionTrak in the same way.

5. Begin using WorkShop like you normally would, by opening, editing, saving, and closingthe program files. FTVersionTrak's seamless integration automates the version control process.

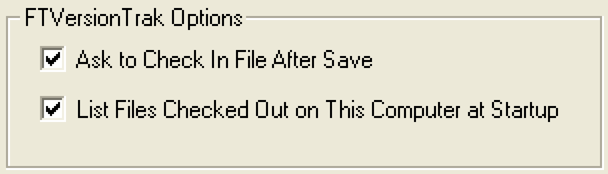
6. Read the FAQs about FTVersionTrak and Using FTVersionTrak in WorkShop for more information. Also see Operation Modes in FTVersionTrak.

Using FTVersionTrak in WorkShop

Using FTVersionTrak in Workshop

Certain aspects of the WorkShop environment are different when your WorkShop program is being protected by FTVersionTrak. Most differences occur automatically when opening and closing WorkShop files. All other version control features can be accessed using the FTVersionTrak toolbar.

You can change the way FTVersionTrak behaves within WorkShop by clicking **Application Setup** from the **Options** menu. The Application Setup dialog box lists options specifically for FTVersionTrak in the **FTVersionTrak Options** group box.

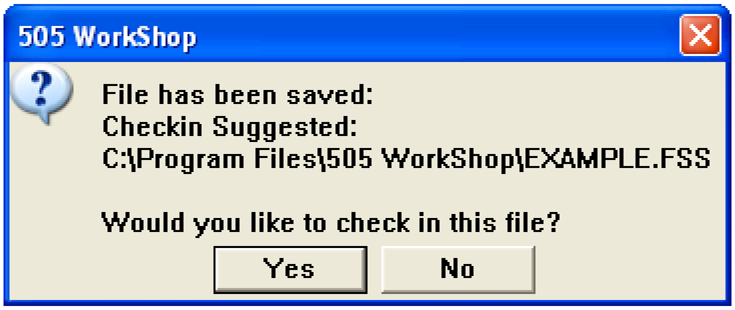


FTVersionTrak Options

☑ Ask to Check In File After Save

☑ List Files Checked Out on This Computer at Startup

Select the **Ask to Check In File After Save** check box to prompt the user to check in a program whenever the file is saved. See Saving WorkShop Files for more information.



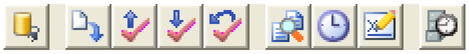
File has been saved:
Checkin Suggested:
C:\Program Files\505 WorkShop\EXAMPLE.FSS

Would you like to check in this file?

Select the **List Files Checked Out on This Computer at Startup** check box to display a list of files checked out whenever you launch WorkShop.

FTVersionTrak Toolbar

The FTVersionTrak toolbar displays a row of icons that represent version control options available in WorkShop. View the FTVersionTrak toolbar by clicking **Toolbars** from the **View** menu.



Icon	Function
	Connect to FTVersionTrak repository and add active program
	Get a version of active program file and place it into your working directory
	Check out active program
	Check in active program
	Undo checkout of active program
	Compare working copy of active program to version in repository
	View version history of active program
	Electronically sign active program
	Launch FTVersionTrak

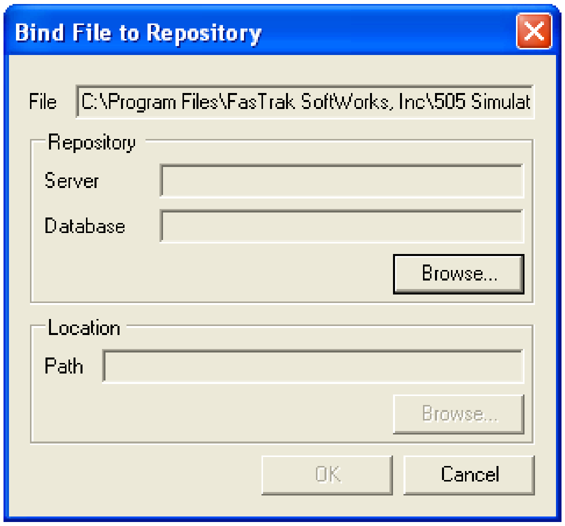
Adding Files to the FTVersionTrak Repository

Before FTVersionTrak can begin securing your program files, they must be added to the FTVersionTrak repository. The repository is a secure, compressed database that exists apart from you local file system. This database keeps track of any changes made to the files added to it, as well as securing them from accidental or unauthorized deletion or removal.

To add a WorkShop file to the FTVersionTrak repository:

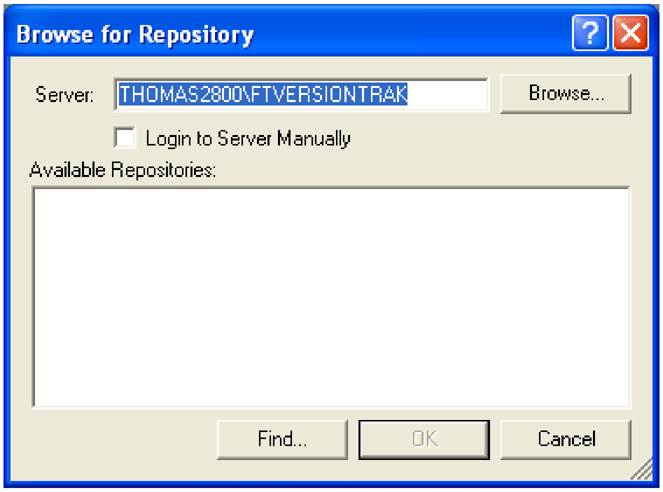
1. Open the program file in WorkShop.

2. Click the button on the FTVersionTrak toolbar. The **Bind File to Repository** dialog box appears.



File: C:\Program Files\FasTrak SoftWorks, Inc\505 Simulat

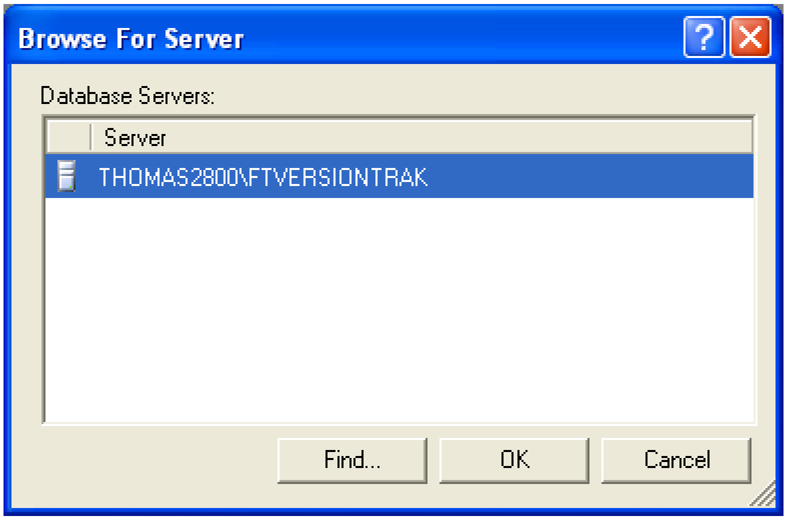
3. Click **Browse**. The **Browse for Repository** dialog box appears.



Server: THOMAS2800\FTVERSIONTRAK

□ Login to Server Manually

4. If an FTVersionTrak database exists on the local machine, it appears in the **Server** box. If this is the database you would like to use, skip to Step 6. If no database exists, or to select another database, click the **Browse** button. The **Browse for Server** dialog box appears.



Browse For Server

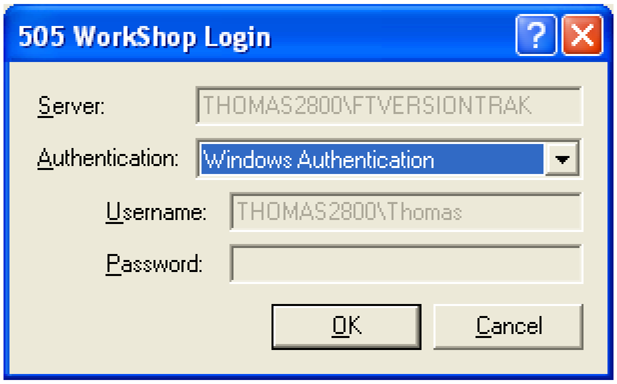
Database Servers:

Server
THOMAS2800\FTVERSIONTRAK

5. Click the **Find** button to search for all available database servers. Select the desired database from the list and click **OK** to return to the **Browse for Repository** dialog box. If you still cannot find the database you are looking for, see you system administrator or consult the FTVersionTrak manual.

6. Select the **Login to Server Manually** check box to force a manual login to the server. Use this option if a different user usually logs in automatically and the login needs to be changed.

7. Select the repository you want to add the file to from the list of **Available Repositories** and click **OK**. If the desired repository does not appear in the list, click the **Find** button to search for all repositories available in the selected database. If you still cannot find the repository you are looking for, see your system administrator or consult the FTVersionTrak manual.



505 WorkShop Login

Server: THOMAS2800\FTVERSIONTRAK

Authentication: Windows Authentication

Username: THOMAS2800\Thomas

Password:

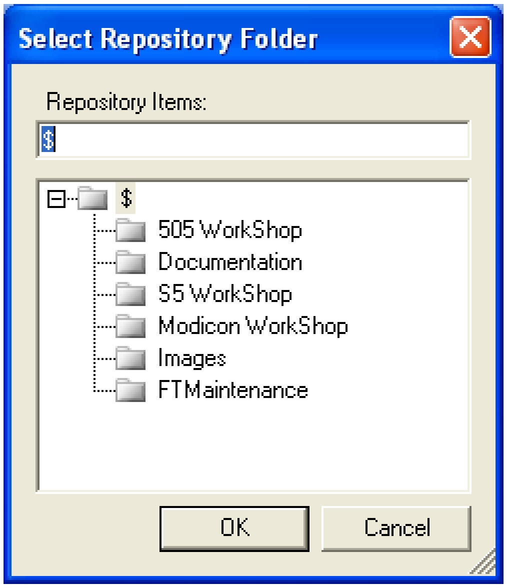
8. Select the preferred authentication type from the **Authentication** combo box:

    - **Windows Authentication** - This option utilizes the local Microsoft Windows user accounts to log on to the server. If this option is selected, the user currently logged in to Windows will appear in the Username text box. No password is necessary, and the login information cannot be edited.

    - **SQL Authentication** - This option uses the login information located on the server itself. Selecting this option will prompt for both a username and password. See your system administrator for more information.

9. Click **OK** to continue.

10. Click the **Browse** button in the **Location** group box. The **Select Repository Folder** dialog box appears.



11. Select the repository folder you would like to add the program file to and click **OK** to return to the **Add File to Repository** dialog box.

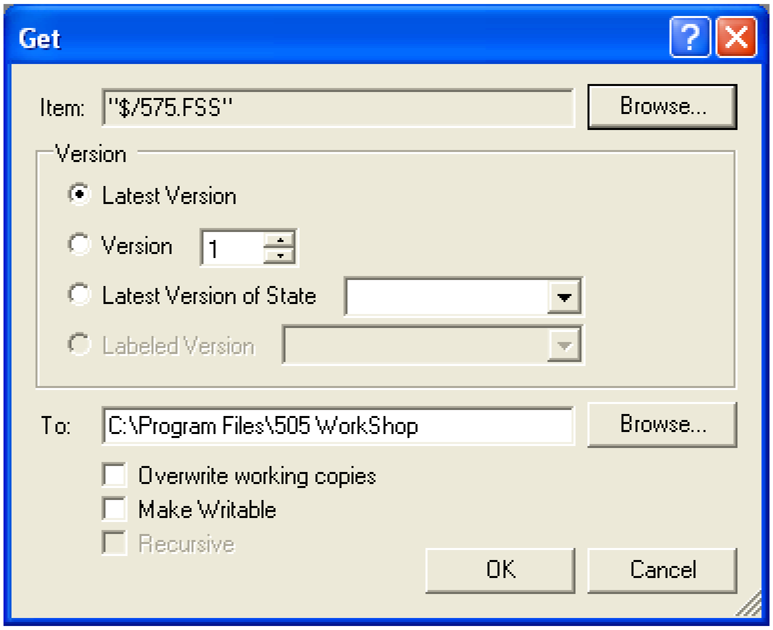
12. Click **OK** in the **Add File to Repository** dialog. The file is added to FTVersionTrak.

Getting Versions of a File

The **Get** action retrieves a version of the active program from the repository and places it in your working directory as a read-only copy to review or check out.

To get a version of the active WorkShop program:

1. Click the icon on the FTVersionTrak toolbar. The **Get** dialog box appears.



Get

Item: "$/575.FSS"

Version

● Latest Version

○ Version 1

○ Latest Version of State

○ Labeled Version

To: C:\Program Files\505 WorkShop

□ Overwrite working copies

□ Make Writable

□ Recursive

2. Select the options of the version you would like to get in the **Version** group box:

    - Selecting **Latest Version** places the latest version of the file into your working directory.

    - Selecting **Version** allows you to choose the version you would like to get.

    - Selecting **Latest Version of State** allows you to choose a version with a particular repository file state.

    - Selecting **Labeled Version** allows you to choose a version with a particular label.

2. In the **To** box, type the directory in which to place the working copy or click **Browse** to locate the directory.

NOTE: If a working directory has been set, it appears in the text box. If a working directory has not been set, the text box appears as blank.

2. Select the **Overwrite working copies** check box to automatically overwrite any files located within the directory assigned in the **To** box during the Get operation.

3. Select the **Make Writable** check box to remove the read-only status from the program file.

NOTE: Making working copies writable is not recommended for files you wish to keep under version control. Do not select this option if you plan on checking out and editing the file.

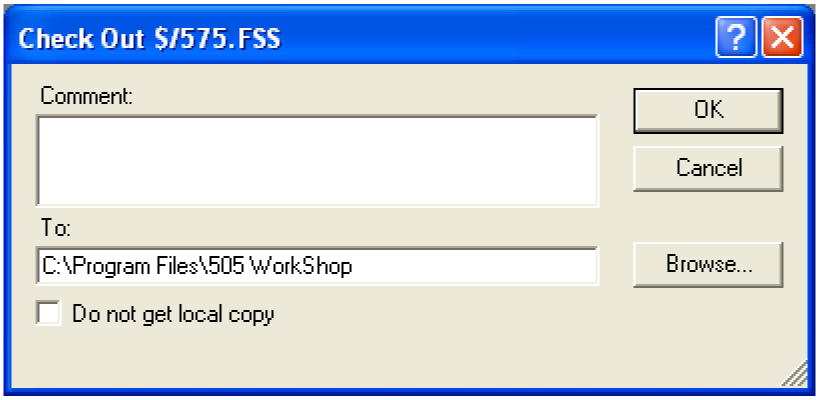
5. Click **OK** when finished. A version of the file is placed in the selected directory.

NOTE: If the path selected in the **To** text box is the same as the path of the active program file, the active file will be overwritten even if the **Overwrite working copies** check box is not selected. If you proceed to overwrite the active program file, the program will exit and any existing changes will be lost. You must open the program again to continue.

Checking Out Files

To make changes to your WorkShop program using FTVersionTrak, it must first be checked out. Checking out a file places a writeable copy of the file within the user's working directory. If the file is already present in the working directory (following a Get action, for example) then FTVersionTrak removes the read-only status on the file while it is checked out.

1. Click the icon on the FTVersionTrak toolbar. The **Check Out** dialog box appears.



C:\Program Files\505 WorkShop

□ Do not get local copy

2. In the **To** box, enter the directory in which to place the working copy or click **Browse** to locate the directory.

> **NOTE:** If a working directory has been set, it appears in the text box. If a working directory has not been set, the text box appears as blank.

2. Select the **Do not get local copy** check box if you do not wish to get the version of the repository file while checking the file out.

> **NOTE**: Using the **Do not get local copy** option only checks out the file. This is helpful if your working copy is different than the latest version within FTVersionTrak.

4. If desired, enter a comment about the check out within the **Comment** text box. This comment may be edited when the file or folder is checked in. Click **OK** when finished.

After checking out a file or folder, the following options are available:

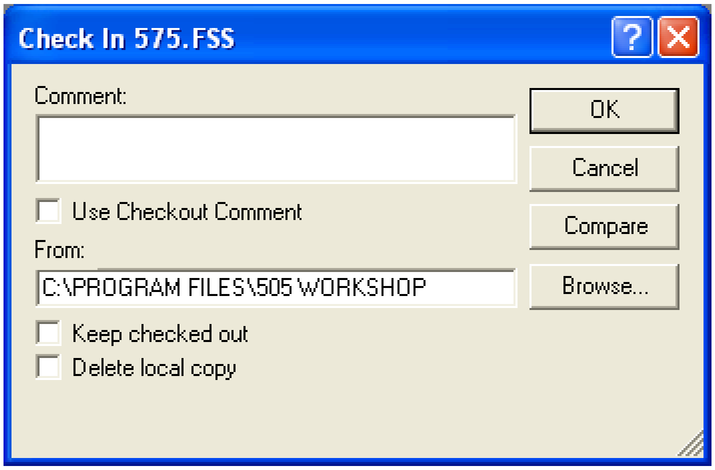
- Check In the file or folder to write any edits to FTVersionTrak and create a new version.
- Undo the Check Out to cancel any changes made to the file or folder.

Checking In Files

Check in the program file to write changes to the master copy located in the FTVersionTrak repository. After you check the file in, other users will be able to Get the modified file, view the changes you have made to the file, and check out the file to work on it as well.

To check in the active WorkShop file:

1. Click the icon on the FTVersionTrak toolbar. The **Check In** dialog box appears.



☐ Use Checkout Comment

From: C:\PROGRAM FILES\505 WORKSHOP

☐ Keep checked out

☐ Delete local copy

2. In the **Comment** box, type a comment for the check in (optional). If a comment was entered during checkout, it will appear by default in the text box. Select the **Use Checkout Comment** check box to use this comment.

3. The **From** box will display the local path that the new version will be written from (usually the working directory). Click **Browse** to navigate to a different directory.

4. Select the **Keep checked out** check box to write any changes to the repository but keep the program checked out to you.

5. Select the **Delete local copy** check box to remove the working copy on your local system after the check in.

6. Click **Compare** to compare the difference between the version being checked in and another version in the repository.

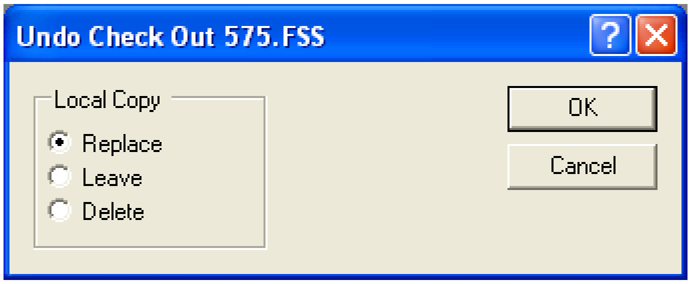
7. Click **OK** when finished to check in the items.

Undoing a Check Out

Undo the check out if you decide not to save any changes to the repository or create a new version of the WorkShop program. Undoing a checkout leaves the file in the state it was in before you checked it out. No new version is created, and no record of the checkout will be left.

To undo a check out of the active WorkShop program:

1. Click the icon in the FTVersionTrak toolbar. The **Undo Check Out** dialog box appears.



Undo Check Out 575.FSS

Local Copy
● Replace
○ Leave
○ Delete

2. Select a **Local Copy** option:

   - Select **Replace** to replace the local copy of the checked out file with the latest version within the repository.
   - Select **Leave** to leave the existing copy of the checked out file on your local system.
   - Select **Delete** to delete the local copy from the location of the check out. If the file was checked out to a location other than the working directory, the location indicated at check out will be deleted and any other copies will be retained.

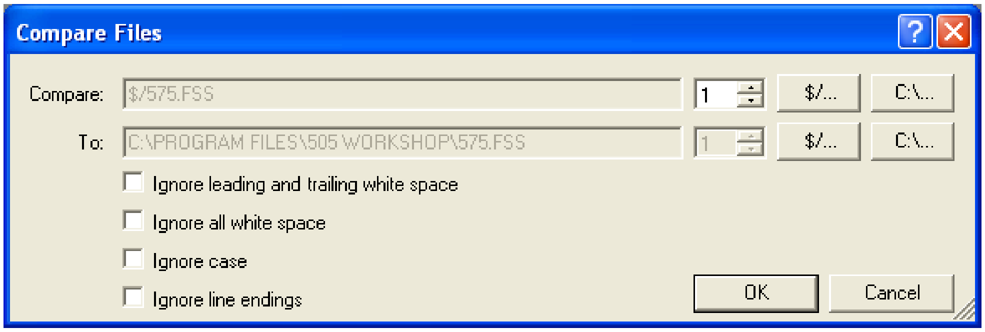
3. Click **OK** when finished to return to the main window.

Comparing WorkShop Files

One of the most useful features of FTVersionTrak is the ability to compare the contents of two WorkShop files to each other. Within WorkShop, you may compare two different versions of the same WorkShop program to each other, or compare a version in the FTVersionTrak repository to the working copy on your local hard drive.

To compare the working copy of the active WorkShop program to the latest version in the repository:

1. Click the icon on the **FTVersionTrak toolbar**. The **Compare Files** dialog box appears.



Compare Files

Compare: $/575.FSS 1

To: C:\PROGRAM FILES\505 WORKSHOP\575.FSS 1

□ Ignore leading and trailing white space

□ Ignore all white space

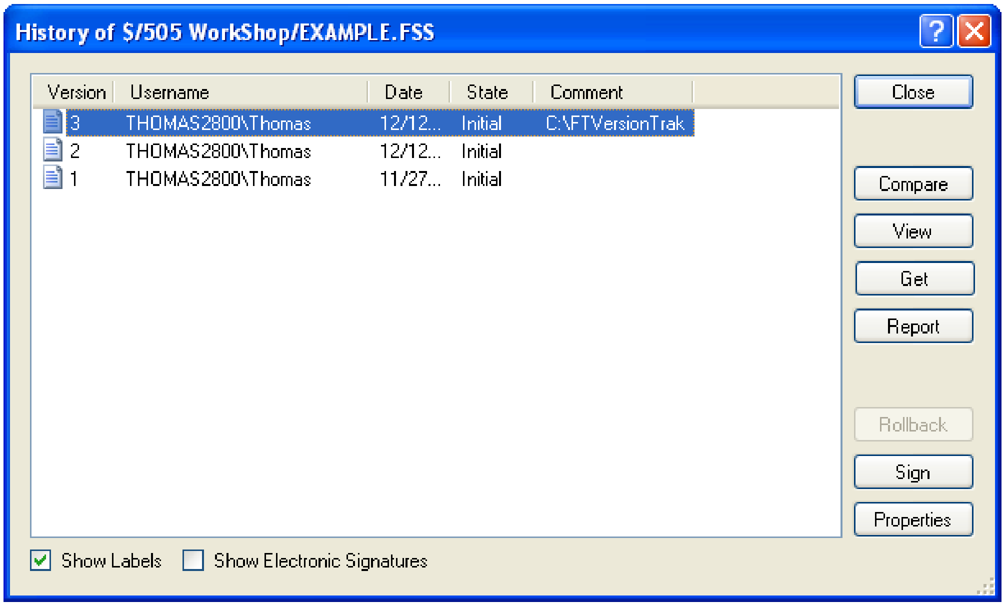
□ Ignore case

□ Ignore line endings

2. Click **OK** to view the file compare results. See the FTVersionTrak documentation for more information on file compare results.

To compare the difference between two version of the active WorkShop program:

1. Click the icon on the FTVersionTrak toolbar. The **History** dialog box appears.

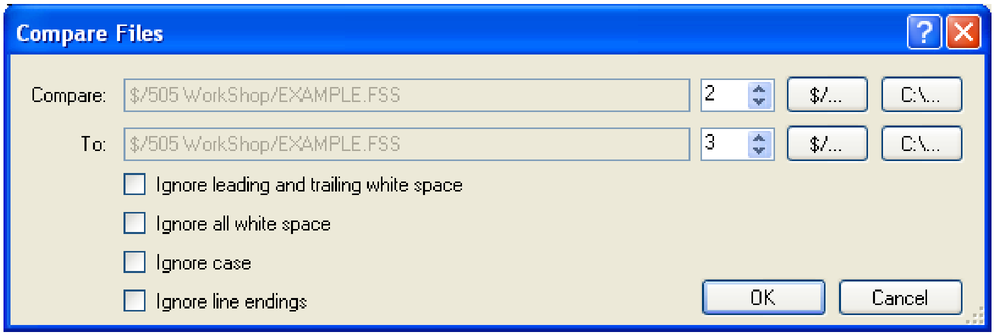


History of $/505 WorkShop/EXAMPLE.FSS

Version	Username	Date	State	Comment
3	THOMAS2800\Thomas	12/12...	Initial	C:\FTVersionTrak
2	THOMAS2800\Thomas	12/12...	Initial	
1	THOMAS2800\Thomas	11/27...	Initial	

☑ Show Labels □ Show Electronic Signatures

2. Select the first version of the file you would like to compare. While pressing the **CTRL** key, select the second version of the file you would like to compare. Click **Compare.** The **Compare Files** dialog box appears.



Compare Files

Compare: $/505 WorkShop/EXAMPLE.FSS 2

To: $/505 WorkShop/EXAMPLE.FSS 3

□ Ignore leading and trailing white space

□ Ignore all white space

□ Ignore case

□ Ignore line endings

- The following options apply only to text file comparison and can be ignored when comparing WorkShop files.
    - Ignore leading and trailing white space
    - Ignore all white space
    - Ignore case
    - Ignore line endings

3. Click **OK** to view the file compare results. See the FTVersionTrak documentation for more information on file compare results.

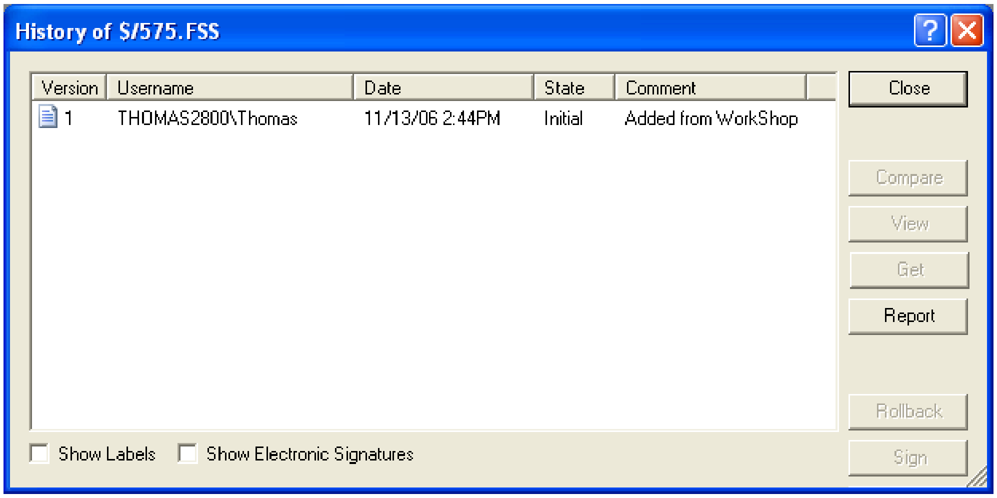
> **NOTE**: Clicking **Compare** without selecting more than one version will compare the selected version to the working copy. Clicking **Compare** without selecting any version will compare the latest version to the working copy.

Viewing File History

Each WorkShop file that is managed by FTVersionTrak is given its own history. As you check out, edit, and check in your programs, the history is updated to reflect these changes. Viewing history is the best way to get a clear picture of the changes a program has gone through.

To view the active WorkShop program's version history:

1. Click the 🕒 icon in the FTVersionTrak toolbar. The History dialog box appears.



History of $/575.FSS

Version	Username	Date	State	Comment
1	THOMAS2800\Thomas	11/13/06 2:44PM	Initial	Added from WorkShop

□ Show Labels □ Show Electronic Signatures

2. The History dialog box displays all the version information of the selected file. Each version displayed in the History dialog box contains the following information:

   - **Version** - The version number of the listed version.

   - **Username** - The name of the user that created the listed version.

   - **Date** - The date and time the listed version was added to the repository.

   - **State** - The version state of the file when it was added to the repository.

   - **Comment** - The contents of the optional comment created when the file was checked in.

3. The following two optional version histories may be viewed by selecting the appropriate check boxes at the bottom of the **History** dialog:

   - **Show Labels** - Select this options to display any associated labels with the repository file. Each label will appear as a separate version of the file, with the tag "Label" substituted for the version number.

   - **Show Electronic Signatures** - Select this option to display any associated electronic signatures with the repository file. Each signature will appear as a separate version of the file, with the tag "Signature" substituted for the version number.

4. The buttons on the right side of the History dialog box are used to manage a file's history:

- **Close** - Closes the **History** dialog box and returns to the main window.

- **Compare** - Selecting a version and clicking **Compare** will compare the selected version with the copy in the user's working directory. Selecting two versions and clicking **Compare** will compare the two versions to each other.

- **View** - Launches the application associated with the selected version, and opens the version of the file within the application as a read-only document.

- **Get** -Retrieves the selected version of the file to the user's local working directory.

- **Report** - Generates a history report of the selected repository file.

- **Rollback** - Reverts the most recent version of the repository file to the selected version. Rollback is only available if the file has more than one version, and can only be selected when a version other than the latest version is selected.

- **Sign** - Electronically signs the selected version of the file, and allows the option to change the version state.

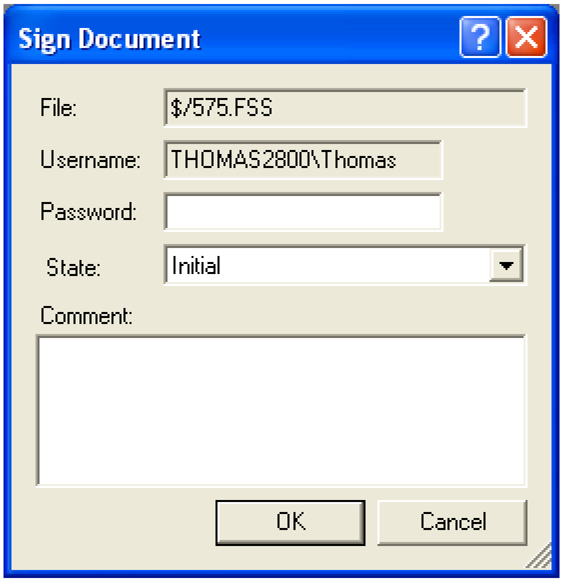
- **Properties** - View the properties of the selected version, and allows the option to change the version comment.

Electronically Signing WorkShop Files

Electronic signatures can be used as an approval method to verify that a certain user has seen a selected version of a repository file, and can also be used to advance the version state of the repository file. FTVersionTrak's electronic signatures are approved by portions of the 21 CFR Part 11 Standard.

To electronically sign the active WorkShop program:

1. Click the button on the FTVersionTrak toolbar. The **Sign Document** dialog box appears.



File: $/575.FSS

Username: THOMAS2800\Thomas

Password:

State: Initial

Comment:

2. The **File** and **Username** boxes contain the selected file and current user, respectively. Type the current user's password in the **Password** text box.

3. Select the current version state of the file from the **State** box and type any comments in the **Comment** box. Comments are optional.

4. Click **OK** when finished to return to the main window.

Launching FTVersionTrak

Some version control tasks cannot be performed using the FTVersionTrak toolbar. These tasks may include:

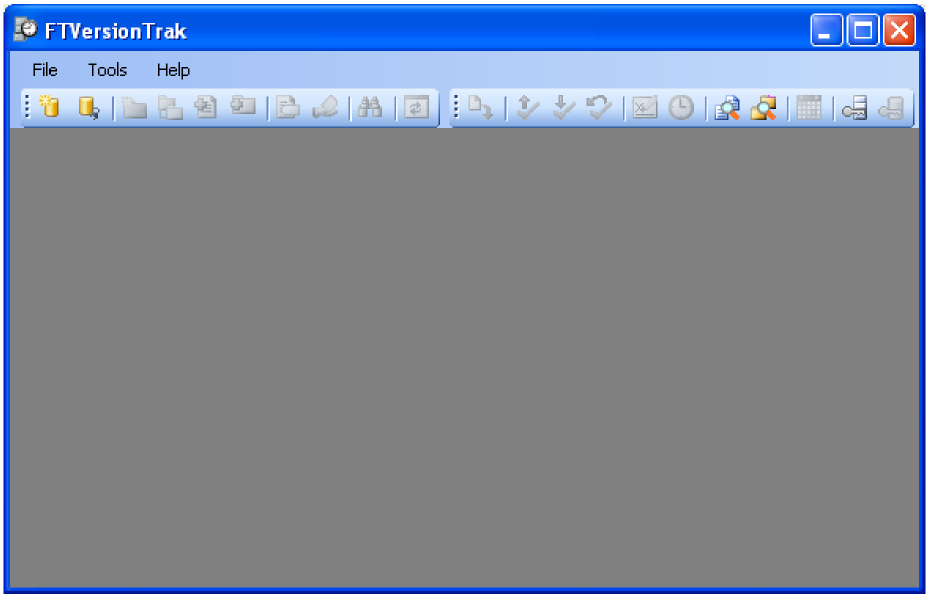
- Getting repository files for the first time
- Renaming repository files
- Deleting repository files
- Moving and sharing repository files
- Setting up server and repository security

- Setting up and viewing audit logs
- Scheduling automated tasks

You must perform these types of functions in the stand-alone FTVersionTrak application.

To launch FTVersionTrak from within WorkShop:

1. Click the button on the FTVersionTrak toolbar. The FTVersionTrak application appears.

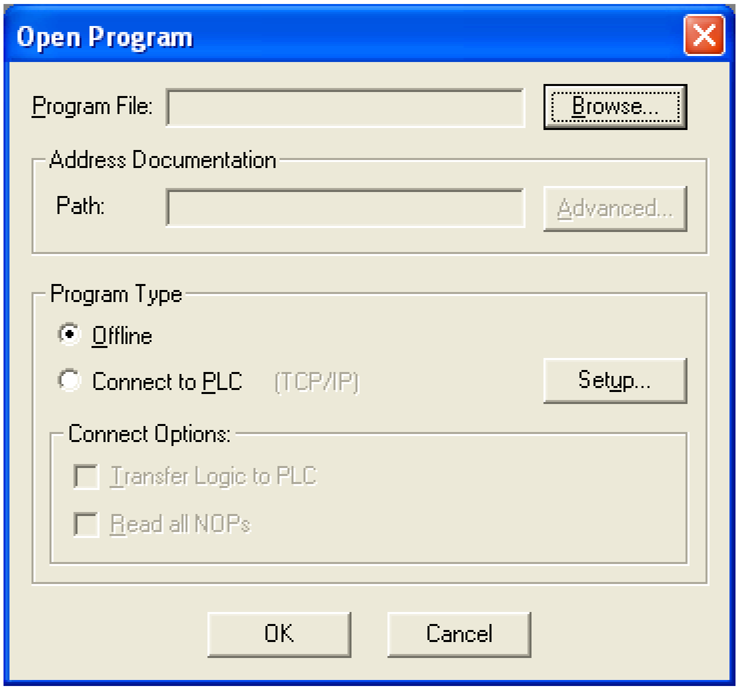


2. Connect to an FTVersionTrak repository by clicking **Connect to Repository** from the **File** menu or by clicking the toolbar button.
3. See the FTVersionTrak documentation for more information about FTVersionTrak's advanced features.

Opening WorkShop Files

Once a WorkShop file has been added to the FTVersionTrak repository and the latest version placed in your working directory, FTVersionTrak's seamless integration automates the version control process. Follow this procedure when opening WorkShop files protected by FTVersionTrak for best results:

1. After launching WorkShop, open the program by clicking **Open** from the **File** menu, or by clicking the 📂 toolbar button. The Open Program dialog box appears.



Open Program

Program File: Browse...

Address Documentation

Path: Advanced...

Program Type

● Offline

○ Connect to PLC (TCP/IP) Setup...

Connect Options:

□ Transfer Logic to PLC

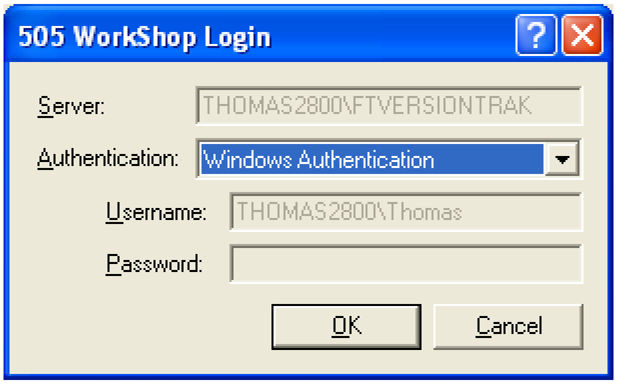
□ Read all NOPs

OK Cancel

2. Click **Browse** to browse for the file.

3. Select the file and then click **Open**.

4. Click **OK** in the Open Program dialog box. A repository login dialog box appears.



505 WorkShop Login

Server: THOMAS2800\FTVERSIONTRAK

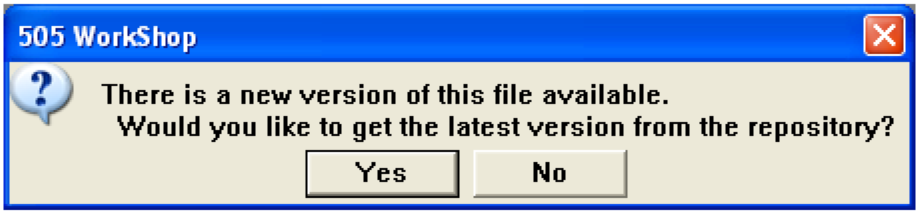
Authentication: Windows Authentication

Username: THOMAS2800\Thomas

Password:

5. Enter your login information (the administrator will provide you with this information, if needed) and click **OK**.

6. FTVersionTrak compares your version of the program with the version stored in the repository. If a newer version of the program is available, a message appears, allowing you to get the latest version.

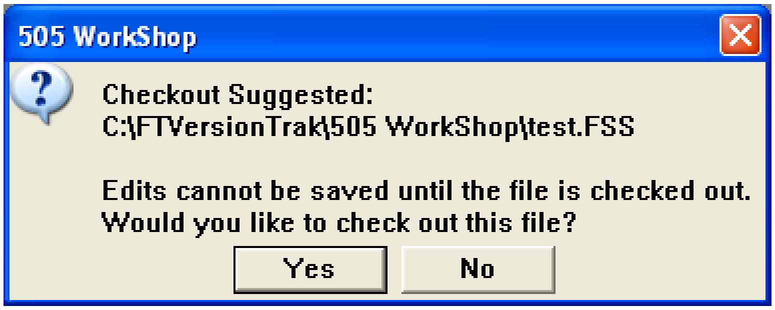


505 WorkShop

There is a new version of this file available.
Would you like to get the latest version from the repository?

7. Click **Yes** to get the latest version. Click **No** to open the older version of the program.

8. FTVersionTrak then verifies the check out status of the file. If the file is checked out to you, it opens normally. If not, a message appears, allowing you to check out the file.



505 WorkShop

Checkout Suggested:
C:\FTVersionTrak\505 WorkShop\test.FSS

Edits cannot be saved until the file is checked out.
Would you like to check out this file?

9. Click **Yes** to check out the file. Click **No** to open the file without checking it out. The program opens in WorkShop.

> **NOTE**: If the program is already checked out by another user, FTVersionTrak will prevent you from checking out and editing the program. The program will open in a read-only state and changes will not be saved.

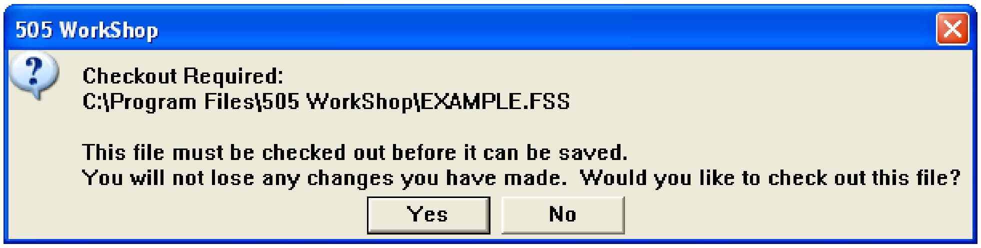
10. After the program opens, the FTVersionTrak toolbar becomes active. The actions available using the FTVersionTrak toolbar pertain to the active program.

Saving WorkShop Files

Edits to WorkShop files protected by FTVersionTrak are not complete until they have been saved and checked in. WorkShop automates this process to prevent accidental loss of changes to the program. The following process illustrates the various scenarios a user encounters when attempting to save a WorkShop file protected by FTVersionTrak.

Saving a WorkShop File That Has Not Been Checked Out

If you attempt to save a file that is tracked by FTVersionTrak, but not checked out, then you will be prompted to check out the file.



Checkout Required:
C:\Program Files\505 WorkShop\EXAMPLE.FSS

This file must be checked out before it can be saved.
You will not lose any changes you have made. Would you like to check out this file?

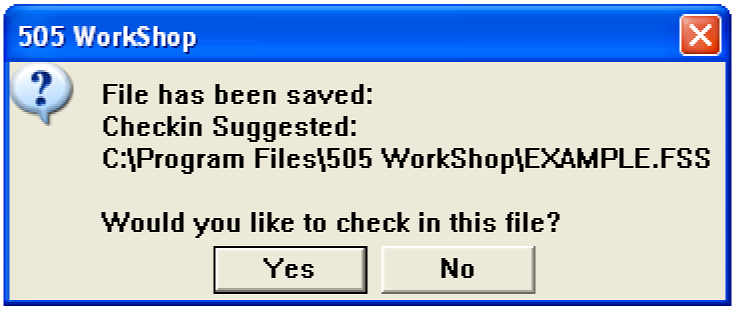
- Clicking **Yes** displays the **Check Out** dialog box. After the file is checked out, WorkShop saves the file.

NOTE: Depending on the FTVersionTrak Options set in WorkShop, available by clicking **Application Setup** from the **Options** menu, you may be prompted to check in the file after it has been saved. Otherwise, you can check in the file by clicking the ✓ button on the FTVersionTrak toolbar.

- If you click **No**, the **Save As** dialog box appears. If the file is not checked out, you must save the file with a different filename to keep any changes made to the file.

Saving a WorkShop File That is Currently Checked Out

When you choose to save a program that is checked out to you, WorkShop can also check in the file for you automatically. Clicking **Application Setup** from the **Options** menu in WorkShop displays the FTVersionTrak Options. If the **Ask to Check In File After Save** check box is selected, the following message appears after each save:



File has been saved:
Checkin Suggested:
C:\Program Files\505 WorkShop\EXAMPLE.FSS

Would you like to check in this file?

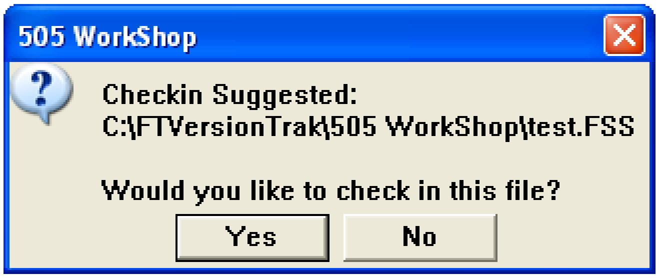
Clicking **Yes** displays the **Check In** dialog box. After the file is checked in, WorkShop keeps the file checked out to you so that you may continue editing the program. Clicking **No** saves the working copy on your computer but does not write any changes to the FTVersionTrak repository. The file can be checked in manually by clicking the ✓ button on the FTVersionTrak toolbar.

Closing WorkShop Files

The procedure to close a WorkShop file is slightly different when the file is protected by FTVersionTrak. Depending on the file's status, FTVersionTrak offers a number of different options to the user to prevent the loss of data.

Closing Programs that are Checked Out

If the program file being closed is checked out to the current user, FTVersionTrak displays a prompt suggesting the file be checked in.


505 WorkShop

Checkin Suggested:
C:\FTVersionTrak\505 WorkShop\test.FSS

Would you like to check in this file?

- Click **Yes** to display the Check In dialog box. After the file is checked in, the file closes normally.

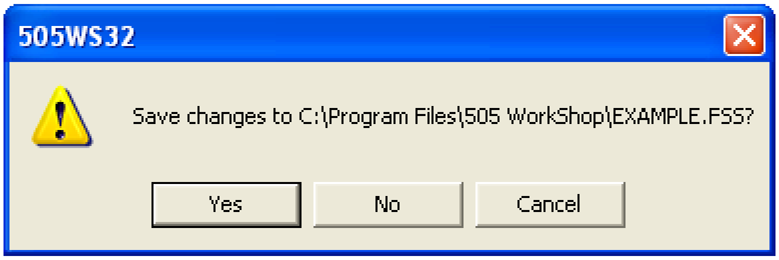
- Click **No** to close the file, leaving it checked out.

NOTE: If the file contains edits that have not been saved, WorkShop will prompt the user to save file before continuing.

Closing Programs that are Checked In

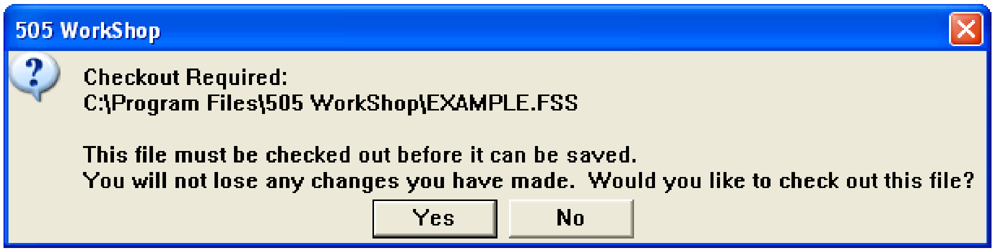
If a program file being closed has been checked in and no edits remain pending, the file closes normally. However, if the file being closed is checked in (or has not yet been checked out) *and* edits have been made to the program that have not yet been saved, WorkShop will not immediately close the program.

WorkShop first prompts the user to save the file.


505WS32

Save changes to C:\Program Files\505 WorkShop\EXAMPLE.FSS?

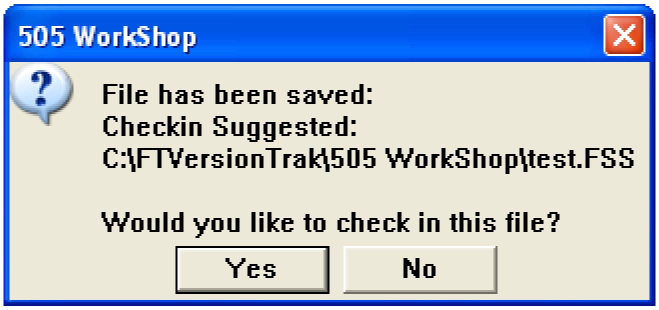
- Click **No** to lose any unsaved changes and close the program.
- Click **Cancel** to cancel the save and keep the program open.
- Click **Yes** to save the file. WorkShop then prompts the user to check out the file.



Checkout Required:
C:\Program Files\505 WorkShop\EXAMPLE.FSS

This file must be checked out before it can be saved.
You will not lose any changes you have made. Would you like to check out this file?

- Click **No** to display the Save As dialog box and save the file to another file name.
- Click **Yes** to display the Check Out dialog box. Once the file has been checked out, Workshop prompts the user to check the file back in to the repository.



File has been saved:
Checkin Suggested:
C:\FTVersionTrak\505 WorkShop\test.FSS

Would you like to check in this file?

- Click **No** to close the program without writing any changes to the repository. The file is still checked out to the user.
- Click **Yes** to write changes to the repository and close the program.

Operation Modes in FTVersionTrak

There are three distinct modes in which WorkShop can operate in regards to the FTVersionTrak functionality.

- **Not Tracked** – The file is not tracked by an FTVersionTrak repository.
- **Connected** – The file is tracked by an FTVersionTrak repository, and a connection to the repository is maintained by WorkShop.
- **Disconnected** – The file is tracked by an FTVersionTrak repository, but the connection is unavailable.

Following is a table that lists the available functions in the FTVersionTrak toolbar based on the operation mode of an active WorkShop file.

Operation	Not Tracked	Connected	Disconnected
Add to Repository	✓	--	--
Get Latest Version	--	✓	--
Check Out File	--	✓	✓ *
Check In File	--	✓	--
Undo Check Out	--	✓	--
Compare Files	✓	✓	✓
View History	--	✓	--
Electronically Sign	--	✓	--
Launch FTVersionTrak	✓	✓	✓

*Disconnected files can still be checked out to a user and edited even if a connection to the repository cannot be made. As long as the file was checked out by the user at a time when the user could connect to the repository, the file remains checked out to the user in disconnected mode. The file can be edited as if it were checked out, and can be checked in once a connection to the repository can be established.

FAQs about FTVersionTrak

What do I need to do to get started?

See Getting Started with FTVersionTrak for more information.

How does FTVersionTrak's version control work?

FTVersionTrak integrates seamlessly with WorkShop to track who is editing program files. When you want to work on a program (and another user isn't working on it), the program file is checked out from FTVersionTrak. You can also simply view programs in WorkShop without checking them out and get the latest changes from other users.

When you are done working on a program, you can check the file into FTVersionTrak manually or allow WorkShop to check in the program file when you close the program. Once your changes are checked in to FTVersionTrak, other users can get or check out the file and access your changes.

What can you do with programs under version control?

- Check out and edit program files without worrying about concurrent or overwritten changes.
- View the latest version of a program file while another user has it checked out.
- Get the latest changes to program files made by other users after they check in their files.
- Set version control options from within WorkShop and perform other version control tasks, such as viewing version history. (Performing version control tasks on your programs outside of WorkShop is possible but not recommended.)
- View the version control status of any program file, such as whether the file is checked out.

How do I use FTVersionTrak with multiple programmers working on the same program?

See **Tips and Strategies for Team Programming** for more information.

Can I use FTVersionTrak for single-user programs?

Yes. We recommend that single-user programs utilize FTVersionTrak's version control features even if they are not programming in a team environment. Using FTVersionTrak is beneficial for single users who want to centralize their programs onto a secure server. FTVersionTrak also provides revision tracking and file state transitioning throughout the life of the program, which is beneficial to both single-user and team programming environments.

Where can I set options for how FTVersionTrak works with WorkShop?

Select the **Options \ Application Setup** menu item in WorkShop to view the available options for changing the way FTVersionTrak behaves in WorkShop.

Do I ever need to open the FTVersionTrak application outside of WorkShop?

Yes, if you are using FTVersionTrak for the first time and need to Get the latest version of a WorkShop file from the FTVersionTrak repository. Also, to set up security, rights, and audit logs, you or your administrator need to do so from within the FTVersionTrak application (see the FTVersionTrak manual for more information). You can launch FTVersionTrak from within WorkShop by clicking the icon in the FTVersionTrak toolbar.

Do I need to check out the program file to open the program?

There is no need to check out the file to simply view the program in WorkShop. However, the program file must be checked out to you if you plan on making any changes to the program.

How do I make sure I'm working on the latest version of a program?

Once the file has been checked in, you can get the latest version of a program when you open the program in WorkShop. You can also get the latest version of any specific program manually by clicking the icon in the FTVersionTrak toolbar.

Tips and Strategies for Team Programming

When working in a team environment, creating a strategy that every team member is comfortable with is necessary to produce the most effective results. For successful team programming, use these example strategies along with the steps outlined in Getting Started with FTVersionTrakto develop your own team's version control strategies. Advantages and disadvantages of each strategy are given. Use some or all of these strategies together, along with your own, to achieve your team's goals.

- **Create and manage user accounts, access rights and repository security.** A system administrator or team manager can implement this strategy to prevent access conflicts and overwritten changes. This strategy takes advantage of the multiple levels of security FTVersionTrak has to offer.

- **Create repositories for specific users**. This strategy assures consistent usage and access among team members. The advantage of this strategy is that it is clear which files each team member is responsible for. Team managers can oversee the changes made by each user by accessing that user's repository.

- **Develop a task checklist.** Create a daily, weekly, or monthly task list that outlines specific version control tasks to be accomplished, such as checking in files, getting the latest version, and electronically signing documents, as well as standardizing steps for audits and reviews of changes made. The advantage of this strategy is that all team members will have a good idea of what kinds of changes are being made, so it is less likely that undesired changes will occur.

- **Keep critical programs checked out.** Keeping a file checked out prevents all other users from being able to make changes to the file. Use this feature to your advantage with your most sensitive programs by keeping them checked out to a privileged account or user. Any necessary changes must be made by that account, and can be written to the FTVersionTrak database without checking the file back in. Other users can view the latest changes at any time but are unable to make changes themselves.

Chapter 4 – WorkShop Setup

Introduction

Before you begin programming, you will probably want to spend some time configuring and customizing the software and some of the hardware attached to your computer. This section will help you with:

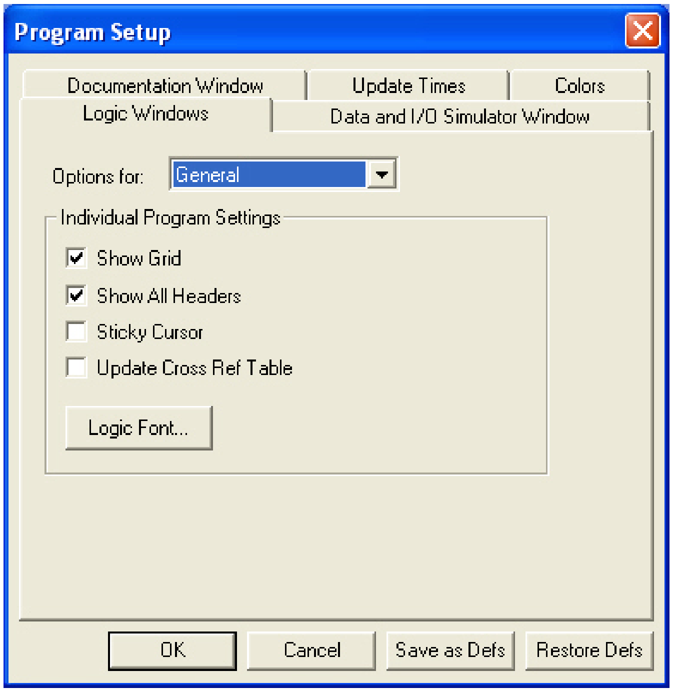
Program Setup	Shows you how to customize 505 WorkShop to fit your preferences.
Communications Setup	Walks you through how to tell your computer which port is attached to your PLC.
Printer Setup	Assists you in determining the correct settings for your printer.
Page Setup	Allows you to configure your pages for printouts.
Fast PLC Setup	Sets up a PLC for a fast connection.

Program Setup

Program Setup consists of sets of tabs governing your project's layout and appearance. These settings are saved with the program; thus, each time you open this program, you do not have to reset your preferences.

To access the Program Setup options:

1. Click **Program Setup** from the **Options** menu. The **Program Setup** dialog box appears.



Options for: General

☑ Show Grid
☑ Show All Headers
□ Sticky Cursor
□ Update Cross Ref Table

2. Click a tab to display various setup selections. The following table describes each feature in the Program Setup dialog box.

Logic Windows Tab, General Options	
Show Grid	Displays the ladder grid when selected.
Show All Headers	Displays ladder, network, and SF headers when selected.

Sticky Cursor	When selected, the current ladder instruction is saved as the cursor. You have to manually select the pointer cursor when you are done editing the current instruction. If not selected, the cursor changes back to the pointer after inserting an instruction.
Update Cross Ref Table	When selected, the Cross Reference table automatically updates whenever ladder is edited.
Logic Font	Changes the font displayed in the active program. Any active Windows font can be selected. To change the font: 1. Click **Font** and the Font dialog box is displayed. 2. Choose a font, font style, and font size. Notice that you can see a sample of the font in the Sample box. 3. Click **OK** in the Font dialog box to save your changes and return to Program Setup. Click **Cancel** to make no font changes and return to Program Setup.
Logic Windows Tab, Ladder Options	
Show Addresses	Displays addresses when selected.
Show Tags	Displays tags when selected.
Show Descriptions	Displays tag descriptions when selected.
Assign Tags	When selected, a window automatically appears if an address (that does not have a tag attached to it) is entered in ladder. It allows you to assign a tag, description, and comment to the address.
Assign Addresses	When selected, a window automatically appears if a tag (that does not match any current tags) is entered in ladder. It allows you to assign an address, description and comment to the tag.
Use TISOFT Keys	Allows the use of certain TISOFT function keys to be used in windows. Such as; coils (Y, C, WY, V, G, W), contacts (X, Y, C, WX, WY, V, K, G, W), /, N, M, =, >, H, I, <, O, U, Ctrl U, J, U.
Column Width	Adjusts the size of the ladder grid. Click the up or down arrow or type in a value between 7 and 24.

Tag Rows	Determines the number of character rows displayed for each tag. Click the up or down arrow or type in a value between 1 – 4.
Description Rows	Determines the number of character rows displayed for each description. Click the up or down arrow or type in a value between 1 – 12.
Status Thickness	Determines the line thickness of the ladder status line. Settings are between 1 – 6.
Logic Windows Tab, Special Functions Options	
Instruction Width	Determines the width allocated for display of Special Function instructions on each line. Click the up or down arrow or type in a value between 1 – 80.
Column One	Determines the width allocated for display of SF first column variables after the instruction. Click the up or down arrow or type in a value between 1 – 300.
Column Two	Determines the width allocated for display of SF second column variables after the instruction. Click the up or down arrow or type in a value between 1 – 300.
Data and I/O Simulator Window Tab	
Column Display	
Include Addresses	If selected, address columns are included in the Data / I/O Simulator Window.
Include Tags	If selected, tag columns are included in the Data / I/O Simulator Window.
Include Descriptions	If selected, description columns are included in the Data / I/O Simulator Window.
Include Time Stamp	If selected, time stamp columns are included in the Data / I/O Simulator Window.
Include Status	If selected, status columns are included in the Data / I/O Simulator Window.

Tag / Tip Display	As you scroll through the tag/ description box in a data window, the corresponding address and description (if it exists) of the selected tag will be displayed to the left and right respectively of the combo box. These are referred to as documentation tips and can be turned on and off by checking and un-checking these boxes. Select addresses, descriptions, both, or neither when the Data / I/O Simulator Window is displayed.
Maximum Rows	The maximum number of data window rows to display. Default is 100, minimum is 10, and maximum is 1000.
Time Stamp Display	Select time, date, and display formats in the Data / I/O Simulator Window when online and Include Time Stamp is selected.
Documentation Window Tab	
Column Display	Select either Tags or Descriptions (or both) for display in the Documentation Window.
Sort Order	Select Address, Tag, or Description order for display in the Documentation Window.
Update Times Tab	
Online Data Window Update	When viewing the Data / I/O Simulator Window, change the speed at which information is received from the PLC.
Online Logic Status Update	When viewing ladder status, change the speed at which information is received from the PLC.
Colors Tab	
Item	The colors of Ladder, Ladder Grid, Ladder Background, Edited Ladder Background, Address Foreground, Tags Foreground, Description Foreground, Rung Header Foreground, File Header Foreground, Status Foreground, Status Optimize Foreground and Parameter Cursor Foreground can be changed when selected from the **Item** box.

8. Click **Restore Defs** to return each feature to the last Save as Defaults setting or the original "factory" setting if Save as Defs has not been used.

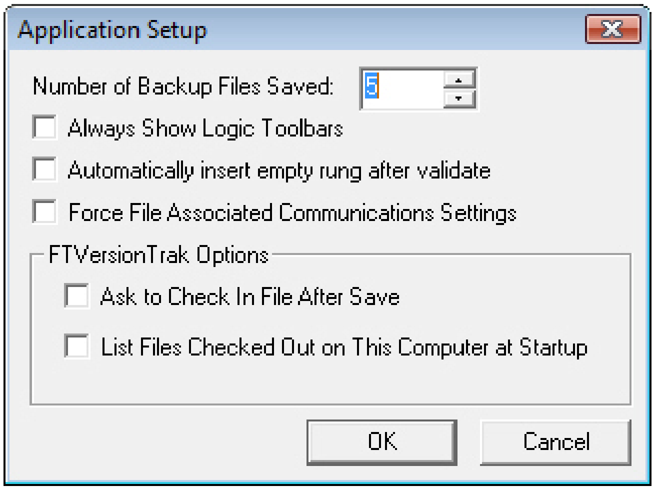
9. Click **OK** when you are finished making your selections or click **Save as Defs** to save the new settings as defaults. These new settings will be used for every new program created. Or click **Cancel** to disregard changes to the settings and return to the active window.

Application Setup

Application Setup contains options that are saved throughout the PLC WorkShop application, regardless of the loaded program.

To access Application Setup:

1. Click **Application Setup** from the **Options** menu. The Application Setup dialog box appears.



Application Setup

Number of Backup Files Saved: 5

□ Always Show Logic Toolbars

□ Automatically insert empty rung after validate

□ Force File Associated Communications Settings

FTVersionTrak Options

□ Ask to Check In File After Save

□ List Files Checked Out on This Computer at Startup

2. Select the options that will be consistent throughout the WorkShop application:

- **Number of Backup Files Saved** - This option designates the maximum number of backup files maintained for each WorkShop program file. The value may be any number between 0 and 999. The default value is 5.

  When this option contains a number greater than zero, a backup file is created each time a WorkShop program file is saved. The backup file is named the same as the program file, appended with **_BAKxxx.fss**, where **xxx** is a sequential number, the largest being the most recently saved backup.

- **Always Show Logic Toolbars** - Displays the main Ladder and Special Function toolbars and any other floated or docked Ladder toolbars when selected. These toolbars remain visible even when no program is open.

- **Automatically insert empty rung after validate** - Select this option to automatically insert an empty rung after validating and entering logic.

- **Force File Associated Communications Settings** - This setting forces the user to connect to the PLC using the communication settings associated with the file. See File Associated Communications for more information.

- **FTVersionTrakOptions** - These options only apply when using FTVersionTrak in conjunctionwith WorkShop. See *Using FTVersionTrak in WorkShop* for more information.

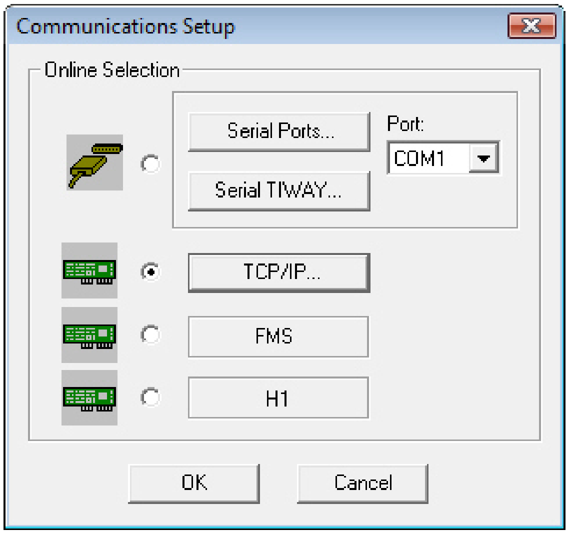
Communication

Setting Up Communications

The Communications Setup allows pre-configure of serial ports, a modem board, or network interface boards in your computer that are used for communications with PLCs.

To access the Communications Setup:

1. Click **Communications Setup** from the **File** menu.
 Result: The Communications Setup dialog box appears.



Port: COM1

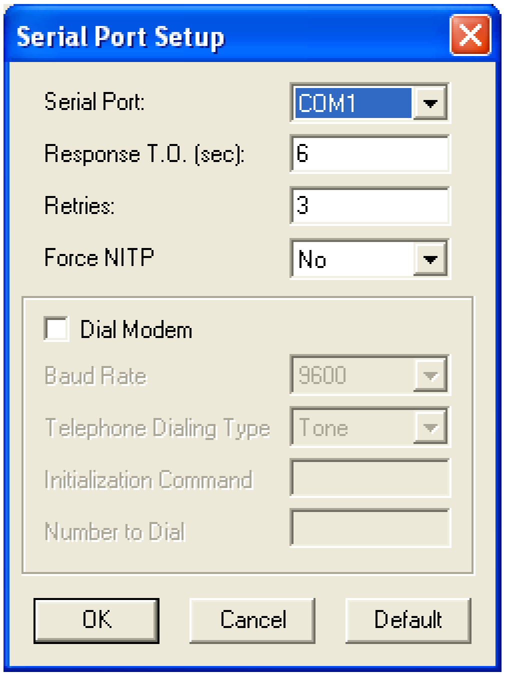
● TCP/IP...

2. Select the appropriate PLC communications that you wish to set up (Serial Ports, TCP/IP, TIWAY, or Profibus FMS).

Serial or Modem Communication

To configure your serial port or modem connection with a PLC:

1. From the Communications Setup dialog box, click the **Serial Ports** button.
 Result: TheSerial Port Setup dialog box appears.



Serial Port Setup

Serial Port: COM1

Response T.O. (sec): 6

Retries: 3

Force NITP: No

□ Dial Modem

Baud Rate: 9600

Telephone Dialing Type: Tone

Initialization Command:

Number to Dial:

2. Select the appropriate setting for each option in the dialog box.

- **Serial Port:** Location where the serial communication port (COM1, COM2, COM3, or COM4) is configured for communications. You do not select which port to communicate out of at this stage.
- **Response T.O. (sec):** Specifies the amount of time, in seconds, that the software waits for a response from the PLC before returning a time-out error. Any whole number between 5 and 25 can be used.
- **Retries:** Specifies the number of times the software will try to re-establish communications with the PLC after a time-out error. Any whole number between 0 and 10 can be used. Use 0 for no retries.
- **Dial Modem:** Selected when the selected form of serial communications is through a modem. The modem parameters must be set to exactly the same communication parameters that you will use. Use the following modem parameters: eight bits, no parity, one-stop bit, and the highest baud rate that your equipment will support.
- **Baud Rate:** The rate of communications between the computer and modem.
- **Telephone Dialing:** Specifies which type of dialing to use. Specify pulse dialing only if this is the only type your phone line supports.
- **Force NITP:** Specifies ASCII communications for the 545, 555, and 575.
- **Initialization Command:** The initialization commands sent to the modem. Consult your modem manual for a list of appropriate commands.

- **Number to Dial:** Specifies the phone number to be dialed. The number format can be **dash (262-238-8088)**, **space (262 238 8088)**, **period (262.238.8088)**, or **none (2622388088)**. Commas (,) may be used if a pause is needed to gain access to an outside line before the number is dialed. For example, if 9 is used to gain access to an outside line and there is a pause between the time 9 is pressed and a dial tone, then the number entered should be 9,262-238-8088.

3. Click **OK** or press **ENTER** to accept the settings. Click **Cancel** to disregard changes and return to the Communications Setup dialog box.

H1 Communications

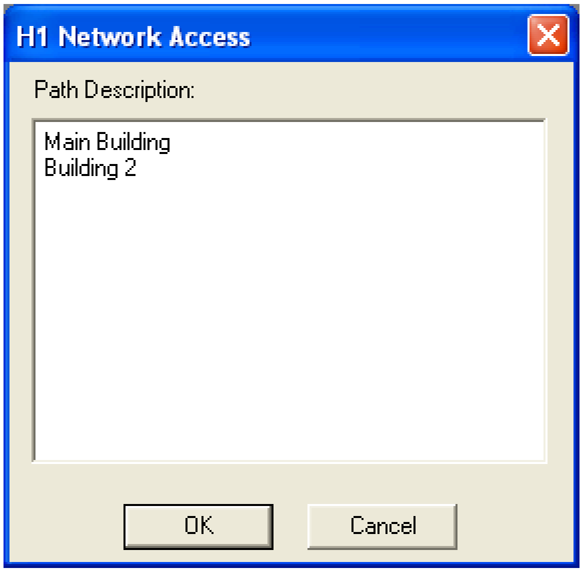
Before H1 Communications can be established with 505 WorkShop the following procedures must be completed:

1. Install CP 1413 or 1613 card.
2. Select I/O range.
3. Select unique interrupt address.
4. Select dual-port ram address.
5. Install TF-1413 or TF-1613 software drivers using Simatic Net Software CD.
6. Configure the CP 1413 or 1613 hardware and software using "COML TF" and "Setting the PG-PC Interface" from Siemen's Simatic Net Software CD.

Access H1 Devices Using 505 WorkShop

To access the H1 network with 505 WorkShop:

1. From the **File** menu, chose **Fast PLC Setup**.
2. Select **H1** from the Fast PLC Connection Setup dialog box.
3. Click **OK** on the Setup dialog box.
4. From the **File** menu, chose **Fast PLC Connection** (H1 communications can also be established via open program).
   Result : The H1 Network Names screen appears.
5. Select a node name. These are the node names you configured using the COML TF-software prior to rebooting. Using the arrow keys or mouse, select an H1 network node name and click **OK**.
   Result: 505 WorkShop is online.



Path Description:

Main Building
Building 2

NOTE: The CP1413 and CP1613 drivers do not run in protected mode. When using either of these drivers only one application may be used at a time.

TIWAY

Using TIWAY

There are two versions of the host adapter hardware for TIWAY: TIWAY I Host Adapter and UNILINK™.

NOTE: Since the Network Interface Module (NIM) does not support some task codes when the controller is in run mode, you cannot perform the following functions communicating through a NIM: Force/Unforce and Find (except Find Address).

Setting Up the UNILINK HOST Adapter

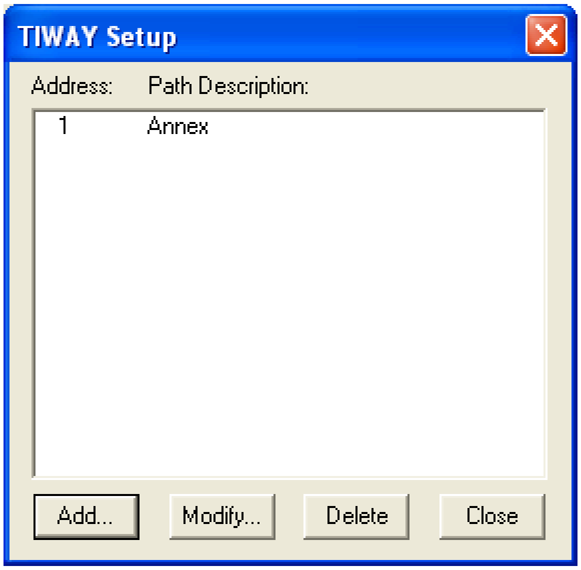
To communicate with 505 WorkShop, the UNILINK Host Adapter must conform to the following parameters:

- NITP protocol
- Full duplex
- Asynchronous
- Maximum Host Baud Rate: 19,200

See your *UNILINK Host Adapter User Manual* for details on setting dip switches for the UNILINK Host Adapter.

TIWAY Setup Configuration

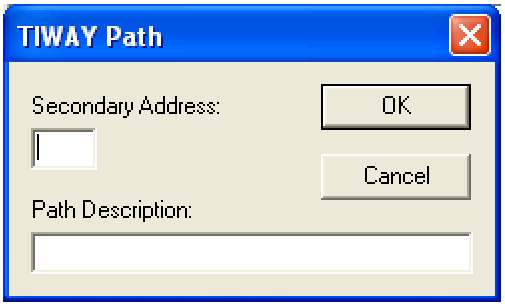
From the Communications Setup dialog box, click the **TIWAY** button.
Result: The TIWAY Setup dialog box appears.



Address:	Path Description:
1	Annex

Secondary Addresses

1. From the TIWAY Setup screen dialog box, click the **ADD** button to enter a new controller secondary address, or the **Modify** button to change the controller secondary address information.
   Result: The TIWAY Path dialog box appears.



2. Enter the controller secondary address for the associated controller. A controller secondary address is a unique number from 1 – 254 that is used to identify a controller on the TIWAY link. Each PLC on TIWAY has a controller secondary address.
3. Enter the controller secondary address Path Description. A Path Description is a 32-character alphanumeric description for the controller secondary address.
4. Click **OK** or press **ENTER** to accept the settings. Click **Cancel** to disregard changes and return to the TIWAY Setup dialog box.

TCP/IP

Connect Your PC to Ethernet

Your system administrator must determine what type of cable is best suited for your installation because it affects your choice of Ethernet card for your PC.

The PPX:505-CP2572 module directly supports 10BaseT (UTP) cabling. If your existing network does not use UTP, but the cabling medium is IEEE 802.3 compliant, you can purchase a transceiver that connects that media to the AUI port on the module. If you are installing a new network, discuss your cabling requirements with your network administrator or your local Siemens distributor. Your Ethernet card purchase should be guided by the type of cabling medium that is best suited for your network. There are really only three PC card options: 10BaseT(UTP), 10Base2(Thin Ethernet), and AUI. Some cards are combinations. The most commonly used are either 10bT or AUI with Fiber Optics cable. 10Base2 is not as widely used, and is not recommended as highly because of the potential network problems. 10Base5 (Thick Ethernet) cable, which also requires the use of transceivers, is sometimes used and can be obtained through your Siemens distributor.

In order to communicate to a 505 PLC, which is connected to a TCP/IP network, a TCP/IP stack needs to be installed on your Windows machine. Windows 95 and Windows NT ship with a TCP/IP stack - WINSOCK.DLL.

If TCP/IP is not listed under the protocol section of your network settings, it needs to be added. You may be asked to insert a Windows disk or CD-ROM. After it has been added, click on properties and enter an IP address, subnet mask, and possibly a default gateway. See your network administrator for more information on these fields if you are not sure what to enter. Every machine on your network must have a unique IP address.

At this point, the 505 TCP/IP Ethernet board needs to be configured (see the following section). Make sure the IP address does not conflict with other devices on the network. A sample configuration appears below:

Devices	IP Address	Subnet Mask
PC #1:	201.98.1.1	255.255.255.0
PC #2:	201.98.1.2	255.255.255.0
505 TCP/IP #1:	201.98.1.8	255.255.255.0
505 TCP/IP #2:	201.98.1.9	255.255.255.0

To use 505 WorkShop over an Ethernet network with the TCP/IP protocol, you need to purchase and install the PPX:505-CP2572 module in a Series 505 base. Refer to the **SIMATIC 505 Ethernet TCP/IP Communication Processor (505-CP2572) User Manual**, order number PPX:505-8132-1, or the **CTI 2572 Ethernet TCP/IP Adapter Installation and Operation Guide**, order number 062-00146, for instructions.

Assign an IP Address to the Module

There are two ways to configure the IP address for your PPX:505-CP2572 module. Each procedure has different advantages, as outlined below.

Procedure	Pros	Cons
Autostart	Communications are functional any time CPU GOOD LED is on. Can re – use same ladder logic program for multiple controllers.	Must reprogram EEPROM whenever CP2572 module is replaced. A CP2572 module programmed in one application and installed in another would respond to the wrong IP address, unless reprogrammed. Cannot swap CP2572 modules without reprogramming EPROMs through serial port by a PC.

Procedure	Pros	Cons
PLC Start	Easy to troubleshoot problems by swapping CP2572 modules; proper IP address is loaded from ladder logic program as soon as CPU enters RUN mode.	IP Address is not loaded unless CPU enters RUN mode; if power is lost when CPU is not in RUN mode, you must manually bring CPU back to RUN mode (via programming device in CPU's RS-232 port) to restore Ethernet communications. If multiple controllers perform the same function, you must modify ladder logic program for each one so that it contains a unique IP address.

The SIMATIC 505 Ethernet TCP/IP Communication Processor (505-CP2572) User Manual, order number PPX:505-8132-1, and the CTI 2572 Ethernet TCP/IP Adapter Installation and Operation Guide, order number 062-00146, describes the Autostart and PLC Start procedures in detail; follow the instructions in the manual to configure the IP address for your module.

New or modified IP address configurations do not take effect until you power cycle the base containing the PPX:505-CP2572 module.

Tips for Using the PLC Start Option

The **SIMATIC 505 Ethernet TCP/IP Communication Processor (505-CP2572) User Manual**, order number PPX:505-8132-1, and the **CTI 2572 Ethernet TCP/IP Adapter Installation and Operation Guide**, order number 062-00146, describes how to build a Startup Network Command Block table, used with the PLC Start option, in the chapter on **Installation** (Chapter 2).

An easy way to construct this table is to open a Data window (see **Using The Data Window**) and enter the desired V-memory address. (For instance, the Ladder Logic Example in the SIMATIC manual assumes that the command block is located in V-memory, starting at location V500.) From the desired location, you can simply key in the values from the Startup Network Command Block example table in the manual, supplying the correct IP address, IP route address, and subnet mask for your network.

For even more permanency, you can put the table into K-memory instead of V-memory. If you use the example ladder program from the SIMATIC manual, you can just add a MOVW box to move the values in K to V.

Connect the Module to the Ethernet

The PPX:505-CP2572 module directly supports 10BaseT (UTP) cabling. If your existing network does not use UTP, but the cabling medium is IEEE 802.3 compliant, you can purchase a transceiver that connects the media to the AUI port on the module. Consult the **SIMATIC 505 Ethernet TCP/IP Communication Processor (505-CP2572) User Manual**, order number PPX:505-8132-1, or the **CTI 2572 Ethernet TCP/IP Adapter Installation and Operation Guide**, order number 062-00146, for information about how to connect cables to the 10bT or AUI port of your module. Consult the Siemens IK 10 catalog for information about how to purchase a Siemens transceiver if you need to use it with the AUI port.

Testing the Connection with PING

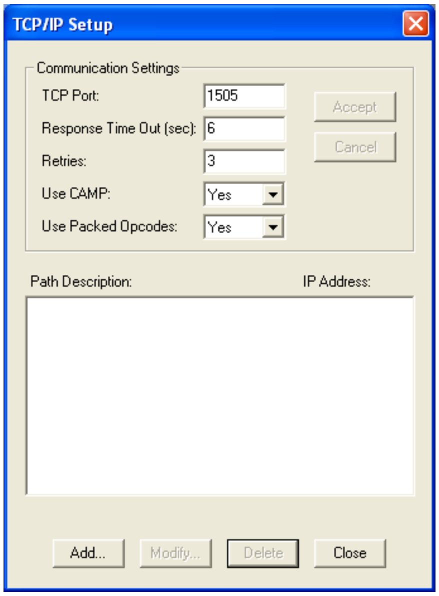
Once the board has been configured, you can test the settings by using a DOS command line utility called PING (comes with the TCP/IP stack). The program sends several test messages to the IP address that you specify on the command line. For example, PING 201.98.1.8; will test the connection to 505 TCP/IP #1 shown above. There should be four successful replies to the PING command. If PING is not successful, there is a problem with the network settings or the 505 TCP/IP board configuration. If PING does not work, 505 WorkShop will not be able to connect to the PLC.

After PING has successful replies, you can configure a TCP/IP connection in 505 WorkShop and open an online window.

TCP/IP Communication Settings

To configure your interface board port for communication with a PLC:

1. From the Communications Setup dialog box, click the **TCP/IP** button.
   Result: The Settings for the TCP/IP Setup dialog box appear.



TCP Port: 1505

Response Time Out (sec): 6

Retries: 3

Use CAMP: Yes

Use Packed Opcodes: Yes

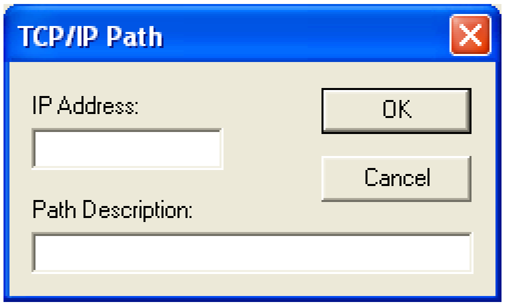
2. Enter the communication settings. Then, click the **Accept** button.

Communication Settings

- **Camp Protocol:** The "Use Camp" option is for optimizing upload and download of PLC programs specifically to CTI 2572 cards. This is defaulted to **Yes** and should only be turned off if the CTI card does not support the CAMP protocol.
- **Packed Opcode:** The "Use Packed" option is for optimizing the Ladder Status and Data Window updates. This is defaulted to Yes and should only be turned off if the Packed opcode is not supported.
- These settings are held in the computer Registery.
- **Path Descriptions:** When attaching to a PLC using TCP/IP, the user is given a path description. This description represents a specific TCP/IP address if a PLC. The description and associated path is entered at the bottom of this dialog.
- **IP Port:** Any number is acceptable as long as it does not interfere with other protocol numbers. This number must match the IP port configured in the 2572 Ethernet TCP/IP module
- **Response T.O. (sec):** Specifies the amount of time, in seconds, that the software waits for a response from the PLC before returning a time-out error. Any whole number between 5 and 25 can be used.
- **Retries:** Specifies the number of times the software will try to re-establish communications with the PLC after a time-out error. Any whole number between 0 and 10 can be used. Use 0 for no retries.

IP Addresses

1. From the IP Addresses section of the TCP/IP Setup dialog box, click the **ADD** button to enter a new IP address, or select an existing IP address and click the **Modify** button to change the IP information.
   Result: The IP Addresses dialog box appears.



NOTE: 505 WorkShop allows 1,000 different IP Addresses and Path Descriptions.

2. Enter the **IP Address** for the associated Interface Board. An IP Address is a 32-bit value that is divided into four 8-bit fields, each separated by a period. For example, `192.3.2.1` is an IP Address. Each computer on a network has a unique IP Address. You should consult your network administrator for the correct IP Addresses for your computer and board.
3. Enter the **IP Address Path Description**. A Path Description is a 32-character alphanumeric description for the IP Address.
4. Click **OK** or press **ENTER** to accept the settings. Click **Cancel** to disregard changes and return to the TCP/IP Setup dialog box.

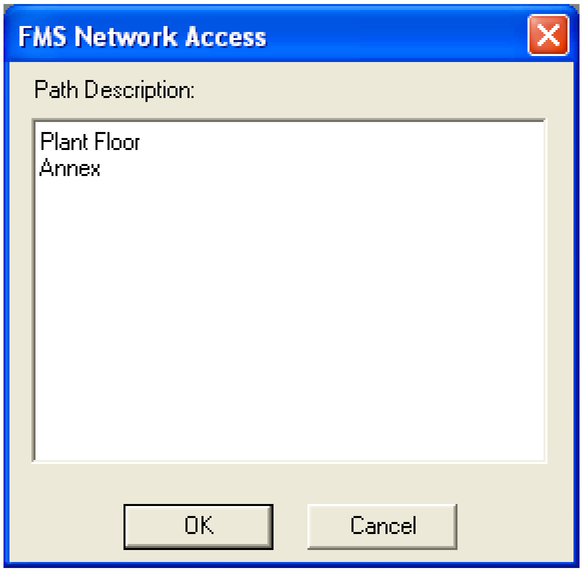
NOTE: Refer to the *2572 Ethernet TCP/IP Module manual* for proper settings.

Setting Up and Using PROFIBUS–FMS

Access FMS Profibus Devices Using 505 WorkShop

To access the FMS Profibus network with 505 WorkShop

1. From the **File** menu, click **Fast PLC Setup**.
2. Select **FMS** from the Fast PLC Connection Setup dialog box.
3. Click **OK** on the Setup dialog box.
4. From the **File** menu, click **Fast PLC Connect**. (FMS communications can also be established via open program).
   Result: The FMS Network Access screen appears.
5. Select a node name. These are the node names you configured using the COML S7 software prior to rebooting. Using the arrow keys or mouse, select an FMS node name and click **OK**.
   Result: 505 WorkShop is online.



Path Description:

Plant Floor
Annex

> **NOTE:** The 505 WorkShop allows 112 different Station Addresses and Path Descriptions.

Installing the PROFIBUS–FMS Communications Processor

The **SIMATIC 505-CP5434-FMS Communications Processor** module (referred to hereafter as the **FMS CP** module) provides the interface required for a SIMATIC 505 programmable logic controller system to communicate with other devices over a common PROFIBUS network. To install the FMS CP module in a SIMATIC 505 base, follow the installation instructions in the *SIMATIC 505 PROFIBUS–FMS Communication Processor (505-CP5434-FMS) User Manual.*

The **FMS CP** module must be configured with the COM5434 Configuration software included with the module. The COM5434 Configuration software operates in Windows 95 or Windows NT only. To install the software, follow the installation instructions in the *SIMATIC 505 PROFIBUS–FMS Communication Processor (505-CP5434-FMS) User Manual*.

Each FMS CP module in a 505 base must be configured to communicate over the PROFIBUS network. The "module local configuration" for each FMS CP module identifies its station address and the network communication parameters it uses to operate on the network.

NOTE: You must define the module local configuration for each FMS CP module using the RS-232 port with the standard 505 WorkShop programming cable before you can communicate with it using the PROFIBUS-FMS port.

Refer to the *SIMATIC 505 PROFIBUS-FMS Communication Processor (505-CP5434-FMS) User Manual* for complete information on configuring the FMS CP module with the COM5434 Configuration software.

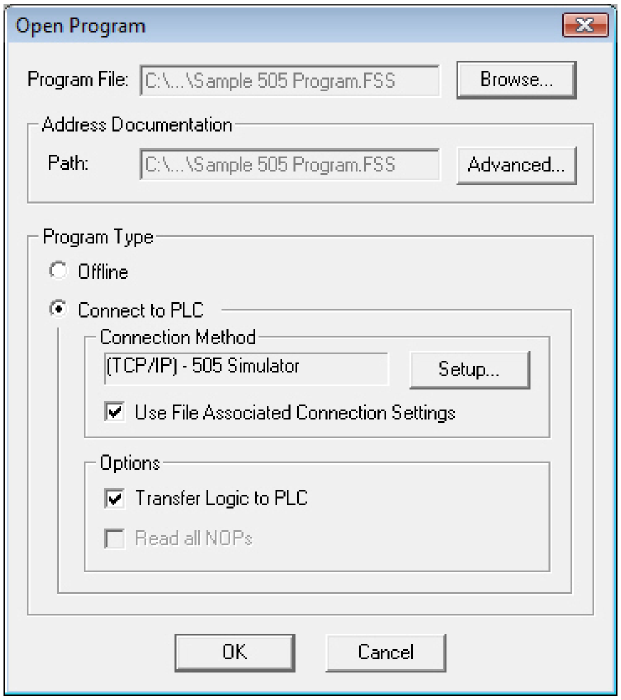
NOTE: Make sure to select the bus parameters, the baud rate, and the highest station address (HSA) that match those of all the other modules on the network. Also be sure to select a unique station address for each FMS CP module on the network.

Once each FMS CP module has been configured to operate on the network, connect each FMS CP station and the CP 5412 card in your PC to the PROFIBUS network, using the PROFIBUS cables and connectors described in the *SIMATIC 505 PROFIBUS-FMS Communication Processor (505-CP5434-FMS) User Manual.*

File Associated Communications

When a file is successfully loaded online in WorkShop, the communication settings are associated with the file so the next time a user wishes to go online with the same file, WorkShop will default to these settings. Communication settings associations are made by writing a block of data to a binary file called *.FTRF (FasTrak Route Format), located in the same folder as WorkShop.

The next time a user loads a WorkShop program file, the associated communication settings appear in the **Open Program** dialog box.



Program File: C:\...\Sample 505 Program.FSS

Address Documentation

Path: C:\...\Sample 505 Program.FSS

Program Type

○ Offline

● Connect to PLC

Connection Method

(TCP/IP) - 505 Simulator

☑ Use File Associated Connection Settings

Options

☑ Transfer Logic to PLC

☐ Read all NOPs

Select the **Use File Associated Connection Settings** check box to accept the connection method associated with the file, or click **Setup** to view or edit Communication Settings.

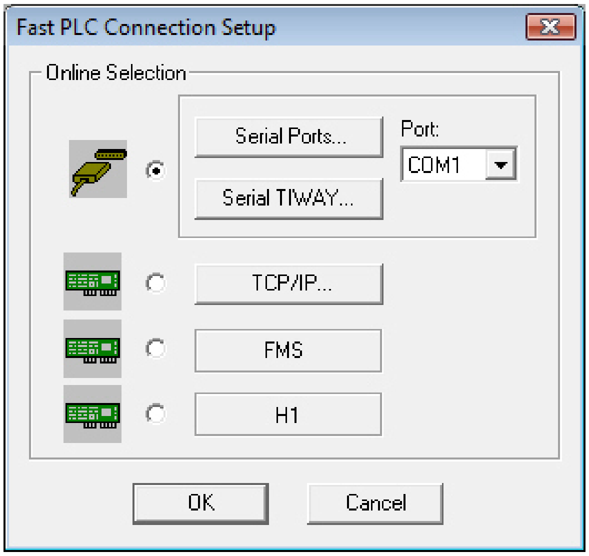
NOTE: Selecting **Force File Associated Communications Settings** in Application Setup will force the user to connect with the saved settings.

Fast PLC Setup

The Fast PLC Setup allows you to configure a single PLC Connection when using Fast PLC Connection.

To access the Fast PLC Setup:

1. Click **Fast PLC Setup** from the **File** menu.
   Result: The Fast PLC Setup dialog box appears.



Fast PLC Connection Setup

Online Selection

● Serial Ports... Serial TIWAY... Port: COM1

○ TCP/IP...

○ FMS

○ H1

2. To configure and select your serial port or board for communication with a PLC:

- Select the appropriate communication port from **Port** box in the Fast PLC Connection Setup dialog box. If you need to configure a port, click **Serial Ports** (Refer to Communications Setup for more information.)

2. Click **OK** or press **ENTER** to accept the settings. Click **Cancel** to disregard changes.

NOTE : The connection options for your Fast PLC Connection is stored in the 505-registry. If you attempt to use Fast PLC Connection and the Fast PLC Setup has not been configured, the Fast PLC Connection Setup window automatically displays before continuing. Connecting to a PLC using Fast PLC Connection does not load any documentation or tag information. If you need to load documentation or tags, use Open Program.

Printer

Printer Setup

Use Print Setup to select a printer and determine where and how your printouts appear.

To access the Print Setup:

1. Start or open a logic program. Click **Print Setup** from the **File** menu.
   Result: The Print Setup dialog box appears.
2. Select the printer you want to use in the **Name** box.
3. Additional setup options may be available depending on the printer you selected. If an **Options** button is available, click it and another dialog box appears. Make your selections and select the **OK** button to return to the Print Setup dialog box.
4. Other options in the Print Setup dialog box include Orientation and Paper Source. Click the desired settings.
5. Click OK in the Print Setup dialog box to save your settings and return to the active logic window.

NOTE: The print setup options can also be accessed from the Print box that appears after clicking **Print** from the **File** menu.

Page Setup

Use Page Setup to select page margins, starting page number, and whether to include a Title page in your printout. Page Setup is accessible from the Print dialog box.

To access Page Setup:

1. Start or open a logic program.
2. Click **Print** from the **File** menu.
3. Click **Page Setup**.
   Result: The Page Setup dialog box appears.
4. Depending on which features you need to customize, choose left, right, top and bottom margin. To change the size of the margins, type the measurement (in inches) for the margin you want to adjust in the Top, Bottom, Left or Right boxes.

5. If you would like to start your printout with a page number other than 1, change the **Starting Page** number.

6. Normally a title page does not print. The title page contains the information you entered in the Title Page Print Editor. If you would like to include this page as the first page in your printouts, click on **Include Title Page**.

7. Click **OK** in the Page Setup dialog box to save your page settings and return to the active logic window.

Chapter 5 – PLC Memory & I/O Configuration

Memory and I/O Configuration Overview

This chapter shows you how to set up and configure your Siemens family PLC. You must configure your PLC before you can create a ladder logic program. Configuration is part of the program; it performs the important function of relating the hardware components to the logic components.

The recommended setup and configuration process is completed in four steps:

1. PLC Type Setup
    - PLC Type
    - Memory Size
2. PLC Memory Configuration
    - Ladder
    - Variable
    - Constant
    - Special
    - User Sub
    - Timer/Counter
    - Drums
    - Shift Register
    - Table Move
    - One Shots
3. I/O Configuration
4. Profibus-DP Configuration

PLC Type Setup, available in offline mode only, defines the type of processor you are creating a logic program for. PLC Memory Configuration and I/O Configuration allow you to configure your PLC. These are available in online and offline mode.

PLC Type Setup (Offline)

PLC Type Setup (Offline)

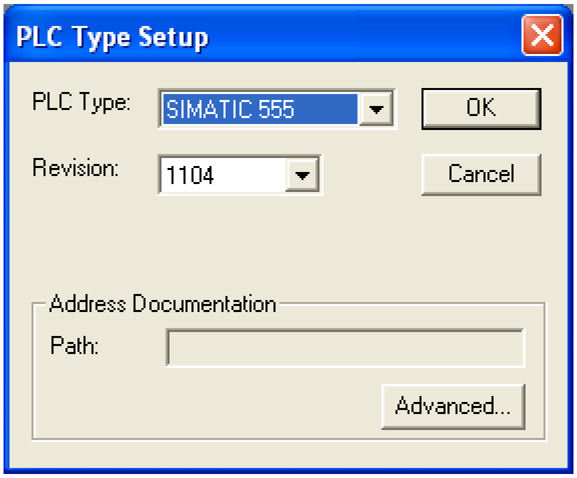
The setup and configuration process begins with PLC Type Setup. You must specify what processor you are using before you can configure the processor.

Valid PLC types are:

- Simatic 520 revision 1101.
- Simatic 520c revision 1101 and 1102.
- Simatic 525 revision 1102 and 1104.
- Simatic 530 revision 1102, 1104, and 1108.
- Simatic 530c revision 1104, 1108, and 1112.
- Simatic 535 revision 1104, 1108, and 1112.
- Simatic 560 revision 2120.
- Simatic 560/565 revision 2120.
- Simatic 560T revision 2820.
- Simatic 560/565T revision 2820.
- Simatic 545 revision 1101, 1102, 1103, 1104, 1105 and 1106.
- Simatic 555 revision 1101, 1102, 1103, 1104, 1105, and 1106.
- Simatic 575 revision 2102, 2103, 2104, 2105, and 2106.
- CTI 2500 revision C100, C200, C300, C400 < 8.01, and C400 >= 8.01.

To set up the PLC:

1. Click **PLC Type Setup** from the **PLC Utilities** menu.
   Result: The PLC Type Setup dialog box appears.



PLC Type Setup

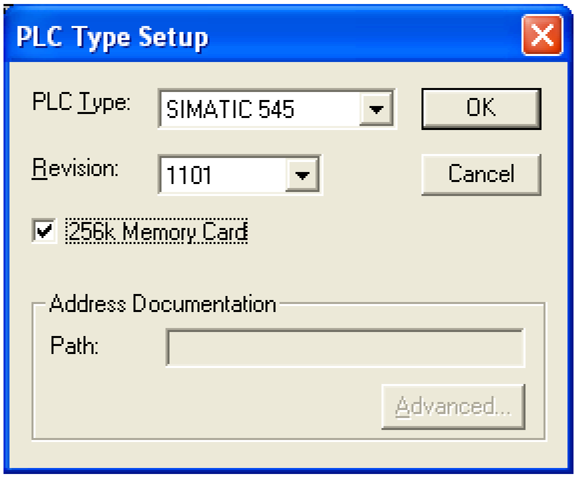
PLC Type: SIMATIC 555

Revision: 1104

Address Documentation

Path:

2. To access a 545-1101 extended memory offline, the extended memory check box must be selected as shown in the following figure.



PLC Type Setup

PLC Type: SIMATIC 545

Revision: 1101

☑ 256k Memory Card

Address Documentation

Path:

3. Select the appropriate **PLC Type**, **Revision**, and for certain processors, **PLC Size**. A detailed explanation of each setup option is described in the following table. If shared documentation is to be associated with the new program, it must be set up at this stage (see Shared Documentation for additional information).

PLC Setup Option	Description
PLC Type	Specifies the type of processor. Selection of PLC type determines choices available for remaining setup options in the PLC Type Setup dialog box.

PLC Setup Option	Description
Revision	Specifies the revision number of the processor.
PLC Size (for some PLCs only)	Specifies the PLC's memory size. Only the valid memory sizes for the PLC selected in PLC Type are displayed.

4. Click **OK** or press **ENTER** to save your settings and return to the active logic program.

Changing PLC Types

The PLC type can be changed even after programming has been initiated. Various error or warning messages can occur when changing from one PLC type to another. These error messages indicate the block and segment of the error. The errors must be fixed before the new PLC's logic can be validated.

To change the PLC type:

1. Click **PLC Type Setup** from the **PLC Utilities** menu.
   Result: The PLC Type Setup dialog box appears.
2. Select the appropriate PLC Type, Revision, and for some PLCs, PLC Memory Size.

PLC Memory Configuration

Controller memory is composed of several functional types. You can configure the amount of memory that is allotted to some of these areas. This is dependent upon your application and PLC type. The configurable memory sizes are given in the SIMATIC 545/555/575 System Reference Manual.

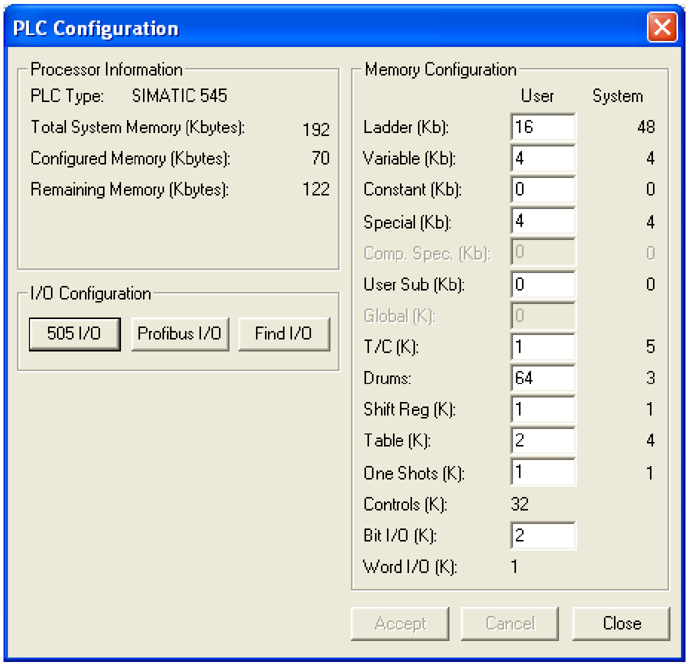
Ladder	User Program Memory • Ladder Memory stores RLL program. • Special Memory stores loops, analog alarms, and SF Programs. • User Memory stores user-defined subroutines.

User Data	Data Area Memory • Variable Memory stores variable data. • Constant Memory stores constant data. • Global and VME Memory are used for VME data transfer (applies to 575 only).*
System Operation	System Memory • RLL instruction tables: drum, timer/counter, shift register, etc. • Image registers and control and relays.* • Subroutine parameter area.* • SF program temporary memory.* • Status Word memory.*
* Not Configurable	

The configuration process begins with PLC Configuration.

Accessing PLC Configuration

1. Click **PLC Configuration** from the **PLC Utilities** menu.
   Result: The PLC Configuration dialog box appears.



Processor Information

PLC Type:	SIMATIC 545
Total System Memory (Kbytes):	192
Configured Memory (Kbytes):	70
Remaining Memory (Kbytes):	122

Memory Configuration

	User	System
Ladder (Kb):	16	48
Variable (Kb):	4	4
Constant (Kb):	0	0
Special (Kb):	4	4
Comp. Spec. (Kb):	0	0
User Sub (Kb):	0	0
Global (K):	0	
T/C (K):	1	5
Drums:	64	3
Shift Reg (K):	1	1
Table (K):	2	4
One Shots (K):	1	1
Controls (K):	32	
Bit I/O (K):	2	
Word I/O (K):	1	

2. Enter the appropriate ranges for the selected PLC memory type.

NOTE: Processor type must be selected before configuration.

The various memory types are described in the pages that follow. Memory types are classified for RLL programming purposes in the following ways:

- **Writeable -** This memory type is read/write. It can be used for both input and output fields of RLL instructions.
- **Readable -** This memory type is read only. It can be used only for the input fields of RLL instructions.
- **No access** - RLL instructions has no access to this memory.

3. Click **Accept** to save your settings and return to the active logic program.

Controller Memory Types

Ladder Memory

A block of memory within the controller is reserved for the RLL program. This memory type is called Ladder Memory (L-Memory). Each RLL instruction used in the program requires one or more 16-bit words of L-Memory.

Image Register Memory

A block of memory within the controller is reserved for maintaining the status of discrete inputs/outputs. This memory type is called the discrete image register. A word image register holds the values of word inputs/outputs.

Control Relay Memory

A block of memory within the controller is reserved for control relays. Control relays are single-bit internal memory locations and do not represent actual hardwired devices.

Special Memory

A block of memory within the controller may be allocated for loops, analog alarms, and Special Function programs. This memory type is called Special Memory (S-Memory). All loop and analog alarm parameters are stored in S-Memory when you program the loop or analog alarm. Likewise, when you create a Special Function program or subroutine, the program is stored in S-Memory.

Temporary Memory

A block of memory within the controller is temporarily reserved during run time whenever a Special Function program is run. One block is allocated for each SF program that is being run. This memory type is 16 words in length and is called Temporary Memory (T-Memory) since it is not saved when the program has completed running.

The controller writes data related to the Special Function program to the first 7 words. You can read this data and/or write over it if you choose. You can use all 16 words just as you would use Variable Memory, except no data is saved when the program has completed.

Variable Memory

A block of memory within the controller may be allocated for user operations. This memory type is called Variable Memory (V-Memory). For example, you can do a math operation and store the result in V-Memory. You can enter values directly into V-Memory with a programming unit.

Constant Memory

A block of memory within the controller may be allocated for constants (unchanging data). This memory type is called Constant Memory (K-Memory). You can use a programming unit to load a table of data into K-Memory and read the table during run time whenever you need the data for an operation.

Status Word Memory

A block of memory within the controller is allocated for storing status information relating to controller operations. This information is stored in one or more status words: STW1, STW2, and so on. These status words can be used in the RLL program to signal and/or correct alarm conditions.

Timer/Counter Memory

A block of memory within the controller is reserved for the operation of the timer/counter group of RLL instructions, including the following:

- Timer (TMR, TMRF)
- Discrete Control Alarm
- Timer(DCAT)
- Up/Down Counter (UDC)

- Counter (CTR)
- Motor Control Alarm
- Timer(MCAT)

⚠ **Warning**	When you assign a number to a timer, counter, up/down counter, or discrete/motor control alarm timer, be sure that you do not use that number for any other timer, counter, up/down counter, or discrete/motor control alarm timer. For example, if you configure a Timer 6 (TMR6), do not configure any other operation, such as a counter (CTR) or a discrete control alarm timer (DCAT) with the number 6. Assigning the same number more than once could cause unpredictable operation by the controller, which could result in death or serious injury to personnel and/or damage to equipment. Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions.

NOTE: If you use an operator interface to change the time/counter values, the new values are not changed in the original RLL program. If the RLL presets are ever downloaded, e.g., as the result of a complete restart or an edit of the network containing the Timer/Counter instruction, the changes made with the operator interface are replaced by the values in the RLL program.

This memory type is divided into areas for storing two types of information. This information consists of Timer/Counter Preset (TCP) data and Timer/Counter Current (TCC) data. When you designate a preset value for one of the instructions in this group, this value is stored as a 16-bit word in TCP-Memory. When the instruction is actually operating, the current time or count is stored as a 16-bit word in TCC-Memory.

Table Move Memory

A block of memory within the controller is reserved for the operation of the table move instructions, including the following:

- Move Word To Table (MWTT).
- Move Word From Table (MWFT).

⚠ **Warning**	When you assign a number to a table move instruction, be sure that you do not use that number for any other table move instruction. For example, if you configure a Move Word To Table #1 (MWTT1), do not configure a Move Word From Table #1 (MWFT1). Assigning the same reference number to more than one table move instruction could cause unpredictable operation by the controller, which could result in death or serious injury to personnel and/or damage to equipment. Do not use the same reference number more than once for a table move instruction.

This memory type consists of one word per table move instruction configured. This word is used to maintain the current count of moves done since the MWTT or MWFT instruction was last reset.

One Shot Memory

A block of memory within the controller is reserved for the operation of the various instructions of the One Shot group, including the following:

- One Shot
- Time Set
- Date Set

⚠ **Warning**	When you assign a number to a One Shot instruction, be sure that you do not use that number for any other One Shot instruction type. For example, do not configure more than one OS11. Assigning the same number for more than one One Shot instruction type can cause unpredictable operation by the controller, which could result in death or serious injury to personnel and/or damage to equipment. Do not use the same number more than once for the same instruction type (for example, use it only once in One Shot, in Timer Set, and so on).

This memory type consists of one byte per configured One Shot instruction. This byte is used to save the previous state of the instruction input.

Because the instructions in the One Shot group use different bits of one byte, these instructions can be assigned identical reference numbers. That is, if you configure a One Shot #11 (OS11), you can configure a Date Set #11.

Shift Register Memory

A block of memory within the controller is reserved for the operation of the shift registers, which include the following:

- Bit Shift Register (SHRB).
- Word Shift Register (SHRW).

⚠ Warning

When you assign a number to a shift register, be sure that you do not use that number for any other shift register type. For example, do not configure SHRB11 and SHRW11.

Assigning the same number for more than one shift register could cause unpredictable operation by the controller, which could result in death or serious injury to personnel and/or damage to equipment.

Do not assign the same reference number to more than one shift register instruction.

This memory type consists of one byte per shift register. This byte is used to save the previous state of the instruction input.

Drum Memory

A block of memory within the controller is reserved for the operation of the various drum types, including the following:

- Drum (DRUM)
- Maskable Event Drum
- Discrete(MDRMD)
- Event Drum (EDRUM)
- MegaEDRUM
- Maskable Event Drum Word(MDRMW)

⚠ **Warning**	When you assign a number to a drum type instruction, be sure that you do not use that number for any other drum type instruction. For example, if you configure a Maskable Event Drum Word #1 (MDRMW1), do not configure an Event Drum #1 (EDRUM1). Assigning the same reference number to more than one drum type instruction could cause unpredictable operation by the controller, which could result in death or serious injury to personnel and/or damage to equipment. Do not assign the same reference number to more than one drum type instruction.

Drum memory is divided into areas for storing the following types of information:

- Drum Step Preset (DSP)
- Drum Count Preset (DCP)
- Drum Step Current (DSC)
- Drum Count Current (DCC)

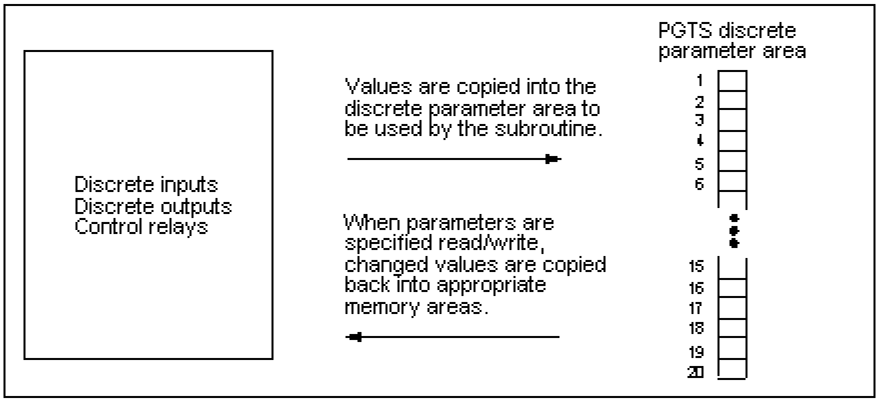
When you specify step and counts-per-step (count preset) values for a drum type, the step preset is stored as a 16-bit word in DSP-Memory, and the counts-per-step values are stored as 16 consecutive 16-bit words in DCP-Memory (except for the DRUM). For the DRUM instruction, counts-per-step values are stored in L-Memory; DCP is not used.

NOTE: If you use an operator interface to change the drum preset values (DSP or DCP), the new values are not changed in the original RLL program. If the RLL presets are ever downloaded, e.g., as the result of a complete restart or an edit of the network containing the drum instruction, the changes made with the operator interface are replaced by the values in the RLL program.

When the instruction is actually operating, the current step is stored as a 16-bit word in DSC-Memory. The current count for this step is stored as a 16-bit word in DCC-Memory.

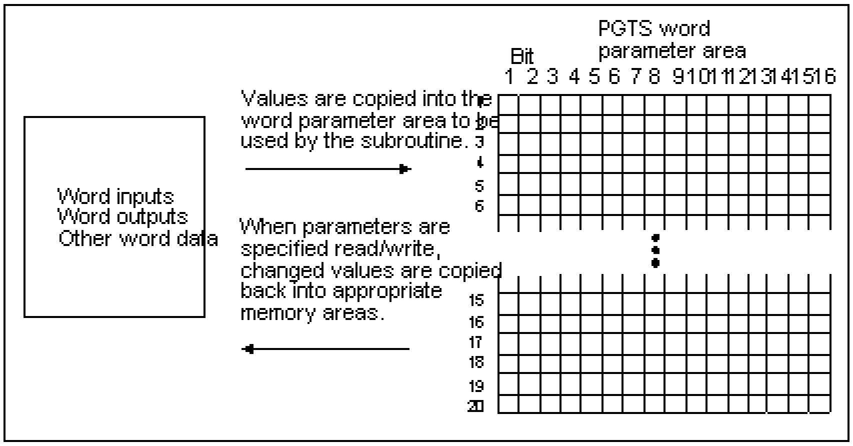
PGTS Discrete Parameter Area

The Parameter Go To Subroutine (PGTS) discrete parameter area is an area of memory within the controller that is reserved for holding the status of discrete bits referenced as parameters in a PGTS RLL instruction. Because up to 32 PGTS subroutines can be programmed, the controller has 32 discrete parameter areas, each capable of storing the status for 20 discrete parameters. When you use a parameter in the subroutine, refer to discrete points as Bn where n = the parameter number.


PGTS discrete parameter area
Values are copied into the discrete parameter area to be used by the subroutine.
Discrete inputs
Discrete outputs
Control relays
When parameters are specified read/write, changed values are copied back into appropriate memory areas.
1
2
3
4
5
6
15
16
17
18
19
20

PGTS Word Parameter Area

The PGTS word parameter area is an area of memory within the controller that is reserved for holding the contents of 16-bit words referenced as parameters in a PGTS RLL instruction. Because up to 32 PGTS subroutines can be programmed, the controller has 32 word parameter areas, each capable of storing the status for 20 word parameters. When you use a parameter in the subroutine, refer to words as Wn, where n = the parameter number.


PGTS word parameter area
Bit
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Values are copied into the word parameter area to be used by the subroutine.
Word inputs
Word outputs
Other word data
When parameters are specified read/write, changed values are copied back into appropriate memory areas.
1
2
3
4
5
6
15
16
17
18
19
20

User External Subroutine Memory

A block of memory within the controller may be allocated for storing externally developed programs written in C, Pascal, Assembly language, etc. This memory type is called User Memory (U-Memory). The size of U-Memory is user configurable.

Global Memory: 575 Only

The 575 CPU allocates a 32K-word block of memory that allows you to transfer data over the VME back-plane. This memory type is called Global Memory (G-Memory). Refer to Appendix I in the *505 Programming Reference* manual for more information about G-Memory.

VME Memory: 575 Only

The 575 controller also allows access to physical VME addresses using the VMM-Memory or VMS-Memory.

- VMM corresponds to VME address modifier 39 (standard non-privileged data access).
- VMS corresponds to VME address modifier 29 (short non-privileged access).

⚠ **Warning**	The 575 controller allows you to use a VME address (VMM or VMS) as a parameter to most word-oriented RLL instructions, such as ADD, SUB, or MOVW, and so on. When a VME address is used and is not recognized by any installed board, a VMEbus error occurs. If the instruction that used the address was other than MOVE or XSUB (with the U-Memory header's E bit set to 1--see Appendix H in the 505 Programming Reference manual), the controller enters the Fatal Error mode, freezes analog outputs and clears discrete outputs. Use the XSUB or MOVE instruction to access the VME address.

I/O Configuration

Controller Functionality in Configuration

Keep in mind that, while you can configure I/O either online (with the controller) or off-line (programming device only), functional differences exist between the two modes. When online, you can perform those functions that require interfacing with the controller. For instance, you must be online to write your I/O configuration to the controller or to read the configuration of a base from the base itself. Configurations saved offline go to the selected program on disk.

I/O Configuration Guidelines

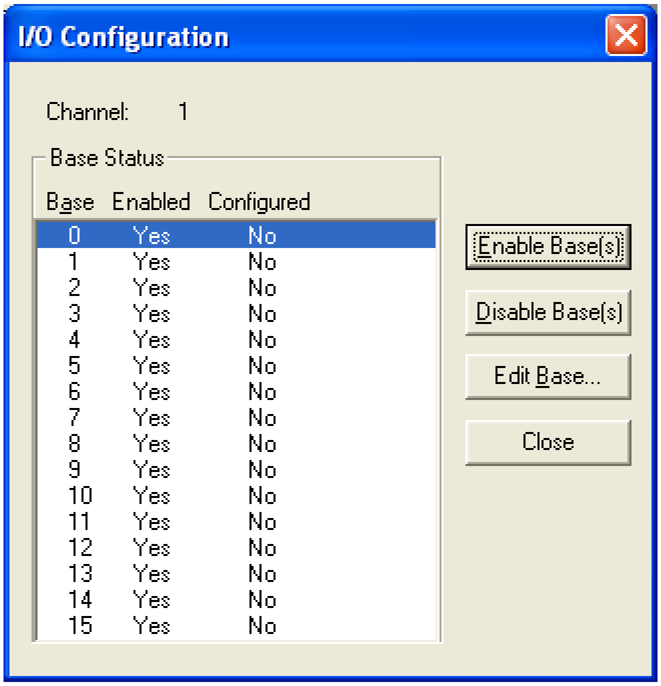
Before entering your I/O configuration, be sure that the I/O points you select conform to the following guidelines:

- The number for the I/O address must begin on an 8-point boundary. An 8-point boundary is (n*8) + 1, e.g., 1, 9, 17, etc. Addresses not starting on an 8-point boundary are changed to do so when you write the values.
- Refer to the I/O module manual for the number of bit and/or word I/O points required for each module. Valid entries for modules with more than 8 points are even numbers from 2 through 28, 32 ,and 64.
- Locations assigned to an I/O module cannot cross I/O channel boundaries. See your controller manual for details.
- 505 WorkShop does not flag duplicate I/O points.

Accessing I/O Configuration

1. Click **PLC Configuration** from the **PLC Utilities** menu.
   Result: The PLC Configuration dialog box appears.

2. Under **I/O Configuration**, click **505 I/O**.
   Result: The I/O Configuration dialog box appears.



Channel: 1

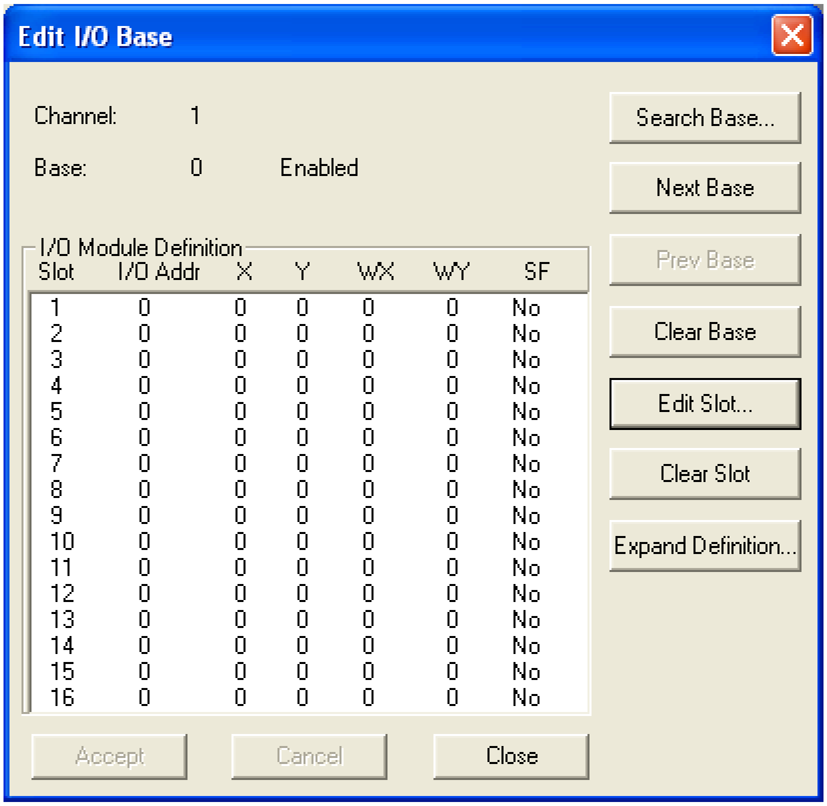
Base Status

Base	Enabled	Configured
0	Yes	No
1	Yes	No
2	Yes	No
3	Yes	No
4	Yes	No
5	Yes	No
6	Yes	No
7	Yes	No
8	Yes	No
9	Yes	No
10	Yes	No
11	Yes	No
12	Yes	No
13	Yes	No
14	Yes	No
15	Yes	No

NOTE: You can enable or disable a base by selecting a base number then clicking **Enable** or **Disable**.

I/O Configuring Procedure

1. In the I/O Configuration dialog box, select the base whose input/output you want to configure.
2. Click **Edit Base**.
   Result: The Edit I/O Base dialog box appears.



Channel: 1

Base: 0 Enabled

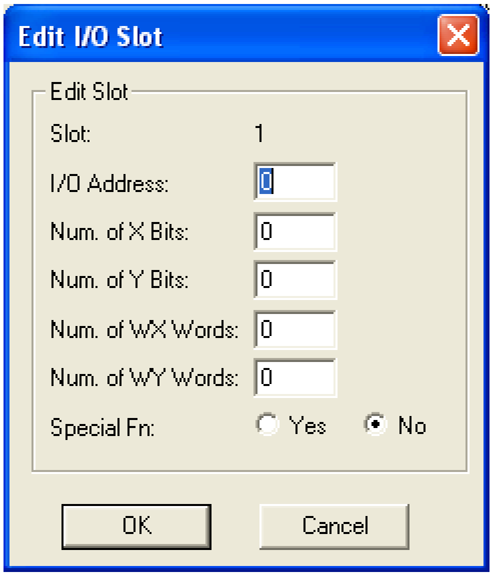
I/O Module Definition

Slot	I/O Addr	X	Y	WX	WY	SF
1	0	0	0	0	0	No
2	0	0	0	0	0	No
3	0	0	0	0	0	No
4	0	0	0	0	0	No
5	0	0	0	0	0	No
6	0	0	0	0	0	No
7	0	0	0	0	0	No
8	0	0	0	0	0	No
9	0	0	0	0	0	No
10	0	0	0	0	0	No
11	0	0	0	0	0	No
12	0	0	0	0	0	No
13	0	0	0	0	0	No
14	0	0	0	0	0	No
15	0	0	0	0	0	No
16	0	0	0	0	0	No

NOTE: If you need to select a different Base number, you can do so by clicking **Next Base** or **Prev Base** on the Edit I/O Base dialog box. You can also click **Search Base** on the Edit I/O Base dialog box and enter a different base number.

NOTE: The individual I/O module can be displayed with its associated Slot number, Tag and Description by clicking **Expanded Definition** on the Edit I/O base dialog box.

3. Select the slot you want to configure, then click **Edit Slot** or press **ENTER**.
   Result: The Edit I/O Slot dialog box appears.



Slot: 1

I/O Address: 0

Num. of X Bits: 0

Num. of Y Bits: 0

Num. of WX Words: 0

Num. of WY Words: 0

Special Fn: ○ Yes ● No

4. Enter the beginning I/O address.
5. Enter the number of I/O points (X, Y, WX, or WY) required for the type of module being configured.
6. If a special function module is to be configured, select the **Yes** button under **Special Fn**.
7. Click **OK**. The Edit I/O Base dialog box becomes the active dialog box.
8. To accept the changes, click **Accept** on Edit I/O Base dialog box.

NOTE: If you are online and have not yet accepted the changes to the base, you can click **Read I/O Base** on the Edit I/O Base dialog box to reset the base display to the readings in the controller. All prior changes will be lost.

Clearing a Base I/O Configuration

1. Start from Edit I/O Base dialog box.
2. Click on the **Clear Base** button on the Edit I/O Base dialog box.

You have finished setting up the software and the hardware. The next step is programming. The Programming chapter discusses 505 WorkShop's many different features for developing ladder logic. You can program in online or offline mode.

Profibus-DP Configuration

Using the Profibus-DP Configurator

The PLC WorkShop Profibus Configurator makes it easy to plan, configure, and diagnose Profibus-DP networks without the need of additional Profibus configuration tools. Completely integrated into PLC WorkShop, the Profibus configurator allows you to configure Profibus masters, slaves, and slave I/O modules from directly within the WorkShop application.

Other time-saving features include:

- Merge legacy COM Profibus *.2BF configuration files.
- Store device description files (GSD) with the WorkShop application.
- Save the entire configuration within the WorkShop program file.
- Assign and modify starting I/O addresses for slave modules.
- Troubleshoot modules with comprehensive online diagnostics.

You no longer need to use multiple utilities to configure your Profibus I/O. With the built-in Profibus Configurator, you can do everything you used to do in COM Profibus while staying within the familiar, easy to use WorkShop environment. With the Profibus Configurator you can:

- Configure the I/O slaves (including any 2500 Series or 505 PROFIBUS-DP RBCs) that you wish to use on the PROFIBUS-DP I/O channel.
- Add or delete slaves or modules or modify bus parameters at any time, without having to use COM Profibus to modify the configuration file and adjust the necessary information before exporting and merging it into 505 WorkShop again.
- Assign or modify starting I/O addresses for the modules of all PROFIBUS-DP slaves used by your 2500 Series or Series 505 CPU.
- Load bus parameters and slaves.
- Toggle between operate and stop mode, and between synchronous and asynchronous communications.
- Enable or disable slaves.

Profibus Configuration

Profibus Configurator

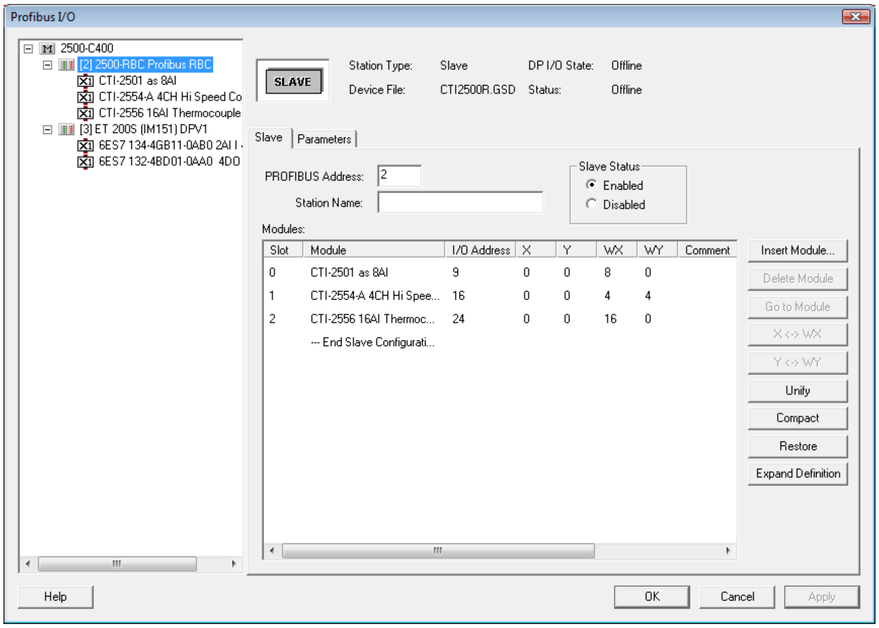
Use the Profibus Configurator to create and manage Profibus-DP networks and devices that have a WorkShop-compatible PLC as the host of a Profibus master module. The Profibus Configurator features a Network Tree and tabs as the main navigational elements.

This section details the features and the functions of the Profibus Configurator. For more information about setting up and editing your Profibus network, see Using the Profibus Configurator.

To access the Profibus Configurator:

1. Click **PLC Configuration** from the **PLC Utilities** menu. The **PLC Configuration** dialog box appears.

2. Click **Profibus I/O**. The **Profibus I/O** window appears.



Profibus I/O

```
⊟ M 2500-C400
    ⊟ [2] 2500-RBC Profibus RBC
        CTI-2501 as 8AI
        CTI-2554-A 4CH Hi Speed Co
        CTI-2556 16AI Thermocouple
    ⊟ [3] ET 200S (IM151) DPV1
        6ES7 134-4GB11-0AB0 2AI I -
        6ES7 132-4BD01-0AA0  4DO
```

Station Type: Slave DP I/O State: Offline
Device File: CTI2500R.GSD Status: Offline

PROFIBUS Address: 2
Station Name:

Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
0	CTI-2501 as 8AI	9	0	0	8	0	
1	CTI-2554-A 4CH Hi Spee...	16	0	0	4	4	
2	CTI-2556 16AI Thermoc...	24	0	0	16	0	
	--- End Slave Configurati...						

The main features of the Profibus I/O window include:

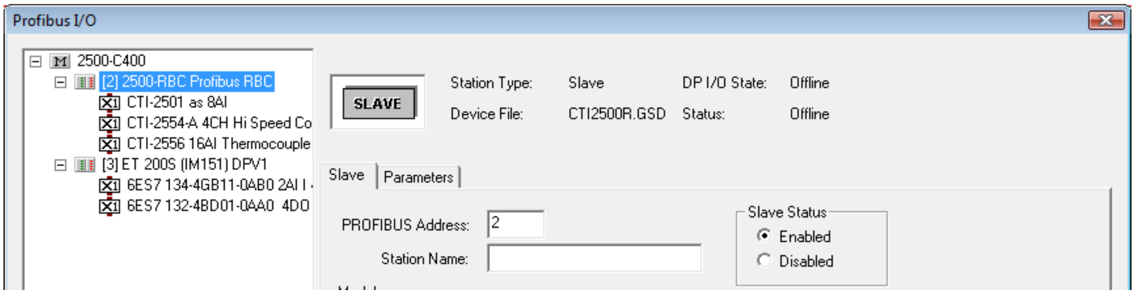
- **Profibus Network Tree -** The Profibus Network Tree appears at the left of the window. It represents a three-level tree view of the PROFIBUS network. The first level is the master, which in this case is the PLC Type selected for the program. The second level contains slave devices. The third level contains the I/O modules residing in each slave. Clicking on the devices at any level will display that device's configuration options in one of the tabs listed below.

- **Master Tab -** Displays status information for the selected master, including all slaves associated with the master. Use the **Master** tab to add slave devices and merge COM Profibus configurations.
- **Bus Parameters Tab -** Displays and allows edits for bus parameters such as number of repeaters and OLMs, as well as cable length and baud rate.
- **Slave Tab -** Displays status information for the selected slave device, including all I/O modules associated with the slave. Use the **Slave** tab to add or remove I/O modules and assign addresses.
- **Parameters Tab -** Displays the slave or I/O module parameters currently set for the selected slave device or module.
- **Diagnostics Tab -** Displays diagnostic information about the selected device or module, updated every second when online.
- **Profibus Operations -** While online, click **Profibus Ops** at the bottom of the window to toggle the operational and sychronization communication modes.

Network Tree

The Network Tree appears on the left side of the Profibus I/O window. It represents the Profibus network in three levels: Master, **Slaves**, and**Modules**, with the Master being the root level of the tree. Selecting any item in the Network Tree displays that item's configuration properties in the appropriate tab on the right side of the window.

For example, selecting the 2500-RBC slave device from the Network Tree displays that device's properties in the **Slave Tab**.



```
⊟ 2500-C400
   ⊟ [2] 2500-RBC Profibus RBC
        CTI-2501 as 8AI
        CTI-2554-A 4CH Hi Speed Co
        CTI-2556 16AI Thermocouple
   ⊟ [3] ET 200S (IM151) DPV1
        6ES7 134-4GB11-0AB0 2AI I -
        6ES7 132-4BD01-0AA0  4DO
```

Station Type: Slave
Device File: CTI2500R.GSD
DP I/O State: Offline
Status: Offline

PROFIBUS Address: 2
Station Name:

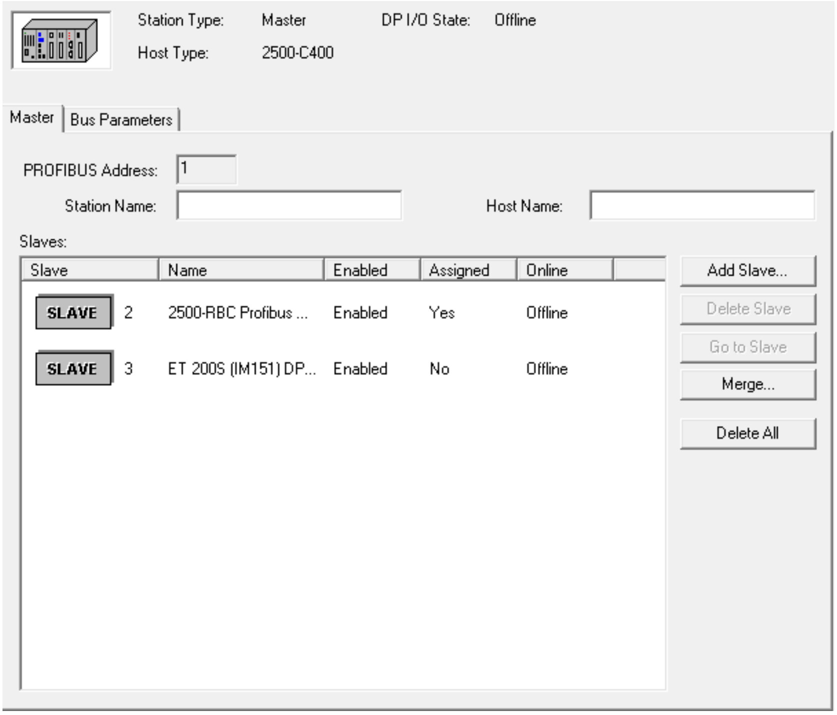
Slave Status
● Enabled
○ Disabled

The slave devices in the Network Tree are listed in descending order of Profibus Address. Changing the Profibus Address in the **Slave** tab will reorder the devices in the Network Tree to retain descending order of address.

While a device is being edited, an asterisk (*) will appear next to the device name in the Network Tree. This asterisk will remain until the configuration is written to either the program file or to the master.

Master Tab

Displays status information for the selected master and all slaves associated with the master. It is also used to add slave devices and merge COM Profibus configurations.



Station Type: Master
DP I/O State: Offline
Host Type: 2500-C400

PROFIBUS Address: 1
Station Name:
Host Name:

Slaves:

Slave		Name	Enabled	Assigned	Online
SLAVE	2	2500-RBC Profibus ...	Enabled	Yes	Offline
SLAVE	3	ET 200S (IM151) DP...	Enabled	No	Offline

Profibus Address - This is the address of the Profibus master. It will always be 1.

Station Name - Can be changed to any meaningful name for reference with other Profibus networks.

Host Name - Can be changed to any meaningful name for reference with other Profibus networks.

Slaves - Displays the slave devices that have been added to the Profibus configuration. Information is shown in the following columns:

Column	Description
Slave	The slave number, which will appear as the Profibus Address in the **Slave** tab. This number can be any integer in the range of 2 - 112.
Name	The station name of the slave device. This name is inherited from the GSD file, and can be changed in the **Station Name** box in the Slave Tab.
Enabled	The enable status of the slave device. This can be either *Enabled* or *Disabled*. This status can be changed in the **Slave** tab.
Assigned	Refers to assignment of I/O addresses within the slave. If a starting I/O address has not been assigned for one or more modules, then **No** will appear under this column.
Online	*Online* if the slave is online and communicating. *Offline* otherwise.

Add Slave - Launches the Hardware Directory, allowing you to add a slave device to the configuration.

Delete Slave - Deletes the selected slave device from the configuration.

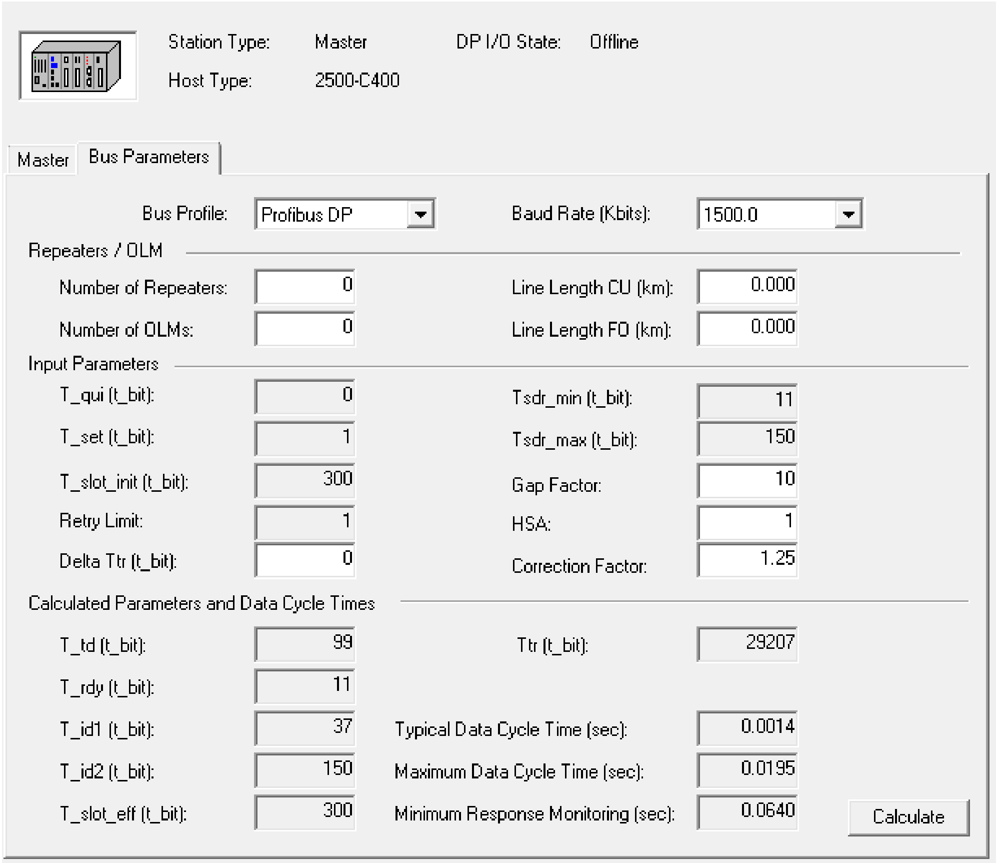
Go to Slave - Displays the configuration options for the selected slave device in the Slave Tab.

Merge - Allows you to merge legacy COM Profibus configuration files into the Profibus Configurator.

Delete All - Completely clears the Profibus configuration.

Bus Parameters Tab

Displays and allows edits for bus parameters such as number of repeaters and OLMs, as well as cable length and baud rate.



Station Type: Master
DP I/O State: Offline
Host Type: 2500-C400

Bus Profile: Profibus DP
Baud Rate (Kbits): 1500.0

Repeaters / OLM

Number of Repeaters: 0
Line Length CU (km): 0.000
Number of OLMs: 0
Line Length FO (km): 0.000

Input Parameters

T_qui (t_bit): 0
Tsdr_min (t_bit): 11
T_set (t_bit): 1
Tsdr_max (t_bit): 150
T_slot_init (t_bit): 300
Gap Factor: 10
Retry Limit: 1
HSA: 1
Delta Ttr (t_bit): 0
Correction Factor: 1.25

Calculated Parameters and Data Cycle Times

T_td (t_bit): 99
Ttr (t_bit): 29207
T_rdy (t_bit): 11
T_id1 (t_bit): 37
Typical Data Cycle Time (sec): 0.0014
T_id2 (t_bit): 150
Maximum Data Cycle Time (sec): 0.0195
T_slot_eff (t_bit): 300
Minimum Response Monitoring (sec): 0.0640

The Bus Profile **Profibus DP** sets default parameters on the bus, while allowing you to specify parameters such as Baud Rate, the number of repeaters and OLMs, and bus line length. This profile conforms to EN 50170, Volume 2, PROFIBUS standards, and in most cases will provide the best performance for your Profibus system. The **Adjustable** profile allows you to configure all bus parameters. Each parameter and its function is listed below.

Baud Rate (Kbits) - This is the transmission rate across the bus. Set this value to the highest operable rate for the lowest-rate device. For example, if all but one of your devices operate at a maximum baud rate of 3 Mbps, and one device operates at a maximum rate of 1.5 Mbps, set the rate to 1500.0. The Baud Rate will also affect the maximum line length. See below for more information.

Number of Repeaters - An RS 485 repeater is required when there are more than 32 devices on a copper line, or the line length exceeds the maximum length for the set Baud Rate. A repeater must be installed between each node that exceeds the maximum line length (see below).

Number of OLMs - An optical link module (OLM) converts the bus line from electrical (copper) to optical (fiber-optic) and amplifies the fiber-optic signal. This device would be used if the bus must be extended over long distances or within environments not suitable for copper cable, such as areas of high electromagnetic interference.

Line Length CU (km) - This value represents the actual length of copper cable used on a bus segment. Please note that as Baud Rate (above) increases, the maximum line length for reliable data transfer decreases:

Baud Rate	Maximum Line Length of Bus Segment (in meters)
9.6 to 187.5 kbps	1000
500 kbps	400
1.5 Mbps	200
3 to 12 Mbps	100

If the maximum line length between nodes on your bus exceeds the above value for the specified baud rate, an RS 485 repeater is necessary to extend the maximum line length:

Baud Rate	Maximum Line Length Between Nodes (in meters)
9.6 to 187.5 kbps	10000
500 kbps	4000
1.5 Mbps	2000
3 to 12 Mbps	1000

The value entered in Line Length CU represents the entire bus segment and affects the Data Cycle Times discussed elsewhere in this section.

Line Length FO (km) - This value represents the actual length of the fiber-optic cable in kilometers.

Input Parameters

T_qui (t_bit) - Quiet time for modulator. Represents the time allowed for modulators and repeaters to switch from send to receive. **T_qui** must be less than **Tsdr_min** and **T_rdy**. **T_qui** is a function of the selected baud rate:

Baud Rate	T_qui
Up to 1.5 Mbps	0 t_bits

Baud Rate	T_qui
Up to 3 Mbps	3 t_bits
Up to 6 Mbps	6 t_bits
Up to 12 Mbps	9 t_bits

T_set - Setup time. The time that may elapse between an event and the reaction to this event.

T_slot_init - Preset slot time (wait-to-receive time). This is the maximum time the sender of a frame must wait until the station addressed responds, regardless of whether it is a message frame or a token frame.

Retry Limit - The maximum number of call retries addressing a slave that does not answer or fails to return correct acknowledgment. Slaves which do not respond after this number of retries and flagged as "out of order".

Delta Ttr - Delta target rotation time. The additional time allowance for other masters on the bus but not part of the Profibus configuration. See Accommodating Additional Profibus Masters.

Tsdr_min - Minimum station delay time (shortest protocol processing time). The shortest time that may elapse between the sending or receiving of the last bit of a telegram and the sending or receiving of the first bit in the next telegram. Tsdr_min must be greater than T_ qui.

Tsdr_max - Maximum station delay time (longest protocol processing time). The longest time that may elapse between the sending or receiving of the last bit of a telegram and the sending or receiving of the first bit in the next telegram.

Gap Factor - Gap-update factor. This factor is the number of token runs after which each active station checks for Profibus address gaps. Profibus address gaps can result when masters are removed.

HSA - Highest station address. Highest master Profibus address on the system.

Correction Factor - Enter a safety margin for the response monitoring time for the calculated target rotation time in the form of a conversion factor (1.00 – 9.99). For example, if you select `1.25` as the conversion factor, the response monitoring time is 1.25 times the target rotation time.

Calculated Parameters and Data Cycle Times

T_td - Transmission delay time. This is the time a frame requires on the bus during transmission.

T_rdy - Ready time. The time in which the master, after sending a call, must be ready to receive the corresponding acknowledgment or response. T_rdy must be greater than T_qui.

T_id1 - Idle time 1. The time which elapses for a sender when the last bit of a telegram is received and the bus idles before the first bit of the next telegram is sent on the bus.

T_id2 - Idle time 2. The time which elapses for a sender after sending a call telegram for which acknowledgment is not received (SDN) and the bus idles before the first bit of a new telegram is sent on the bus.

T_slot_eff - Effective slot time (wait-to-receive time). This is the maximum time the sender of a frame must wait until the station addressed responds, regardless of whether it is a message frame or a token frame. Long lines and signal amplifiers on the bus (RS 485 repeaters or optical link modules (OLMs)) make it necessary to increase the preset slot time (T_slot_init).

Ttr - Target rotation time. The maximum time allowed for a token run. The time available to the master to send data telegrams to the slaves depends on the difference between this target time and the actual token runtime.

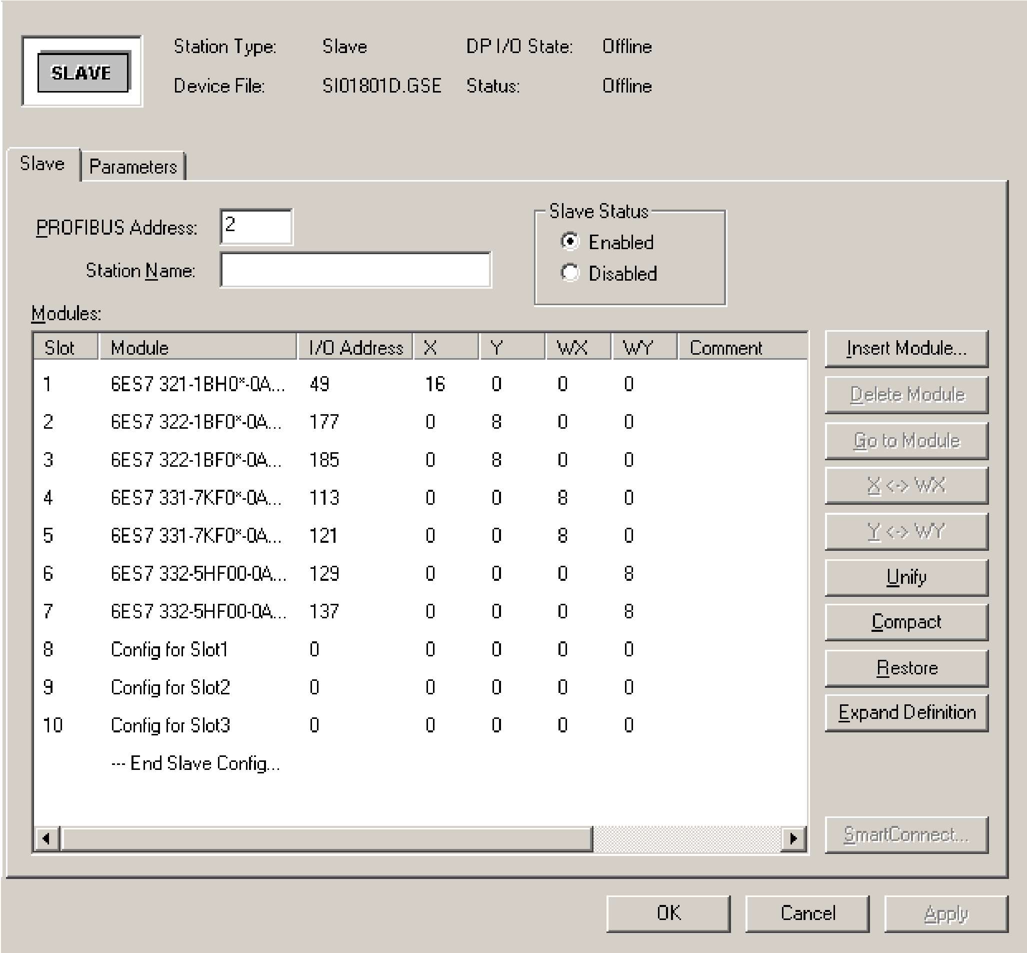
Typical Data Cycle Time - The average reaction time on the bus when all parameterized slaves exchange data with the master, no slave reports diagnostics and there is no additional traffic on the bus.

Maximum Data Cycle Time - The maximum reaction time on the bus when all parameterized slaves exchange data with the master. This time allows for missing slaves, slaves reporting diagnostics and slaves being configured/parameterized.

Minimum Response Monitoring - This is the lowest response monitoring time that can be parameterized when the **response monitoring / Ttr** factor is taken into account.

Slave Tab

Displays status information for the selected slave device, all I/O modules associated with the slave, and allows you to add or remove I/O modules and assign addresses.



Station Type: Slave
Device File: SI01801D.GSE
DP I/O State: Offline
Status: Offline

PROFIBUS Address: 2
Station Name:

Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	6ES7 321-1BH0*-0A...	49	16	0	0	0	
2	6ES7 322-1BF0*-0A...	177	0	8	0	0	
3	6ES7 322-1BF0*-0A...	185	0	8	0	0	
4	6ES7 331-7KF0*-0A...	113	0	0	8	0	
5	6ES7 331-7KF0*-0A...	121	0	0	8	0	
6	6ES7 332-5HF00-0A...	129	0	0	0	8	
7	6ES7 332-5HF00-0A...	137	0	0	0	8	
8	Config for Slot1	0	0	0	0	0	
9	Config for Slot2	0	0	0	0	0	
10	Config for Slot3	0	0	0	0	0	
	--- End Slave Config...						

The **Slave** tab contains all the tools necessary to configure and address each Profibus I/O module. The features of the dialog are detailed below. See *Configuring and Addressing Profibus I/O Modules* for more information about these features.

Profibus Address - Can be any value from 2 – 112. This value differentiates the device from other devices on the bus and must be unique for each slave device. The master device is always at address 1.

Station Name - Any name up to 40 characters. This field replaces the default device name supplied by the GSD file and will display in the Network Tree and the **Master** tab as the name of the slave device.

Slave Status - Enable or disable the slave device by selecting the appropriate radio button.

Modules - Displays the I/O modules and I/O address configuration of each module. Information is shown in the following columns:

Column	Description
Slot	The slot number of the selected module. The slot number is incremented by 1 for each added module, starting from the Module Offset, which is specified by the device master file.
Module	Also specified by the device master file, this is the name of the I/O module that has been inserted into the slave device.
I/O Address	The starting address point for the module. This is the only user-editable column in the **Modules** list box.
X	Displays the number of discrete input address points available for the module.
Y	Displays the number of discrete output address points available for the module.
WX	Displays the number of word input address points available for the module.
WY	Displays the number of word output address points available for the module.
Comment	An editable text field for optional comments; maximum of 20 characters.

Insert Module - allows you to insert I/O modules for the selected slave device.

Delete Module - deletes the currently selected module from the configuration.

Go to Module - displays the parameters for the currently selected module.

X<->WX - toggles the image register type for the selected module between discrete and word inputs. To ensure that discrete are toggled to words, the discrete must be on a 16-bit boundary.

Y<->WY - toggles the image register type for the selected module between discrete and word outputs. To ensure that discrete are toggled to words, the discrete must be on a 16-bit boundary.

Unify - moves all modules for the selected slave into the first module. Unification is only allowed if all modules are either discrete or words. Only the first address is retained.

Compact - moves all discrete image register types to word image register types for every module of the selected slave. It then unifies all the modules into the first module. To ensure that discrete are toggled to words, the discrete must be on a 16-bit boundary. Only the first address is retained.

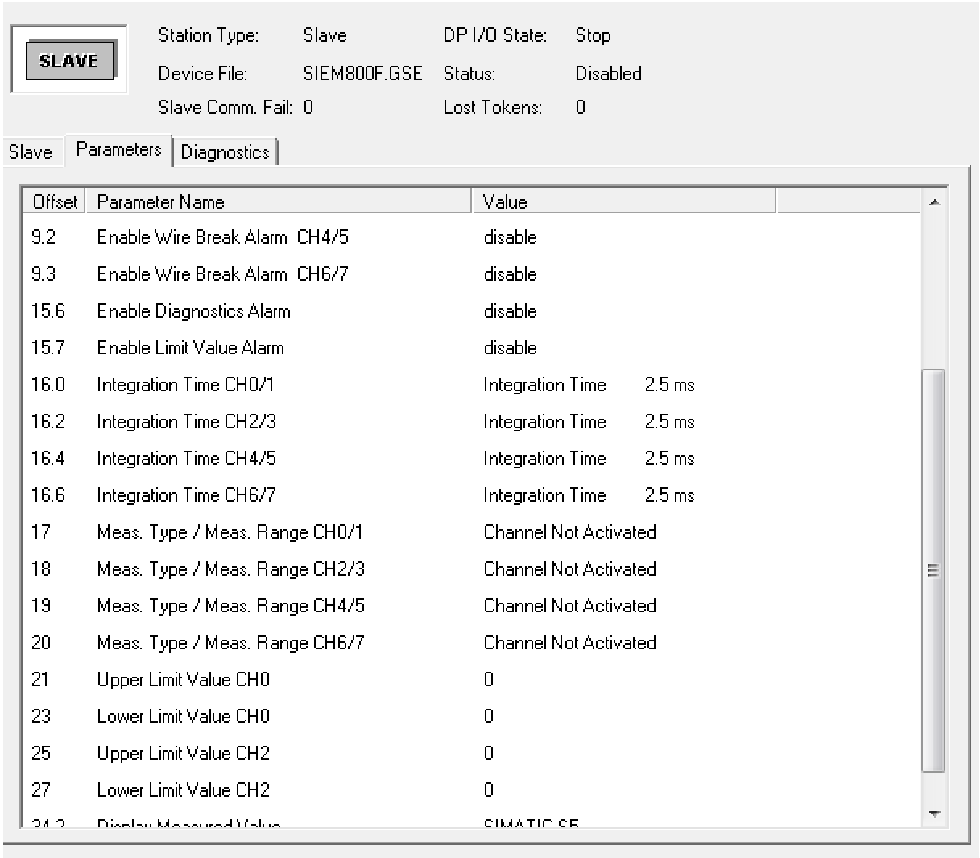
Restore - restores modules for the selected slave according to the initial configuration, including the image register types. Zero addresses are assumed for all but the first address, which is kept.

Expand Definition - shows used addresses for the selected module beyond the starting address to prevent addressing conflicts.

Smart Connect - allows you to perform actions on SmartConnect modules for the selected slave device.

Slave/Module Parameters Tab

Displays the slave or I/O module parameters currently set for the selected slave device or module.



Station Type: Slave
DP I/O State: Stop
Device File: SIEM800F.GSE
Status: Disabled
Slave Comm. Fail: 0
Lost Tokens: 0

Offset	Parameter Name	Value
9.2	Enable Wire Break Alarm CH4/5	disable
9.3	Enable Wire Break Alarm CH6/7	disable
15.6	Enable Diagnostics Alarm	disable
15.7	Enable Limit Value Alarm	disable
16.0	Integration Time CH0/1	Integration Time 2.5 ms
16.2	Integration Time CH2/3	Integration Time 2.5 ms
16.4	Integration Time CH4/5	Integration Time 2.5 ms
16.6	Integration Time CH6/7	Integration Time 2.5 ms
17	Meas. Type / Meas. Range CH0/1	Channel Not Activated
18	Meas. Type / Meas. Range CH2/3	Channel Not Activated
19	Meas. Type / Meas. Range CH4/5	Channel Not Activated
20	Meas. Type / Meas. Range CH6/7	Channel Not Activated
21	Upper Limit Value CH0	0
23	Lower Limit Value CH0	0
25	Upper Limit Value CH2	0
27	Lower Limit Value CH2	0
24.2	Display Measured Value	SIMATIC S5

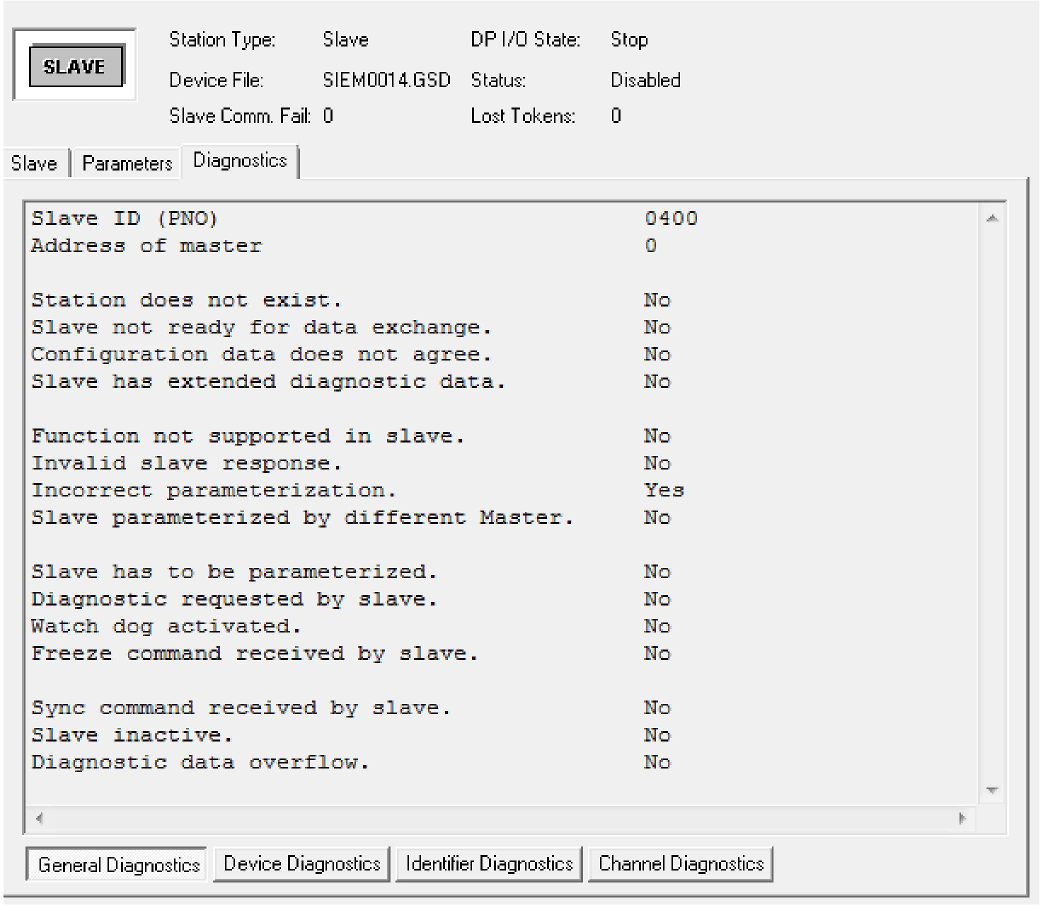
The availability of parameters for any slave device or I/O module is determined by the device master file, which is displayed at the top of the dialog. If the configurator is inlimited editing mode, or if a device master file is not present, no parameter information will be displayed.

Configurable device parameters are displayed in the list box. Information is shown in the following columns:

Offset	The memory offset of the parameter. This is in the format of **B.b** where **B** is the byte offset, and **b** is the bit number.
Parameter Name	The name of the parameter. This information is retrieved from the device master file.
Value	The value of the parameter string. To change this value from the default, click the item and select the new value from the drop-down menu.

Diagnostics Tab

While online, the Profibus Configurator delivers a constant stream of comprehensive diagnostic information from each configured slave device. The **Diagnostics** tab supports up to four types of diagnostics, including **General Diagnostics**, **Device Diagnostics**, **Identifier Diagnostics**, and **Channel Diagnostics**. Not all of these options may be available for each configured slave device; see your slave device manufacturer's documentation for more information about diagnostics availability.



Station Type: Slave DP I/O State: Stop
Device File: SIEM0014.GSD Status: Disabled
Slave Comm. Fail: 0 Lost Tokens: 0

```
Slave ID (PNO)                                0400
Address of master                             0

Station does not exist.                       No
Slave not ready for data exchange.            No
Configuration data does not agree.            No
Slave has extended diagnostic data.           No

Function not supported in slave.              No
Invalid slave response.                       No
Incorrect parameterization.                   Yes
Slave parameterized by different Master.      No

Slave has to be parameterized.                No
Diagnostic requested by slave.                No
Watch dog activated.                          No
Freeze command received by slave.             No

Sync command received by slave.               No
Slave inactive.                               No
Diagnostic data overflow.                     No
```

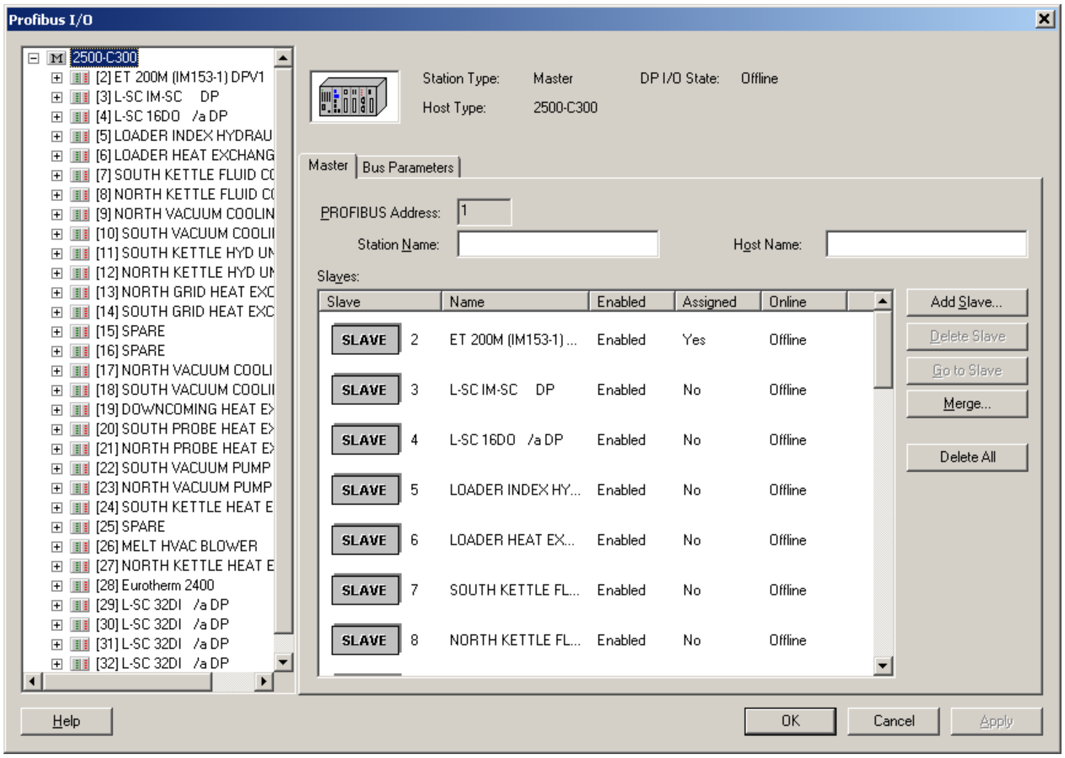
Hardware Directory

The Hardware Directory displays and organizes the Profibus slave devices available for configuration. Each device in the Hardware Directory is a representation of a device master file (GSD) that has been added to the directory. The information contained in the GSD determines how and where the device is displayed in the directory.

To view the Hardware Directory:

1. Click **PLC Configuration** from the **PLC Utilities** menu. The **PLC Configuration** dialog box appears.

2. Click **Profibus I/O** button. The **Profibus I/O** window appears.



```
2500-C300
  [2] ET 200M (IM153-1) DPV1
  [3] L-SC IM-SC     DP
  [4] L-SC 16DO    /a DP
  [5] LOADER INDEX HYDRAU
  [6] LOADER HEAT EXCHANG
  [7] SOUTH KETTLE FLUID CC
  [8] NORTH KETTLE FLUID CC
  [9] NORTH VACUUM COOLIN
  [10] SOUTH VACUUM COOLII
  [11] SOUTH KETTLE HYD UN
  [12] NORTH KETTLE HYD UN
  [13] NORTH GRID HEAT EXC
  [14] SOUTH GRID HEAT EXC
  [15] SPARE
  [16] SPARE
  [17] NORTH VACUUM COOLI
  [18] SOUTH VACUUM COOLII
  [19] DOWNCOMING HEAT EX
  [20] SOUTH PROBE HEAT EX
  [21] NORTH PROBE HEAT EX
  [22] SOUTH VACUUM PUMP
  [23] NORTH VACUUM PUMP
  [24] SOUTH KETTLE HEAT E
  [25] SPARE
  [26] MELT HVAC BLOWER
  [27] NORTH KETTLE HEAT E
  [28] Eurotherm 2400
  [29] L-SC 32DI    /a DP
  [30] L-SC 32DI    /a DP
  [31] L-SC 32DI    /a DP
  [32] L-SC 32DI    /a DP
```

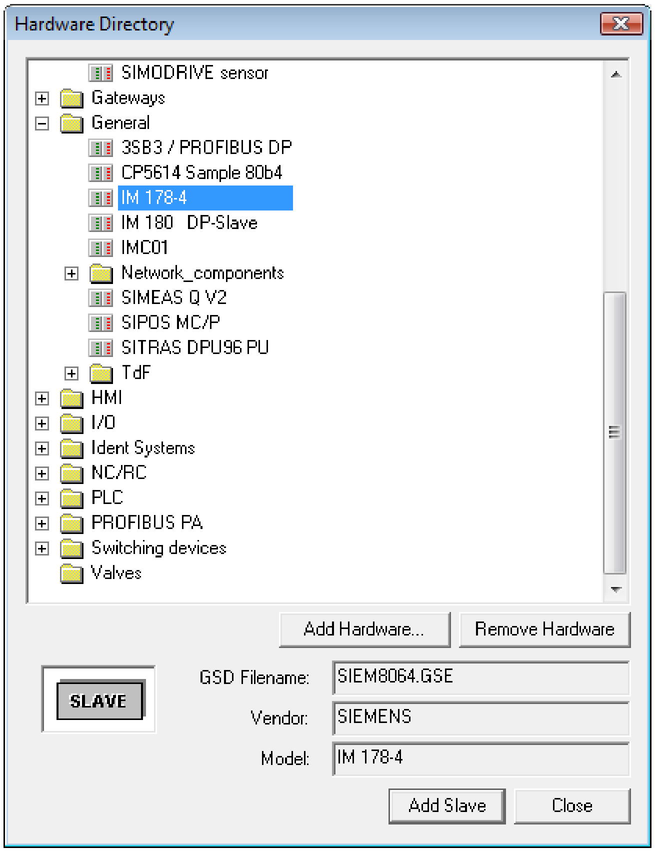
Station Type: Master   DP I/O State: Offline
Host Type: 2500-C300

PROFIBUS Address: 1
Station Name:
Host Name:

Slaves:

Slave		Name	Enabled	Assigned	Online
SLAVE	2	ET 200M (IM153-1) ...	Enabled	Yes	Offline
SLAVE	3	L-SC IM-SC DP	Enabled	No	Offline
SLAVE	4	L-SC 16DO /a DP	Enabled	No	Offline
SLAVE	5	LOADER INDEX HY...	Enabled	No	Offline
SLAVE	6	LOADER HEAT EX...	Enabled	No	Offline
SLAVE	7	SOUTH KETTLE FL...	Enabled	No	Offline
SLAVE	8	NORTH KETTLE FL...	Enabled	No	Offline

3. While on the Master Tab, click **Add Slave**. The **Hardware Directory** dialog box appears.



GSD Filename: SIEM8064.GSE
Vendor: SIEMENS
Model: IM 178-4

Add Hardware - allows you to add additional slave devices by loading their GSD file into the directory. See Device Master Files for more information.

Remove Hardware - removes the selected device from the Hardware Directory, and deletes the stored GSD file.

Add Slave - adds the selected device to the configuration. This device will appear in the **Network Tree** as well as the **Master Tab**.

Using the Profibus Configurator

Using the Profibus Configurator

Your objective in creating a configuration with the Profibus Configurator is to define module types for each slave and assign starting I/O addresses to each module. Once you accomplish that, you can program Profibus I/O modules just as you would 505 I/O.

The tables below provides the information you need in order to configure your slave devices in the Profibus Configurator.

CREATING A NEW PROFIBUS NETWORK

Task	Comment
Open or create a program file in WorkShop	You can modify an existing program file configuration, if appropriate, or create a new file. The PLC Type selected for the program file will act as the Profibus master.
Add device files	Add slave device description files (GSD) that represent each slave device on the network to the Hardware Directory to begin network configuration.
Modify bus parameters	You can accept the default settings, unless you wish to modify one, such as baud rate.
Assign slave(s)	Choose slave(s), such as the 2500 PROFIBUS-DP RBC, up to 112.
Configure slave(s)	Add I/O modules present within the slave device and assign starting I/O addresses to each module.
Save the configuration	The Profibus configuration is saved with the file.

MERGING AN EXISTING NETWORK FROM COM PROFIBUS

Task	Comment
Migrating from COM Profibus to the Profibus Configurator	If you are a COM Profibus user, read this topic first to ensure a smooth migration to the WorkShop Profibus Configurator.
Open or create a program file in WorkShop	The PLC Type selected for the program file will act as the Profibus master.
Add device files	(Optional) This step is not required if you do not plan on editing your network after the merge.
Import (merge) configuration	If you have already configured your Profibus network in COM Profibus, WorkShop will accept the merged configuration.
Modify bus parameters	(Optional) You can accept the default settings, unless you wish to modify one, such as baud rate.
Assign slave(s)	(Optional) If all device files are present for the merged configuration, you can assign and configure additional slave devices. See Limited Editing Mode.
Configure slave(s)	(Optional) Add I/O modules present within the slave device and assign starting I/O addresses to each module.
Save the configuration	The Profibus configuration is saved with the file, so there is no longer a need to save and store the configuration separately.

Device Master Files

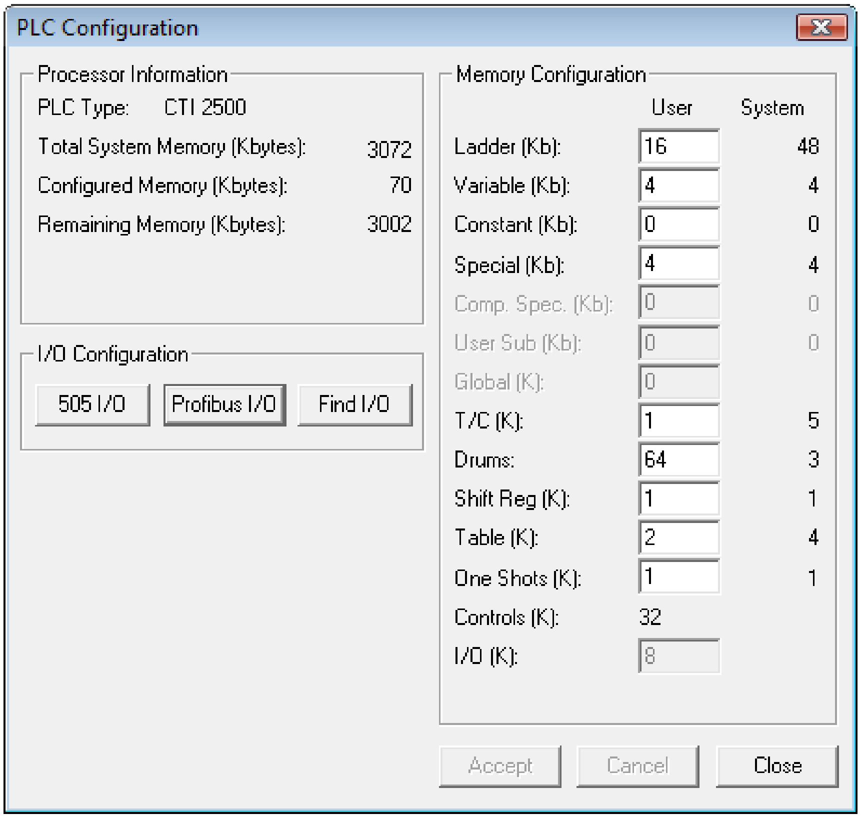
A device master file, or GSD, is required for every Profibus device so that it can be integrated in the Profibus Configurator. A GSD file contains a device description in a uniform format stipulated by the IEC 61158-3 DP-V0 PROFIBUS standard. The Profibus Configurator uses the GSD to categorize the device in the Hardware Directory, determine what I/O modules are available to configure, and what kinds of parameter and diagnostics information to display.

To enable field devices of other vendors to be connected, device master files that can be integrated in the configurator are generally supplied with the hardware. The configurator can interpret these device master files provided the files are created in accordance with the IEC 61158-3 DP-V0 PROFIBUS standard.

No device master files are included with PLC WorkShop except for the master files associated with the supported PLC types. All other device master files must be added to the configurator by the user. Device master files are added from within the Hardware Directory, which is accessible from the **Master** tab of the Profibus I/O dialog box. Once a device master file is added, that device can be added and configured to any WorkShop program created or edited on the same machine, until the device is removed from the Hardware Directory.

To add a device master file to the configuration:

1. Click **PLC Configuration** from the **PLC Utilities** menu. The **PLC Configuration** dialog box appears.



PLC Configuration

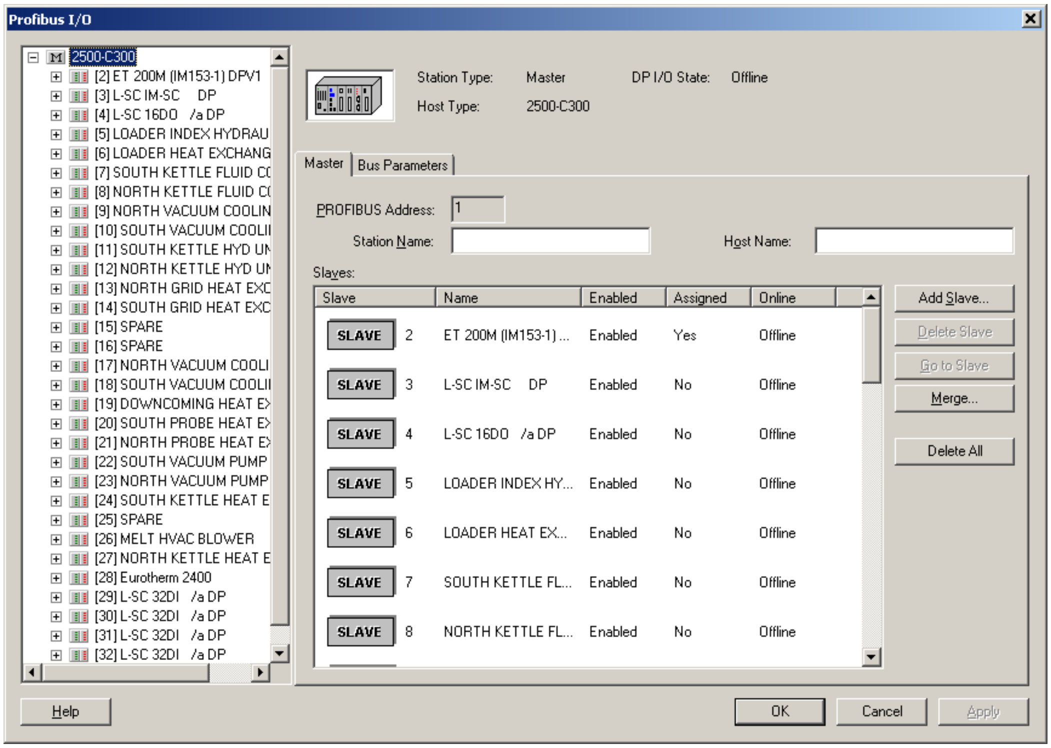
Processor Information

PLC Type:	CTI 2500
Total System Memory (Kbytes):	3072
Configured Memory (Kbytes):	70
Remaining Memory (Kbytes):	3002

Memory Configuration

	User	System
Ladder (Kb):	16	48
Variable (Kb):	4	4
Constant (Kb):	0	0
Special (Kb):	4	4
Comp. Spec. (Kb):	0	0
User Sub (Kb):	0	0
Global (K):	0	
T/C (K):	1	5
Drums:	64	3
Shift Reg (K):	1	1
Table (K):	2	4
One Shots (K):	1	1
Controls (K):	32	
I/O (K):	8	

2. Click **Profibus I/O**. The **Profibus I/O** window appears.



- 2500-C300
  - [2] ET 200M (IM153-1) DPV1
  - [3] L-SC IM-SC   DP
  - [4] L-SC 16DO   /a DP
  - [5] LOADER INDEX HYDRAU
  - [6] LOADER HEAT EXCHANG
  - [7] SOUTH KETTLE FLUID CO
  - [8] NORTH KETTLE FLUID CO
  - [9] NORTH VACUUM COOLIN
  - [10] SOUTH VACUUM COOLII
  - [11] SOUTH KETTLE HYD UN
  - [12] NORTH KETTLE HYD UN
  - [13] NORTH GRID HEAT EXC
  - [14] SOUTH GRID HEAT EXC
  - [15] SPARE
  - [16] SPARE
  - [17] NORTH VACUUM COOLI
  - [18] SOUTH VACUUM COOLII
  - [19] DOWNCOMING HEAT EX
  - [20] SOUTH PROBE HEAT EX
  - [21] NORTH PROBE HEAT EX
  - [22] SOUTH VACUUM PUMP
  - [23] NORTH VACUUM PUMP
  - [24] SOUTH KETTLE HEAT E
  - [25] SPARE
  - [26] MELT HVAC BLOWER
  - [27] NORTH KETTLE HEAT E
  - [28] Eurotherm 2400
  - [29] L-SC 32DI   /a DP
  - [30] L-SC 32DI   /a DP
  - [31] L-SC 32DI   /a DP
  - [32] L-SC 32DI   /a DP

Station Type: Master   DP I/O State: Offline
Host Type: 2500-C300

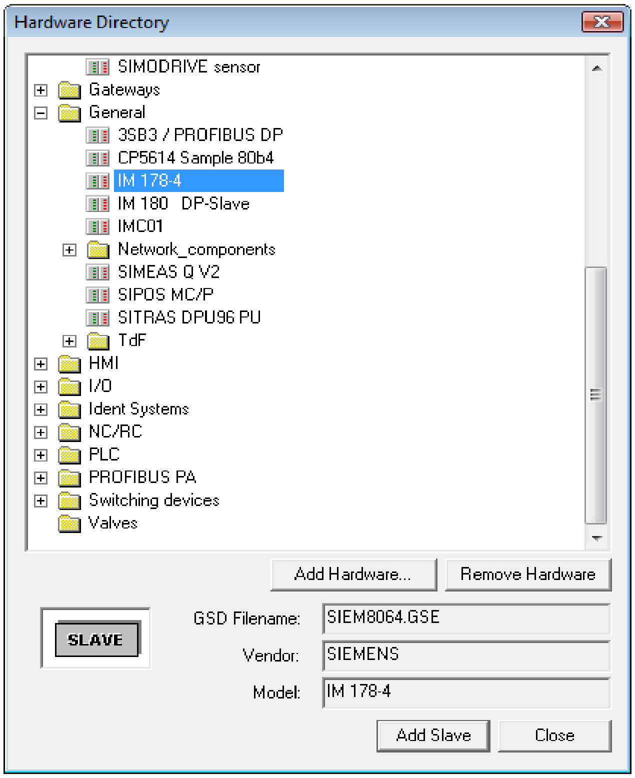
PROFIBUS Address: 1
Station Name:
Host Name:

Slaves:

Slave		Name	Enabled	Assigned	Online
SLAVE	2	ET 200M (IM153-1) ...	Enabled	Yes	Offline
SLAVE	3	L-SC IM-SC DP	Enabled	No	Offline
SLAVE	4	L-SC 16DO /a DP	Enabled	No	Offline
SLAVE	5	LOADER INDEX HY...	Enabled	No	Offline
SLAVE	6	LOADER HEAT EX...	Enabled	No	Offline
SLAVE	7	SOUTH KETTLE FL...	Enabled	No	Offline
SLAVE	8	NORTH KETTLE FL...	Enabled	No	Offline

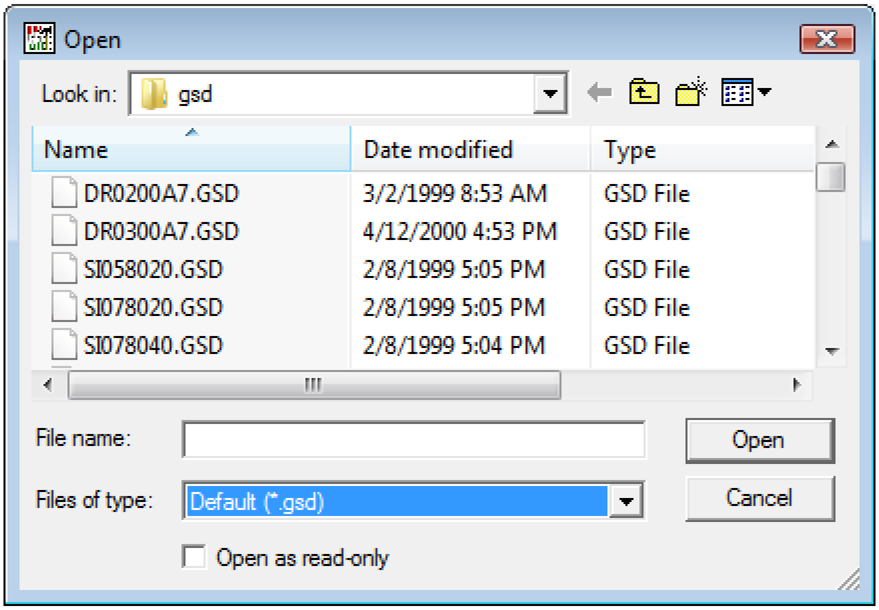
3. Select the Profibus master module from the **Network Tree**. The **Master** tab is displayed on the right.

4. Click **Add Slave**. The **Hardware Directory** dialog box appears.



GSD Filename: SIEM8064.GSE
Vendor: SIEMENS
Model: IM 178-4

5. Click **Add Hardware** and browse for the device master file for the device you wish to add. Click **Open** to add the device.



Look in: gsd

Name	Date modified	Type
DR0200A7.GSD	3/2/1999 8:53 AM	GSD File
DR0300A7.GSD	4/12/2000 4:53 PM	GSD File
SI058020.GSD	2/8/1999 5:05 PM	GSD File
SI078020.GSD	2/8/1999 5:05 PM	GSD File
SI078040.GSD	2/8/1999 5:04 PM	GSD File

File name:
Files of type: Default (*.gsd)
□ Open as read-only

NOTE: Device manufacturers often supply more than one device master file for a single device to support multiple languages. These files have different file extensions that identify the language for which the file was written. These extension include, but are not limited to, *.GSE (English), *.GSF (French), *.GSG (German), *.GSI (Italian), *.GSP (Portuguese), and *.GSS (Spanish).

The *.GSD extension represents a default or language-neutral file. When adding a device master file, this *.GSD extension is selected by default when you browse for your file. Selecting the **Files of type** drop-down menu allows you to specify a language-specific device master file.

6. When adding one or more GSD files to the Hardware Directory, the configurator scans the file for unsupported or unrecognized information and logs the event to a text file. If any unsupported information is found, a warning message appears, allowing you to view the event log for more details about the problem. In most cases, the device is still added to the Hardware Directory, with any unsupported features ignored. Contact your device manufacturer for more information.

7. Once the file is added, you can select the device from the Hardware Directory and click the **Add Slave** button to add the device to the configuration or click **Remove Hardware** to delete the device.

Migrating from COM Profibus to the Profibus Configurator

With the Profibus Configurator, you no longer have create and manage your Profibus configurations using the COM Profibus configuration utility. However, if you are used to using COM Profibus, there are a few things to keep in mind while migrating from COM Profibus to the WorkShop Profibus Configurator. The following guide will help you understand the differences between the two utilities, and ease your transition to the new process.

Please note that an alternative to this process is to reconfigure your Profibus network directly within the WorkShop Profibus Configurator. See Using the Profibus Configurator.

What You'll Need:

- A licensed copy of PLC WorkShop for Siemens 505 Version 4.30 or higher
- The PLC WorkShop program file (.FSS) that will contain the Profibus configuration
- The latest device description files (GSD) for each Profibus slave device on your network (refer to the device manufacturer for the latest GSD file(s) for your devices)
- The latest version (v5.1) of the COM Profibus configuration utility (included with your WorkShop installation)
- The COM Profibus configuration file (.PB5) that contains the configuration to be merged into WorkShop
- If available, the COM Profibus binary file (.2BF) generated from the latest COM Profibus configuration (this file can be created within COM Profibus at any time, see below for details)

NOTE: Before you begin, please note that saving your PLC WorkShop program file (.FSS) in WorkShop Version 4.30 or higher will permanently alter the file in a manner that will make it no longer accessible in WorkShop versions prior to 4.30. It is suggested that you create a backup copy of your program file in case you need to access it with an older version of the software.

1. Within the COM Profibus utility, open the configuration file (.PB5) that will be merged into WorkShop.

2. Click **Station List** from the **Documentation** menu. This will provide you with a list of all the devices on your Profibus network, along with the GSD files associated with each device. Printing this list may be helpful during and after the configuration merge.

3. In the graphical bus display, select the master device (the PLC) and click **File**, click **Export**, and then click **Binary File** to create and save the binary file (.2BF) which will be merged into WorkShop.

4. Within PLC WorkShop, open the program file (.FSS) that will contain the merged Profibus configuration. Please note that although you may have already merged your Profibus configuration in earlier versions of WorkShop, you will need to perform

the merge again for full editing capabilities. Read more about Limited Editing Mode below.

5. Click **PLC Configuration** from the **PLC Utilities** menu and click **Profibus I/O** to access the Profibus Configurator.

6. Add your GSD files to the configurator by clicking the **Add Slave** button. This will take you to the Profibus **Hardware Directory**. Clicking the **Add Hardware** button will display an **Open** dialog within which you will be able to select the GSD files to add to the Hardware Directory. By default, COM Profibus stores its GSD files in the C:\SIEMENS\CPBV51\gsd directory.

7. Using the Station List generated in step 2, identify the GSD files you will need to import into the Hardware Directory. Please note that by default the Hardware Directory only identifies the standard .GSD file extensions when browsing for files to import. If your GSD file has a different extension (.GSE, for example), select the appropriate extension from the **Files of type** drop-down menu at the bottom of the Open dialog. Once you have added all your GSD files, click the **Close** button in the Hardware Directory to return to the Profibus Configurator.

8. With the **Master** module (the PLC) selected, click the **Merge** button and navigate to the location of the binary file (.2BF) created in step 3 above. By default, COM Profibus saves the file in the C:\SIEMENS\CPBV51\data directory. Select the binary file and click the **Open** button to begin the merge process.

9. If, during the merge process, the configurator finds a module that does not quite match the information in the GSD, a dialog will appear that allows you to select the module that best represents your hardware. Select the appropriate module from the list to continue. WorkShop then displays the results of the merge.

10. Configure the I/O addresses of your slave modules by following the directions in Configuring and Addressing Profibus I/O Modules.

11. Complete the configuration by clicking **OK** in the Profibus Configurator display and saving the program file. The Profibus configuration is also saved with the program file.

Following these steps will ensure that your Profibus configuration can be completely edited and updated on demand when necessary. If you cannot complete a certain step in this process (for example, you no longer have access to the exact GSD file(s) that were used to create your configuration in COM Profibus, and therefore cannot add them to the Hardware Directory) you may still be able to merge your configuration successfully, but with limited editing capabilities.

This is known as Limited Editing Mode. In Limited Editing Mode, your configuration will still be valid and can be downloaded to the PLC. However, you will not be able to edit certain aspects of the configuration, such as adding or removing slave devices and I/O modules, or editing bus or module parameters. You are able to modify I/O addresses and enable or disable slaves while in Limited Editing Mode.

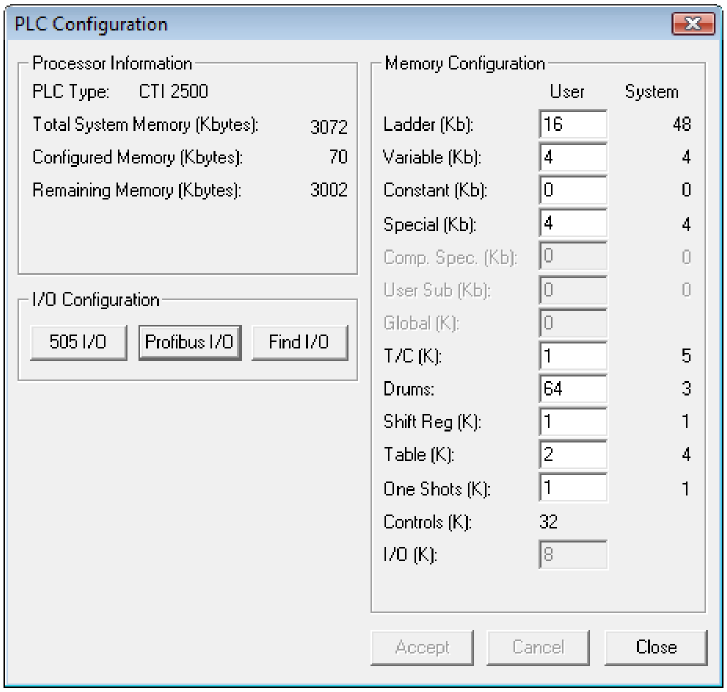
Merging Configuration Data From COM PROFIBUS Into 505 WorkShop

The **Merge** button, located on the **Master** tab of theProfibus Configurator, allows you to import configuration data from a binary file created with COM Profibus. The steps you take are the same regardless of whether you are importing data from an entirely new configuration, or merely importing selected items that have been modified from a previous configuration session in COM Profibus. The Merge function performs a comparison between the current configuration information and the contents of the selected binary file exported from COM Profibus.

> **NOTE:** Merging configuration data from COM Profibus will overwrite the current configuration's slave and module data. I/O addresses for modules that exist in both the current configuration and the merged file will not be overwritten.

To import and/or configure data from the COM Profibus software, you must be running 505 WorkShop, and the binary file (with its .2BF extension) that you created with COM Profibus must be in a known location. All device master files (GSDs) associated with the binary file configuration must be loaded into the Hardware Directory for full editing capabilities. Follow the steps below to execute:

1. Click **PLC Configuration** from the **PLC Utilities** menu. The **PLC Configuration** dialog box appears.

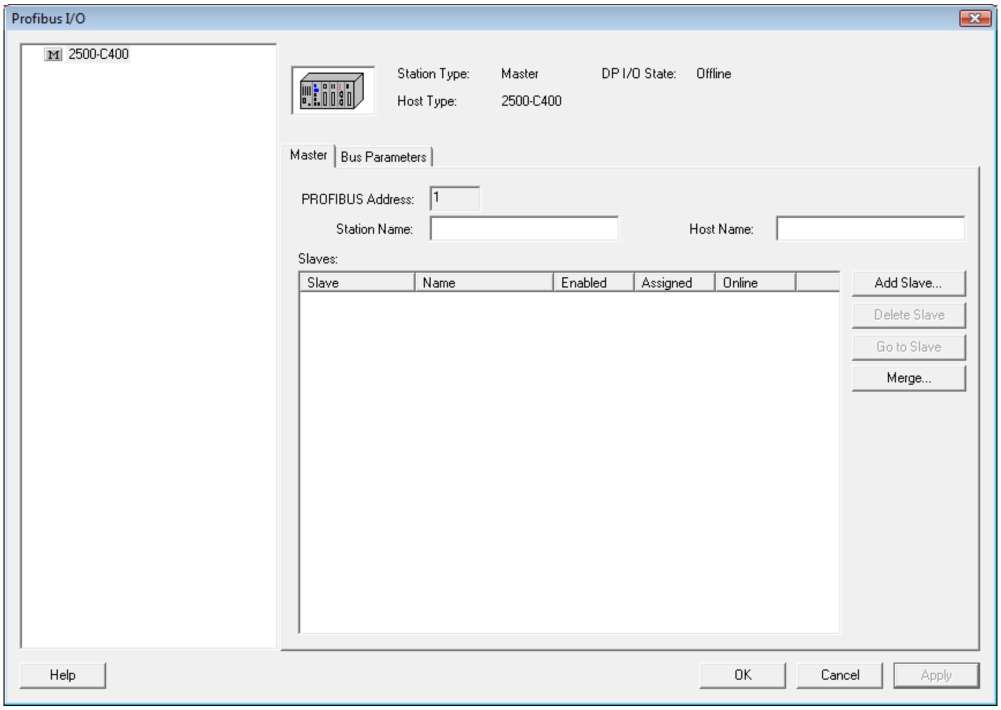


PLC Type: CTI 2500

Total System Memory (Kbytes):	3072
Configured Memory (Kbytes):	70
Remaining Memory (Kbytes):	3002

	User	System
Ladder (Kb):	16	48
Variable (Kb):	4	4
Constant (Kb):	0	0
Special (Kb):	4	4
Comp. Spec. (Kb):	0	0
User Sub (Kb):	0	0
Global (K):	0	
T/C (K):	1	5
Drums:	64	3
Shift Reg (K):	1	1
Table (K):	2	4
One Shots (K):	1	1
Controls (K):	32	
I/O (K):	8	

2. Click **Profibus I/O**. The **Profibus I/O** dialog box appears.



Station Type: Master DP I/O State: Offline
Host Type: 2500-C400

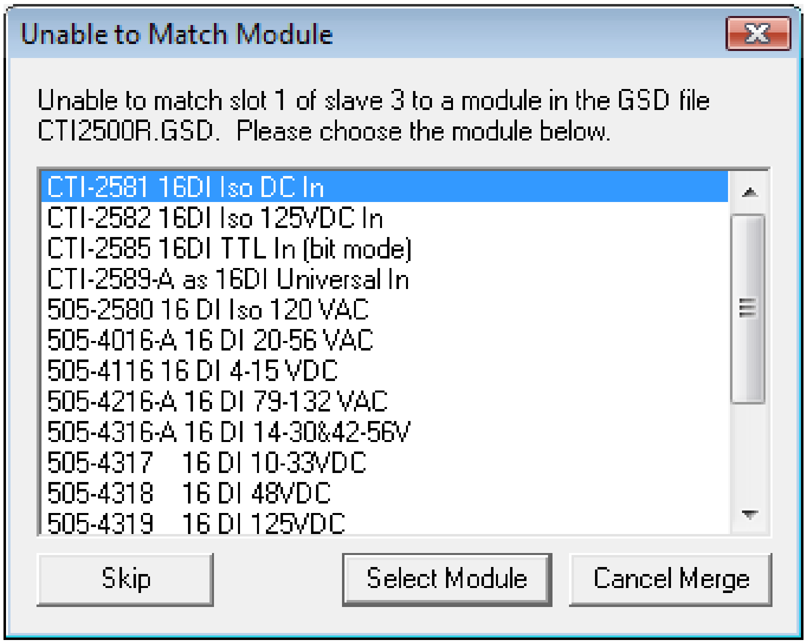
PROFIBUS Address: 1
Station Name:
Host Name:

Slave	Name	Enabled	Assigned	Online

3. On the **Master** tab, click **Merge** to import COM Profibus configuration data. The **Open** dialog box appears.

4. Type the name of the *.2BF binary file or browse to search other drives or directories.

5. During the Merge operation, the configurator compares the slave device and I/O module information in the binary file to the information in the GSDs loaded into the Hardware Directory. In some situations, the module information in the binary file may not exactly match the GSD. In this case, the configurator presents a dialog box allowing you to select the appropriate module for the configuration.

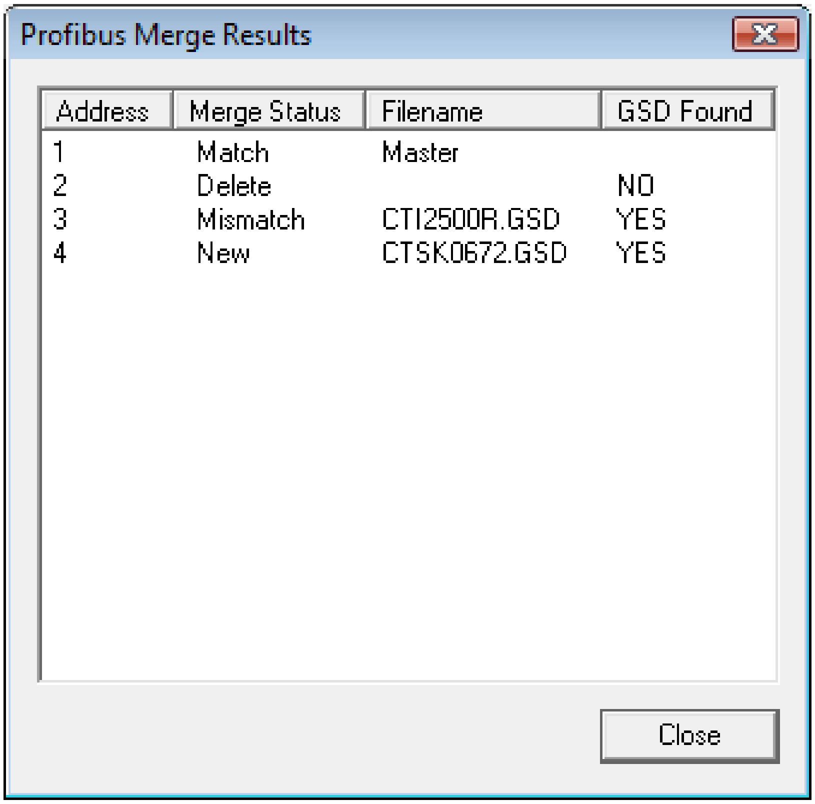


Unable to Match Module

Unable to match slot 1 of slave 3 to a module in the GSD file CTI2500R.GSD. Please choose the module below.

CTI-2581 16DI Iso DC In
CTI-2582 16DI Iso 125VDC In
CTI-2585 16DI TTL In (bit mode)
CTI-2589-A as 16DI Universal In
505-2580 16 DI Iso 120 VAC
505-4016-A 16 DI 20-56 VAC
505-4116 16 DI 4-15 VDC
505-4216-A 16 DI 79-132 VAC
505-4316-A 16 DI 14-30&42-56V
505-4317 16 DI 10-33VDC
505-4318 16 DI 48VDC
505-4319 16 DI 125VDC

6. When the merge is complete, the **Profibus Merge Results** dialog box displays a report that details the changes made to the Profibus configuration.



Profibus Merge Results

Address	Merge Status	Filename	GSD Found
1	Match	Master	
2	Delete		NO
3	Mismatch	CTI2500R.GSD	YES
4	New	CTSK0672.GSD	YES

The **Profibus Merge Results** dialog box shows the following information:

- **Address –** The Profibus addresses affected by the merge, from 1 – 112 (or 1 – 32 for the 545L).
- **Merge Status –** The **Merge Status** of each module:
  - **Match -** All slaves have a Match status when first entered into the Profibus Configurator. A slave will retain this status until it is edited or a file is merged thatdoes not contain this slave with identical configuration.
  - **Mismatch -** A slave has a Mismatch status when merging a file that has the same slave number (but different configuration) as the current network.
  - **Delete -** A slave can only have a Delete status after merging a file that does not contain this slave but exists in the current network.

- **New -** A slave can only have a New status after merging a file that contains this slave and at the same time is nonexistent in the current network.

- **Filename –** The file name of the device master file (GSD) associated with the merged module.
- **GSD Found –** An indication of whether or not a GSD file was found for the merged module. Merged slave devices that are not represented in the Profibus Configurator Hardware Directory with their associated GSD files are subject to limited editing only.

7. The Profibus configuration information obtained from the COM Profibus binary file is merged into 505 WorkShop. The current configuration is overwritten.

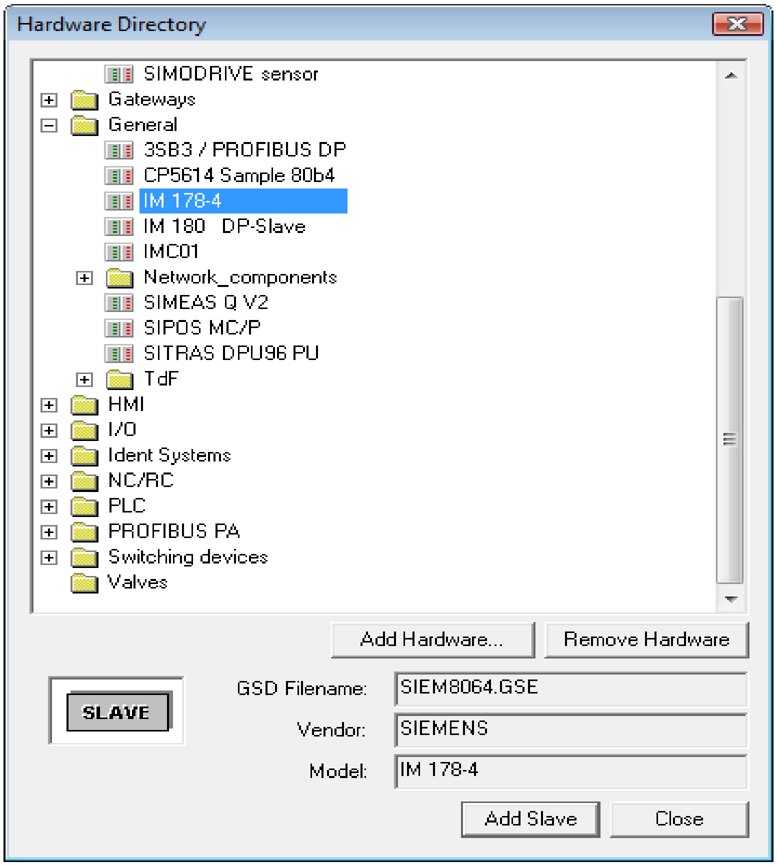
NOTE: Merged slave devices are initially disabled after merging. See **Configuring and Addressing Profibus Modules** for more information.

Assigning Slaves to the Profibus Configuration

Slave devices can be added to the configuration either by merging from a COM Profibus binary file or by following the steps below. Please note that merging a COM Profibus configuration will place the configurator inlimited editing mode unless all devices in the configuration are represented by a valid device master file within the Hardware Directory in WorkShop.

To assign slaves to the configuration:

1. Add the associated device master file to the **Hardware Directory** if you have not already done so.
2. Find and select the slave device within the Hardware Directory and click **Add Slave** to add the device.



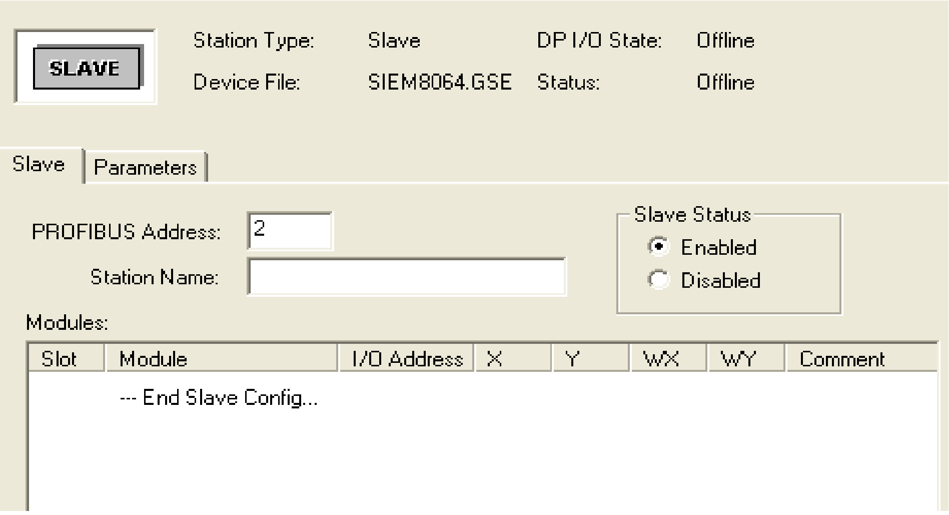
GSD Filename: SIEM8064.GSE

Vendor: SIEMENS

Model: IM 178-4

3. Repeat steps 1 and 2 for any additional slave devices you wish to add to the configuration. Click **Close** when finished.

4. Configure the device by selecting it from the **Network Tree** or by double-clicking the device from within the **Master** tab. The **Slave** tab for the selected device appears.



Station Type: Slave   DP I/O State: Offline

Device File: SIEM8064.GSE   Status: Offline

PROFIBUS Address: 2

Station Name:

Slave Status: ● Enabled ○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
	--- End Slave Config...						

5. By default, the configurator assigns the next available consecutive Profibus address to the device. This address, as well as the displayed name of the device, can be changed in the Slave Tab.

6. Enable or disable the slave by selecting **Enabled** or **Disabled** from the **Slave Status** group box.

7. Click **Apply** or **OK** to keep the changes, or if online, to write the changes to the master.

8. See Configuring and Addressing Profibus I/O Modules to learn how to assign and address Profibus I/O.

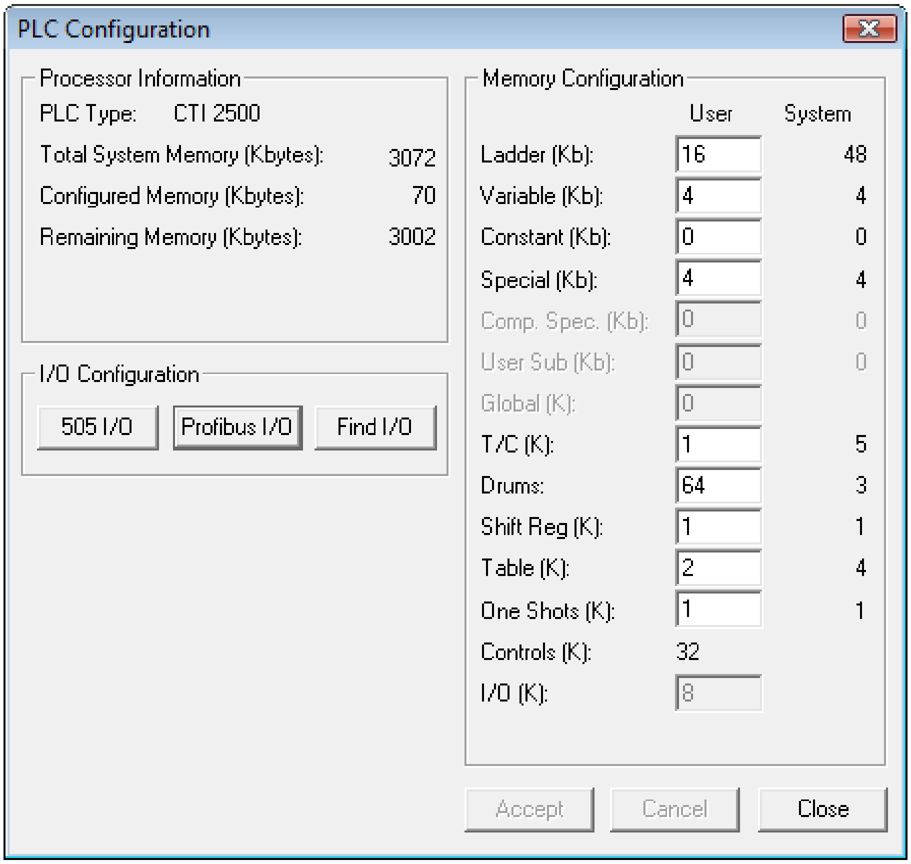
Configuring and Addressing Profibus I/O Modules

Before entering your I/O configuration, be aware of the following restrictions:

- For bit or bit-and-word modules (but not for word-only modules), the number for the I/O address must begin on an 8-point boundary. An 8-point boundary is (n * 8) + 1 (for example, 1, 9, 17, and so on). Addresses not starting on an 8-point boundary are changed to do so when you write the values.
- WorkShop does not flag duplicate I/O points. Use the Find I/O functions under the **PLC Configuration** dialog box to search for duplicate I/O points.

To edit the I/O address:

1. Launch the Profibus Configurator by clicking **PLC Configuration** from the **PLC Utilities** menu. The **PLC Configuration** dialog box appears.



PLC Configuration

Processor Information

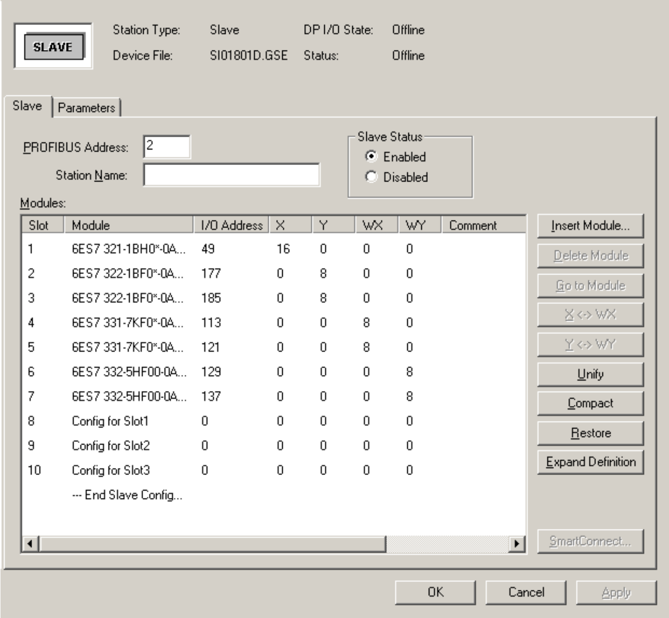
PLC Type:	CTI 2500
Total System Memory (Kbytes):	3072
Configured Memory (Kbytes):	70
Remaining Memory (Kbytes):	3002

Memory Configuration

	User	System
Ladder (Kb):	16	48
Variable (Kb):	4	4
Constant (Kb):	0	0
Special (Kb):	4	4
Comp. Spec. (Kb):	0	0
User Sub (Kb):	0	0
Global (K):	0	
T/C (K):	1	5
Drums:	64	3
Shift Reg (K):	1	1
Table (K):	2	4
One Shots (K):	1	1
Controls (K):	32	
I/O (K):	8	

2. Click **Profibus I/O**. The **Profibus I/O** dialog box appears.

3. Select the slave module to be edited from either the Network Tree or the **Master** tab. The **Slave Tab** appears.



Station Type: Slave
DP I/O State: Offline
Device File: SI01801D.GSE
Status: Offline

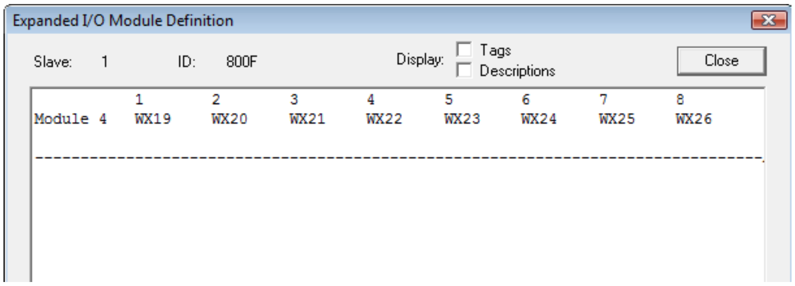
PROFIBUS Address: 2
Station Name:

Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	6ES7 321-1BH0*-0A...	49	16	0	0	0	
2	6ES7 322-1BF0*-0A...	177	0	8	0	0	
3	6ES7 322-1BF0*-0A...	185	0	8	0	0	
4	6ES7 331-7KF0*-0A...	113	0	0	8	0	
5	6ES7 331-7KF0*-0A...	121	0	0	8	0	
6	6ES7 332-5HF00-0A...	129	0	0	0	8	
7	6ES7 332-5HF00-0A...	137	0	0	0	8	
8	Config for Slot1	0	0	0	0	0	
9	Config for Slot2	0	0	0	0	0	
10	Config for Slot3	0	0	0	0	0	
	--- End Slave Config...						

4. Click the **I/O Address** column of the I/O module to configure and enter the starting I/O address. The remaining I/O addresses are assigned automatically according to the number of points available for the module. For example, if you entered ***19*** as the I/O address of a module with 8 WX points, WorkShop assigns addresses 19WX...26WX to the module. This automatic configuration is illustrated when clicking **Expand Definition**:



Slave: 1 ID: 800F

Display: □ Tags □ Descriptions

```
            1      2      3      4      5      6      7      8
Module 4    WX19   WX20   WX21   WX22   WX23   WX24   WX25   WX26

-----------------------------------------------------------------------------
```

5. After entering the I/O address click **Apply** to write the configuration to the controller (online) or to the program file (offline).

The **Slave** tab also allows you to perform the following tasks:

- The **X<->WX** button toggles the image register type for the selected module between discrete and word inputs. To ensure that discrete are toggled to words, the discrete must be on a 16-bit boundary.
- The **Y<->WY** button toggles the image register type for the selected module between discrete and word outputs. To ensure that discrete are toggled to words, the discrete must be on a 16-bit boundary.
- The **Unify** button moves all modules for the selected slave into the first module. Unification is only allowed if all modules are either discrete or words. Only the first address is retained.
- The **Compact** button moves all discrete image register types to word image register types for every module of the selected slave. It then unifies all the modules into the first module. To ensure that discrete are toggled to words, the discrete must be on a 16-bit boundary. Only the first address is retained.
- The **Restore** button restores modules for the selected slave according to the configuration, including the image register types. Zero addresses are assumed for all but the first address, which is kept.
- The **Smart Connect** button allows you to perform actions on Smart Connect modules for the selected slave device.

Accommodating Additional Profibus Masters

In order to take into account the target rotation time of a master not contained in the Profibus Configurator, proceed as follows:

1. Fully configure both master systems. This results in a target rotation time **(Ttr)** for each master system:

   - **Ttr1 -** Calculated by the Profibus Configurator

   - **Ttr2** - Calculated by another software tool

   The sum of the two target rotation times is the final target rotation time.

2. Go to the Bus Parameters tab.

3. Note the target rotation time **(Ttr)** calculated by the Profibus Configurator.

4. Enter the sum of **Ttr1** and **Ttr2** in the **Delta Ttr** parameter field.

5. When you click the **Calculate**, the configurator calculates the new target rotation time (Ttr) in bit time (t_bit) units.

6. In the non-505 master system, add the target rotation time (**Ttr1**) noted under step 3 to the target rotation time (**Ttr2**) of the non-505 master system.

Limited Editing Mode

A situation may occur in which the Profibus configuration exists with the WorkShop program but the associated device master files (GSD) are either not present in the localHardware Directoryor not an exact match with the GSD parameter data within the Hardware Directory. The most likely scenarios in which this situation is present include the following:

- The configuration data was merged from COM Profibus, and the associated GSD(s) were not added to or are different than those in the Hardware Directory.

- An online attach to the controller was executed, without loading a program file.

In these scenarios, the Profibus Configurator is placed into limited editing mode. Limited editing mode affects many areas of the Profibus Configurator. See the table below for specific editing restrictions.

Location	Restricted Operations
Master Tab	The user is unable to add or remove any slave device
Bus Parameters Tab	The user is unable to modify bus parameters
Slave Tab	The user is unable to add or remove any I/O module
Parameters Tab	The user is unable to add or change parameters

WorkShop will provide a warning message stating that your configuration has been placed in limited editing mode. To ensure that you have full editing capabilities after merging your configuration from COM Profibus, please see Migrating from COM Profibus to the Profibus Configurator.

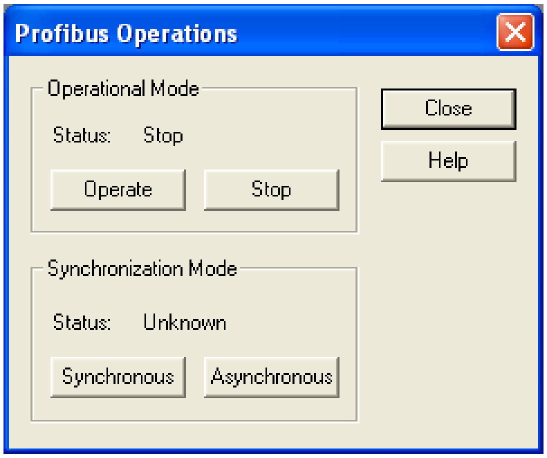
Limited editing mode does not affect online operation of the Profibus devices on the network. Instead, it only restricts the editing or updating of the Profibus configuration in your WorkShop program. If you do not anticipate any changes needing to be made to the configuration, you need not be concerned about the effects of limited editing mode on your processes. However, if you plan to make changes to the configuration and you no longer have access to the files needed to merge a fully editable configuration, you will need to recreate your configuration using the Profibus Configurator.

Profibus Operations

Profibus Operations allows you to change the operations mode from Operate to Stop, or Stop to Operate. You can also select from Synchronous to Asynchronous, or Asynchronous to Synchronous.

To open the Profibus Operations dialog box while online with the controller:

1. Click **Profibus Ops**. on the Profibus I/O dialog box or click **Profibus Operations** from the **PLC Utilities** menu. The Profibus Operations dialog box appears.



Status: Stop

Status: Unknown

Operational Mode

- **Operate -** Places Profibus I/O communications in operate mode, meaning active communication is being made between the master and slave modules (unless master is in a fault state).

- **Stop -** Places Profibus I/O communications in stop mode, meaning active communication is not being made between the master and slaves (unless the master is in a fault state).

Synchronization Mode

- **Synchronous -** Synchronizes Profibus communications to the RLL scan.

- **Asynchronous -** Profibus communications is independent to the RLL scan.

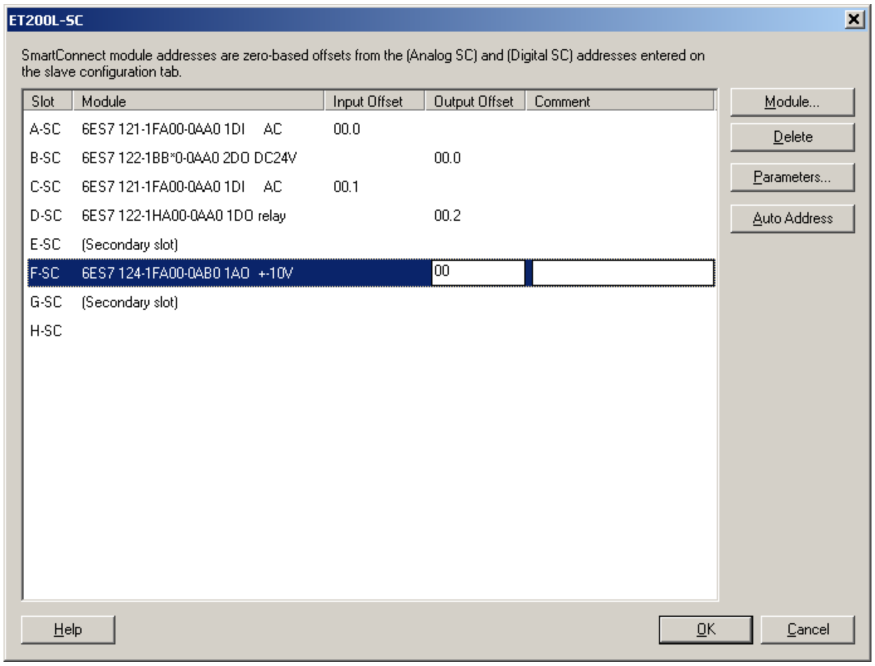
NOTE: If your Profibus communications are in Operate mode, modifying your existing configuration can affect your ongoing process. Unexpected process operation could cause serious injury or death to personnel, and/or damage to equipment. Be prepared for the effect on your process, and take any necessary safeguards, if you choose to update your bus configuration or add and modify slave devices while your Profibus communications are in Operate mode.

Working with Smart Connect Modules

SMART CONNECT CONFIGURATOR

Click **Smart Connect** on the **Slave** tab of the Profibus Configurator to open the Smart Connect Configurator. (For more information on accessing the **Slave** tab, see *Slave Tab*).

The following information is displayed in the Smart Connect Configurator.



ET200L-SC

SmartConnect module addresses are zero-based offsets from the (Analog SC) and (Digital SC) addresses entered on the slave configuration tab.

Slot	Module	Input Offset	Output Offset	Comment
A-SC	6ES7 121-1FA00-0AA0 1DI AC	00.0		
B-SC	6ES7 122-1BB*0-0AA0 2DO DC24V		00.0	
C-SC	6ES7 121-1FA00-0AA0 1DI AC	00.1		
D-SC	6ES7 122-1HA00-0AA0 1DO relay		00.2	
E-SC	(Secondary slot)			
F-SC	6ES7 124-1FA00-0AB0 1AO +-10V		00	
G-SC	(Secondary slot)			
H-SC				

Slot	Identifies the slot on the terminal block where the Smart-Connect module is located.
Module	The name of the SmartConnect module.
Input Offset	The amount of the input offset, based on the address for the slave displayed on the **Slave** tab.
Output Offset	The amount of the output offset, based on the address for the slave displayed on the **Slave** tab.
Comment	An optional user-defined comment.

You can perform the following actions from the Smart Connect Configurator:

- Click **Module** to add a Smart Connect module.
  See Add a Smart Connect Module for additional information about adding Smart Connect modules.

- Click **Delete** to delete the selected module.
  See Delete a Smart Connect Module for additional information about deleting Smart Connect modules.

- Click **Parameters** to specify the parameters of the selected module. Not all modules have parameters that are modifiable.
  See Smart Connect Module Parameters for additional information about modifying the parameters of a Smart Connect module.

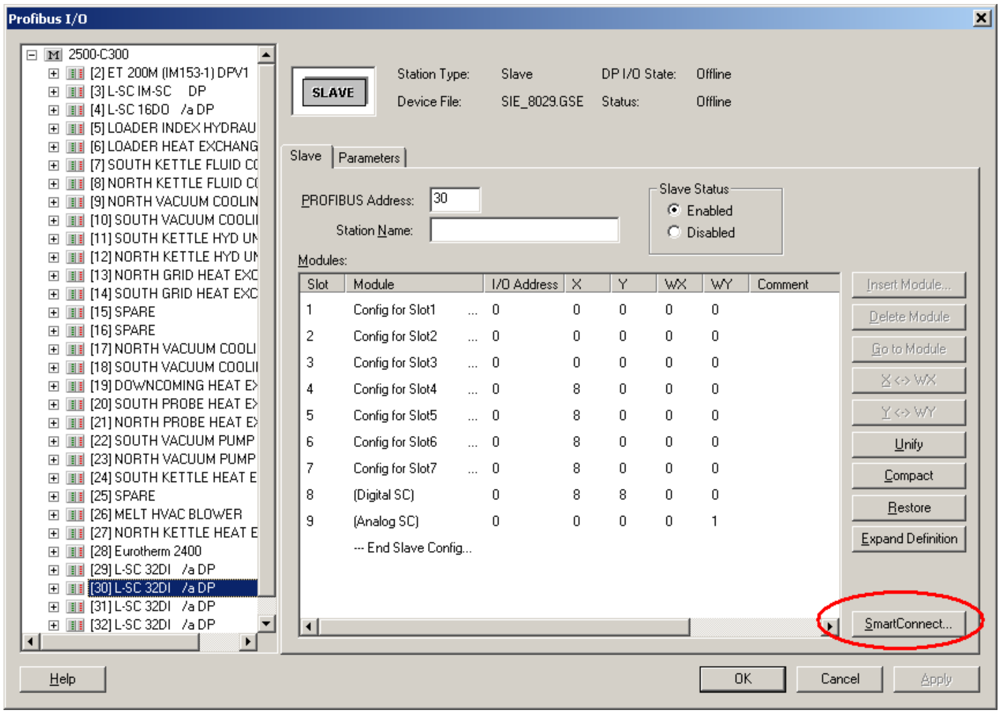
- Enter the Input Offset, Output Offset, and comments for all of the Smart Connect modules associated with a slave.
  See Enter Input Offset, Output Offset, and Comments for more information.

Add a Smart Connect Module

To add a Smart Connect module to a slave that supports Smart Connect modules:

1. In the Profibus Configurator, click a slave that supports Smart Connect. See *Configuring and Addressing Profibus I/O Modules* for additional information about the Profibus Configurator.

2. Click **Smart Connect** to open the Smart Connect Configurator.



Profibus I/O

2500-C300
[2] ET 200M (IM153-1) DPV1
[3] L-SC IM-SC DP
[4] L-SC 16DO /a DP
[5] LOADER INDEX HYDRAU
[6] LOADER HEAT EXCHANG
[7] SOUTH KETTLE FLUID C(
[8] NORTH KETTLE FLUID C(
[9] NORTH VACUUM COOLIN
[10] SOUTH VACUUM COOLI
[11] SOUTH KETTLE HYD UN
[12] NORTH KETTLE HYD UN
[13] NORTH GRID HEAT EXC
[14] SOUTH GRID HEAT EXC
[15] SPARE
[16] SPARE
[17] NORTH VACUUM COOLI
[18] SOUTH VACUUM COOLI
[19] DOWNCOMING HEAT E>
[20] SOUTH PROBE HEAT E>
[21] NORTH PROBE HEAT E>
[22] SOUTH VACUUM PUMP
[23] NORTH VACUUM PUMP
[24] SOUTH KETTLE HEAT E
[25] SPARE
[26] MELT HVAC BLOWER
[27] NORTH KETTLE HEAT E
[28] Eurotherm 2400
[29] L-SC 32DI /a DP
[30] L-SC 32DI /a DP
[31] L-SC 32DI /a DP
[32] L-SC 32DI /a DP

SLAVE

Station Type: Slave
Device File: SIE_8029.GSE
DP I/O State: Offline
Status: Offline

Slave | Parameters

PROFIBUS Address: 30
Station Name:

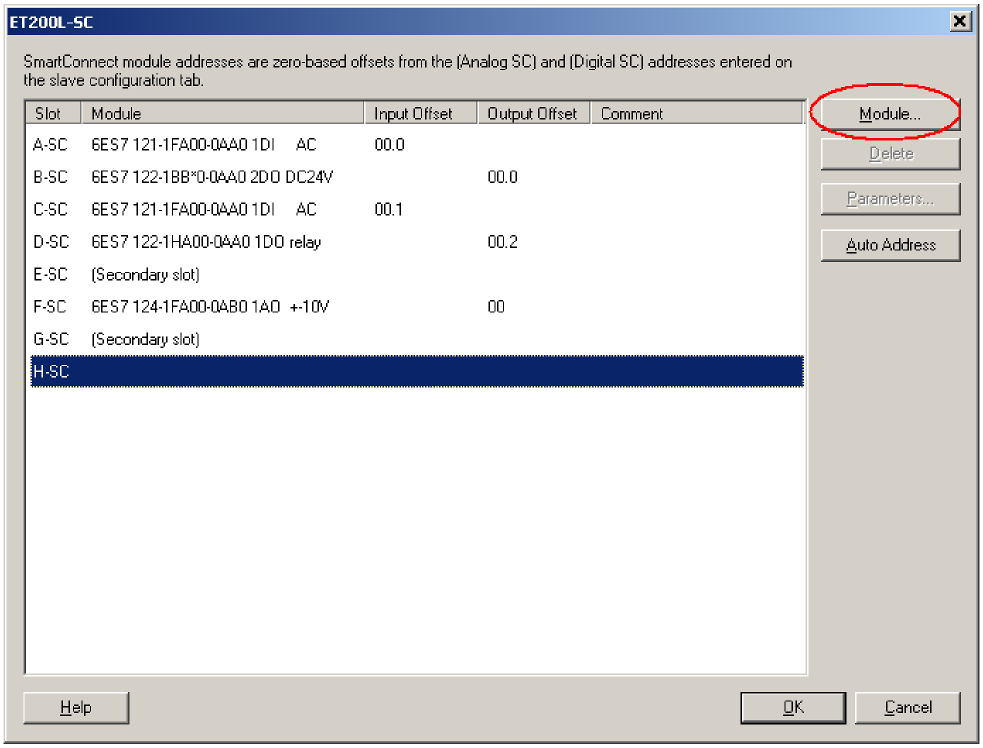
Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module		I/O Address	X	Y	WX	WY	Comment
1	Config for Slot1	...	0	0	0	0	0	
2	Config for Slot2	...	0	0	0	0	0	
3	Config for Slot3	...	0	0	0	0	0	
4	Config for Slot4	...	0	8	0	0	0	
5	Config for Slot5	...	0	8	0	0	0	
6	Config for Slot6	...	0	8	0	0	0	
7	Config for Slot7	...	0	8	0	0	0	
8	(Digital SC)		0	8	8	0	0	
9	(Analog SC)		0	0	0	0	1	
	--- End Slave Config...							

> **NOTE:** If the **Smart Connect** button is not enabled, then the selected slave does not support Smart Connect, or the slave is associated with a master device file that does not support Smart Connect.

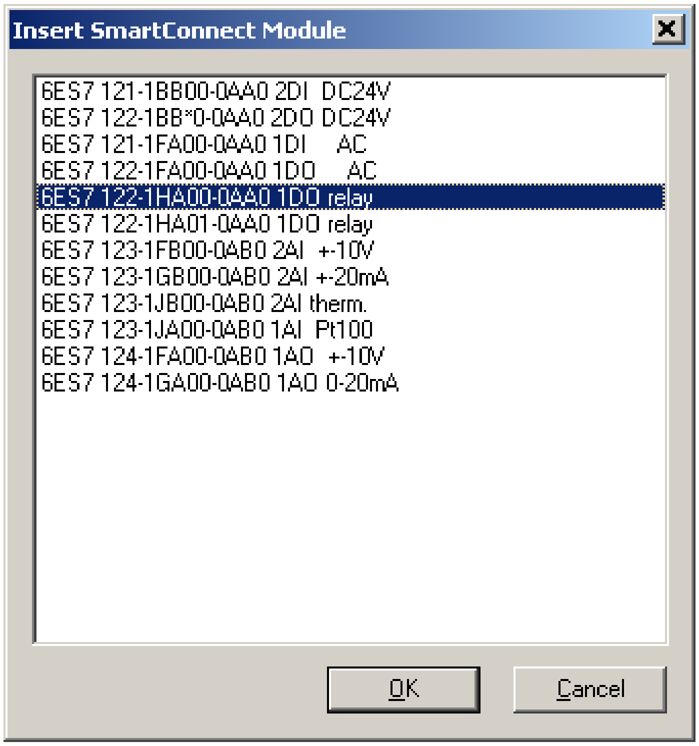
3. In the Smart Connect Configurator, click **Module**.



SmartConnect module addresses are zero-based offsets from the (Analog SC) and (Digital SC) addresses entered on the slave configuration tab.

Slot	Module	Input Offset	Output Offset	Comment
A-SC	6ES7 121-1FA00-0AA0 1DI AC	00.0		
B-SC	6ES7 122-1BB*0-0AA0 2DO DC24V		00.0	
C-SC	6ES7 121-1FA00-0AA0 1DI AC	00.1		
D-SC	6ES7 122-1HA00-0AA0 1DO relay		00.2	
E-SC	(Secondary slot)			
F-SC	6ES7 124-1FA00-0AB0 1AO +-10V		00	
G-SC	(Secondary slot)			
H-SC				

4. In the **Insert Smart Connect Module** window, click the module you want to add, and then click **OK**.

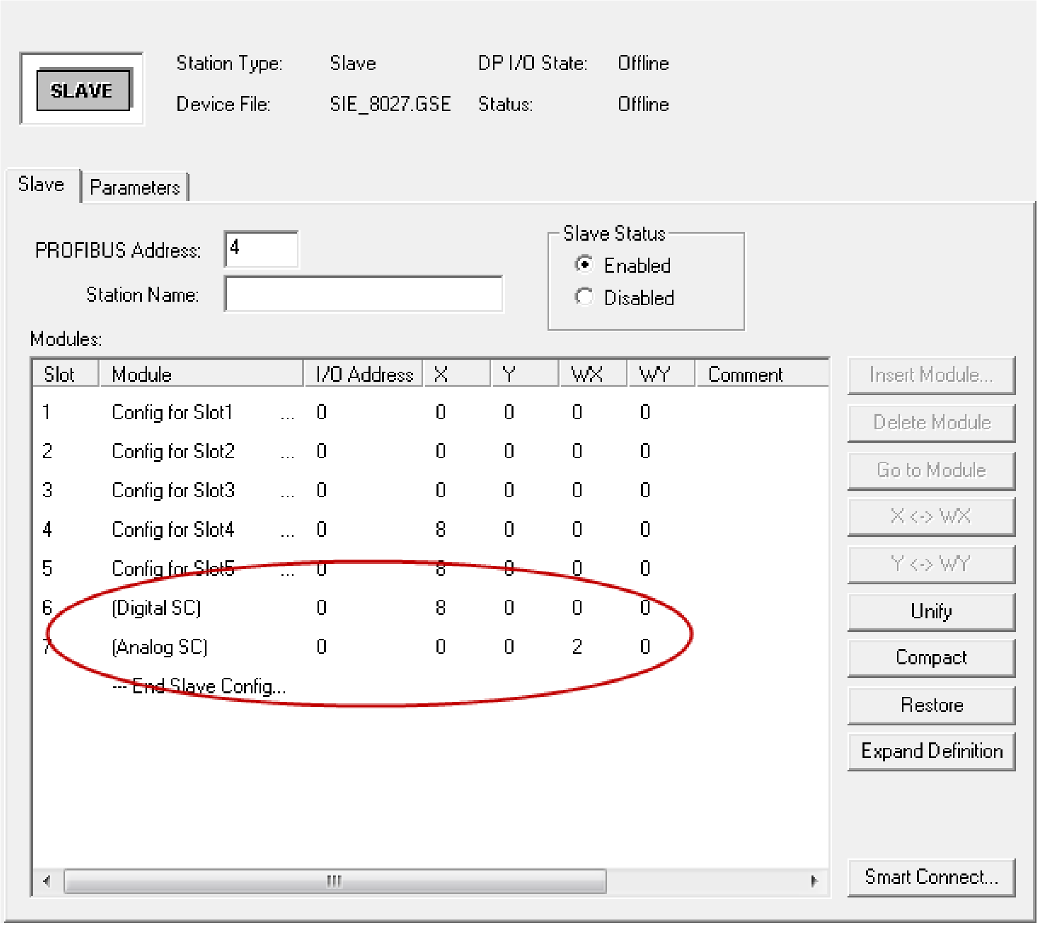


Insert SmartConnect Module

6ES7 121-1BB00-0AA0 2DI DC24V
6ES7 122-1BB*0-0AA0 2DO DC24V
6ES7 121-1FA00-0AA0 1DI AC
6ES7 122-1FA00-0AA0 1DO AC
6ES7 122-1HA00-0AA0 1DO relay
6ES7 122-1HA01-0AA0 1DO relay
6ES7 123-1FB00-0AB0 2AI +-10V
6ES7 123-1GB00-0AB0 2AI +-20mA
6ES7 123-1JB00-0AB0 2AI therm.
6ES7 123-1JA00-0AB0 1AI Pt100
6ES7 124-1FA00-0AB0 1AO +-10V
6ES7 124-1GA00-0AB0 1AO 0-20mA

After a Smart Connect Module is added, pseudo modules (or dummy modules) are displayed on the **Slave** tab. These modules are named **Digital SC** and **Analog SC**. They are used to define the base I/O address from which the Smart Connect modules are offset.

- **Digital SC** defines the base addresses for X/Y addresses.
- **Analog SC** defines the base addresses for WX/WY addresses.



Station Type: Slave
Device File: SIE_8027.GSE
DP I/O State: Offline
Status: Offline

PROFIBUS Address: 4
Station Name:

Slave Status
● Enabled
○ Disabled

Modules:

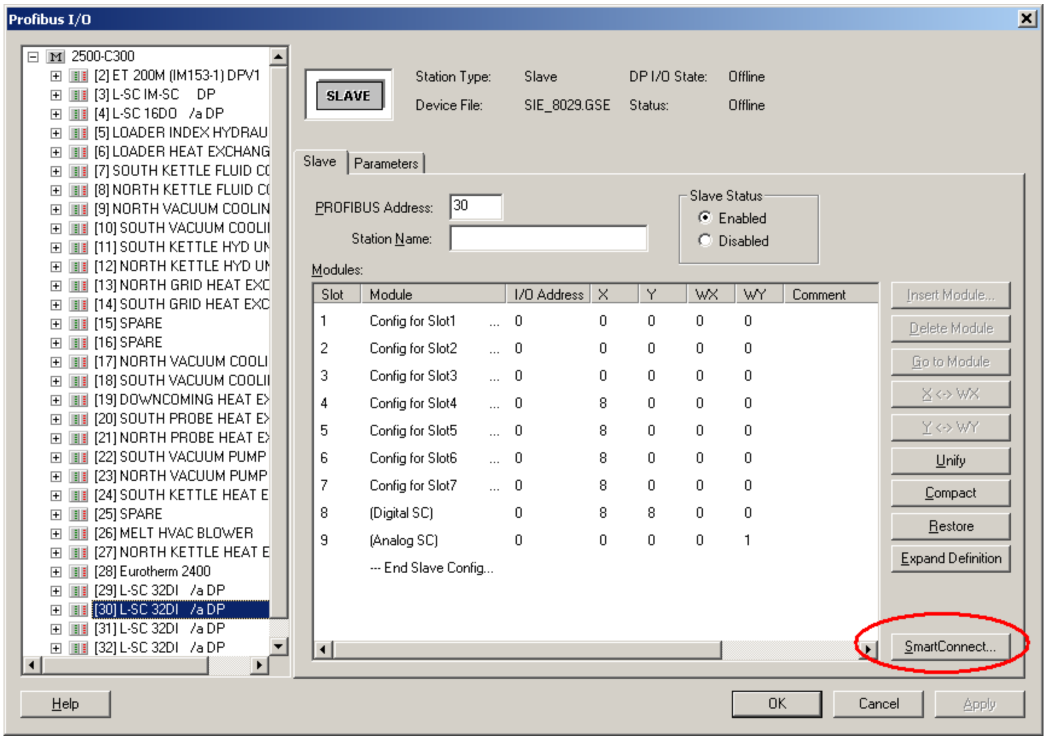
Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	Config for Slot1 ...	0	0	0	0	0	
2	Config for Slot2 ...	0	0	0	0	0	
3	Config for Slot3 ...	0	0	0	0	0	
4	Config for Slot4 ...	0	8	0	0	0	
5	Config for Slot5 ...	0	8	0	0	0	
6	(Digital SC)	0	8	0	0	0	
7	(Analog SC)	0	0	0	2	0	
	--- End Slave Config...						

DELETE A SMART CONNECT MODULE

To delete a Smart Connect module from a slave that supports Smart Connect modules:

1. In the Profibus Configurator, click the slave associated with the Smart Connect module you want to delete. See *Configuring and Addressing Profibus I/O Modules* for additional information about the Profibus Configurator.

2. Click **Smart Connect** to open the Smart Connect Configurator.



Profibus I/O

- 2500-C300
  - [2] ET 200M (IM153-1) DPV1
  - [3] L-SC IM-SC DP
  - [4] L-SC 16DO /a DP
  - [5] LOADER INDEX HYDRAU
  - [6] LOADER HEAT EXCHANG
  - [7] SOUTH KETTLE FLUID CO
  - [8] NORTH KETTLE FLUID CO
  - [9] NORTH VACUUM COOLIN
  - [10] SOUTH VACUUM COOLI
  - [11] SOUTH KETTLE HYD UN
  - [12] NORTH KETTLE HYD UN
  - [13] NORTH GRID HEAT EXC
  - [14] SOUTH GRID HEAT EXC
  - [15] SPARE
  - [16] SPARE
  - [17] NORTH VACUUM COOLI
  - [18] SOUTH VACUUM COOLI
  - [19] DOWNCOMING HEAT EX
  - [20] SOUTH PROBE HEAT EX
  - [21] NORTH PROBE HEAT EX
  - [22] SOUTH VACUUM PUMP
  - [23] NORTH VACUUM PUMP
  - [24] SOUTH KETTLE HEAT E
  - [25] SPARE
  - [26] MELT HVAC BLOWER
  - [27] NORTH KETTLE HEAT E
  - [28] Eurotherm 2400
  - [29] L-SC 32DI /a DP
  - [30] L-SC 32DI /a DP
  - [31] L-SC 32DI /a DP
  - [32] L-SC 32DI /a DP

SLAVE

Station Type: Slave
Device File: SIE_8029.GSE
DP I/O State: Offline
Status: Offline

Slave | Parameters

PROFIBUS Address: 30
Station Name:

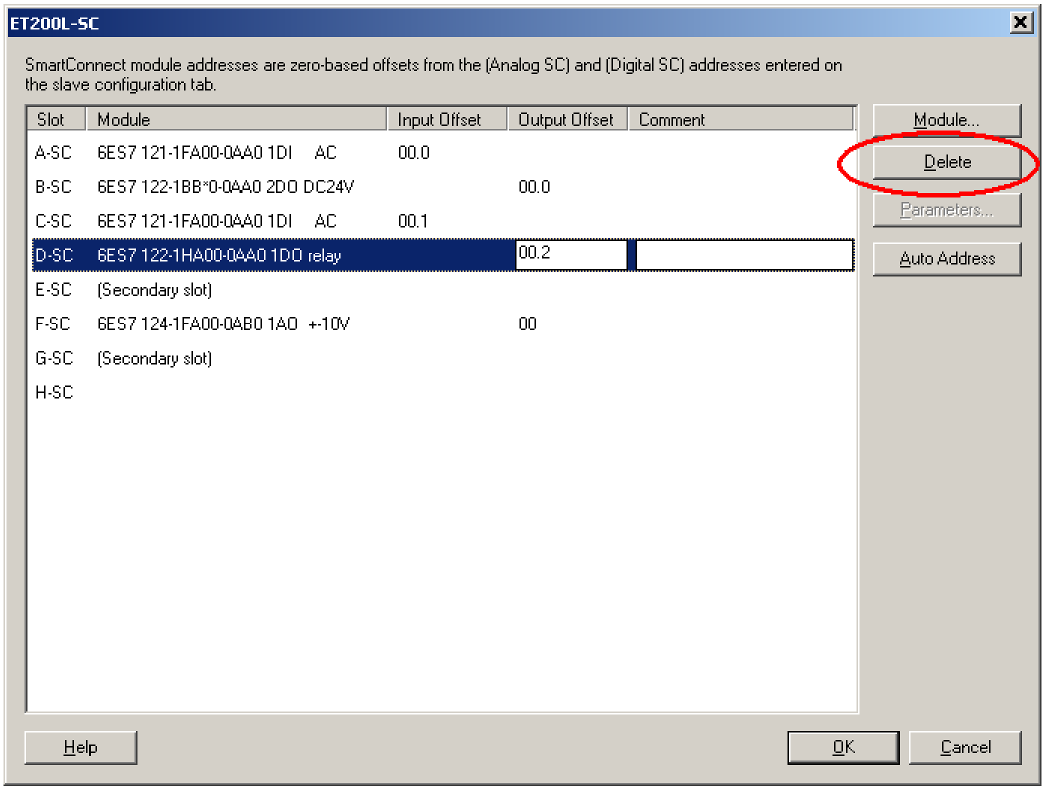
Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	Config for Slot1 ...	0	0	0	0	0	
2	Config for Slot2 ...	0	0	0	0	0	
3	Config for Slot3 ...	0	0	0	0	0	
4	Config for Slot4 ...	0	8	0	0	0	
5	Config for Slot5 ...	0	8	0	0	0	
6	Config for Slot6 ...	0	8	0	0	0	
7	Config for Slot7 ...	0	8	0	0	0	
8	(Digital SC)	0	8	8	0	0	
9	(Analog SC)	0	0	0	0	1	
	--- End Slave Config...						

NOTE: If the **SmartConnect** button is not enabled, then the selected slave does not support Smart Connect, or the slave is associated with a master device file that does not support Smart Connect.

3. In the Smart Connect Configurator, select the module you want to delete.



SmartConnect module addresses are zero-based offsets from the (Analog SC) and (Digital SC) addresses entered on the slave configuration tab.

Slot	Module	Input Offset	Output Offset	Comment
A-SC	6ES7 121-1FA00-0AA0 1DI AC	00.0		
B-SC	6ES7 122-1BB*0-0AA0 2DO DC24V		00.0	
C-SC	6ES7 121-1FA00-0AA0 1DI AC	00.1		
D-SC	6ES7 122-1HA00-0AA0 1DO relay		00.2	
E-SC	(Secondary slot)			
F-SC	6ES7 124-1FA00-0AB0 1AO +-10V		00	
G-SC	(Secondary slot)			
H-SC				

4. Click **Delete**.

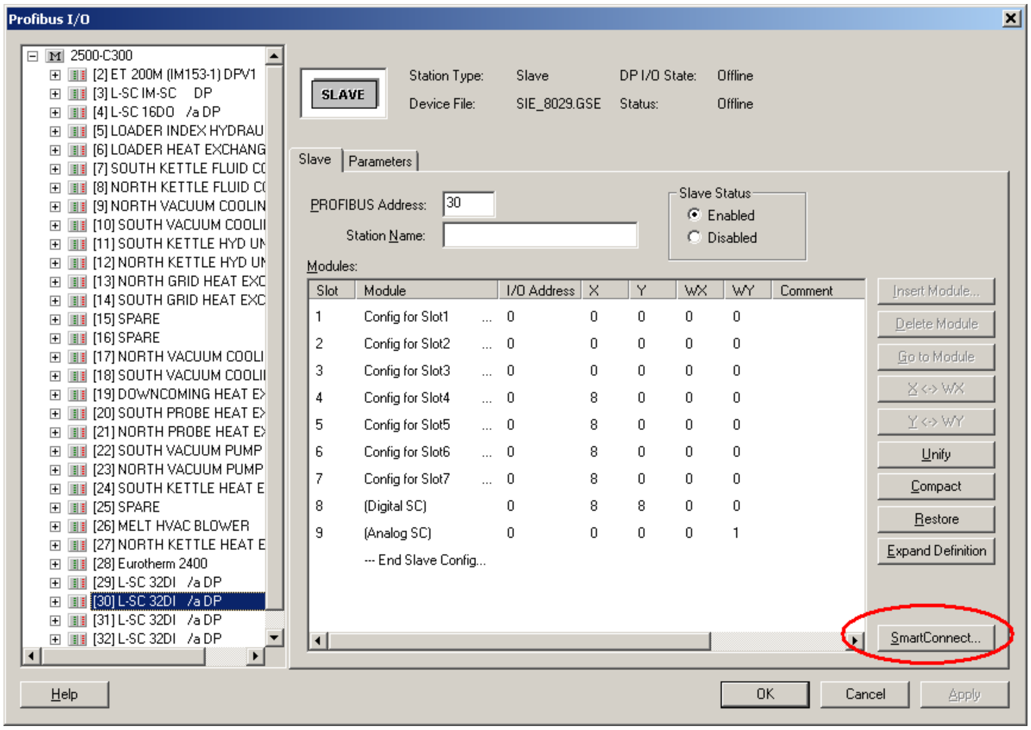
   The selected module is deleted.

Modify the Parameters of a Smart Connect Module

To modify the parameters of a Smart Connect module associated with a slave that supports Smart Connect modules:

1. In the Profibus Configurator, click the slave associated with the Smart Connect module whose parameters you want to modify. See *Configuring and Addressing Profibus I/O Modules* for additional information about the Profibus Configurator.

2. Click **Smart Connect** to open the Smart Connect Configurator.



2500-C300
- [2] ET 200M (IM153-1) DPV1
- [3] L-SC IM-SC DP
- [4] L-SC 16DO /a DP
- [5] LOADER INDEX HYDRAU
- [6] LOADER HEAT EXCHANG
- [7] SOUTH KETTLE FLUID CO
- [8] NORTH KETTLE FLUID CO
- [9] NORTH VACUUM COOLIN
- [10] SOUTH VACUUM COOLI
- [11] SOUTH KETTLE HYD UN
- [12] NORTH KETTLE HYD UN
- [13] NORTH GRID HEAT EXC
- [14] SOUTH GRID HEAT EXC
- [15] SPARE
- [16] SPARE
- [17] NORTH VACUUM COOLI
- [18] SOUTH VACUUM COOLI
- [19] DOWNCOMING HEAT EX
- [20] SOUTH PROBE HEAT EX
- [21] NORTH PROBE HEAT EX
- [22] SOUTH VACUUM PUMP
- [23] NORTH VACUUM PUMP
- [24] SOUTH KETTLE HEAT E
- [25] SPARE
- [26] MELT HVAC BLOWER
- [27] NORTH KETTLE HEAT E
- [28] Eurotherm 2400
- [29] L-SC 32DI /a DP
- [30] L-SC 32DI /a DP
- [31] L-SC 32DI /a DP
- [32] L-SC 32DI /a DP

Station Type: Slave DP I/O State: Offline
Device File: SIE_8029.GSE Status: Offline

PROFIBUS Address: 30
Station Name:

Slave Status
● Enabled
○ Disabled

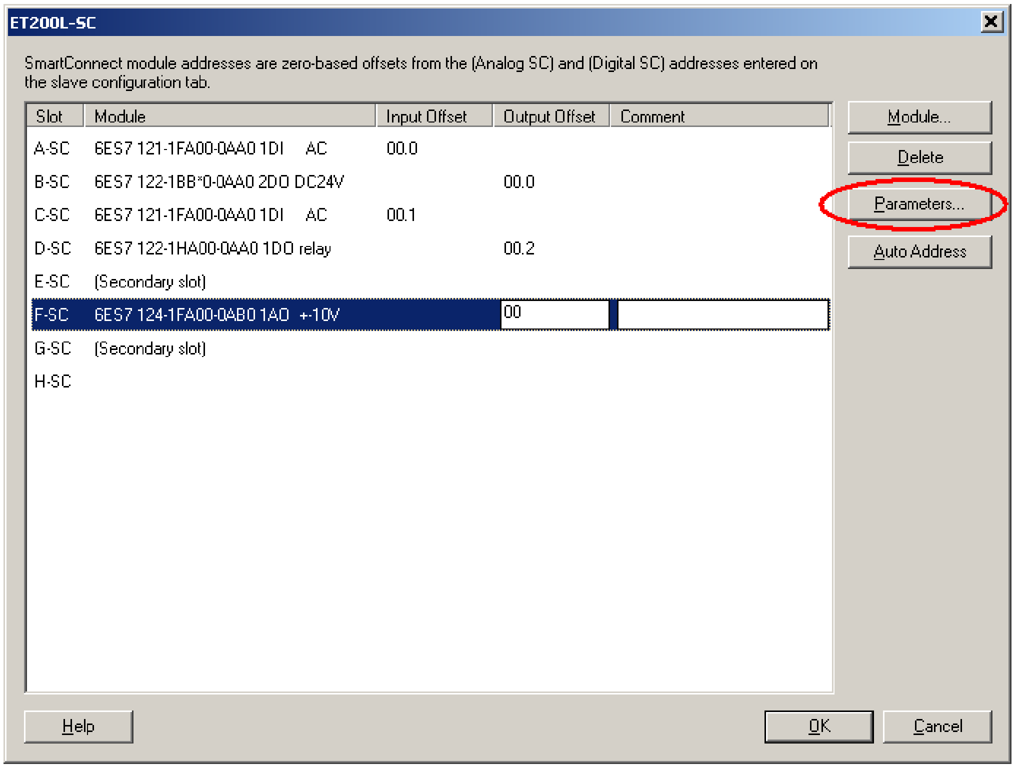
Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	Config for Slot1 ...	0	0	0	0	0	
2	Config for Slot2 ...	0	0	0	0	0	
3	Config for Slot3 ...	0	0	0	0	0	
4	Config for Slot4 ...	0	8	0	0	0	
5	Config for Slot5 ...	0	8	0	0	0	
6	Config for Slot6 ...	0	8	0	0	0	
7	Config for Slot7 ...	0	8	0	0	0	
8	(Digital SC)	0	8	8	0	0	
9	(Analog SC)	0	0	0	0	1	
	--- End Slave Config...						

NOTE: If the **Smart Connect** button is not enabled, then the selected slave does not support Smart Connect, or the slave is associated with a master device file that does not support Smart Connect.

3. In the Smart Connect Configurator, select the module whose parameters you want to modify.

4. Click the **Parameters** button.



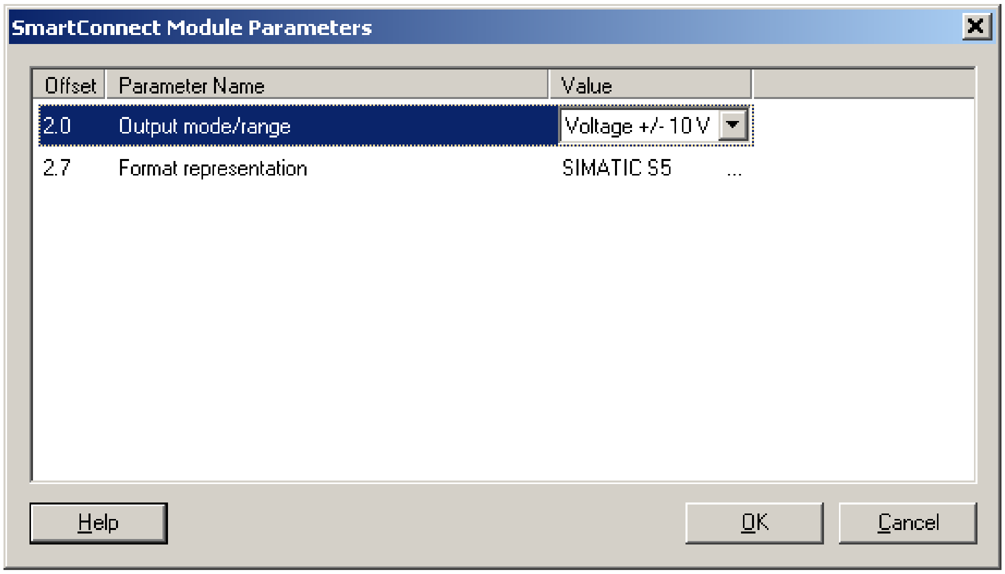
ET200L-SC

SmartConnect module addresses are zero-based offsets from the (Analog SC) and (Digital SC) addresses entered on the slave configuration tab.

Slot	Module	Input Offset	Output Offset	Comment
A-SC	6ES7 121-1FA00-0AA0 1DI AC	00.0		
B-SC	6ES7 122-1BB*0-0AA0 2DO DC24V		00.0	
C-SC	6ES7 121-1FA00-0AA0 1DI AC	00.1		
D-SC	6ES7 122-1HA00-0AA0 1DO relay		00.2	
E-SC	(Secondary slot)			
F-SC	6ES7 124-1FA00-0AB0 1AO +-10V		00	
G-SC	(Secondary slot)			
H-SC				

NOTE: If the **Parameters** button is not enabled, the selected Smart Connect module does not have parameters that can be modified.

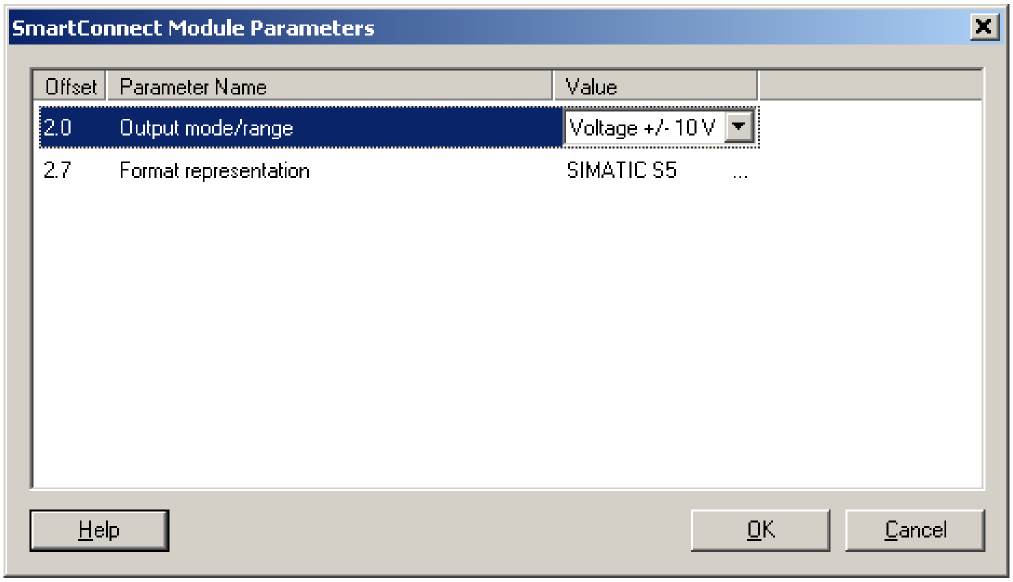
5. Modify the parameters as required. See *Smart Connect Module Parameters* for additional information.



Offset	Parameter Name	Value
2.0	Output mode/range	Voltage +/- 10 V
2.7	Format representation	SIMATIC S5 ...

SMART CONNECT MODULE PARAMETERS

Configurable parameters for the selected Smart Connect Module are displayed in the Smart Connect Module Parameters window.



Offset	Parameter Name	Value
2.0	Output mode/range	Voltage +/- 10 V
2.7	Format representation	SIMATIC S5 ...

Information is shown in the following columns:

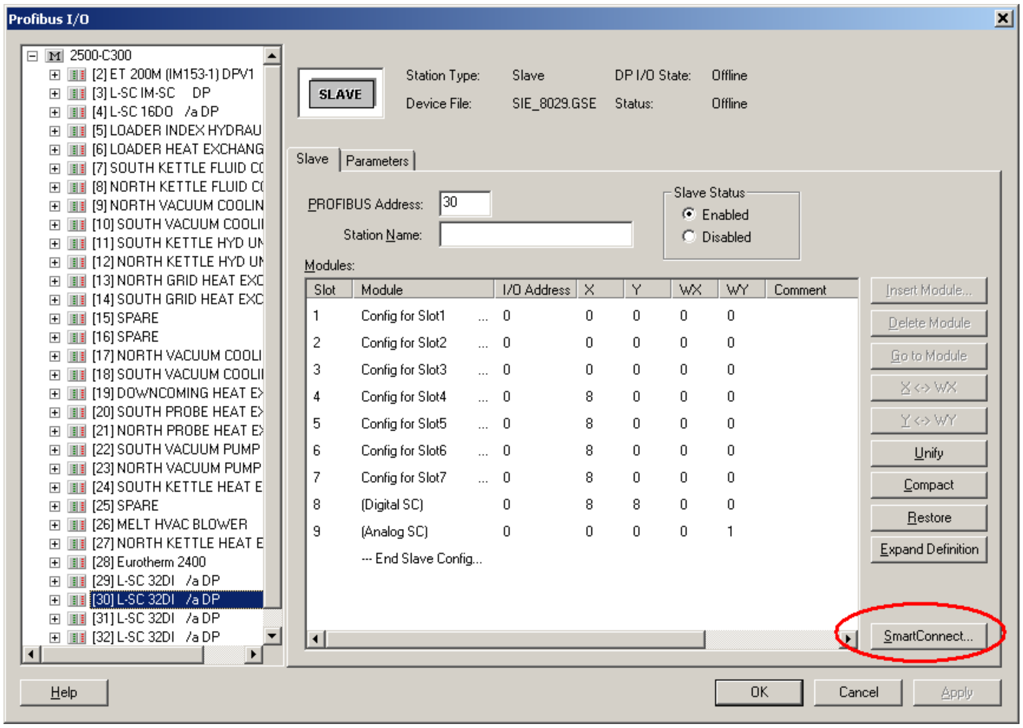
Column Name	Description
Offset	The memory offset of the parameter. This is in the format of **B.b** where **B** is the byte offset, and **b** is the bit number.
Parameter Name	The name of the parameter. This information is retrieved from the device master file.
Value	The value of the parameter string. To change this value from the default, click the item and select the new value from the drop-down menu.

ENTER INPUT OFFSET, OUTPUT OFFSET, AND COMMENTS VALUES

To enter the input offset, the output offset, and comments for Smart Connect modules:

1. In the Profibus Configurator, click the slave associated with the Smart Connect module whose offset values you want to modify. See *Configuring and Addressing Profibus I/O Modules* for additional information about the Profibus Configurator.

2. Click **Smart Connect** to open the Smart Connect Configurator.



2500-C300
[2] ET 200M (IM153-1) DPV1
[3] L-SC IM-SC DP
[4] L-SC 16DO /a DP
[5] LOADER INDEX HYDRAU
[6] LOADER HEAT EXCHANG
[7] SOUTH KETTLE FLUID CO
[8] NORTH KETTLE FLUID CO
[9] NORTH VACUUM COOLIN
[10] SOUTH VACUUM COOLI
[11] SOUTH KETTLE HYD UN
[12] NORTH KETTLE HYD UN
[13] NORTH GRID HEAT EXC
[14] SOUTH GRID HEAT EXC
[15] SPARE
[16] SPARE
[17] NORTH VACUUM COOLI
[18] SOUTH VACUUM COOLI
[19] DOWNCOMING HEAT EX
[20] SOUTH PROBE HEAT EX
[21] NORTH PROBE HEAT EX
[22] SOUTH VACUUM PUMP
[23] NORTH VACUUM PUMP
[24] SOUTH KETTLE HEAT E
[25] SPARE
[26] MELT HVAC BLOWER
[27] NORTH KETTLE HEAT E
[28] Eurotherm 2400
[29] L-SC 32DI /a DP
[30] L-SC 32DI /a DP
[31] L-SC 32DI /a DP
[32] L-SC 32DI /a DP

Station Type: Slave
Device File: SIE_8029.GSE
DP I/O State: Offline
Status: Offline

PROFIBUS Address: 30
Station Name:

Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	Config for Slot1 ...	0	0	0	0	0	
2	Config for Slot2 ...	0	0	0	0	0	
3	Config for Slot3 ...	0	0	0	0	0	
4	Config for Slot4 ...	0	8	0	0	0	
5	Config for Slot5 ...	0	8	0	0	0	
6	Config for Slot6 ...	0	8	0	0	0	
7	Config for Slot7 ...	0	8	0	0	0	
8	(Digital SC)	0	8	8	0	0	
9	(Analog SC)	0	0	0	0	1	
	--- End Slave Config...						

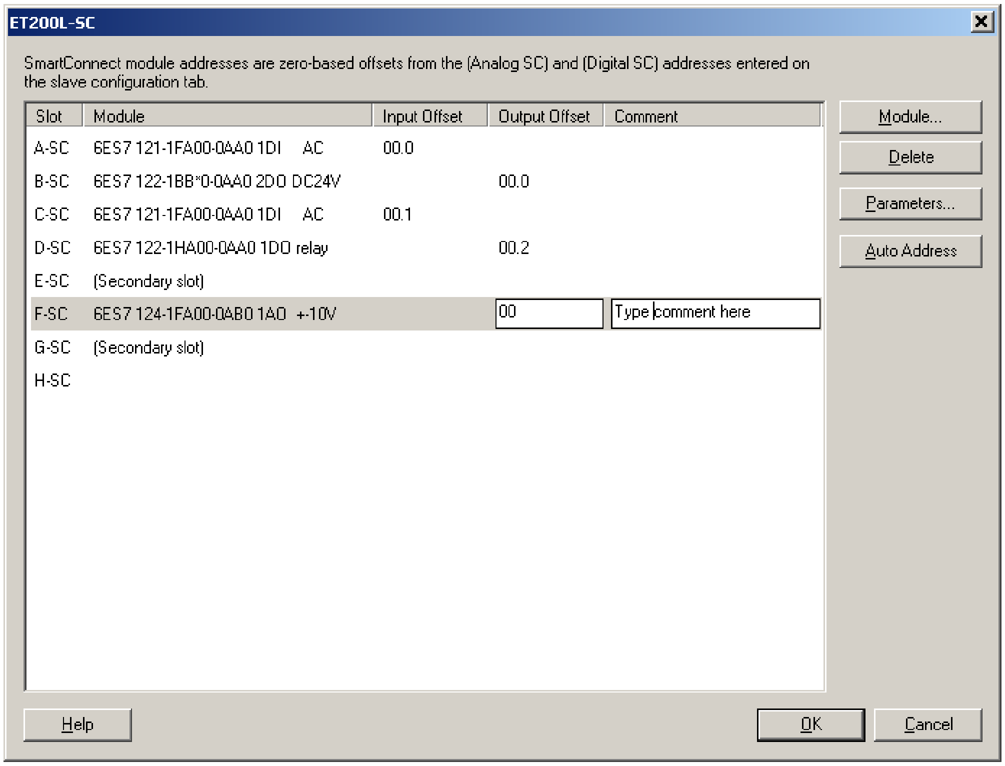
NOTE: If the **Smart Connect** button is not enabled, then the selected slave does not support Smart Connect, or the slave is associated with a master device file that does not support Smart Connect.

3. Do one of the following:

   - To manually enter offset values, first click the **Input Offset** column of a Smart Connect module and then enter the appropriate Input Offset value. Then, click the **Output Offset** column and enter the appropriate Output Offset value. Repeat for each Smart Connect module.

   - To have the offset values automatically set, click the **AutoAddress** button.

NOTE: Input and Output Offset values are offset from the base I/O address associated with the **Digital SC** or **Analog SC** representing the Smart Connect module listed on the **Slave** tab.



ET200L-SC

SmartConnect module addresses are zero-based offsets from the (Analog SC) and (Digital SC) addresses entered on the slave configuration tab.

Slot	Module	Input Offset	Output Offset	Comment
A-SC	6ES7 121-1FA00-0AA0 1DI AC	00.0		
B-SC	6ES7 122-1BB*0-0AA0 2DO DC24V		00.0	
C-SC	6ES7 121-1FA00-0AA0 1DI AC	00.1		
D-SC	6ES7 122-1HA00-0AA0 1DO relay		00.2	
E-SC	(Secondary slot)			
F-SC	6ES7 124-1FA00-0AB0 1AO +-10V		00	Type comment here
G-SC	(Secondary slot)			
H-SC				

4. To type a comment for a Smart Connect module, click the **Comment** column of a Smart Connect module and enter the appropriate comment.

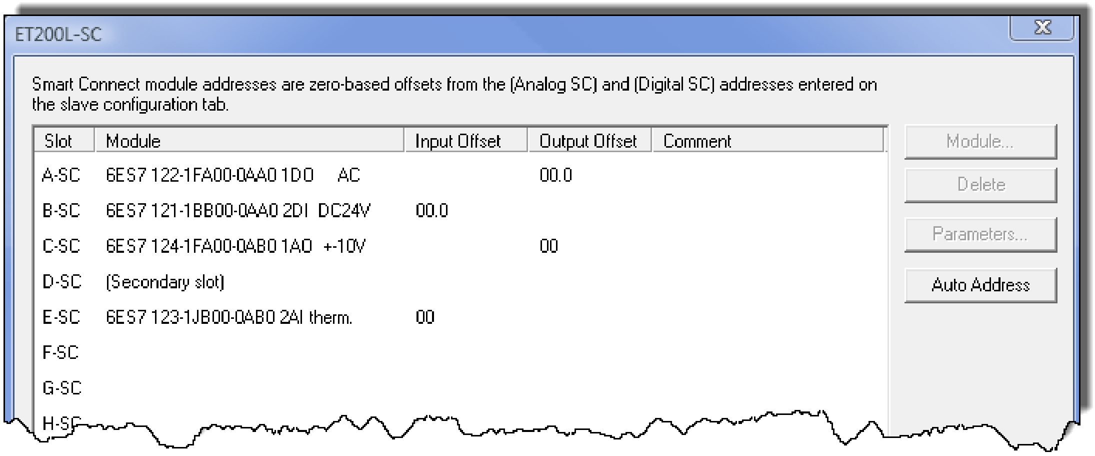
ADDRESSING SMART CONNECT MODULES

When viewing Smart Connect modules on the **Slave** tab, two pseudo modules, or dummy modules, are displayed: **Digital SC** and **Analog SC**. These modules serve to define the base 505 addresses from which the Smart Connect modules are offset. The Digital SC defines the base addresses for X/Y addresses. The Analog SC defines the base addresses for WX/WY addresses.

Both digital inputs and digital outputs are offset from the same Digital SC base address. Both analog inputs and analog outputs are offset from the same Analog SC base address. The inputs come first, then the outputs.

Consider the following example:

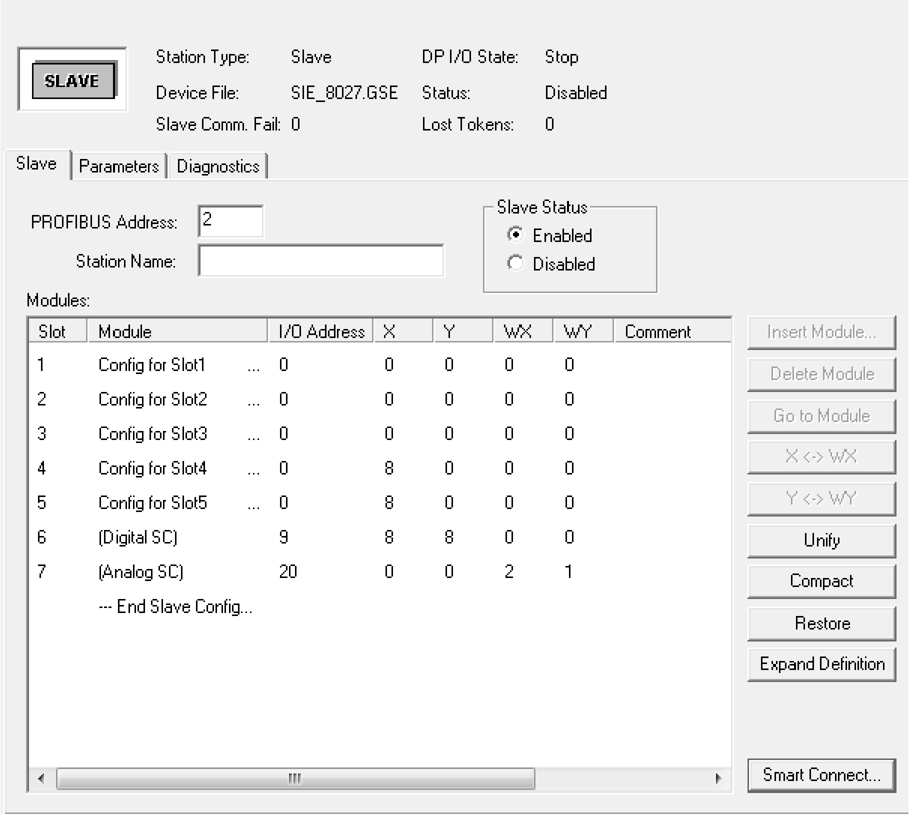
The following image shows the configuration of Smart Connect modules on the Smart Connect Configurator:



Smart Connect module addresses are zero-based offsets from the (Analog SC) and (Digital SC) addresses entered on the slave configuration tab.

Slot	Module	Input Offset	Output Offset	Comment
A-SC	6ES7 122-1FA00-0AA0 1DO AC		00.0	
B-SC	6ES7 121-1BB00-0AA0 2DI DC24V	00.0		
C-SC	6ES7 124-1FA00-0AB0 1AO +-10V		00	
D-SC	(Secondary slot)			
E-SC	6ES7 123-1JB00-0AB0 2AI therm.	00		
F-SC				
G-SC				
H-SC				

The following image shows the configuration of the Smart Connect modules on the Slave tab:



Station Type: Slave
Device File: SIE_8027.GSE
Slave Comm. Fail: 0
DP I/O State: Stop
Status: Disabled
Lost Tokens: 0

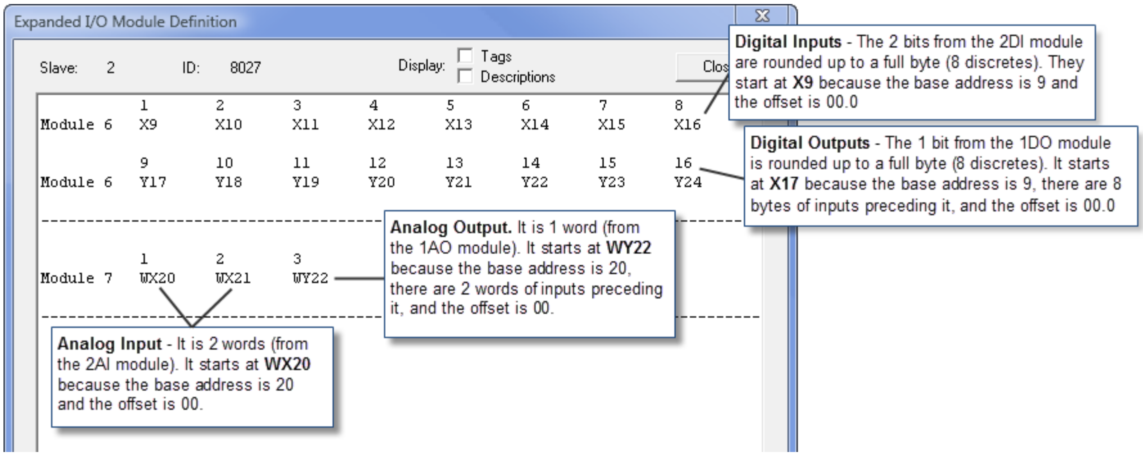
PROFIBUS Address: 2
Station Name:

Slave Status
● Enabled
○ Disabled

Modules:

Slot	Module	I/O Address	X	Y	WX	WY	Comment
1	Config for Slot1 ...	0	0	0	0	0	
2	Config for Slot2 ...	0	0	0	0	0	
3	Config for Slot3 ...	0	0	0	0	0	
4	Config for Slot4 ...	0	8	0	0	0	
5	Config for Slot5 ...	0	8	0	0	0	
6	(Digital SC)	9	8	8	0	0	
7	(Analog SC)	20	0	0	2	1	
	--- End Slave Config...						

The following image shows the resulting addresses:



Expanded I/O Module Definition
Display: □ Tags □ Descriptions
Clos

Slave: 2 ID: 8027

```
         1      2      3      4      5      6      7      8
Module 6 X9     X10    X11    X12    X13    X14    X15    X16

         9      10     11     12     13     14     15     16
Module 6 Y17    Y18    Y19    Y20    Y21    Y22    Y23    Y24
-----------------------------------------------------------------

         1      2      3
Module 7 WX20   WX21   WY22
-----------------------------------------------------------------
```

Digital Inputs - The 2 bits from the 2DI module are rounded up to a full byte (8 discretes). They start at **X9** because the base address is 9 and the offset is 00.0

Digital Outputs - The 1 bit from the 1DO module is rounded up to a full byte (8 discretes). It starts at **X17** because the base address is 9, there are 8 bytes of inputs preceding it, and the offset is 00.0

Analog Output. It is 1 word (from the 1AO module). It starts at **WY22** because the base address is 20, there are 2 words of inputs preceding it, and the offset is 00.

Analog Input - It is 2 words (from the 2AI module). It starts at **WX20** because the base address is 20 and the offset is 00.

DETERMINING ADDRESSES OF SMART CONNECT MODULES

The following procedures can be used to determine the addresses of Smart Connect Modules:

DIGITAL INPUT MODULE:

- The starting address of each module is an X address with the following address number:
  `(Base Digital Address) + (Input Offset Byte * 8) + (Input Offset Bit)`

DIGITAL OUTPUT MODULE:

- The highest-numbered digital input offset is located, the discrete inputs provided by that module are added, and the resulting offset is rounded up to the nearest whole byte. This gives the number of X addresses that must be skipped before starting the output addressing.

- The starting address of each module is a Y address with the following address number:
  `(Base Digital Address) + (Number of X Addresses) + (Output Offset Byte * 8) + (Output Offset Bit)`

ANALOG INPUT MODULE:

- The starting address of each module is a WX address with the following address number:
  `(Base Analog Address) + (Input Offset Byte / 2)`

ANALOG OUTPUT MODULE:

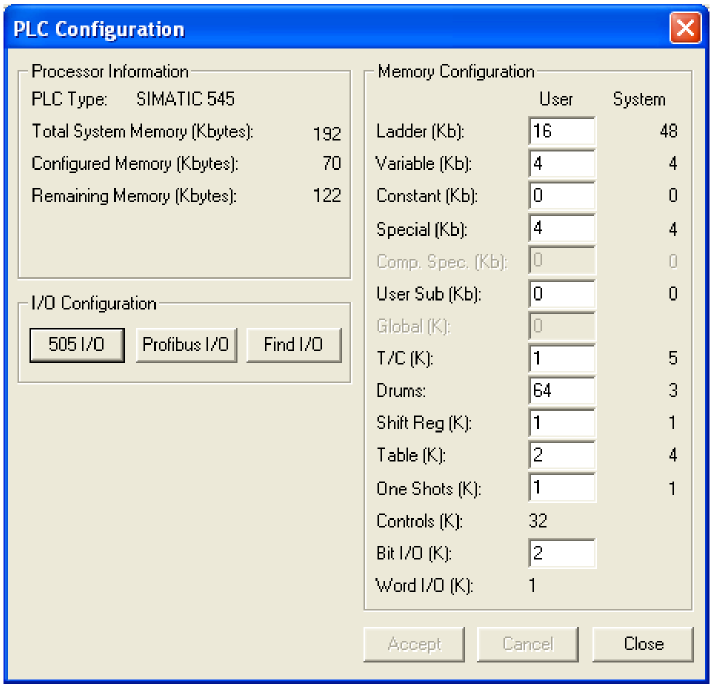
- The highest-numbered analog input offset is located, the analog input bytes provided by that module are added, and the result is divided by 2 (to convert bytes into words). This gives the number of WX addresses that must be skipped before starting the output addressing.

- The starting address of each module is a WY address with the following address number:
  `(Base Analog Address) + (Number of WX Addresses) + (Output Offset Byte / 2)`

Find Configured I/O

To find configured I/O:

1. Click PLC Configuration from the PLC Utilities menu. The PLC Configuration dialog box appears.



PLC Configuration

Processor Information

PLC Type: SIMATIC 545

Total System Memory (Kbytes): 192

Configured Memory (Kbytes): 70

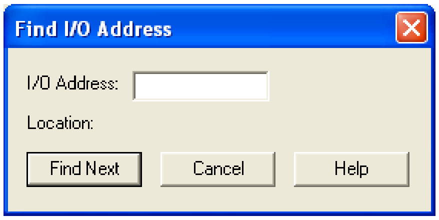
Remaining Memory (Kbytes): 122

I/O Configuration

Memory Configuration

	User	System
Ladder (Kb):	16	48
Variable (Kb):	4	4
Constant (Kb):	0	0
Special (Kb):	4	4
Comp. Spec. (Kb):	0	0
User Sub (Kb):	0	0
Global (K):	0	
T/C (K):	1	5
Drums:	64	3
Shift Reg (K):	1	1
Table (K):	2	4
One Shots (K):	1	1
Controls (K):	32	
Bit I/O (K):	2	
Word I/O (K):	1	

2. Under I/O Configuration, click **Find I/O**. The Find I/O Address dialog box appears.



Find I/O Address

I/O Address:

Location:

3. Enter an **X**, **Y**, **WX**, or **WY** address and click **Find Next**.

4. Find will first search 505 I/O, then search PROFIBUS I/O. When the address is found, you can click the **Find Next** button to find the next location of the address.

Chapter 6 – Programming

Online Versus Offline Programming

Before you begin programming, it is important that you understand the differences between programming online and programming offline.

While programming online, you are connected to a PLC, which may be running. Changing logic in one network may affect logic in another network. These changes may create unexpected or hazardous results.

⚠ **Warning**	Editing or modifying a program online may produce unexpected or hazardous results.

In the online mode, PLC Status in Ladder can be displayed. However, some editing features are not available, including Cut and Paste.

Using the Ladder Editor

The Ladder Editor is where to begin programming since it allows you to display, access, and/or modify logic in the active logic program. You can view existing programs or you can create a new one.

To view an existing program:

1. Open or Import a logic program (see open program).
2. If there is logic in the program but does not appear, click on the toolbar or click **Ladder Editor** from the **View** menu.

Programming Ladder

Programming Ladder

Several logic program windows can be displayed simultaneously. However, only one window is active at a time. In the active logic window, the ladder editor allows you to enter and modify ladder logic.

To make a logic window active using the mouse, click within that window. To make a logic window active using the keyboard, press **ALT+W** and press the number of the corresponding logic window. You will notice that the active window comes to the front of all other windows.

Insert a New Network

In the active logic program window, you can insert a new network using the mouse or the keyboard.

To insert a new network using the mouse:

1. Click (new network button) on the Toolbar. Notice that the new network attaches to the pointer.
2. Bring the pointer into the active logic window. Position the pointer where you want the new network.
3. Click the left mouse button. The new network is inserted. For example, if the cursor is positioned in Network 002, the new network becomes Network 002 and existing Network (002) becomes 003.
4. Repeat Step 3 to insert additional networks.
5. Remove the new network from the pointer by clicking the arrow on the Instruction Bar.

To insert a new network using the keyboard:

1. Press **ALT+P** and the Program menu drops down.
2. Press **S** or use the down arrow keys to highlight New Network and press **ENTER**. The New Network dialog box appears.
3. Enter the number of the network you wish to enter. If a network 002 exists and you enter 2 in the Network Number box, the existing Network 002 becomes Network 003 and the new network becomes 002.
4. Press **ENTER** and the new network is inserted.
5. Repeat Step 3 to enter additional networks.

Insert a New Row

You can insert a new row to a network similar to inserting a new network. In the active logic program window, use the mouse or keyboard to place the cursor on an existing row in the network.

To enter a new row using the mouse:

1. Click (new row) on the Toolbar. Notice that the new row attaches to the pointer.
2. Place the pointer in the position where you want the new row to appear.
3. Click the left mouse button and the new row is inserted.
4. Repeat Step 3 to insert additional rows.
5. Remove the new row from the pointer by clicking the arrow on the Instruction Bar.

To insert a new row using the keyboard:

1. Press the **INSERT** key to enable the **Ins** cursor mode. The status toolbar indicates which cursor mode is currently enabled:

   - When Overtype mode is enabled, **OVR** is displayed in the far right side of the Status toolbar.

- When Ins mode is enabled, **OVR** is *not* displayed in the far right side of the Status toolbar.

3. Use the arrow keys to position the parameter cursor (red or highlighted box) in the last row of the network.
4. Press **ENTER** and the new row appears as the last row.
5. Repeat Step 3 to enter additional networks.

Ladder Instructions

Entering Instructions Using the Mouse and Instruction Bar

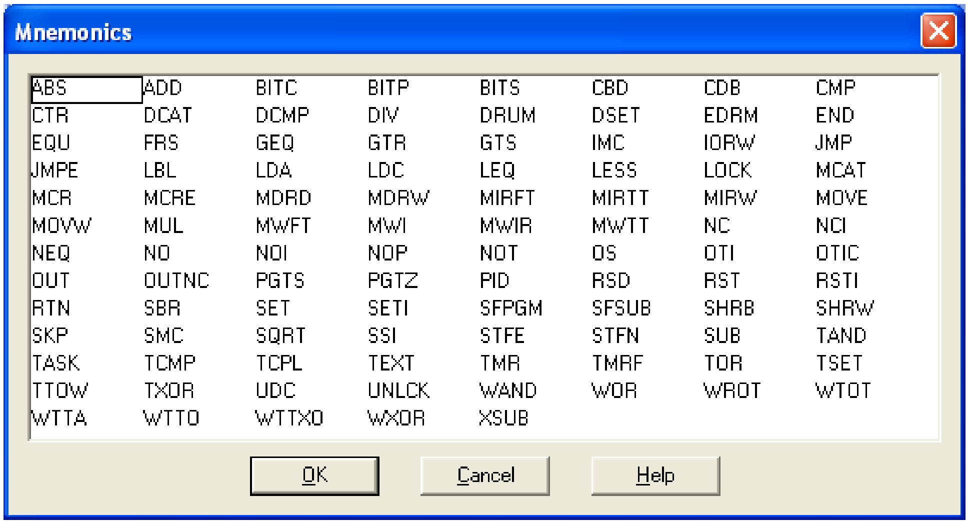
1. Move the pointer to the Instruction bar.
2. Click the instruction you want to use. If the instruction you want to use is not displayed, click the appropriate instruction group to display the instruction, then click the instruction.

   For example, if you want to insert a short instruction, you can click the short instruction if it is visible on the instruction bar. If the short instruction is not visible, first click the **Relay** button to display the Short instruction, then click the Short instruction.
3. Move the pointer over the logic program. Notice that the instruction is attached to the pointer.
4. Position the pointer where you wish to place the instruction.
5. Click the left mouse button, and the instruction is placed in that location. If an instruction cannot be placed in that location, an error message is displayed.
6. If the sticky cursor has been turned on in the Program Setup under General then the instruction will remain attached to the pointer. Click the left mouse button once for each additional instruction you want to insert. Click the arrow in the middle of the Instruction Bar or another instruction to remove the instruction from the pointer.
7. If the sticky cursor has not been turned on in the Program Setup then after the instruction has been dropped into place the pointer returns to an arrow.

Entering Mnemonic Instructions with the Keyboard

1. In the active logic program, position the cursor (using the arrow keys) where the instruction is to be located.

2. Type in the instruction mnemonic at the cursor location and press **ENTER**. If you forget an instruction mnemonic, type a question mark (**?**) and press **ENTER**. The following mnemonic pick list will be displayed. Pick the mnemonic you desire by double clicking on the mnemonic or arrow to the mnemonic and press **ENTER**. The mnemonic pick list will also display if an illegal mnemonic is entered.



ABS	ADD	BITC	BITP	BITS	CBD	CDB	CMP
CTR	DCAT	DCMP	DIV	DRUM	DSET	EDRM	END
EQU	FRS	GEQ	GTR	GTS	IMC	IORW	JMP
JMPE	LBL	LDA	LDC	LEQ	LESS	LOCK	MCAT
MCR	MCRE	MDRD	MDRW	MIRFT	MIRTT	MIRW	MOVE
MOVW	MUL	MWFT	MWI	MWIR	MWTT	NC	NCI
NEQ	NO	NOI	NOP	NOT	OS	OTI	OTIC
OUT	OUTNC	PGTS	PGTZ	PID	RSD	RST	RSTI
RTN	SBR	SET	SETI	SFPGM	SFSUB	SHRB	SHRW
SKP	SMC	SQRT	SSI	STFE	STFN	SUB	TAND
TASK	TCMP	TCPL	TEXT	TMR	TMRF	TOR	TSET
TTOW	TXOR	UDC	UNLCK	WAND	WOR	WROT	WTOT
WTTA	WTTO	WTTXO	WXOR	XSUB			

3. The following is a list of all 505 ladder instruction mnemonics:

Mnemonic	Instruction
ABS	Take absolute value of a word.
ADD	Addition.
BITC	Clears a specified bit.
BITP	Examines status of a specified bit.
BITS	Sets a specified bit.
J	Creates Down line
U	Creates Up line
H	Draws horizontal line
CBD	Converts binary to BCD value.
CDB	Converts BCD inputs to binary.
CMP	Compare.
CTR	Counts recurring events.

Mnemonic	Instruction
DCAT	Discrete control alarm timer.
DCMP	Compares current date with a specified date.
DIV	Division
DRUM	Simulates electro-mechanical stepper switch.
DSET	Sets date in real-time clock.
EDRUM	Simulates electro-mechanical stepper switch. Can be indexed by timer, event, or timer and event.
END	Unconditionally terminates a scan.
EQU	Equal to.
FRS	Force role swap
GEQ	Greater than or equal to.
GTR	Greater than.
GTS	Calls a subroutine.
IMC	Compares status of discrete points with a specified bit pattern in a set of patterns.
IORW	Does immediate read or write to discrete or word I/O.
JMP	Freezes outputs in zone of control.
JMPE	Freezes outputs in zone of control.
LBL	Selectively enable/disable program segments during scan.
LDA	Copies the logical address of a memory location into a memory location.
LDC	Copies the logical address of a memory location into a memory location.
LEQ	Less than or equal to.
LESS	Less than
LOCK	Used together with UNLOCK and provide a mechanism whereby multiple applications in the 575 system can coordinate access to shared resources.
MCAT	Motor control alarm timer.

Mnemonic	Instruction
MCR	Master control relay.
MCRE	Master control relay.
MDRMD	Drum; uses configurable mask to control coils.
MDRMW	Drum; uses configurable mask to write to words.
MIRF	Copies a table into the control relay memory or discrete image register.
MIRT	Copies status of control relays or discrete image register bits to table.
MIRW	Copies bit status from control relays or discrete image register to a word.
MOVE	Copies bytes, words, or long words from a source location to a destination location.
MOVW	Copies words from one location to another.
MUL	Multiplication
MWFT	Move word from table.
MWI	Copies words from one location to another using indexed addresses.
MWIR	Copies bits of a word to the discrete image register, or the control relay memory.
MWTT	Copies a word to a table.
NC	Normally closed contact.
NEQ	Not equal to.
NO	Normally open contact.
NOP	No operation.
NOT	Inverts power flow.
OS	Turns on output for a single scan.
OTI	Immediate coil
OTIC	Immediate closed coil
OUT	Coil
OUTNC	Coil Normally Closed.

Mnemonic	Instruction
PGTS	Calls an RLL subroutine and passes parameters to it.
PGTSZ	Calls an RLL subroutine and passes parameters to it. Discrete parameters indicated as outputs are cleared when the subroutine is not executed.
RET	
RSD	Transfers a PROFIBUS-DP slave's current diagnostic to user memory.
RST	Reset coil/bit.
RSTI	Immediate reset of a coil/bit.
SBR	Designates the beginning of an RLL subroutine.
RTN	Returns control from an RLL subroutine to the main RLL program.
SET	Set coil/bit.
SETI	Immediate set of a coil/bit.
SFPGM	Calls a special function program from RLL.
SFSUB	Calls a special function subroutine from RLL.
SHRB	Bit shift register.
SHRW	Word shift register.
SHT	
SKP	Selectively enable/disable program segments during scan.
SMC	Compares status of discrete points with a set of specified bit patterns.
SQRT	Square Root.
SSI	Scan synchronization inhibit
STFE	Searches for a word in a table equal to a specified word.
STFN	Searches for a word in a table not equal to a specified word.
SUB	Subtraction
TAND	ANDs the corresponding bits in two tables.

Mnemonic	Instruction
TASK	Start a new RLL program segment.
TCMP	Compares current time with a specified time.
TCPL	Inverts status of each bit in a table.
TEXT	Places textual information into L-Memory.
TMR	Times events.
TMRF	Times events.
TOR	ORs the corresponding bits in two tables.
TSET	Sets time in real-time clock.
TTOW	Copies a word from a table.
TXOR	Does an EXCLUSIVE OR on the corresponding bits in two tables.
UDC	Counts events up or down.
UNLCK	Used together with LOCK and provide a mechanism whereby multiple applications in the 575 system can coordinate access to shared resources.
WAND	Does logical bit-by-bit AND on two words.
WOR	Does logical bit-by-bit OR on two words.
WROT	Rotates the 4-segment bits of a word.
WTOT	Copies a word into a table.
WTTA	ANDs bits of a word with the bits of a word in a table.
WTTO	ORs bits of a word with the bits of a word in a table.
WTTXO	Does an EXCLUSIVE OR on the bits of a word with the bits of a word in a table.
WXOR	Does logical bit-by-bit EXCLUSIVE OR on two words.
XSUB	Calls an externally developed subroutine and passes parameters to it.

If the TISOFT mode is turned on in the program setup (see Ladder options under the **LOGIC** tab in Program Setup) the following list of the function key alternatives and the CTRL/ALT functions are available.

HOT KEYS

Key	Comment
Y	COILS Valid if cursor is in an output column
C	COILS Valid if cursor is in an output column
WY	COILS Valid if cursor is in an output column
V	COILS Valid if cursor is in an output column
G	COILS Valid if cursor is in an output column
W	COILS Valid if cursor is in an output column
X	CONTACTS Valid if cursor is in an input column
Y	CONTACTS Valid if cursor is in an input column
C	CONTACTS Valid if cursor is in an input column
WX/WY	CONTACTS Valid if cursor is in an input column
V	CONTACTS Valid if cursor is in an input column
K	CONTACTS Valid if cursor is in an input column
G	CONTACTS Valid if cursor is in an input column
W	CONTACTS Valid if cursor is in an input column
/	Open/closed contact/coil toggle
DEL	Delete current element
END	Moves to last column/row 1 of current rung
ENTER	Edit: moves to next row, current rung, or to next rung
	Display: moves to next row or rung
=	Equal-to Relational Contact
ESC	Deletes current address and puts you into edit mode for address.
TAB	Deletes current address and puts you into edit mode for address.
>	Greater-than-or-Equal-to Relational Contact
? or \	List mnemonics for current field
HOME	Moves to column 1, row 1 of current rung

Key	Comment
H	Draws horizontal line
N	Deletes horizontal line
I	Immediate contact and coil
INS	Insert Mode
<	Less-than Relational Contact
!	Not-Equal Relational Contact
O	Create/edit output coil
PgUp	Page Up
PgDn	Page Down
Ctrl L	Edits synonym/descriptor
U	Unforce
Ctrl U	Usage Table
J	Creates Down line
U	Creates Up line
M	Deletes vertical line

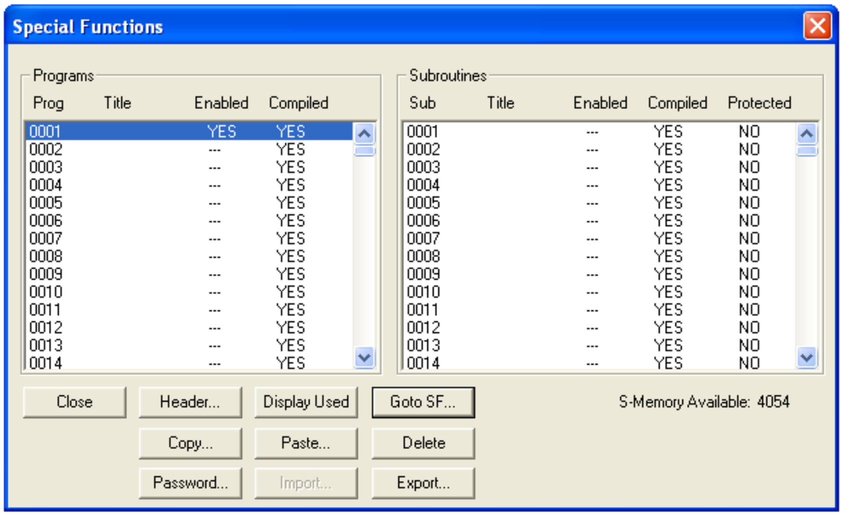
SF Program and Subroutine Editor

Using the SF Program and Subroutine Editor

The SF Program and Subroutine Editor gives you the ability to display, access, and/or modify program using special functions.

To access the Special Function Program Editor:

1. Click **Special Functions** from the **View** menu (**ALT+V**, **F**).



Prog	Title	Enabled	Compiled
0001		YES	YES
0002		---	YES
0003		---	YES
0004		---	YES
0005		---	YES
0006		---	YES
0007		---	YES
0008		---	YES
0009		---	YES
0010		---	YES
0011		---	YES
0012		---	YES
0013		---	YES
0014		---	YES

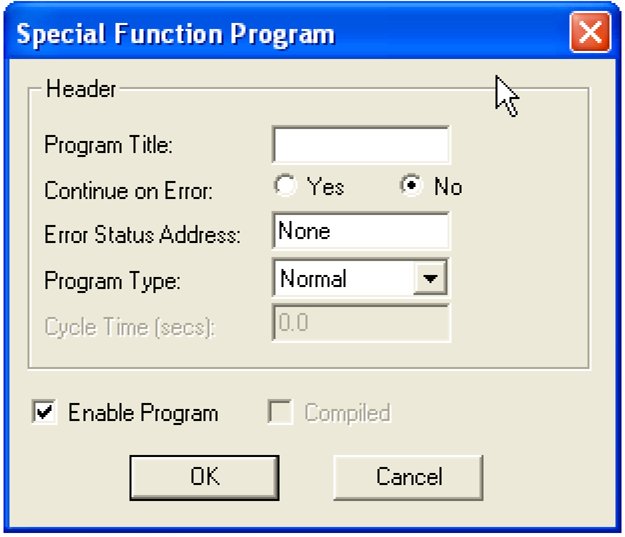
Sub	Title	Enabled	Compiled	Protected
0001		---	YES	NO
0002		---	YES	NO
0003		---	YES	NO
0004		---	YES	NO
0005		---	YES	NO
0006		---	YES	NO
0007		---	YES	NO
0008		---	YES	NO
0009		---	YES	NO
0010		---	YES	NO
0011		---	YES	NO
0012		---	YES	NO
0013		---	YES	NO
0014		---	YES	NO

S-Memory Available: 4054

See **Special Functions Dialog** for details.

2. Select the Special Function Program to create or edit. If a Header has already been programmed, skip ahead to item number 10.

3. Click **Header** to display the header dialog.



Special Function Program

Header

Program Title:

Continue on Error: ○ Yes ● No

Error Status Address: None

Program Type: Normal

Cycle Time (secs): 0.0

☑ Enable Program ☐ Compiled

4. Enter a title for the program in the **Program Title** box. The title is optional and can be left blank.

5. Select **Yes** or **No** in the **Continue On Error** area to have the program continue or stop when an error occurs.

6. Select the **Program Type** from the drop-down list.

- **Normal:** The Special Function Program runs in the normal way: when the input to an SFPGM command in ladder logic transitions from false to true, the Special Function Program runs once. The Special Function Program does not run again until the input transitions to false and then back to true. If the in-line parameter of the SFPGM command is set to true, the Special Function Program runs immediately, during the RLL scan. Otherwise, the Special Function Program is queued to run during the normal SF scan.

- **Priority:** Similar to Normal, but the Special Function Program runs in a priority time slice. The time slices can be configured independently.

- **Cyclic:** The Special Function Program runs repeatedly while the input to the SFPGM is true. The Cycle Time(secs.) parameter controls how frequently the Special Function Program runs.
  Restricted: The Special Function Program is called by loops and alarms.

6. If the **Program Type** is **Cyclic**, enter the cycle time in seconds (0.5 – 6553.5).

7. Select the **Enable Program** check box to allow exaction of the SF program. You can also enable and disable the program from within the SF editor by typing [**SHIFT+F2**].

8. For the 555-1105/-1106 and 575-2105/-2106 CPUs, the compile mode is selectable. When compiled mode is selected, the SF program or subroutine is translated to the native instruction set of the CPU's microprocessor. The compiled code is then executed whenever the program or subroutine is scheduled for execution. The advantages of compiled execution are:

   - Significant execution speed improvement. For example, a MATH statement that adds two floating-point values will execute in less than 10 μs when compiled, versus more than 100 μs when executed by the SF interpreter. Depending on the program's size and the placement of the target LABEL within the program, a GOTO statement may take 1 ms or more when executed by the interpreter. Compiled execution of a GOTO statement takes less than 1 microseconds no matter where in the program the LABEL is located. This represents a 1,000x improvement.
   - A compiled SF program or subroutine can be executed in-line to the user RLL program. This means that when the enable input to the SFPGM or SFSUB box instruction is on, the program or subroutine is executed immediately and its result is available for use in the next rung of the current RLL scan.

9. There are several reasons to choose interpreted mode for a SF program. The primary reasons are as follows:

   - If the program has one or more statements that are not allowed in a compiled program, or if it calls a subroutine that is not compiled, then it may not be compiled.
   - A compiled program requires both S-Memory and Compiled Special (CS)-Memory, while an interpreted program requires only S-Memory. As a rule of thumb, the compiled code for a SF program requires twice as much CS-Memory as S-Memory. For example, a SF program that uses 1 Kbyte of S-Memory also uses 2 Kbytes of CS-Memory.
   - A second SF program or subroutine on the same execution queue cannot preempt a compiled SF program or subroutine. This may present a scheduling problem for a cyclic, loop, or analog alarm queue. For example, if a compiled program is executing on a loop setpoint, a higher priority loop will not execute until the compiled program completes. This is not a problem if the program's execution time is small. However, if the program requires significant execution time, this could cause unnecessary loop overruns.

NOTE: Most SF programs and subroutines can be compiled. However, an SF program or subroutine which contains any of the following instructions cannot be compiled: The data compacting instructions: PACK, PACKLOOP, PACKRS, and PACKAA, the shift register instructions: SSR, FTSR–IN and FTSR–OUT, the PRINT instruction, and the BCD instructions: BCDBIN and BINBCD.

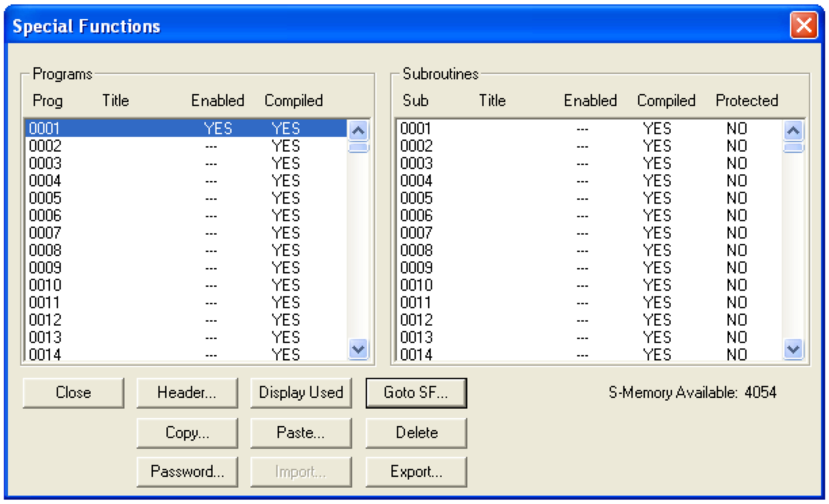
Additionally, the CDT and SDT instructions, when used in a compiled SF program or subroutine, must specify a static table; that is, the table's base address must be a V, K, G, VMS, or VMM address and the table's size must be specified as a constant.

10. Save Header changes and return to the SF Programs Subroutines dialog box by clicking **OK**. To disregard changes and return to the SF Programs Subroutines dialog box, click **Cancel**.

Special Functions Dialog Box

Use the **Special Functions** dialog box to manage special function programs and subroutines.

To access the **Special Functions** dialog box, click **Special Functions** from the **View** menu or click the ƒSF toolbar button.



Programs

Prog	Title	Enabled	Compiled
0001		YES	YES
0002		---	YES
0003		---	YES
0004		---	YES
0005		---	YES
0006		---	YES
0007		---	YES
0008		---	YES
0009		---	YES
0010		---	YES
0011		---	YES
0012		---	YES
0013		---	YES
0014		---	YES

Subroutines

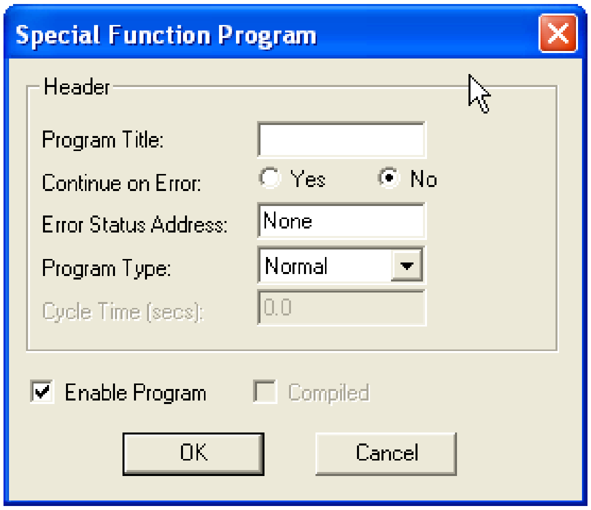
Sub	Title	Enabled	Compiled	Protected
0001		---	YES	NO
0002		---	YES	NO
0003		---	YES	NO
0004		---	YES	NO
0005		---	YES	NO
0006		---	YES	NO
0007		---	YES	NO
0008		---	YES	NO
0009		---	YES	NO
0010		---	YES	NO
0011		---	YES	NO
0012		---	YES	NO
0013		---	YES	NO
0014		---	YES	NO

S-Memory Available: 4054

- **Programs**: The preceding figure shows the Special Function Programs. Click **Display Used** to list only the SFs which have been defined. Click **Display All** to show both used and unused SFs.

- **Subroutines**: This list shows the Special Function Subroutines

- **Header**: Click **Header** to access the **Special Function Program** dialog box to view and edit the header information for the selected special function program or subroutine.



Program Title:

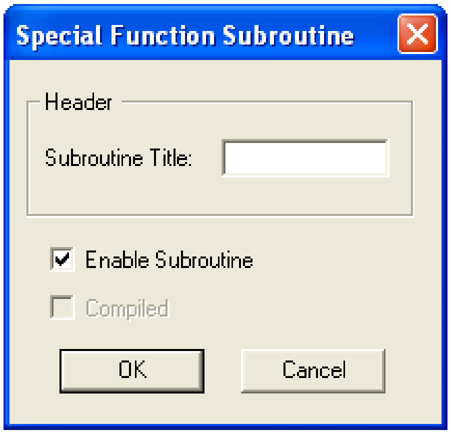
Continue on Error: ○ Yes ● No

Error Status Address: None

Program Type: Normal

Cycle Time (secs): 0.0

☑ Enable Program ☐ Compiled



Subroutine Title:

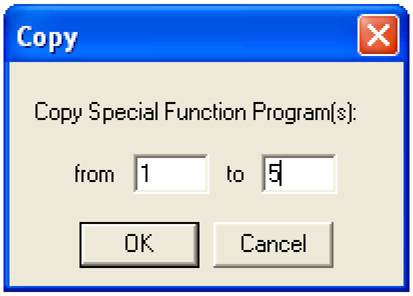
☑ Enable Subroutine

☐ Compiled

- **Display Used/Display All**: Click this button to toggle between showing *all* the SFP and SFS slots (used or not), and displaying *only* the slots that are in use.

- **Goto SF**: Open the **Special Function editor** for the selected special function program or subroutine.

- **Copy**: Copy the highlighted special function programs or subroutines so that they can be pasted. When you click **Copy**, a dialog box appears, listing the special function programs or subroutines to be copied.

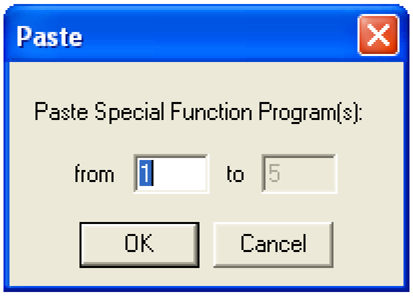


Copy Special Function Program(s):

from 1 to 5

Change the values in the **from** and **to** boxes if necessary and click the **OK** button.

- **Paste**: Paste the copied special function programs or subroutines to the SFP or SFS slots starting at the selected slot. When you click the **Paste** button, a dialog box appears showing the line numbers where the special function programs or subroutines will be pasted.



Paste Special Function Program(s):

from 1 to 5

Change the **from** boxes if necessary.
The slots where the special function programs or subroutines will be pasted must be empty.

NOTE: Special function programs and subroutines can only be copied and pasted **offline**.

- **Delete**: Delete the highlighted special function programs or subroutines.
- **Password**: **Protect Special Function Subroutines with a password** in CTI 2500 Series programs.
- **Import / Export**: The selected Special Function program or subroutine can be saved to or loaded from a file.

Insert a New Row

You can insert a new row to a Special Function Program similar to inserting a new network. In the active logic program window, use the mouse, or keyboard to place the cursor on an existing row in the Special Function Program.

To enter a new row using the mouse:

1. Click the Append Row button on the Toolbar. Notice that the new row attaches to the pointer.
2. Place the pointer in the position where you want the new row to appear.
3. Click the left mouse button and the new row is inserted.
4. Repeat Step 3 to insert additional rows.
5. Remove the new row from the pointer by clicking the arrow on the Instruction Bar.

To insert a new row using the keyboard:

1. Press the **INSERT** key to enable **Ins** mode. See the Status Line near the bottom of the screen.
2. Use the arrow keys to position the parameter cursor (red or highlighted box) in the last row of the Special Function Program.
3. Press **ENTER** and the new row appears as the last row.
4. Repeat Step 3 to enter additional rows.

Entering Special Function Program Instructions

You can enter instructions into your Special Function Program using either the Instruction Bar or Menu Bar.

To enter instructions using the Instruction Bar:

1. Move the pointer to the Instruction bar.
2. Click with the left mouse button on the desired instruction on the lower half of the Instruction Bar. If the desired instruction is not displayed, click the appropriate instruction group on the top half of the instruction bar.
3. Move the pointer over the Special Function Program. Notice that the instruction is attached to the pointer.
4. Position the pointer where you wish to place the instruction.
5. Click the left mouse button, and the instruction is placed in that location. If an instruction cannot be placed in that location, an error message is displayed.
6. The instruction remains attached to the pointer. Click the left mouse button once for each additional instruction you want to insert. Click the arrow in the middle of the Instruction Bar or another instruction to remove the instruction from the pointer.

Using the menu to enter instructions with the keyboard:

1. In the active Special Function Program, use the arrow keys to move the cursor to the spot you wish to place the instruction.
2. Type in the character mnemonic for the instruction or Press **ALT+P, I** to open the Selection Instruction dialog box from the Program menu.
3. Use the arrow keys to move up and down the Group and Instruction scroll boxes, and the Tab key to move between the boxes.
4. Highlight desired instruction, and press **ENTER** to insert the instruction.
5. Repeat Steps 1 – 5 for each instruction you want to enter.

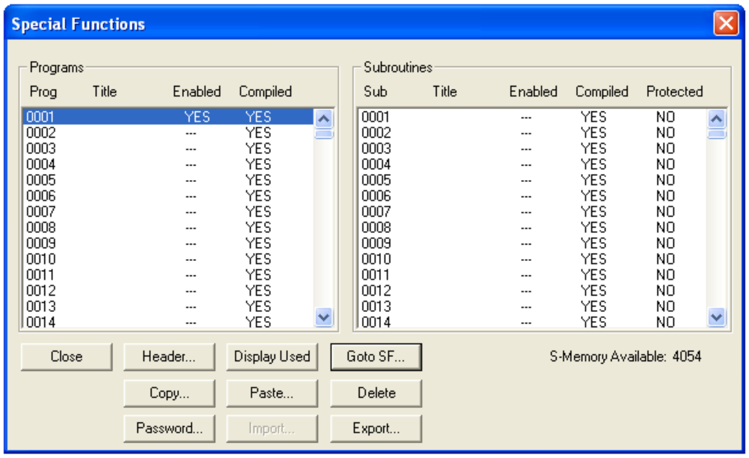
Password-Protected Subroutines

Special Function subroutines can be protected by a password to ease in sharing proprietary SF programs. System integrators and equipment manufacturers may need to provide programming objects in order for equipment to function correctly, but may not want to allow the logic in these programs to be altered by the end user. By protecting these subroutines with a password, they can then be imported and exported between programs without requiring users to know the logic contained within.

Because end users do not have access to the logic of password-protected subroutines, creators of such subroutines should not reference PLC addresses within the subroutine. Instead, programmers should use T-memory and parameters passed in a SFSUB or CALL instruction so that they remain device independent.

To password protect a Special Function subroutine:

1. Open the Special Functions dialog box by clicking **Special Functions** from the **View** menu or clicking the toolbar button.

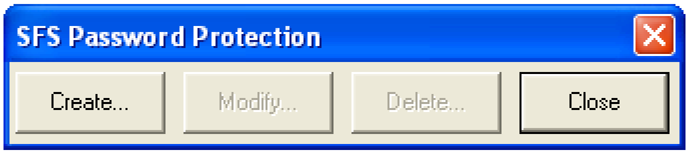


Prog	Title	Enabled	Compiled
0001		YES	YES
0002		---	YES
0003		---	YES
0004		---	YES
0005		---	YES
0006		---	YES
0007		---	YES
0008		---	YES
0009		---	YES
0010		---	YES
0011		---	YES
0012		---	YES
0013		---	YES
0014		---	YES

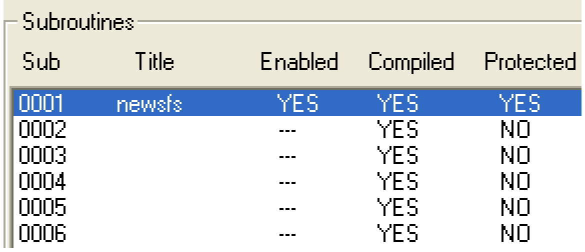
Sub	Title	Enabled	Compiled	Protected
0001		---	YES	NO
0002		---	YES	NO
0003		---	YES	NO
0004		---	YES	NO
0005		---	YES	NO
0006		---	YES	NO
0007		---	YES	NO
0008		---	YES	NO
0009		---	YES	NO
0010		---	YES	NO
0011		---	YES	NO
0012		---	YES	NO
0013		---	YES	NO
0014		---	YES	NO

S-Memory Available: 4054

2. Select a subroutine and click **Password** to create, modify, or delete a password for the selected subroutine.

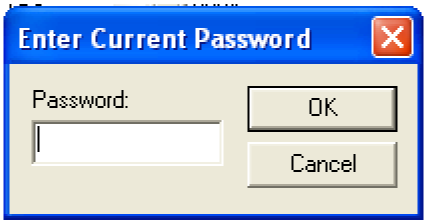


3. Subroutines that are password-protected display a YES in the **Protected** column of the **Subroutines** list.



Sub	Title	Enabled	Compiled	Protected
0001	newsfs	YES	YES	YES
0002		---	YES	NO
0003		---	YES	NO
0004		---	YES	NO
0005		---	YES	NO
0006		---	YES	NO

4. Once a password is created for a subroutine, the password must be entered to enable editing. Double-clicking the protected subroutine or selecting the **Goto SF** button requires the user to enter the password assigned to the subroutine.

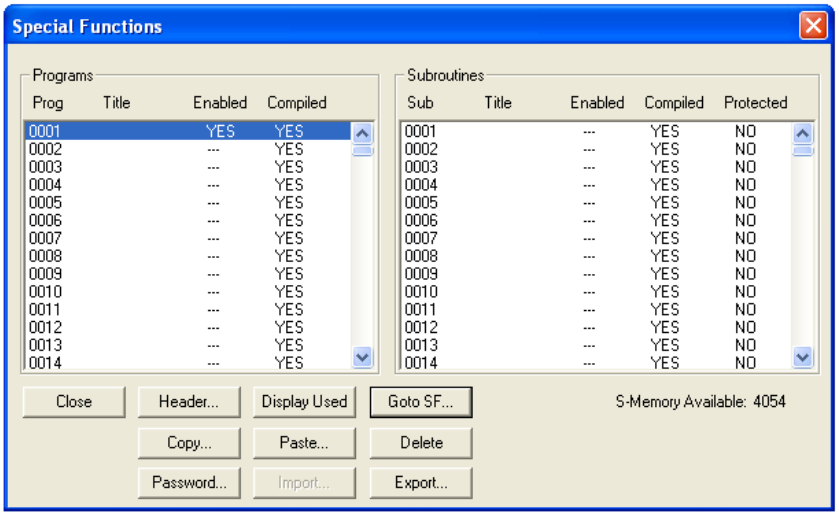


Importing and Exporting Special Function Programs and Subroutines

Use the following procedure to import or export Special Function programs or subroutines.

Exporting Programs and Subroutines

1. Open the Special Functions dialog box by clicking **Special Functions** from the **View** menu or clicking the toolbar button.

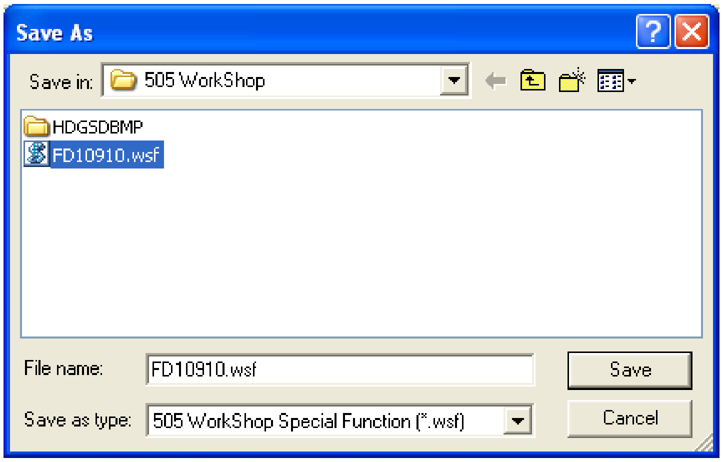


Prog	Title	Enabled	Compiled
0001		YES	YES
0002		---	YES
0003		---	YES
0004		---	YES
0005		---	YES
0006		---	YES
0007		---	YES
0008		---	YES
0009		---	YES
0010		---	YES
0011		---	YES
0012		---	YES
0013		---	YES
0014		---	YES

Sub	Title	Enabled	Compiled	Protected
0001		---	YES	NO
0002		---	YES	NO
0003		---	YES	NO
0004		---	YES	NO
0005		---	YES	NO
0006		---	YES	NO
0007		---	YES	NO
0008		---	YES	NO
0009		---	YES	NO
0010		---	YES	NO
0011		---	YES	NO
0012		---	YES	NO
0013		---	YES	NO
0014		---	YES	NO

S-Memory Available: 4054

2. Select the program or subroutine number from the list that contains the program you would like to export and click **Export**. The **Save As** dialog box appears.



Save in: 505 WorkShop

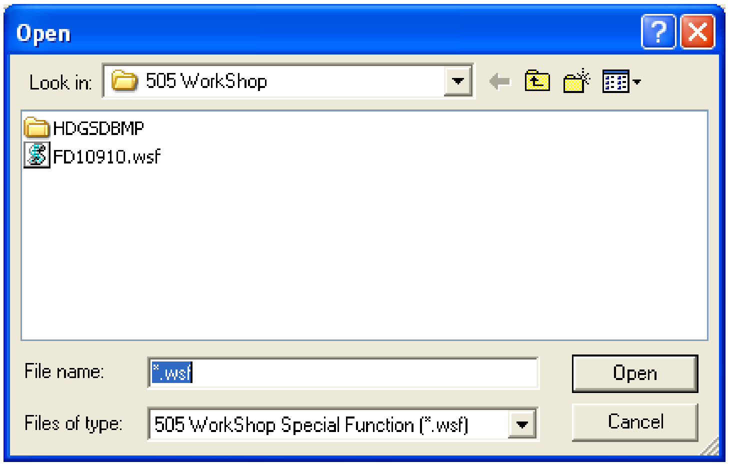
File name: FD10910.wsf

Save as type: 505 WorkShop Special Function (*.wsf)

2. Browse to the location in which you would like to save the program. Enter a file name for the program and click **Save**. The file will be saved as a *.WSF (505 WorkShop Special Function) file.

Importing Programs and Subroutines

1. From the Special Functions dialog box, select a program or subroutine number from the list that does not already contain a program, and click **Import**. The Open dialog box appears.



Look in: 505 WorkShop

File name: *.wsf

Files of type: 505 WorkShop Special Function (*.wsf)

2. Browse to the location of the Special Function *.WSF file you would like to import. Select the appropriate file and click **Open**. The program is imported to the selected program number.

Editing Logic

Cut

To use the cut feature:

1. Select the information you want to cut. You can cut parts of a network, all of a network or multiple networks.
2. Cut your selection to the clipboard with one of the following:
3. Click ✂ on the toolbar.
4. Click **Cut** from the **Edit** menu.
5. Press **CTRL+X**.

Copy

To use the copy feature:

1. Select the information you want to cut. You can cut parts of a network, all of a network or multiple networks.
2. Copy your selection onto the clipboard with one of the following:
    - Click ⎘ on the toolbar.
    - Click **Copy** from the **Edit** menu.
    - Press **CTRL+C**.

Paste

To access the paste feature:

1. Move the cursor to the desired location.
2. Paste clipboard contents into the new location with one of the following:

3. Click 📋 on the toolbar.
4. Click **Paste** from the **Edit** menu.
5. Press **CTRL+V**.

NOTE: When pasting, clipboard contents are inserted before existing items. For example, if you are pasting a network and the cursor is positioned at Network 2, click paste and the clipboard contents become Network 2. The previous Network 2 becomes Network 3.

Paste With Rewire

Paste With Rewire allows you to past the contents of the clipboard and change the elements address at the same time.

To access the rewire feature:

1. Move the cursor to the desired location.
2. Paste clipboard contents into the new location.
3. Click **Paste with Rewire** from the **Edit** menu.
4. Choose the appropriate options. You can select the number of copies you wish to copy and/or you can select to offset each address by a certain value. If the addresses you select have descriptions or tags associated with them, you can choose to paste those also.

NOTE: When pasting with rewire, valid addresses for instructions are not checked until you Validate and Enter Logic.

5. Click **OK**.

NOTE: When pasting with rewire, clipboard contents are inserted before existing items. For example, if you are pasting a network and the cursor is positioned at Network 2, click paste and the clipboard contents become Network 2. The previous Network 2 becomes Network 3.

Clear

Use **Clear** to clear an item without removing the space it occupies.

To clear an item or items:

1. Select the item or items you want to clear by clicking, then holding and dragging the pointer over the desired logic.
2. Click **Clear** from the **Edit** menu or press the **DELETE** key.
3. Click the items you want to clear.
4. Click **OK** or press **ENTER** and the selected items are cleared.

⚠ **Warning**	Editing or modifying a program online may produce unexpected or hazardous results.

Delete

Use Delete to clear an item and remove the space it occupies.

To delete:

1. Select the item or items you wish to delete.
2. Click **Delete** from the **Edit** menu. The Delete dialog box appears.
3. Click the items you want to delete.
4. Click **OK** or press **ENTER**.

Insert

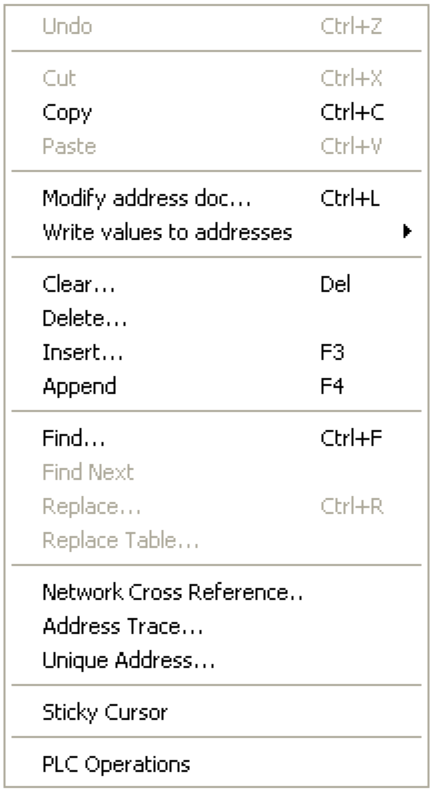
Use **Insert** to insert a selected object (network, row or column) at the point of the current cursor position.

To insert an object:

1. Click **Insert** from the **Edit** menu. The Insert dialog box will appear.
2. Click on the object you want to insert.
3. Click **OK** or press **ENTER**.

Right Mouse Button Shortcut Menus

The menu items available with the right mouse button are as follows:



Validate and Enter

While programming in online or offline mode, logic must be validated and entered before it can be saved to disk or transferred online. To validate and check your logic:

1. Press **F8**, click ✓ on the toolbar, or click **Validate and Enter** from the **Program** menu. The message "Validating and Enter" appears on the screen.
2. After logic is validated and entered and, if necessary, problems fixed, the logic program can be saved or transferred online.

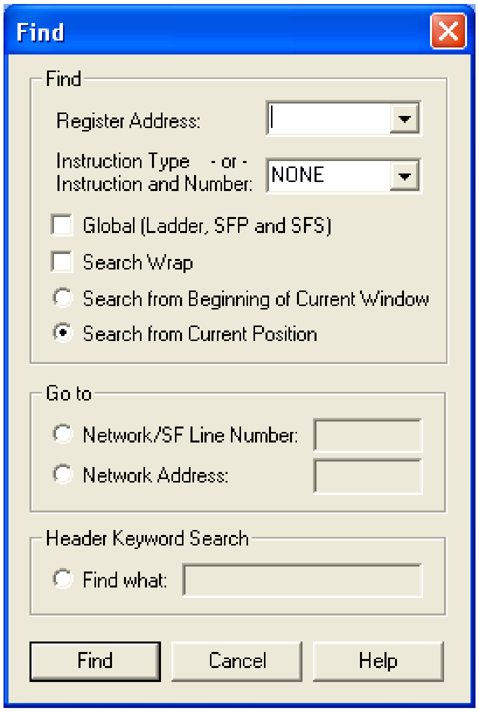
Finding Logic

Finding Logic

Use the **Find** dialog box to go to:

- a particular register or bit address
- a particular PLC instruction type
- a particular register or bit address used in a particular instruction type
- a particular network or SF line number
- a particular network address
- a particular keyword in a network header

To access the Find dialog box, click **Find** from the **Edit** menu, or click the toolbar button 🔍.



Find

Find

Register Address:

Instruction Type - or - Instruction and Number: NONE

□ Global (Ladder, SFP and SFS)

□ Search Wrap

○ Search from Beginning of Current Window

● Search from Current Position

Go to

○ Network/SF Line Number:

○ Network Address:

Header Keyword Search

○ Find what:

To search for an address used in a particular type of instruction, set both the **Register Address** and the **Instruction Type**.

    - **Register Address**: Enter the register or bit address or valid tag to search for. Timers and counters are stored in TCC registers.

    - **Instruction Type or Instruction and Number**: Enter the instruction type to search for. If the instruction type includes a reference number a number may be appended to the instruction. For example, to search for any SFPGM block, set this field to SFPGM. To search for the SFPGM 20 block, set this field to SFPGM20.

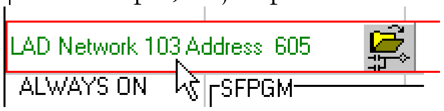
    - **Global (Ladder, SFP, SFS)**: Select this check box to search the entire program: the ladder and all Special Function Programs and Subroutines.

    - **Search Wrap**: If this box is selected and the item being searched for is not found before the end of the current program area (the ladder logic, if you are editing ladder logic, or the current SFP or SFS if you are editing SF) the search continues from the start of the current program area.

    - **Search from Beginning/Search from Current Position**: If the **Search from Current Position** option button is selected, the search begins at the cursor location. Otherwise, the search begins at the start of the program area.

- **Go to**: Use these fields to jump directly to a known location in the current program area (the ladder logic, if you are editing ladder logic, or the current SFP or SFS if you are editing SF). Select the option button, and enter the network/line number or address.

  For example, to jump to network number 103:



LAD Network 103 Address 605

ALWAYS ON

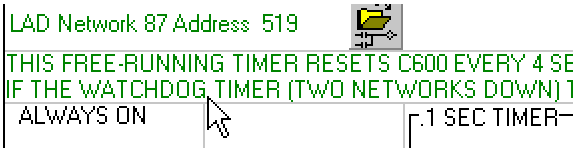
SFPGM

    - **Network/SF Line Number**: Select this option button and enter the network number, if you are editing ladder logic, or the line number if you are editing a Special Function program or subroutine.

    - **Network Address**: Select this option button and enter the ladder memory address where the network is located.

- **Header Keyword Search**: Use this field to locate a network based on keywords in the header documentation.

  For example, to find a network that has to do with a watchdog timer:



LAD Network 87 Address 519

THIS FREE-RUNNING TIMER RESETS C600 EVERY 4 SE
IF THE WATCHDOG TIMER (TWO NETWORKS DOWN) 1

- **Find What:** Select the option button and enter text that appears in the header.

After finding an item, to find the next instance of the item, click **Find Next** from the **Edit** menu or click the toolbar icon

Find Next

Click on the toolbar or click **Find Next** from the **Edit** menu to find the next occurrence of an address or instruction.

Find Documentation

Use the **Find Documentation** dialog box to locate documentation:

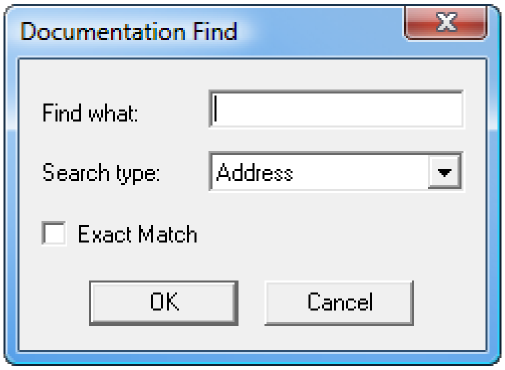
- for a particular address
- including a particular tag
- including a particular description
- by keyword: where a specific text string appears anywhere in the documentation

To access the Find Documentation dialog box:

1. Open the Documentation window by clicking **Documentation Window** from the **View** menu or by clicking the toolbar button .
2. Do one of the following:

- Click **Find** from the **Edit** menu
- Click the toolbar icon
- Press **CTRL+F**
- Press **ALT+E, F**

- Click **Find** from the right-click menu.
  The **Documentation Find** dialog box appears.



Documentation Find

Find what:

Search type: Address

3. In the **Find What** box, type the text to search for. For example, you could enter `C21`, `Stop Pulse`, or `Drum Wash 1`.

4. In the **Search** box, select the type of search you want to perform.

   - **Address**: In an address search, the program's documentation is searched to find an address that matches, or most closely matches, the text entered in the **Find What** box. For example, if your program does not use a *C21* address, and you type `C21` in the **Find What** box, the search could highlight `C20` or `C22`.

   - **Description:** In a description search, the program's documentation is searched to find descriptions that match the text entered in the **Find What** box. If the **Exact Match** check box is selected, the entire description must be entered in the **Find What** box; otherwise, only the first few characters are needed.
     Note: The Description search is a sequential search that begins with the first character in the description. All leading characters, including spaces, must be entered in the **Find What** box in order for the search to find a phrase. For example, if the description you want to find is *Drum Wash 1*, and `Wash 1` is entered in the **Find What** box, the description *Drum Wash 1* will *not* be found by the search. To find the description of *Drum Wash 1*, `Drum` or `Drum Wash` can be entered in the **Find What** box. If the **Exact Match** check box is selected, then the phrase `Drum Wash 1` must entered in the **Find what** box.

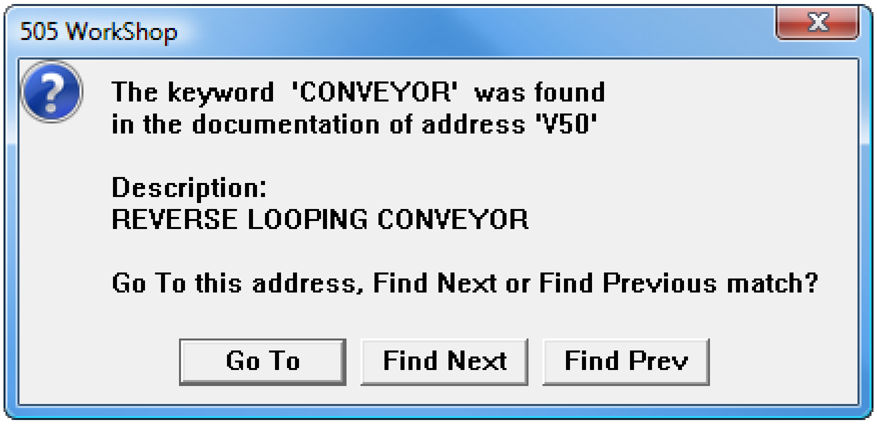
   - **Keyword**: In a keyword search, the program's documentation is searched to find descriptions, tags, and comments containing the text entered in the **Find what** box. Unlike the other searches, where the text entered in the **Find what** box must match the beginning characters of the phrase you are searching for, in a keyword search the text in the **Find what** box can be found anywhere within the **Description**, **Tag**, or **Comment** fields.

Example: Suppose you enter the phrase `Wash` in the **Find what** box and specify a **Search type** of **Keyword**. The search will return all instances where the phrase `Wash` is used, including a tag of `Wash`, a description of `Drum Wash`, and a comment of `Start Wash 1 here`.

If the **Match Case** check box is selected, the case of the text entered in the **Find what** box must match the case of the text you are searching for. For example, if the **Match Case** check box is selected, searching for `drum` will not find `DRUM`.

5. Click **OK** to begin the search.

Addresses, tags, and descriptions that are found will be located, displayed, and highlighted in the Documentation Window. After a Keyword search, a message window appears with the following search options .


505 WorkShop

The keyword 'CONVEYOR' was found
in the documentation of address 'V50'

Description:
REVERSE LOOPING CONVEYOR

Go To this address, Find Next or Find Previous match?

- **Go To** - Click **Go To** to go to the address at which the keyword was found.
- **Find Next** - Click **Find Next** to look for the next occurrence of the keyword.
- **Find Prev** - Click **Find Prev** to reverse the search direction to look for previous occurrences of the keyword.

Search and Replace Address

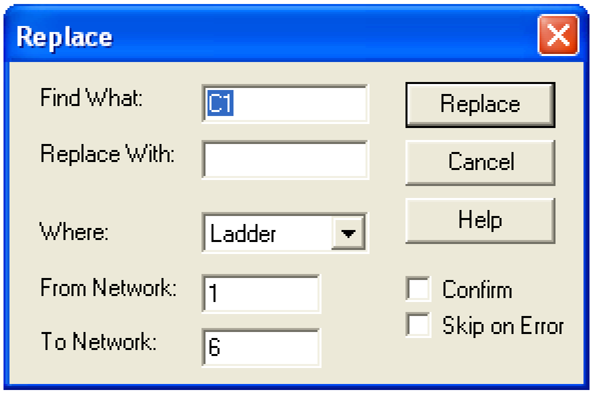
Search and Replace Address

You can use the Replace command on the Edit menu to search for a specified address and replace them with another address. The following logic windows support Search and Replace by address:

- SF programs
- SF subroutines
- Ladder Editor
- Alarms
- PID Loops

Use the following steps to conduct a Search and Replace Address:

1. Click **Replace** from the **Edit** menu or press (**CTRL+R**) and the Replace dialog box appears.



Find What: C1
Replace With:
Where: Ladder
From Network: 1
To Network: 6
☐ Confirm
☐ Skip on Error

2. Specify the address number to be replaced in the **Find What** field and the address replacing it in the **Replace With** field. For example, to replace C1 with C2, type these two address numbers in the **Find What** box and the **Replace With** box. With field respectively. With this setting, all occurrences of address C1 are Changed to address C2 for the selected logic type range.
3. Specify the logic type by clicking on the drop-down box in the **Where** field and selecting one of the 5 logic types.

4. In the **From Network** and **To Network** boxes, type the search range for the replacement address. If no range is selected, the software defaults to the total number of networks/lines in the target logic type.

5. Confirm. When the **Confirm** check box is not selected on the Replace dialog box, the program automatically changes all **Find What** addresses to **Replace With** addresses. When the **Confirm** check box is selected, the program displays each address where the Replace is to occur. The address to be replaced is surrounded by a red outlined rectangle and the following options are displayed in the Replace dialog box:

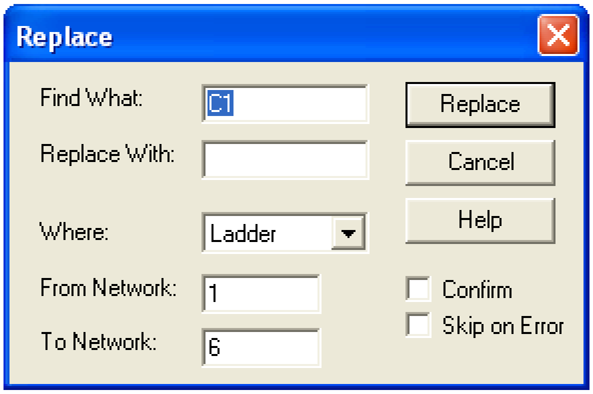
- Click **Replace** to perform the specified replacement.
- Click **Skip** to skip the address and go on to the next item to be replaced.
- Click **Stop** to cancel the replace operation and return to the specified logic window.

6. Skip on Error. When the **Skip on Error** check box is selected on the Replace dialog box, the program will skip illegal replacements and go on to the next item to be replaced automatically. If the **Skip on Error** check box is not selected, the program will flag illegal replacements and the following options are displayed:

- Click **Skip** to skip the address and go on to the next item to be replaced.
- Click **Stop** to Cancel the Replace operation and return to the specified logic window.

Search and Replace Table

The **Replace Table** feature expands the capabilities of the original **Replace** feature, illustrated below.

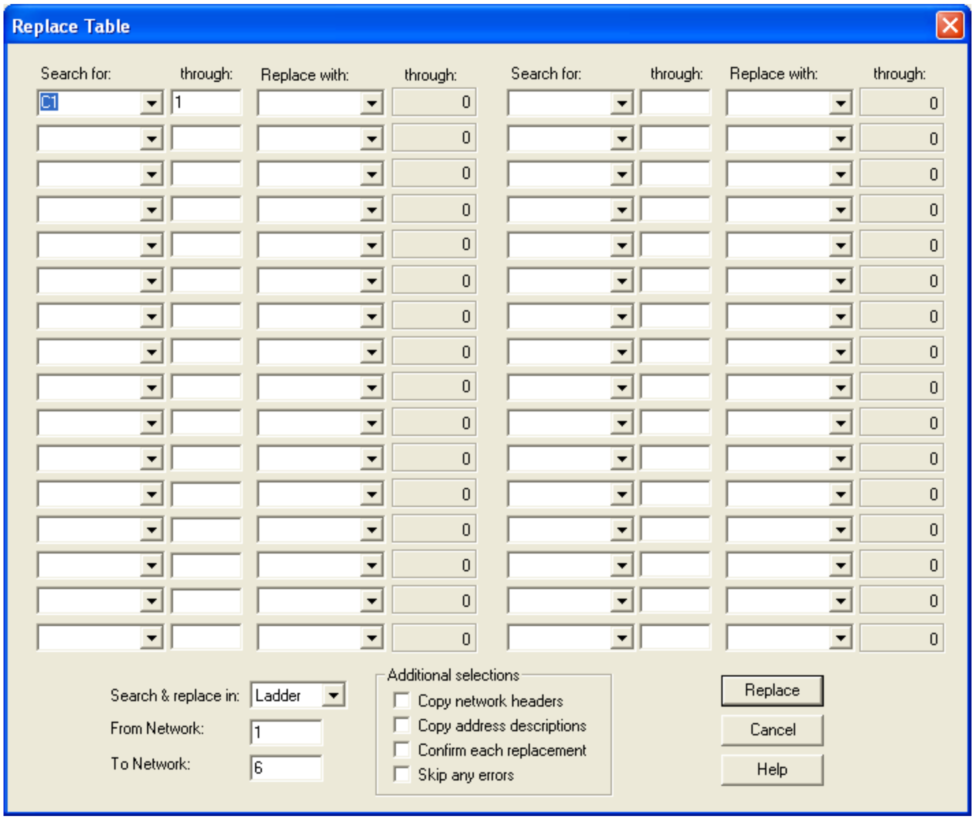


Find What: C1
Replace With:
Where: Ladder
From Network: 1
To Network: 6
□ Confirm
□ Skip on Error

The original **Replace** feature can search and replace only one address at a time. The **Replace Table** allows up to 32 address ranges to be searched and replaced in one continuous process within an offline PLC program.

Replace Table Dialog Box

Click **Replace Table**from the **Edit** menu to display the Replace Table dialog box.



Search for:	through:	Replace with:	through:	Search for:	through:	Replace with:	through:
C1	1		0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0
			0				0

Search & replace in: Ladder
From Network: 1
To Network: 6

Additional selections
□ Copy network headers
□ Copy address descriptions
□ Confirm each replacement
□ Skip any errors

Search for Combo Boxes

Each **Search for** combo box specifies the address (type and number) from which that search and replace operation will be performed. The drop lists in these combo boxes contain prefixes of all valid address and instruction types. Enter a number after the address prefix to designate the starting point of the address range to be searched and replaced.

For example, the partial drop list may contain the following address prefixes:

X, **Y**, **C**, **V**, **K**, **WX**, and **WY**

Select address prefix **C** and enter **12** after it. This indicates the starting address of this search and replace range is **C12**.

Through Boxes (associated wtih Search for)

The numeric values entered in the **through** boxes located to the right of the **Search for** boxes specify the address at which the search and replace range ends. This value must be greater than or equal to the address number entered in the **Search for** combo box.

Continuing the example above, entering *47* in the **through** box indicates this search range starts with address **C12** and ends with address **C47**.

Replace with Combo Boxes

The **Replace with** combo box specifies the address (type and number) which will replace the address range entered in the **Search for** combo box.

The items in the drop list are based upon the address type chosen in the **Search for** combo box. If a bit address type was selected in the **Search for** combo box, the **Replace with** drop list contains only bit address types. Similarly, if a WORD address type was selected in the **Search for** combo box, the **Replace with** drop list contains only WORD address types.

When box instructions are selected in the **Search for** combo box, only an instruction of the same type is allowed in the **Replace with** combo box. So if an *EDRUM* instruction is entered in the **Search for** combo box, only an *EDRUM* instruction can be entered in the **Replace with** combo box.

Continuing the example above, entering *X4* in the **Replace with** combo box indicates the **Search for** addresses starting with **C1** will be replaced with a range of addresses starting with **X4**.

Through Boxes (associated with Replace through)

The numbers displayed in the **through** boxes located to the right of the **Replace with** boxes are automatically calculated based upon the ranges entered in the **Search for** and its **through** boxes.

Continuing the example above, the **Search for** range starts at **C12** and ends at **C47**. This is a range of **47 – 12 = 35**, or **35** addresses of the **C** type. Since the starting address entered in the **Replace with** combo box is **X4**, the last address in the replace range is **4 + 35 = 39**, or **X39**. The number **39** is displayed in this **through** box.

When the search and replace process begins, any occurrence of **C12** is replaced with **X4**. Any **C13** is replaced with **X5,** and so on as illustrated below:

C12 is replaced with **X4**

C13 is replaced with **X5**

C14 is replaced with **X6**

C15 is replaced with **X7**

C16 is replaced with **X8**

.

.

.

C45 is replaced with **X37**

C46 is replaced with **X38**

C47 is replaced with **X39**

Performing Multiple Search and Replace Operations

Any or all of the 32 **Search for** and **Replace with** ranges can be used to perform multiple search and replace operations in one continuous process. However, once an address is changed during a given process, it will not be changed again even when another Search for and Replace with range is set to change the new address.

For example, one search and replace range is set to change **C1** to **X4**. A following search and replace range is set to change **X4** to **B19**. The search and replace process will not perform both changes, **C1** to **X4** then change **X4** to **B19**. Instead, the first change, **C1** to **X4**, occurs. Then the process moves to the next address in the PLC program and determines if it will be replaced.

Search & replace in Combo Box

The search and replace operation can be performed on 5 isolated sections of the PLC program:

- Ladder
- SFS (Special Function Subroutines)
- SFP (Special Function Programs)

- Alarms
- PID Loops.

Use the **Search & replace in** combo box to select the desired section of the PLC program in which to perform the search and replace operation.

From and To Edit Boxes

A search range within the program area selected in the **Search & replace in** combo box can be entered in the **From** and **To** edit boxes.

As the **Search & replace in** selection changes, the default values displayed in the **From** and **To** boxes include the entire range available in that PLC program section.

For example, when *Ladder* is selected, the default range displayed starts at network **1** and ends at the last network in the ladder.

Special Instructions Group Box

Additional actions can be performed as the search and replace operation executes. These actions can be selected within the **Special Instructions** group box. These actions are available only when **Ladder**, **SFS** or **SFP** are selected in the **Search & replace in** combo box.

The Copy Network Headers Check Box

A network can be documented with a network header. This network header is actually associated with the address of the network's output coil. When the search and replace process changes the address of a network's coil, the original network header is no longer tied to that network.

There are two options in this situation. Either the network header (if any) associated with the coil's new address replaces the network's previous header. Or the network header associated with the coil's original address is copied to the coil's new address.

As an example of the first option, the address of a network's output coil is **C1**. The network header associated with address **C1** is **PROCESS 1 INDICATOR LIGHT**. The search and replace operation changes **C1** to **X44**. The output coil of this network is now address **X44**. Address **X44** has no network header associated with it. As a result, this particular network loses its network header.

In the second option, when the search and replace operation changes the network output coil address from **C1** to **X44**, the network header **PROCESS 1 INDICATOR LIGHT** is copied from address **C1** to address **X44**. This allows the network to retain its original network header.

To select the first option, clear the **Copy network header** check box. To select the second option, select the **Copy network header** check box.

Copy Address Descriptions Check Box

The documentation of each address includes the **Tag**, **Description** and **Description Comment**. The Description portion of the original address can be copied to the address which replaces it. Select the **Copy address descriptions** check box to copy the original address's Description to the address which replaces it.

Confirm Each Replacement Check Box

Select the **Confirm each replacement** check box to force the search and replace process to stop and request user confirmation before performing each replacement. Clear this box to allow the search and replace process to proceed without pausing for user confirmation.

Skip Any Errors Check Box

Some replacements may be invalid, such as replacing addresses which are beyond configured limits or selecting instructions which are not available for the PLC type. When these errors occur, search and replace may be set to stop, display the error and request user confirmation before proceeding.

Alternately, search and replace may ignore any errors and continue its process without pausing for user confirmation. Select the **Skip any errors** check box to allow search and replace to continue past any errors without requesting user confirmation.

Replace Button

When the **Search for** and **Replace with** ranges you want to use have been entered, click **Replace** to start the search and replace process.

Cancel Button

Click **Cancel** to exit the **Replace Table** dialog box without performing the search and replace process.

Help Button

Click **Help** to display general help text about the **Replace Table** dialog box.

Data Window

Using the Data Window

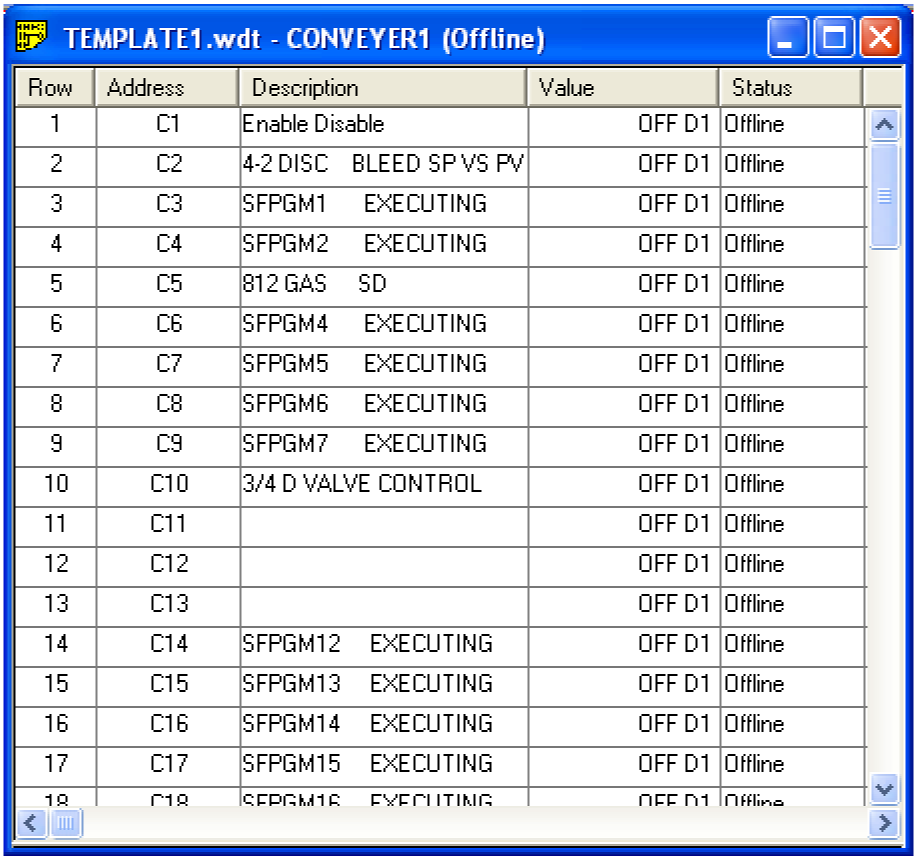
The Data Window is used to view and change the data values of your program.

Once you display addresses in the Data Window, you can enter specific values. If monitoring data online, you can enter a value for a particular address, send it directly to the processor, and you can force I/O address on and off.

You can also create tables of addresses, store them on a disk, and transfer them to the PLC at a later time.

With a logic program open, click **Data Window** from the **View** menu or click the ▦ toolbar icon. The Data Window dialog box appears. Click **Program Setup** from the **Options**menu or the context menu to change which columns are displayed in the Data Window. See Program Setup for more information.

Multiple data windows for a single logic program can be open at one time. The program associated with the open data window is displayed after the name of the window.



Row	Address	Description	Value	Status
1	C1	Enable Disable	OFF D1	Offline
2	C2	4-2 DISC BLEED SP VS PV	OFF D1	Offline
3	C3	SFPGM1 EXECUTING	OFF D1	Offline
4	C4	SFPGM2 EXECUTING	OFF D1	Offline
5	C5	812 GAS SD	OFF D1	Offline
6	C6	SFPGM4 EXECUTING	OFF D1	Offline
7	C7	SFPGM5 EXECUTING	OFF D1	Offline
8	C8	SFPGM6 EXECUTING	OFF D1	Offline
9	C9	SFPGM7 EXECUTING	OFF D1	Offline
10	C10	3/4 D VALVE CONTROL	OFF D1	Offline
11	C11		OFF D1	Offline
12	C12		OFF D1	Offline
13	C13		OFF D1	Offline
14	C14	SFPGM12 EXECUTING	OFF D1	Offline
15	C15	SFPGM13 EXECUTING	OFF D1	Offline
16	C16	SFPGM14 EXECUTING	OFF D1	Offline
17	C17	SFPGM15 EXECUTING	OFF D1	Offline
18	C18	SFPGM16 EXECUTING	OFF D1	Offline

When a data window is selected, the **Data** menu appears in the WorkShop Menu Bar. Most data window actions can be performed using the **Data** menu or the **Diagnostics** menu, or by right-clicking the Data Window and selecting a command from the context menu.

To view or manipulate data in the Data Window:

1. Type an address or tag in the address field. Press **ENTER** to accept the address/tag.

> **NOTE:** Press **CTRL+ L** on the Description or Tag column to display the Documentation Window.

2. Repeat Step 1 for each value you want to view. After entering a value, click **Next** from the **Data** menu (or press **F5**) to move down one cell and fill in the next address or tag, or click **Previous** from the **Data** menu (or press **F6**) to move down one cell and fill in the previous address or tag.

   Both **Next** and **Previous** may also be selected by right-clicking the Data Window and selecting **Next** or **Previous** from the context menu.

3. Perform a Data Fill to quickly display a preformatted range of addresses by clicking **Fill** from the **Data** menu. See Data Fill for more information.

> **NOTE**: Each Data Window can accept up to 100 rows of data.

4. Create a table of addresses from the Data Window and store it to a file by clicking **Save Template** from the **Data** menu. The file is saved as a Data Template (*.WDT) file. To load a saved Data Template, click **Load Template** from the **Data** menu. When a template is loaded, the template name is displayed in the title bar as in the example above.
5. Click **On** or **Off** from the **Diagnostics** menu or right-click and select **On** or **Off** from the context menu to set discrete addresses on or off for a single scan.
6. Click **Force On** or **Force Off** from the **Diagnostics** menu or right-click and select **Force On** or **Force Off** from the context menu to force on or off discrete addresses.
7. Click **Force Memory** from the **Diagnostics** menu or right-click and select **Force Memory** from the context menu to force word addresses to a specific value and format. See Forcing an Element for more information.
8. Click **Clear Force** from the **Diagnostics** menu to clear the force of a selected address, or click **Clear All Forces** to clear all currently forced addresses. See Clear a Forced Element for more information.

9. Click **Show Forces** from the **Diagnostics** menu to display all forced addresses. See Show Forces for more information.
10. Click **Status On** or **Status Off** from the **Data** menu to toggle data window status updates.

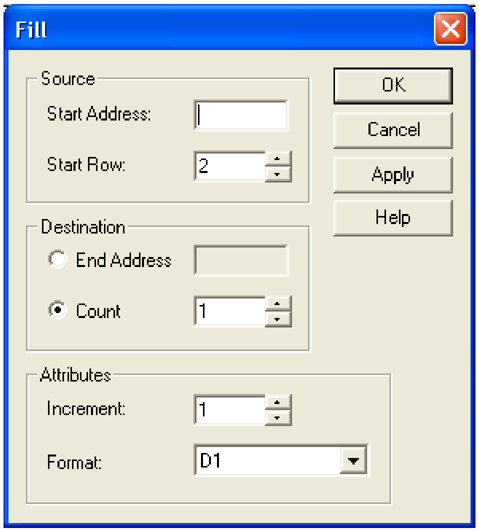
For more on WorkShop's diagnostics capabilities, see Auxiliary PLC Functions and Displays.

Data Fill

Use the **Fill** feature within the Data Window to quickly monitor and evaluate a range of I/O values.

To fill the Data Window:

1. Access the Data Window by clicking **Data Window** from the **View** menu.
2. Select the first row in which data is to be filled.
3. Click **Fill** from the **Data** menu. The **Fill** dialog box appears.



Start Address:

Start Row: 2

○ End Address

● Count 1

Increment: 1

Format: D1

- **Start Address:** Enter the first address in the series.
- **Start Row:** Enter the row number of the line that will hold the start address.

- **End Address:** To specify the range by address, select the **End Address** option button and enter the last address in the series.
- **Count:** To specify the range by number of lines/addresses, select the **Count** option button and enter the number of lines to be filled.
- **Increment:** Set the increment between addresses. For example, with an increment of 1, each address in the range is added to the log sheet. With an increment of 2, starting with an even numbered address, the even numbered addresses will be added to the log sheet.
- **Format:** Select the display format for the data. See Data Format for more information.
- **OK:** Fill the range and close the dialog box.
- **Cancel:** Close the dialog without filling the range.
- **Apply:** Click **Apply** to fill the range without closing the dialog box. The **Start Address** and **Start Row** fields will be updated to just past the end of the range specified previously. For example, if the start address was X1, the start row 10, and the Count 10, after the **Apply** button is clicked, the new start row will be 20.

Data fills can also be entered more efficiently in the address box directly using the following format:

```
Start Address - End Address \ increment \ data format
```

For example, to display addresses between V1 and V10 in increments of two with a value format of F32, enter in the address box:

```
V1-V10\2\F32
```

The output below will appear in the Data Window:

V1 0 F32

V3 0 F32

V5 0 F32

V7 0 F32

V9 0 F32

Increment and data format entries are not required to perform the data fill. The data format of each address can be changed independently of other addresses when desired. Continuing the example above, if you clicked in the address box for V9 and typed V9\U16, the Data Window would display the same address as an unsigned integer.

Customizing the Display

The Data Window can be customized to display tags, descriptions, both tags and descriptions, or neither. These columns can be displayed if selected in the Program Setup.

To modify the display, click **Program Setup** from the **Options** menu or type **ALT+O, P**. Click the **Data Window and I/O Simulator Window** tab, and make your selections in the Column Display area.

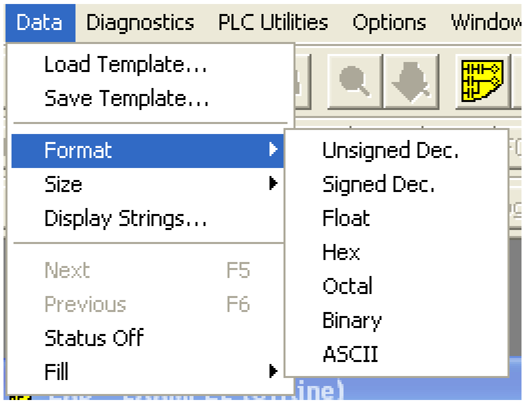
- Select the **Include Tags** check box to include tags.
- Select the **Include Descriptions** check box to include descriptions.
- Clear both check boxes if you do not want to include tags and descriptions.

For more Data Window display options See *Program Setup in Chapter 4*.

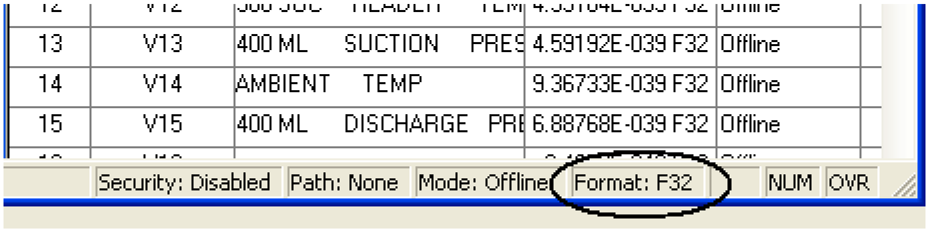
Data Format

While in the Data Window, the type of data displayed for byte, word and double word addresses can be changed to a variety of formats. Click **Format** from the **Data** menu and then select the data format you want to use.

Click **Size**from the **Data** menu to choose between 16- and 32-bit data formats.



When an address is entered into the Data Window, the address value will be displayed in the selected format, which becomes the default format for the Data Window. The default format is displayed in the WorkShop status bar at the bottom of the WorkShop window whenever the Data Window is active.



13	V13	400 ML SUCTION PRES	4.59192E-039 F32	Offline
14	V14	AMBIENT TEMP	9.36733E-039 F32	Offline
15	V15	400 ML DISCHARGE PRE	6.88768E-039 F32	Offline

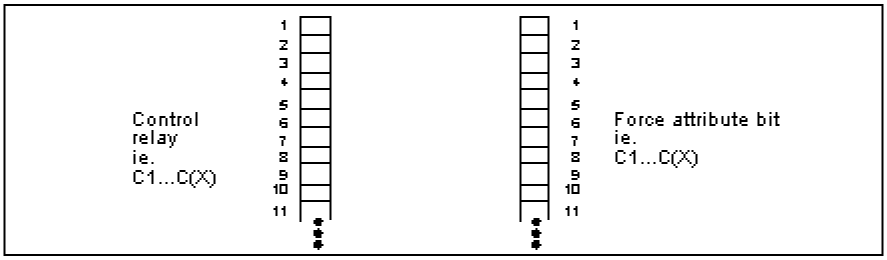
Security: Disabled | Path: None | Mode: Offline | Format: F32 | NUM | OVR

The default format displayed in the status bar changes whenever another format is selected, except when using the real dot notation (V1. or LPV.) or a discrete address (X1, C1, Y1). In those instances the default format remains unchanged.

Format	Description
D1	Discrete (1-bit)
U8	Unsigned Decimal (8-bit)
S8	Signed Decimal (8-bit)
O8	Octal (8-bit)
B8	Binary (8-bit)
A8	ASCII (8-bit)
U16	Unsigned Decimal (16-bit)
S16	Signed Decimal (16-bit)
H16	Hexadecimal (16-bit)
O16	Octal (16-bit)
B16	Binary (16-bit)
A16	ASCII (16-bit)
F32	Floating Point (32-bit)
U32	Unsigned Decimal (32-bit)
S32	Signed Decimal (32-bit)
H32	Hexadecimal (32-bit)
O32	Octal (32-bit)
B32	Binary (32-bit)
A32	ASCII (32-bit)

Forcing an Element

As a troubleshooting tool, discrete I/O addresses, word I/O addresses, and control relays can be forced. The force attribute bit provides a single-bit memory location for storing the status of forced elements. If an element has been forced, the element retains that forced status during a power cycle as long as the battery is good.

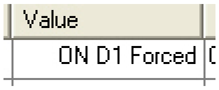


Forcing Discrete Elements

To force a discrete element from either the Data Window or Ladder logic editor, complete the following steps:

FROM THE DATA WINDOW:

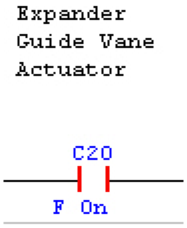
- Select the element you want to force and then click **Force On** or **Force Off** from the **Diagnostics** menu, or right- click and select **Force On** or **Force Off** from the shortcut menu. The force appears next to the value of the element in the Data Window.



Value
ON D1 Forced

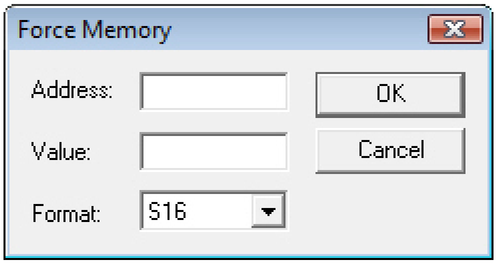
FROM THE LADDER EDITOR:

- Select the element you want to force and click **Force On** or **Force Off** from the Diagnostics menu. The force will appear below the element in the ladder diagram.



Forcing Word Elements

WX and WY word addresses can also be forced to a specified value. Click **Force Memory** from the **Diagnostics** menu or right-click and select **Force Memory** from the shortcut menu. The **Force Memory** dialog box appears.

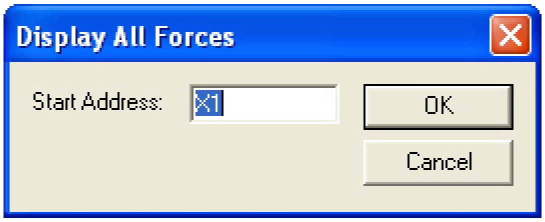


Enter the word address to force in the **Address** box, and the value you want to use in the **Value** box. In the **Format** drop down box, select the appropriate data format.

Show Forces

To show all forced elements complete the following steps:

1. With the Data Window open and active, click **Show Forces** from the Data menu. The **Display All Forces** dialog box appears.



2. Enter an address to start the display in the **Start Address** box and click **OK** when finished. All forced addresses occurring after the Start Address appear in the Data Window.

Clear a Forced Element

To Clear a Forced Element from either Data Window or ladder logic editor complete the following steps.

From the Data Window:

1. Select the element you wish to force in the data window.
2. Click either **Force On** or **Force Off** from the **Diagnostics** menu, or right-click the element and select **Force On** or **Force Off** from the shortcut menu. The force appears next to the value of the element in the Data Window.

From the Ladder Logic:

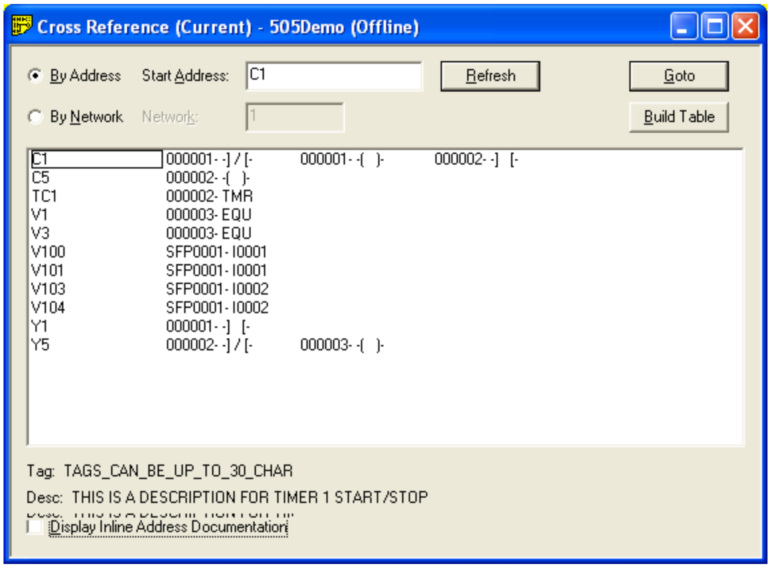
1. Select the element you wish to force in the ladder logic editor.
2. Click either **Force On** or **Force Off** from the **Diagnostics** menu.

Complete Cross Reference

In both online (network mode only) and offline programming, you locate all the uses of an address in a program by viewing the Cross Reference window.

> **NOTE:** Logic that has not been validated ad entered will not be included in the cross reference.

1. To access the Cross Reference window, click **Cross Reference** from the **View** or click the toolbar button. If you have more than one program loaded, the information displayed is for the program in the active window. The cross reference can be based on address or networks by selecting the appropriate button.


Cross Reference (Current) - 505Demo (Offline)
● By Address
Start Address:
○ By Network
Network:
Refresh
Goto
Build Table
□ Display Inline Address Documentation

Start Address: C1

Network: 1

```
C1      000001- -] / [-     000001- -(  )-     000002- -]  [-
C5      000002- -(  )-
TC1     000002- TMR
V1      000003- EQU
V3      000003- EQU
V100    SFP0001- I0001
V101    SFP0001- I0001
V103    SFP0001- I0002
V104    SFP0001- I0002
Y1      000001- -]  [-
Y5      000002- -] / [-     000003- -(  )-
```

Tag: TAGS_CAN_BE_UP_TO_30_CHAR

Desc: THIS IS A DESCRIPTION FOR TIMER 1 START/STOP

- To view address documentation inline, check the **Display inline Address Documentation** check box. When the box is cleared, address documentation is shown just above the box.
- Enter the starting address in the **Start Address** box or the starting network in the **Network** box. Click **Refresh**. The address is displayed on the left side with the network number next to the element. The **Tag** and **Description** of the selected address are displayed on the bottom left of the screen.
- Select the logic item you want to view from the view window. Click **Goto** to jump to the first occurrence of the address in the ladder logic editor. Alternatively, you can double-click the item to jump to its first occurrence.

NOTE: The title line gives the status of the cross-reference. To bring it current, click **Build Table**.

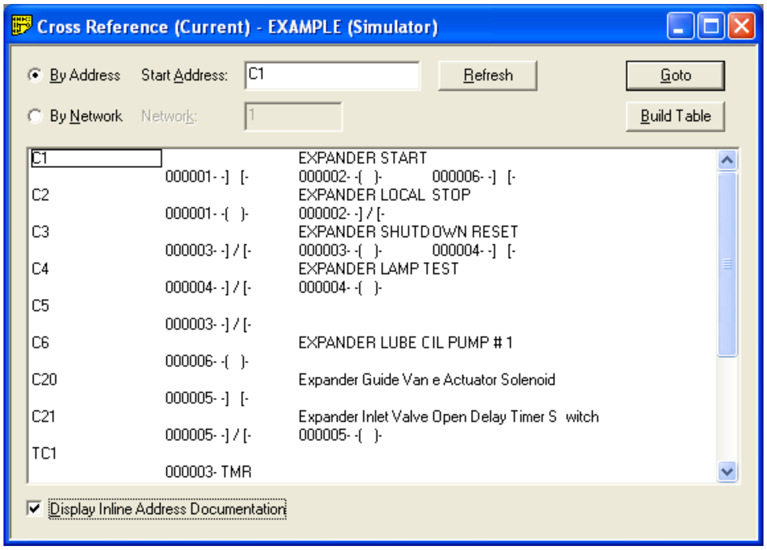
NOTE: When the **Update Cross Ref Table** check box is selected in the Program Setup dialog box, changes to ladder logic appear in the cross reference display as soon as they are validated and entered. Otherwise, they appear when the cross reference table is rebuilt.

Ladder Network Cross Reference

You can track addresses in a program by viewing the Cross Reference table.

> **NOTE** Only validated and entered logic is considered part of the current program. Thus, logic that is not entered and validated is not displayed in the Cross Reference Table. See **Validate and Enter Logic**.

1. Position the cursor over the instruction network to cross-reference. Click **Network Cross Reference** from the **View** menu. The **Network Cross Reference** window appears. If you have more than one program loaded, the information displayed is for the program in the active window.



● By Address Start Address: C1

○ By Network Network: 1

```
C1                 EXPANDER START
       000001- -]  [-     000002- -(  )-     000006- -]  [-
C2                 EXPANDER LOCAL  STOP
       000001- -(  )-     000002- -] / [-
C3                 EXPANDER SHUTDOWN RESET
       000003- -] / [-    000003- -(  )-     000004- -]  [-
C4                 EXPANDER LAMP TEST
       000004- -] / [-    000004- -(  )-
C5
       000003- -] / [-
C6                 EXPANDER LUBE CIL PUMP # 1
       000006- -(  )-
C20                Expander Guide Van e Actuator Solenoid
       000005- -]  [-
C21                Expander Inlet Valve Open Delay Timer S  witch
       000005- -] / [-    000005- -(  )-
TC1
       000003- TMR
```

☑ Display Inline Address Documentation

2. To view address documentation inline, select the **Display inline Address Documentation** check box. When the check box is cleared, address documentation is shown just above the box.

3. To go to a network location where a particular address is used, select the network number and click **Goto**, or double-click the network number.

Address Used

Displaying Addresses Used

To show if specific elements are used in your program, you can build an element usage listing. The following element types can be shown in the Ladder Element Used Table.

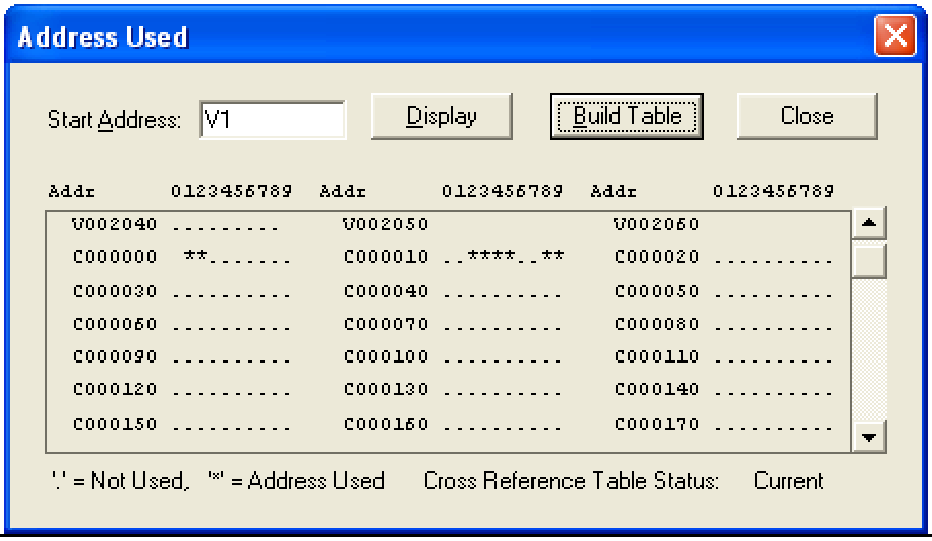
X	WX	C	K	TC	SHR	OS
Y	WY	V	STW	DRM	MWT	

Creating an Address Used Listing

To create an element usage listing both online and offline programming, you can track addresses in a program by viewing the **Address Used** listing.

1. Click **Address Used** from the **View** menu. The **Address Used** window appears. If you have more than one program loaded, the information displayed is for the program in the active window. The Address Used listing uses information from the Cross Reference Table. If the Cross Reference Table is not current, a warning will appear to build the table.

> **NOTE:** Only validated and entered logic is considered part of the current program. Thus, logic that is not entered and validated will not show in the Address Usage listing. See Validate and Enter Logic for more information.



Start Address: V1

```
Addr       0123456789   Addr       0123456789   Addr       0123456789
  V002040  .........      V002050                 V002060
  C000000   **........    C000010  ..****..**     C000020  ..........
  C000030  ..........     C000040  ..........     C000050  ..........
  C000060  ..........     C000070  ..........     C000080  ..........
  C000090  ..........     C000100  ..........     C000110  ..........
  C000120  ..........     C000130  ..........     C000140  ..........
  C000150  ..........     C000160  ..........     C000170  ..........
```

'.' = Not Used, '*' = Address Used   Cross Reference Table Status: Current

2. Type an address or tag in the **Start Address** box and then click **Display**.

   - The area below the **Start Address** box contains all addresses used in the active program. Elements are displayed in increments of 10 (**C0**, **C10**, **C20**, and so on.). Usage of the points between is shown in the adjacent column from 0 – 9 (**C1** under **1**, **C2** under **2**, and so on).

   - The following indicators are used to indicate the memory usage of the address/tag:

Indicator	Description
Blank	Point does not exist.
Dot (.)	Point is not used in the program.
Asterisk (*)	Point is used in the program

3. Use the scroll bar on the right side of the Address Used window to view additional addresses.
4. Repeat Steps 2 – 3 for each address/tag you want to find.
5. Close the **Address Used** window.

> **NOTE:** If you have the **Update Cross Ref Table** check box selected in the Program Setup dialog box, all changes made to logic that are validated and entered are automatically updated in the **Address Used Listing**.

Address Trace

Tracing an Address

The Address Trace is an online or off-line ladder scan for a specific address. The search address is based on the cursor position.

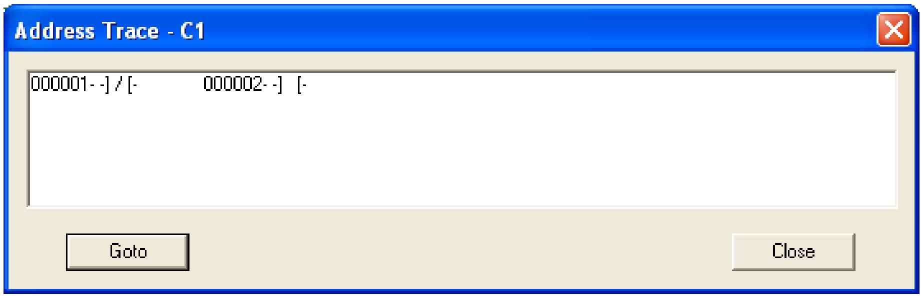
The Trace scans for address instances based on the type of instruction where the address is found. If the cursor is located on an input instruction, then the corresponding address for the output instruction is searched for. If the cursor is located on an output instruction then the corresponding address for the input instruction is searched for. Each time the Trace function is selected a new addresses search is invoked.

The address supported by trace are: X, Y, C, WX, WY, K, V, TCP, TCC, STW, DSP, DCP, DSC, DCC, all Gs, VMM, VMS, DRUM, MOVE, OS, TIMER and COUNTER. Trace does not work on expression parameters in SFSUB, however.

Invoking Address Trace

To create an Address Trace both online and offline:

Click **Address Trace** from the **View** menu. The Address Trace window appears. If you have more than one program loaded, the information displayed is for the program in the active window.



```
000001- -] / [-        000002- -]  [-
```

The list box has five columns. Each column holds one location. The location consists of rung number and item found. The list box displays the locations in order of rung number.

The **GOTO** button closes the Address Trace window and places the cursor in ladder logic window at the network number selected in the Address Trace list box.

Unique Address

Unique determines if an element already exists in your ladder program and, if so, gives you the location. For example, if a TIMER is needed for a new feature, you can use the Unique function to see if TMR**nnnn** is already used. Since a TMR is a global memory box, 505 WorkShop also checks to see if any TMR, TMRF, CTR, UDC, MCAT, or DCAT has the same nnnn designator.

NOTE: Unique checks only for occurrences of the designated element in L-Memory. It does not search for an element in Loops, Analog Alarms, SFPGMs, SFSUBs, Intelligent I/O, or Operator Interface devices.

To access the Unique function:

1. Select an item in the logic window to search on.
2. Click **Unique Address** from the **View** menu. The Unique Address window appears.

The two results of the search are:

- Address exists only at current network.
- Address exist at network number XXXX.

If you have more than one program loaded, the information displayed is for the program in the active window only.

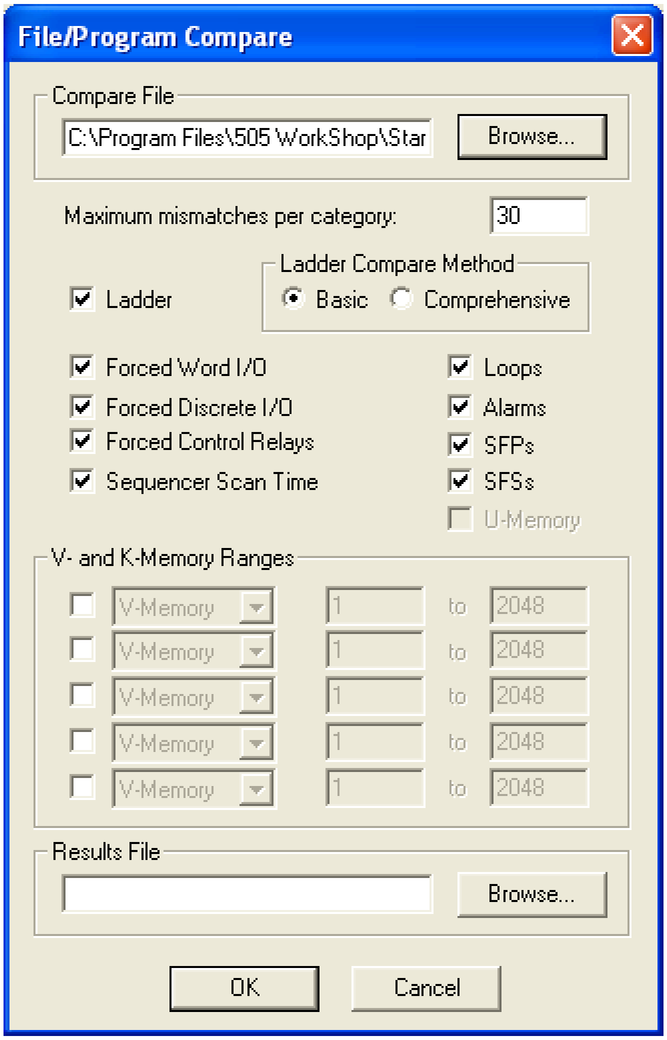
Compare

File Program Compare compares the following data of the selected program on disk to the data in the controller (online) or offline:

- Ladder
- Forced Word I/O
- Forced Discrete I/O
- Forced Control Relays
- Sequencer Scan Time
- Loops
- Alarms
- Special Function Programs
- Special Function Subroutines
- U-Memory
- V and K Memory

To perform a File Program Compare a program must be open.

1. Click **File Program Compare** from the **File** menu.
   Result: The File Program Compare window appears.


File/Program Compare

Compare File: C:\Program Files\505 WorkShop\Star

Maximum mismatches per category: 30

☑ Ladder

Ladder Compare Method: ● Basic ○ Comprehensive

☑ Forced Word I/O
☑ Forced Discrete I/O
☑ Forced Control Relays
☑ Sequencer Scan Time
☑ Loops
☑ Alarms
☑ SFPs
☑ SFSs
□ U-Memory

V- and K-Memory Ranges

□	V-Memory	1	to	2048
□	V-Memory	1	to	2048
□	V-Memory	1	to	2048
□	V-Memory	1	to	2048
□	V-Memory	1	to	2048

Results File:

2. Click **Browse** to locate the disk file to compare or enter the file name in the **Compare File** box.

3. Enter the **Maximum mismatches per category**. Maximum mismatches per category allows you to abort the compare process if the number of mismatches exceeds the number entered in the Maximum mismatches per category selection box.

4. Select the check boxes that correspond to the items you want to compare. For each of the V or K memory address, you can also choose the range for the comparison.

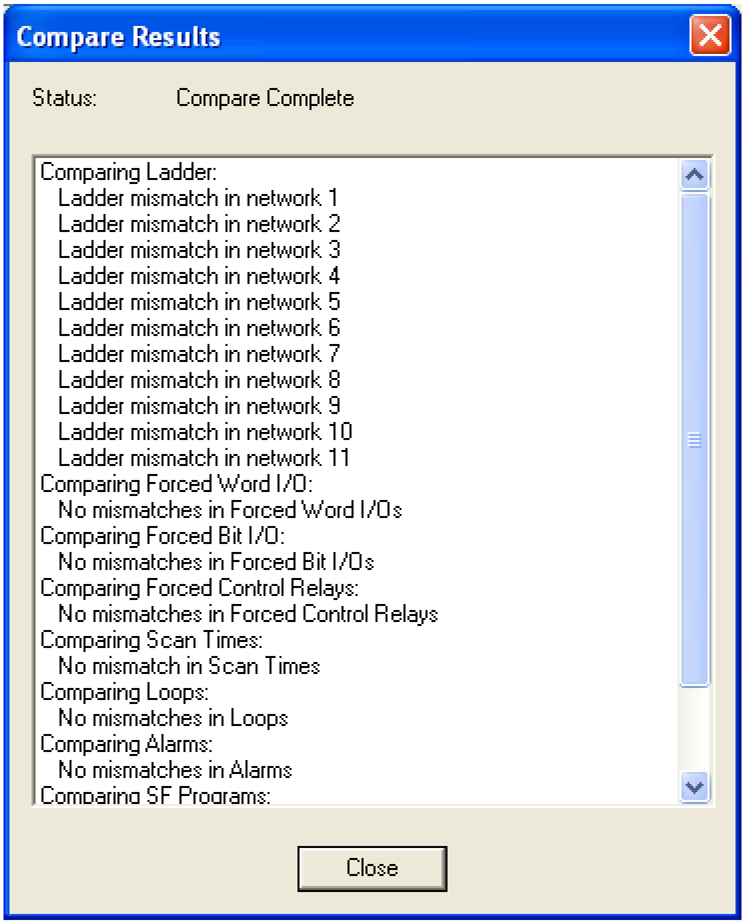
5. If you are comparing ladder logic, select the method. The **Comprehensive** compare provides a better, more detailed comparison. The **Basic** compare is much faster.

6. Enter a result file path and name in the **Result File** box if the results of the compare are to be saved to a file.

7. Click **OK** to start the compare process.

NOTE: If there is more than one program open, the File Program Compare compares the program in the active window.

When the compare finishes, a Compare Results dialog box similar to the following appears. Any mismatches between the File and controller or offline program are listed.



Status: Compare Complete

```
Comparing Ladder:
   Ladder mismatch in network 1
   Ladder mismatch in network 2
   Ladder mismatch in network 3
   Ladder mismatch in network 4
   Ladder mismatch in network 5
   Ladder mismatch in network 6
   Ladder mismatch in network 7
   Ladder mismatch in network 8
   Ladder mismatch in network 9
   Ladder mismatch in network 10
   Ladder mismatch in network 11
Comparing Forced Word I/O:
   No mismatches in Forced Word I/Os
Comparing Forced Bit I/O:
   No mismatches in Forced Bit I/Os
Comparing Forced Control Relays:
   No mismatches in Forced Control Relays
Comparing Scan Times:
   No mismatch in Scan Times
Comparing Loops:
   No mismatches in Loops
Comparing Alarms:
   No mismatches in Alarms
Comparing SF Programs:
```

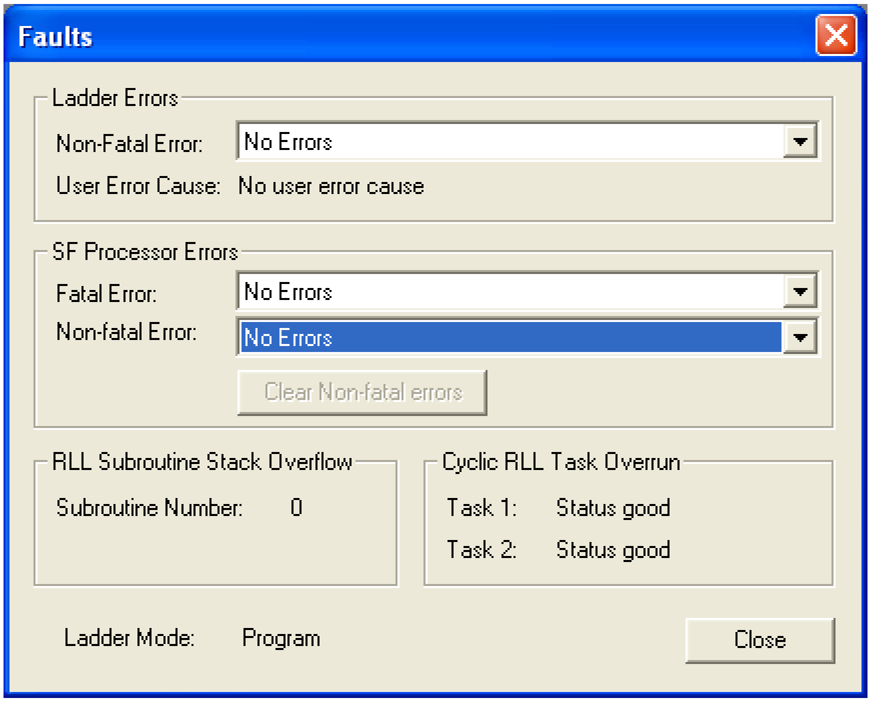
Displaying Processor Faults

You can display the Faults of your processor while online.

To display the processor faults:

1. Click **Faults** from the **Diagnostics** menu.

2. The online Faults are displayed.



Non-Fatal Error: No Errors
User Error Cause: No user error cause

Fatal Error: No Errors
Non-fatal Error: No Errors

Subroutine Number: 0

Task 1: Status good
Task 2: Status good

Ladder Mode: Program

CTI 2500 Error Codes

Startup Errors

These errors may be encountered during a power-on start and will be displayed on the Multi-Segment Display (MSD).

Error Number	Description	Corrective Action
E01–E20	Indicates a problem initializing hardware or software.	Cycle power. If the problem persists contact CTI Product Support.
E81 – E99	Missing or corrupted application firmware	These errors will occur if you remove power from the controller during a firmware update before the new firmware has been completely written to flash. To correct this problem, reload the application firmware. See the *CTI 2500 Installation and Operation Guide* for instructions.

Fatal Error Codes

When a fatal error occurs, “FE” will be displayed on the MSD. WorkShop displays these codes when you select the Diagnostics / Faults menu item.

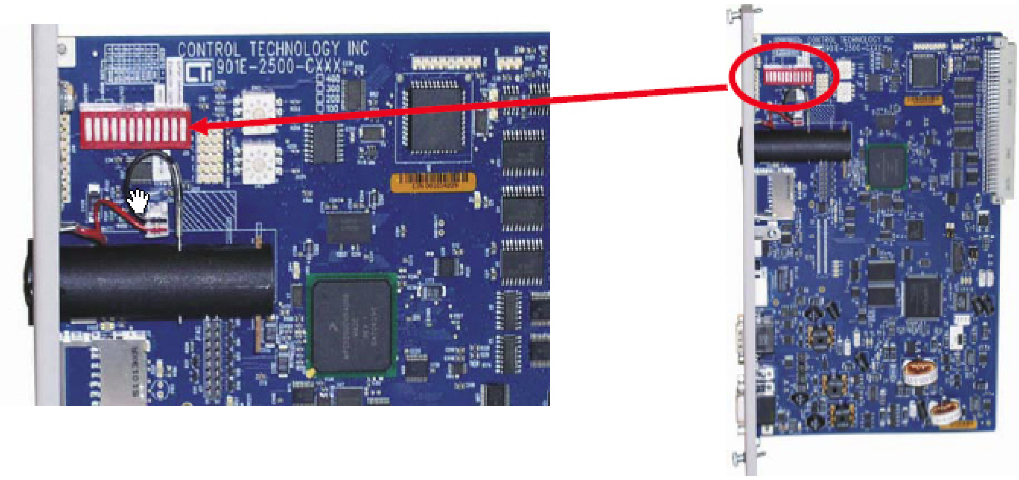
Code	Description	Corrective Action
010B	Abnormal Power Loss Indicates power was removed before the controller could complete an orderly shutdown.	Use Partial or Complete Restart to clear this error.
010D	User Program Flash Restore Error Indicates that the program stored in flash could not be used.	After clearing this error, using Partial or Complete Restart, you must erase the user program in flash, reload the program to RAM, then save it to flash.
0113	Scan Watchdog Timeout This error indicates that the actual scan time exceeded the watchdog setting.	The most common cause of the problem is setting the cyclic RLL cycle too small, so that other scan elements do not get enough time to run.
0114	Compiled RLL Checksum Error Indicates the compiled RLL has been corrupted.	These errors may be caused by to excessive conductive or radiated interference affecting the controller memory. Use Partial or Complete Restart to clear this error. If this problem persists, ensure the system is properly grounded.
0134	Compiled SF Checksum Error This error indicates that one or more compiled SF programs/subroutines have been corrupted.	

Code	Description	Corrective Action
0300	Operating System Error Indicates that an error has been detected in the operation of the system firmware.	Error details can be obtained from the system event log. If this error persists, contact CTI Product Support
0400	Diagnostic Error Indicates that a general diagnostic error has occurred.	Error details can be obtained from the system event log.
0600	Hardware Failure Indicates that a failure in a hardware component has been detected.	Error details can be obtained from the system event log.
0608	System Clock Failure Indicates the system clock cannot be accessed.	To clear this error you must cycle power to the controller. If the problem persists, contact CTI Product Support.
060B	L Memory Invalid Power loss during in-progress RLL edit operation.	After clearing this error, you must reload the RLL.
060C	L Memory Invalid Power loss during L memory resize operation	After clearing this error, you must reload the RLL.
060D	S Memory Invalid Power loss during in-progress S memory edit operation.	After clearing this error, you must reload the RLL.

Code	Description	Corrective Action
060F	System service failure	To clear this error, you must cycle power to the controller. If the problem persists, contact CTI Product Support.

CTI 2500 User Switch Settings

The switchblock containing the user switches is located on the circuit board as shown in the following picture.



SW1 – Battery Switch

The battery switch can be used to disconnect the battery. You may want to temporarily disconnect the battery to clear memory or to preserve the battery when storing the unit. The battery is connected when the switch is in the closed position and disconnected when the switch is in the open position.

SW2: SW4 – Serial Port Baud Rate.

Switches 2 through 4 are used to set the baud rate for the serial port as indicated in the following table.

Baud Rate	Switch Position		
	SW2	SW3	SW4
115, 200	Closed	Open	Open
57, 600	Closed	Open	Closed

Baud Rate	Switch Position		
	SW2	SW3	SW4
38, 400	Closed	Closed	Open
19, 200	Closed	Closed	Closed
9600	Open	Open	Open
2400	Open	Closed	Open
1200	Open	Open	Closed
300	Open	Closed	Closed

SW5 – Serial Port Electrical Interface

This switch selects whether the RS-232 electrical interface or RS-422 electrical interface is used. For typical programming applications you should select RS-232. The open position selects RS-232. The closed position selects RS-422.

SW6 – Program Port Selection

This switch selects whether only TCP port 4452 can be used for programming or whether TCP port 1505 can also be used. The open position selects port 4452 only. The closed position allows both 4452 and 1505.

NOTE: The setting applies to the local Ethernet port only and does not affect programming via Special Function modules, such as the 2572- A or 2572.

When possible, you should use port 4452 only. This setting allows you to block other users from concurrently modifying the program by enabling port lockout while you are programming.

Some Ethernet programming interfaces, such as APTNET, use a fixed program port of 1505 and cannot use port 4452. If you are using one of these, you may choose to use both 4452 and 1505 as local programming ports. If you choose this option, the CTI 2500 controller cannot prevent concurrent network programming.

SW7: SW11 – Reserved

Switches 7 through 11 are reserved for future use.

SW12 – Firmware Update

Switch 12 is used to enter the firmware update state. When the switch is open, the controller will start up in the normal operating mode. When the switch is closed, the controller will start up in the firmware update mode.

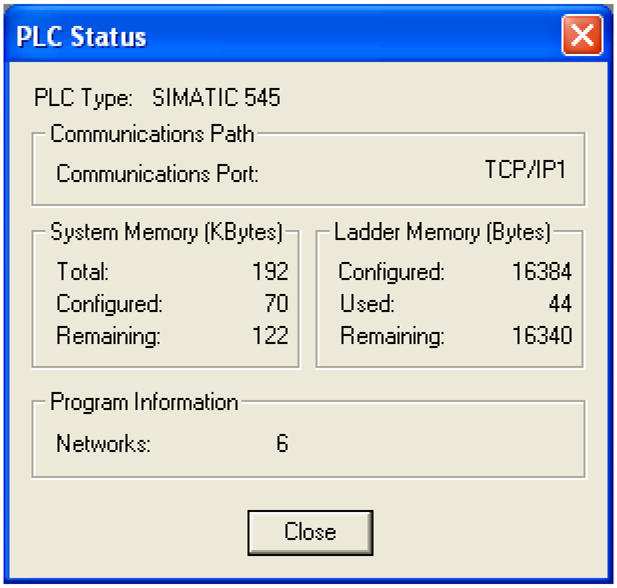
Auxiliary PLC Functions and Displays

Displaying Processor Status

You can display the status of your processor while online or offline.

To display the processor status:

1. Click **PLC Status** from the **PLC Utilities** menu (**ALT+U, P**).
2. Either the PLC Status for online or offline is displayed.
3. Click Close to close the PLC Status box, and return to the active logic program.



PLC Status

PLC Type: SIMATIC 545

Communications Path

Communications Port: TCP/IP1

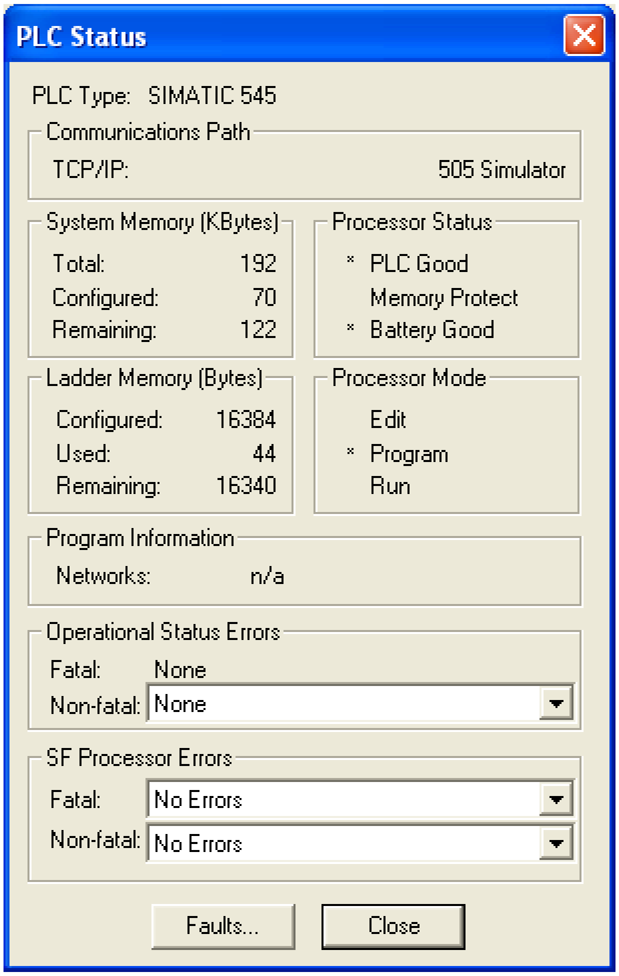
System Memory (KBytes)	
Total:	192
Configured:	70
Remaining:	122

Ladder Memory (Bytes)	
Configured:	16384
Used:	44
Remaining:	16340

Program Information

Networks: 6

PLC Status Offline



PLC Status

PLC Type: SIMATIC 545

Communications Path
TCP/IP: 505 Simulator

System Memory (KBytes)
Total: 192
Configured: 70
Remaining: 122

Processor Status
* PLC Good
Memory Protect
* Battery Good

Ladder Memory (Bytes)
Configured: 16384
Used: 44
Remaining: 16340

Processor Mode
Edit
* Program
Run

Program Information
Networks: n/a

Operational Status Errors
Fatal: None
Non-fatal: None

SF Processor Errors
Fatal: No Errors
Non-fatal: No Errors

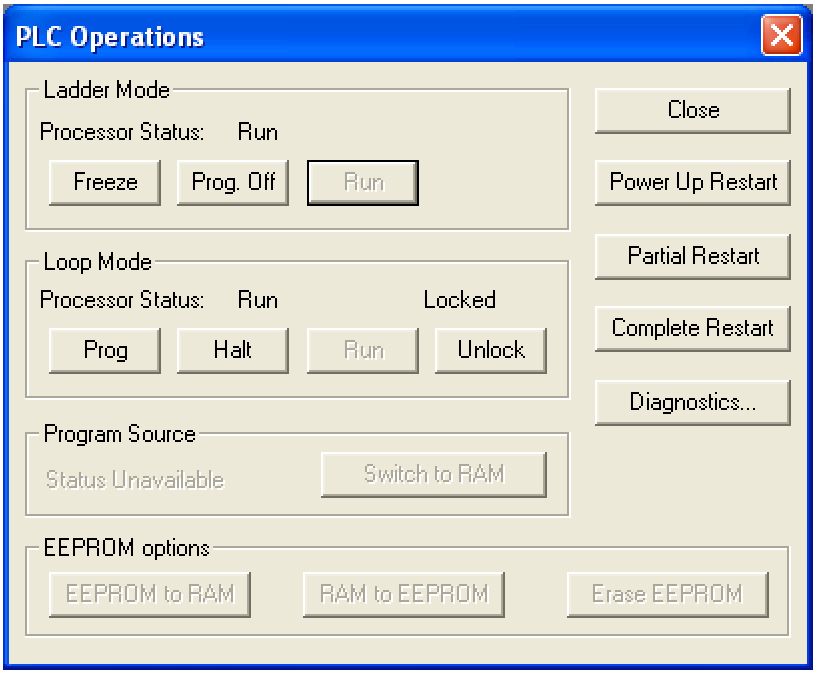
PLC Status Online

PLC Operations

This menu item allows you to view and modify PLC operations while online.

To access PLC Operations:

1. Click **PLC Operations** from the **PLC Utilities** menu (**ALT+U, O**). The PLC Operations dialog box appears.
2. When you have S-memory configured, you receive a display with three fields to change operating mode. Use the mouse or arrow keys to select the desired field.



PLC Operations

Ladder Mode
Processor Status: Run

Loop Mode
Processor Status: Run Locked

Program Source
Status Unavailable

Changing Ladder Mode

Without S-memory configured, the LADDERS field is the only option for changing program mode.

Freeze

Freeze places the controller in PROGRAM FREEZE mode. All outputs are frozen in their current states. However, intelligent I/O modules still can update outputs. To select PROGRAM FREEZE mode, click **Freeze** on the PLC Operations dialog box. The following message appears:

```
Stop the PLC with outputs frozen? Select either YES or
NO.
```

Prog Off

Prog_Off places the controller in PROGRAM OFF mode. Discrete outputs are set to zero, and all word outputs are frozen. However, intelligent I/O modules still can update outputs. To select PROGRAM OFF mode, click **Prog_Off** on the PLC Operations dialog box. The following message appears

```
Stop the PLC with outputs cleared? Select either YES or
NO.
```

⚠ **Warning**	When you elect to go to **PROGRAM OFF** mode, you receive the message, `Stop the PLC with outputs cleared?` Select either **YES** or **NO**. Intelligent I/O modules (e.g., the 386/ATM module, the Programmable BASIC module, the Servo Axis module, or the High Speed Pulse Input module) can update outputs even when the controller is in PROGRAM mode, if your code permits. If an intelligent I/O module writes directly to an image register point, its write takes precedence even when **PGMFRZ/PGMOFF** is in effect. This could cause unexpected control action, resulting in death or serious injury to personnel, and/or damage to equipment. Do not write directly to output image register points from an intelligent I/O module. Instead, write to a control relay or V-memory location and have your RLL program copy this location to the output point.

Run

Run places the controller in RUN mode, beginning execution of the ladder program. To select PROGRAM RUN mode, click **RUN** on the PLC Operations dialog box. The following message appears:

```
Run PLC? Select either YES or NO.
```

Changing Loop Mode

> **NOTE:** Your loop card cannot be in PROGRAM mode while the discrete CPU is in RUN mode.

When you select Loop Mode, you have the following options available.

Prog places the loop card in PROGRAM mode, and control blocks are neither running nor being queued for running. To select LOOP PROGRAM mode, click **Prog** on the PLC Operations dialog box. The following message appears:

```
Set the loop processor to program mode? Select either YES
or NO.
```

Halt places the loop card in HOLD mode; enabled control blocks are being queued to run, but are not running. Upon returning to RUN mode, execution resumes where it was halted. To select LOOP HALT mode, click **Halt** on the PLC Operations dialog box. The following message appears:

```
Set the loop processor to halt mode? Select either YES or
NO.
```

Run places the loop card in the RUN mode; enabled control blocks are being queued and are running. To select LOOP RUN mode, click **Run** on the PLC Operations dialog box. The following message appears:

```
Set the loop processor to run mode? Select either YES or
NO.
```

The loop mode can either follow that of the discrete CPU or be in RUN mode independent of the ladder program. To invoke this option, select the LOCKED or UNLOCKED field.

- Unlock frees the loop card for selection of RUN operating mode independent of the ladder CPU.
- Lock locks the loop card to follow the operating mode selected for ladders.

To select LOOP LOCK/UNLOCK mode:

When the PLC is in locked mode, click **Unlock**. When the PLC is in unlocked mode, click **Lock**. The following message appears:

```
Lock or Unlock loop processor from ladder operation mode?
Select either YES or NO.
```

Run Controller Diagnostics

Use Diagnostics to run diagnostics on your controller. To execute Diagnostics:

1. Click **Diagnostics** on the PLC Operations dialog box. The message "`Execute Diagnostics?`" appears.

2. Click **YES** or **NO**.

Programming EEPROMS

To perform the following EEPROM tasks, your controller must be in PROGRAM mode.

1. Copy the contents of RAM to EEPROM.
2. Copy the contents of EEPROM to RAM.
3. Erase the contents of EEPROM.

To execute the above EEPROMS tasks:

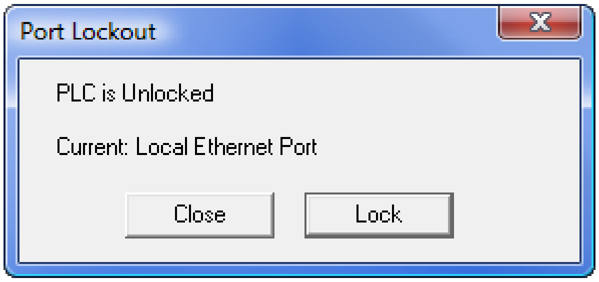
1. Click one of the preceding EEPROM tasks from the PLC Operations dialog box. The message "`Do you want to copy EEPROM to RAM?`" or a similar message appears.
2. Click **YES** or **NO**.

Programming Port Lockout

Use Port Lockout to prevent program changes from being made at different ports simultaneously.If the controller is unlocked, the Port Lockout button will display **Locked**. If the controller is locked, the Port Lockout button will display **Unlock**.

To execute Port Lockout:

1. Click **Port Lockout** from the PLC Utilities menu (**ALT+U, O**). The Port Lockout dialog box appears.



Port Lockout

PLC is Unlocked

Current: Local Ethernet Port

2. If the PLC is unlocked, click **Lock** to lock the communication port. The message "Lock communication ports?" appears.

3. If the PLC is locked, click **Unlock** to unlock the communication port. The message "Unlock communication ports?" appears.

> **NOTE:** Programming devices connected through the same Dual Communication Port (DCP) cannot lock each other out.

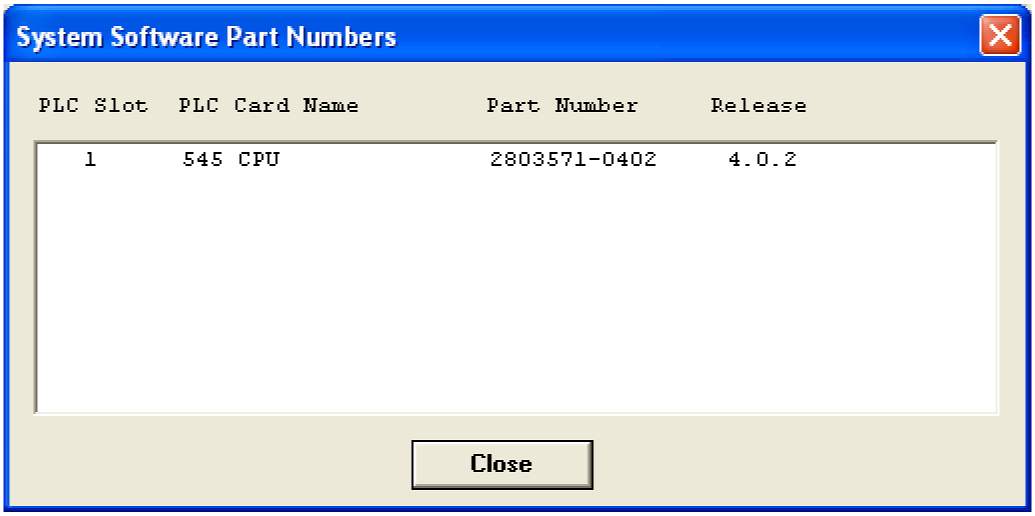
4. Click **YES** or **NO**.

System Part Number

Use System Part Number to read the software part number and the release number of the cards installed in your controller.

To execute System Part Number:

1. Click **System Part Number** from the **PLC Utilities** menu pr press **ALT+U, N**. The System Part Number dialog box appears. The part number and release for each card, along with the slot number and name of the card, is shown.



PLC Slot	PLC Card Name	Part Number	Release
1	545 CPU	2803571-0402	4.0.2

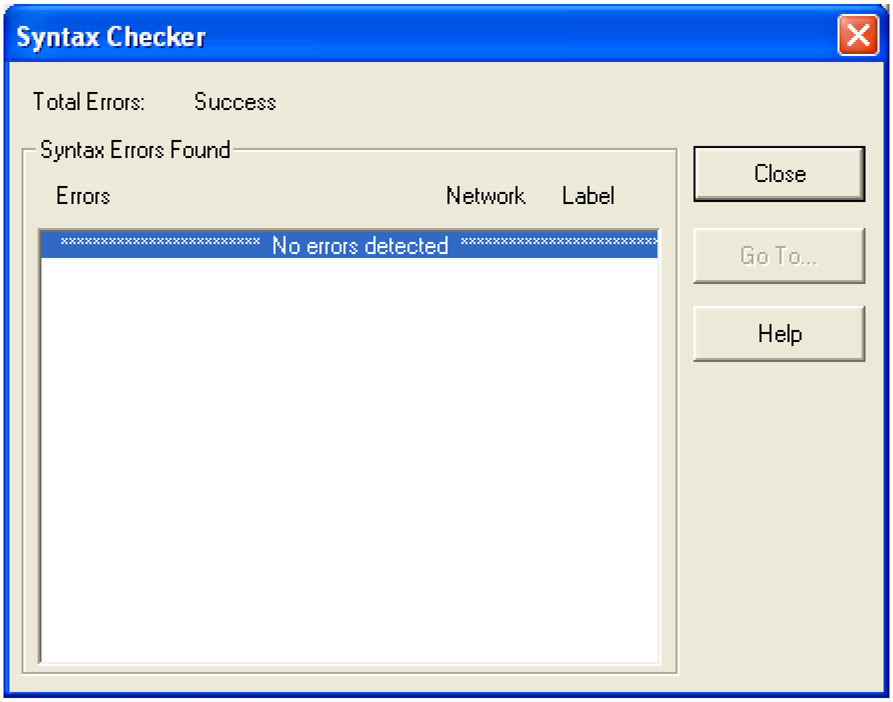
Performing Syntax Check

Use the Syntax Check to check your RLL program for errors that will prevent the controller from entering RUN mode (such as UNKNOWN INSTRUCTION, LADDER

ELEMENT OUT OF RANGE, NO CORRESPONDING PAIR, or OUT OF MEMORY). Syntax Check is currently available only on 545, 555, and 575 controllers.

To execute the Syntax Checker:

1. Click **Syntax Checker** on the **Diagnostics** menu or press **ALT+D, Y**. The Syntax Checker dialog box is displayed.



Total Errors: Success

************************* No errors detected *************************

Up to 16 errors can be displayed on the Syntax Check screen; if more than 16 errors are detected, `ADDITIONAL ERRORS DETECTED` is displayed. To display the additional errors, use the scroll bar on the dialog box.

If no errors are detected, "`No errors detected`" is displayed on the bottom line.

If errors are detected, they will be listed within the dialog box. The logic errors can be viewed by selecting the error and then clicking **Go To** on the Syntax Checker dialog box.

Ladder Status (Online)

You can display the values of your addressees in the PLC by using Status. Status can be displayed for Ladder networks. Status is an online feature only.

Status will continue to update when you scroll and cursor within the program.

To display Ladder status:

1. Click **Ladder Status** from the **Diagnostics** menu or press **ALT+D, L**. If a check mark is displayed before the **Ladder Status** menu item, then Ladder Status is enabled.
2. Ladder status is indicated by the following features:

- Contacts and Coils, when on, are displayed in Red.
- Addresses in box instructions indicate the current value for each address.

NOTE: Ladder Status mode is automatically exited when an attempt is made to edit a network. When the network is validated and entered, Status is automatically displayed again.

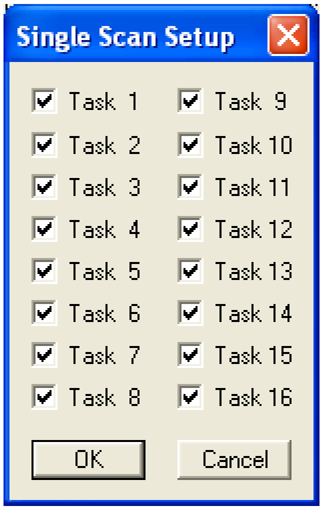
2. Click **Ladder Status** from the Diagnostics menu to stop displaying status.

Initiating a Single Scan

Using a single scan allows you to view a single execution of your program. You must have the controller in program mode in order to execute a single scan.

To perform a single scan of your program, complete the following steps.

1. Place the controller in program mode.
2. Click **Single Scan Setup** from the **Diagnostics** menu (**ALT+D, I**). The Single Scan Setup menu dialog box is displayed. If your programmable controller supports the Single Scan pop-up task box for more than one task, you can select which tasks to execute during the single scan.



☑ Task 1
☑ Task 2
☑ Task 3
☑ Task 4
☑ Task 5
☑ Task 6
☑ Task 7
☑ Task 8
☑ Task 9
☑ Task 10
☑ Task 11
☑ Task 12
☑ Task 13
☑ Task 14
☑ Task 15
☑ Task 16

3. Select the tasks you want to include in the scan, then click **OK**.

4. Click **Single Scan** on the **Diagnostics** menu or press **CTRL+Q** to execute a single scan according to the single scan task configuration.

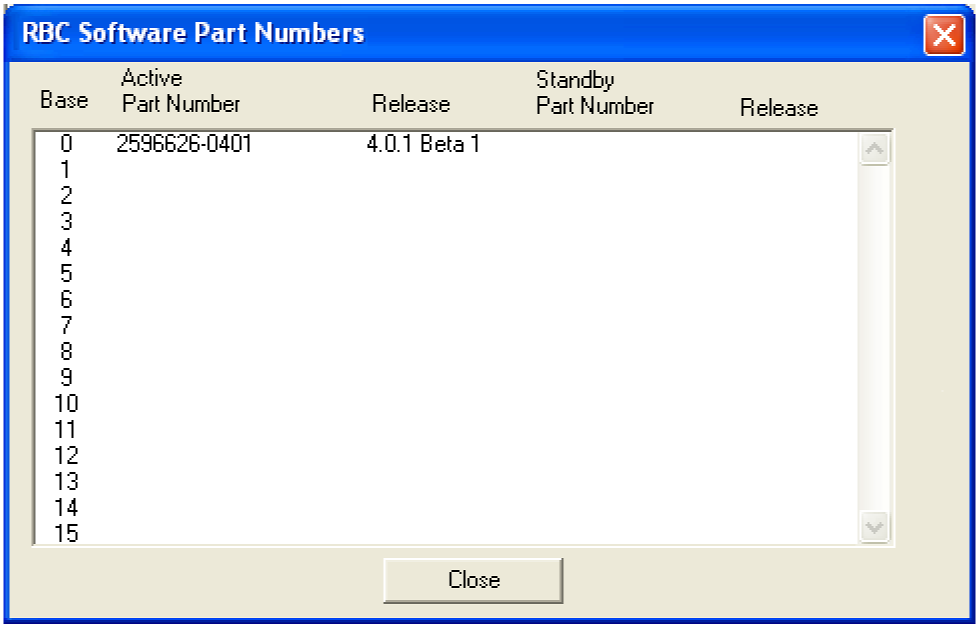
RBC Part Number

You can display the RBC Software part number and release number while online.

1. Click **PLC RBC Part Number** from the **PLC Utilities** menu or press **ALT+U, R**.

2. The RBC software number(s) and release numbers are displayed in the following format.

3. Click **Close** to exit the RBC Part Number box and return to the active logic program.

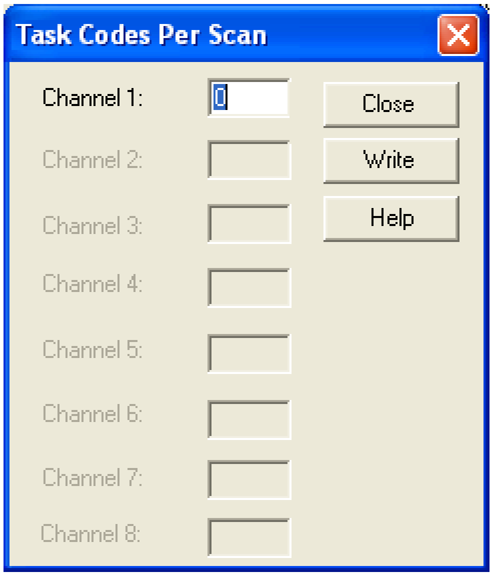


Base	Active Part Number	Release	Standby Part Number	Release
0	2596626-0401	4.0.1 Beta 1		
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				

Task Codes Per Scan

Task Codes Per Scan is used to set the number of task codes processed per scan for SF modules on each channel. To invoke the function:

1. Click **Task Codes Per Scan** from the **PLC Utilities** menu or press **ALT+U, A**.
2. The Task Codes Per Scan dialog box is displayed in the following format. Only numbers for the channels you have configured are displayed; for example, if you have four channels, the number goes to 4.
3. Type in the number of task codes for each scan.
4. Click the **Write** button to enter the numbers.
5. Click **Close** to exit the Task Codes Per Scan dialog box and return to the active logic program.



Channel 1: 0
Channel 2:
Channel 3:
Channel 4:
Channel 5:
Channel 6:
Channel 7:
Channel 8:

Diagnostics on Base

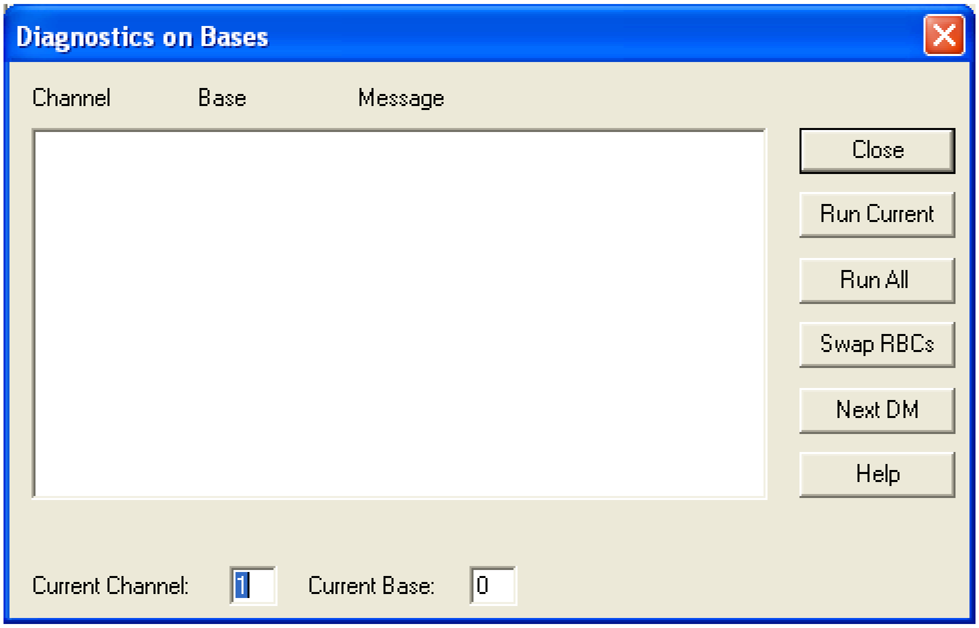
Diagnostics on Base is used to run diagnostics on one or all the I/O bases. To invoke the operation:

1. Click **Diagnostics on Bases** from the **PLC Utilities** menu or press **ALT+U, D**. The Diagnostics on Base dialog box is displayed.
2. To run base diagnostics on one base:
   - Enter a channel and base in the **Current Channel** and **Current Base** boxes.
   - Click **Run Current** and the data will be displayed in the dialog box.
3. To locate the Dual Media base:

- Enter a channel and base in the **Current Channel** and **Current Base** boxes.
- Click **Next DM** and the data will be displayed in the dialog box.

4. To change the active and standby roles of RBCs on a particular base:
   - Enter a channel and base in the **Current Channel** and **Current Base** boxes.
   - Click **Swap RBCs**.
5. To run base diagnostics on all bases:
   - Click **Run All** and the data will be displayed in the dialog box.

6. Click **Close** to exit the Diagnostics on Bases dialog box and return to the active logic program.



Current Channel: 1 Current Base: 0

Hot Backup

Hot Backup is used to select the status of a hot backup unit. Hot Backup is only valid for the 565 controller. To execute the function:

1. Click **Hot Backup** from the **PLC Utilities** menu (**ALT+U, H**). The Hot Backup dialog box is displayed, with the status of the Hot Backup.
2. Select one of the following three status modes:

- **Standby to Offline:** Puts the standby unit in PROGRAM mode.
- **Standby to Online:** Puts the standby unit in RUN mode.
- **Switch:** Switches the roles of the active unit and standby unit.

4. Click **Close** to exit the Hot Backup and return to the active logic program.

Password

The password feature provides protection for areas of memory that are part of the program. There are two passwords, one for the selected program on disk and one for the controller. They do not have to be the same.

> **NOTE:** You do not need to enter a password to go online. However, if the selected program on disk is protected, you must enter a password to go offline.

A password value consists of 1 – 8 alphanumeric digits (for example, 0–9 or uppercase A–Z). Online, you can be prompted for the password for the controller program and/or for the selected program on disk. Offline, you are prompted for a password only for the selected program on disk.

The selected program on disk may be in one of two states of password protection:

- **No Password:** The selected program on disk is not protected. Any authorized user may enter an initial password.
- **Disabled Password:** The selected program on disk is not protected. Any authorized user may change or delete the password.

The programmable controller may be in one of three states of password protection:

- **No Password:** The controller program is not protected. Any authorized user may enter an initial password.
- **Disabled Password:** The controller program is not protected. The user may change or delete the password. Any authorized user may enable the password.
- **Enabled Password:** The controller program is protected according to the protection level assigned to the password (see below). If a protected operation is attempted from any communications port, the operation is denied and an error response is given. Only an authorized user may change, delete, or disable the password.

Three levels of access are available when a password has been entered and enabled in the controller:

- **No Access:** The controller program cannot be read or modified.
- **Read-only Access:** The controller program can be read but it cannot be modified.
- **Full Access:** The controller program is not protected.

Password Operational Modes

Online Password Operational Modes

There are nine online operational modes for password. The following paragraphs describe online password operational modes and online disk password operations.

The following numbered paragraphs detail the corresponding mode-number information found in Online Password Operations Table.

> **NOTE:** If converting files from TISOFT to 505 WorkShop, check to make sure that the selected program on disk has TISOFT 5.0 or greater format.

- **Mode 1:** If the controller and the selected program on disk do not have a password, you will not be prompted for a password. (Save and Open functions will be allowed.) No password will be written to the selected program on disk or to the controller.

- **Mode 2:** If the selected program on disk has a password and you enter a password for the selected program on disk at the online prompt, you will be able to use Save and Open functions.

- **Mode 3:** If the selected program on disk has a password and you do not enter a password for the selected program on disk at the online prompt, you will not be allowed to use the Save function. You will, however, be able to use the Open function, but only if the controller supports password. You will also have full access to the controller and the selected program on disk.

- **Mode 4:** If the controller has a password and you enter a password for the controller at the online prompt, you will be able to use the (Save) and the (Load) functions. Save writes the controller password to the selected program on disk.

Open retains the controller password. You will also have full access to the controller and the selected program on disk.

- **Mode 5:** If the controller has a password and you do not enter a password for the controller at the online prompt, you will not be able to use the (Save) and the (Open) functions. Depending on the controller password access level, you will be allowed partial to full access to the controller. You will also have full access to the selected program on disk.

- **Mode 6:** If both the controller and the selected program on disk have passwords and you enter a password for both at the online prompt, you will be able to use the (Save) and the (Open) functions. The passwords for both the selected program on disk and for the controller are retained. You will also have full access to the selected program on disk and to the controller.

- **Mode 7:** If both the controller and the selected program on disk have passwords and you enter a password only for the selected program on disk at the online prompt, you will not be able to use the (Save) and (Open) functions. You will have partial to full access to the controller depending on the controller access level. You will also have full access to the selected program on disk.

- **Mode 8:** If both the controller and the selected program on disk have passwords and you enter a password for the controller at the online prompt, you will not be allowed to use the (Save) function. You will, however, be able to use the (Open) function. Open will write the selected program on disk password to the controller and enable the password in the controller. You will also have full access to the controller. Some reads and no writes will be allowed to the selected program on disk.

- **Mode 9:** If both the controller and the selected program on disk have passwords, and you do not enter a password for either the controller or the selected program on disk at the online prompt, you will not be able to use either the (Save) or the (Open) functions. You will, however, have partial to full access to the controller depending on the controller access level. Some reads and no writes will be allowed to the selected program on disk.

All online password operational modes are summarized in the following table.

Mode No.	Controller Password	Offline Password	User Password	Save Allowed to Disk?	Open Allowed to PLC?	Comments
1	No	No	Not asked for.	Yes. No password.	Yes. No password.	Selected program on disk must have 5.0 format or greater. There is no password for selected program on disk or in the controller.
2	No	Yes	User gives password for selected program on disk.	Yes. Selected program on disk password is retained.	Yes. Disk password is written to controller, if controller supports password.	Full access to controller and selected program on disk is allowed.
3	No	Yes	User does not give password for program on disk.	No. Selected program on disk is password protected.	Only if controller supports password.	Full access to controller is allowed. Some reads and no writes are allowed to selected program on disk.

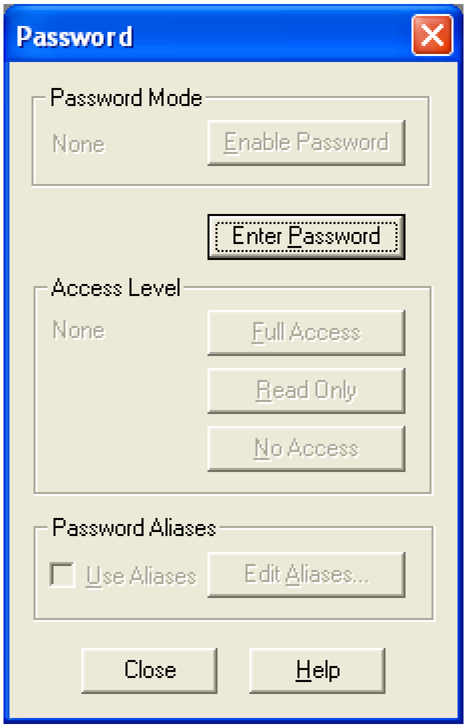
Mode No.	Controller Password	Offline Password	User Password	Save Allowed to Disk?	Open Allowed to PLC?	Comments
4	Yes	No	User gives controller password.	Yes. Controller password is written to disk.	Yes. Controller password is retained.	Full access to controller and to selected program on disk is allowed.
5	Yes	No	User does not give a password.	No. Controller is password protected.	No. Controller is password protected.	Partial to full access to controller is allowed depending on access level. Full access is allowed to selected program on disk.
6	Yes	Yes	User gives disk and controller password.	Yes. Selected program on disk password is retained.	Yes. Controller password is retained.	Full access to selected program on disk and to controller is allowed.

Mode No.	Controller Password	Offline Password	User Password	Save Allowed to Disk?	Open Allowed to PLC?	Comments
7	Yes	Yes	User gives disk password.	No. Controller is password protected.	No. Controller is password protected.	Partial to full access to controller is allowed depending on access level. Full access is allowed to selected program on disk.
8	Yes	Yes	User gives controller password.	No. Selected program on disk is password protected.	Yes. Selected program on disk password is written to controller and enabled.	Full access to controller is allowed. Some reads and no writes are allowed to selected program on disk.

Mode No.	Controller Password	Offline Password	User Password	Save Allowed to Disk?	Open Allowed to PLC?	Comments
9	Yes	Yes	User gives no password.	No.	No.	Partial to full access to controller is allowed depending on access level. Some reads and no writes are allowed to selected program on disk.

To invoke Password from Online or Offline:

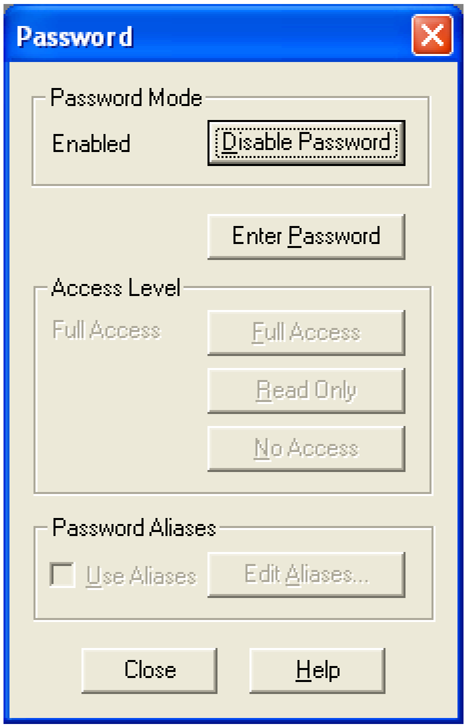
1. Click **Password** from the **PLC Utilities** menu (**ALT+U, W**).
2. The Password dialog box is displayed in the format shown below.



Password Mode: None

Access Level: None

Online Password Selection and Access Level



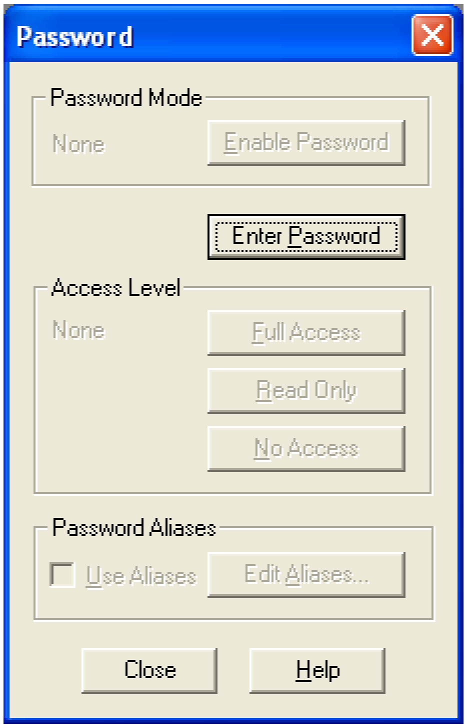
Password Mode: Enabled

Access Level: Full Access

The buttons in the Password dialog box:

- **Close-**Allows you to return to the ladder display screen.
- **Enter Password-**Allows you to enter or change the password for the selected program in the controller. WorkShop prompts you for the new password twice. If the new passwords are not the same, the password is not changed. To delete a password (or to make the selected program on disk unprotected), enter a null password or press clear and enter a new password.
- **NoAccess-**Allows you to set the protection level of the controller for no access. This option is written to the controller. No Access does not work without a password.
- **Read Only-**Allows you to set the protection level of the controller for read-only access. This option is written to the controller. Read Only does not work without a password.
- **Full Access-**Allows you to set the protection level of the controller for full read/write access. This option is written to the controller. Full Access does not work without a password.
- **Enable Password-**Allows you to enable password protection for the controller.
- **Disable Password-**Allows you to disable password protection for the controller. If you have not already entered a password for the controller, 505 WorkShop prompts you for the current password. If the password you provide is not correct, 505 WorkShop does not disable the password protection. This function does not work unless you provide a password.

Offline Password Selection and Access Level



Password Mode
None

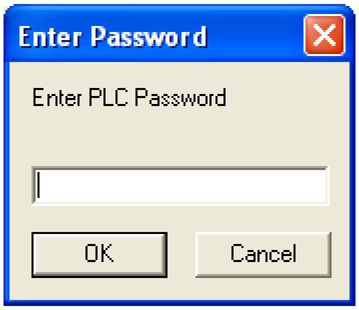
Access Level
None

The buttons in the Password dialog are defined below:

- **Close-**Allows you to return to the ladder display screen.
- **Enter Password-**Allows you to enter or change the password for the selected program on disk. WorkShop prompts you for the new password twice. If the new passwords are not the same, the password is not changed. To delete a password (or to make the selected program on disk unprotected), enter a null password or press clear and enter a new password.
- **No Access-**Allows you to set the protection level of the controller for no access. This option is written to the controller when you perform an (Open) function. No Access does not work without a password.
- **Read Only-**Allows you to set the protection level of the controller for read-only access. This option is written to the controller when you perform an (Open) function. Read Only does not work without a password.
- **Full Access-**Allows you to set the protection level of the controller for full read/write access. This option is written to the controller when you perform an (Open) function. Full Access does not work without a password.

PLC Password Alias

Online access to many PLC's can be restricted with its onboard password feature. This PLC password is a case-insensitive alphanumeric string of up to 8 characters. When attaching online to a PLC containing a password, the **Enter Password** dialog box requests the correct PLC password before allowing access to the PLC.


Enter Password

Enter PLC Password

This PLC password is actually stored in the PLC. Therefore, programming packages other than 505 WorkShop also request the same PLC password when attaching to the PLC.

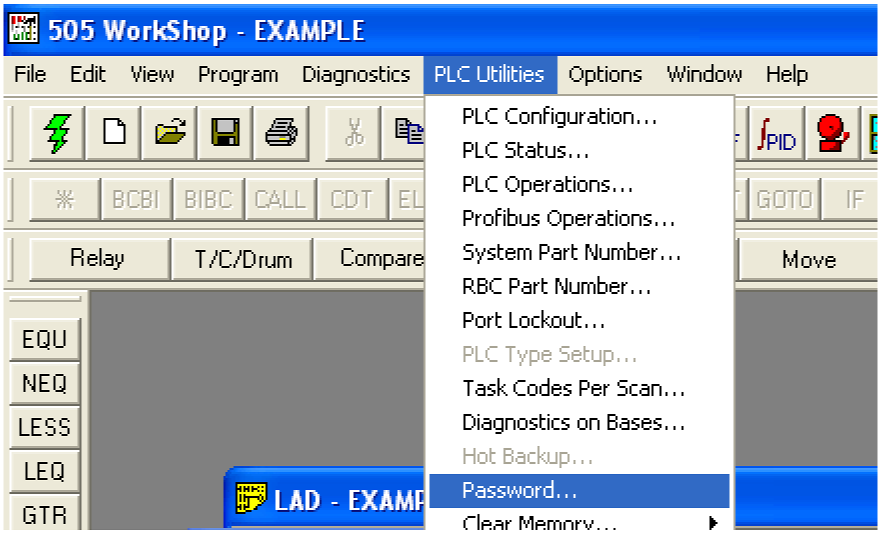
Some administrators prefer using 505 WorkShop but are aware their PLCs can be accessed through other programming packages when users know the actual passwords stored in the PLCs. These administrators may place an additional layer of security over the onboard PLC password feature by using *PLC Password Aliases*. Administrators maintain a list of PLC password aliases in 505 WorkShop. These aliases are case-insensitive alphanumeric strings up to 8 characters long and are stored on the PC on which 505 WorkShop runs. Each alias is associated with a PLC password stored in a PLC.

When PLC password aliases are used, a PLC password is requested as seen in the dialog above. But, instead of entering the password actually stored in the PLC, the password alias is entered. 505 WorkShop looks up this alias in its list of password aliases to find the associated PLC password. This associated PLC password is then used to grant online access to the PLC.

> **NOTE**: PLC password aliases can be used only when either **FasTrak Security or NT Authentication Security** are in use.

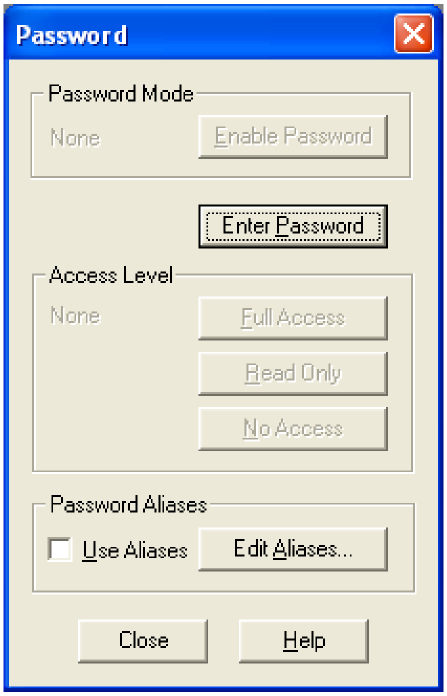
Accessing the PLC Password Alias Feature

PLC password aliases are maintained through the PLC Password dialog. Select **Password** from the **PLC Utilities** menu below to display this dialog.



The PLC Password Dialog

The following PLC **Password** dialog box retains its original functionality, which allows entry and modification of the actual PLC password and setting of the access level (full, read-only, or no access) within the PLC. However, the addition of the controls within the Password Aliases group box offers access to the PLC password alias feature.



Password Mode: None

Access Level: None

□ Use Aliases

The controls within the Password Aliases group box are enabled only when either FasTrak Security or NT Authentication Security are in use. When these controls are clicked, a valid security administrator password must be entered.

The Use Aliases Check Box

When attaching to a PLC which contains a password, the **Enter Password** dialog requires the correct PLC password before granting access to the PLC.

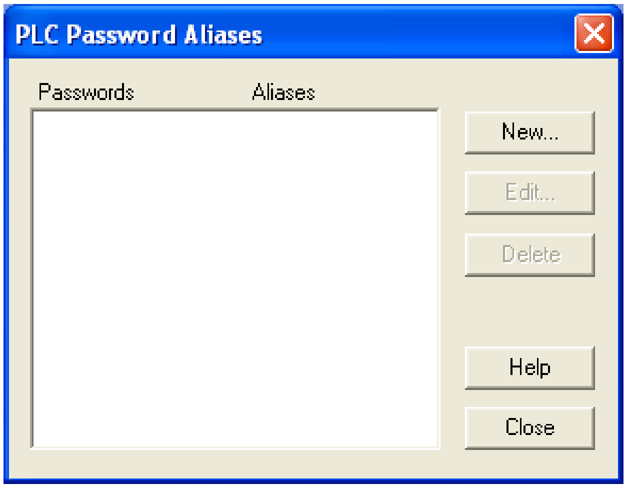
- If the **Use Aliases**check box is not selected, the actual password stored in the PLC must be entered.
- If this check box is selected, the PLC password alias associated with the PLC's actual password must be entered instead.

The Edit Aliases Button

The list of PLC passwords and the aliases with which they are associated can be accessed by clicking the **Edit Aliases** button. Clicking this button displays the **PLC Password Aliases** dialog below.

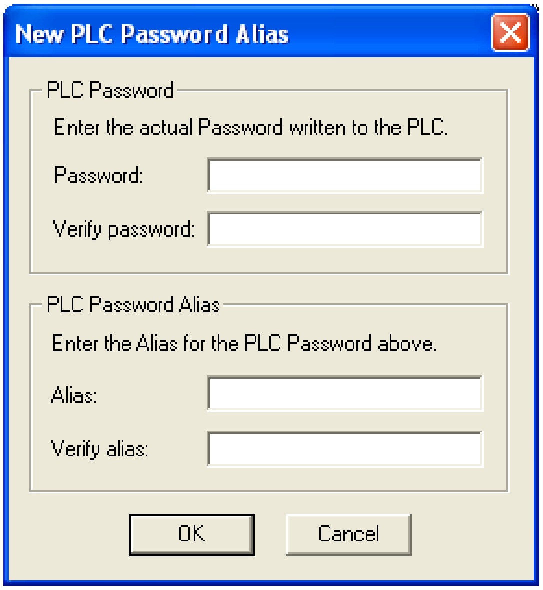
THE PLC PASSWORD ALIASES DIALOG

Click the **Edit Aliases**button above to display the **PLC Password Aliases** dialog below. The list box contains the PLC password and PLC password alias pairs already entered.



THE NEW BUTTON

Click the **New** button to enter a new PLC Password/PLC Password Alias pair. The **Enter New PLC Password Alias** dialog appears.



Enter the actual Password written to the PLC.

Enter the Alias for the PLC Password above.

1. In the **PLC Password** area, enter the actual PLC password in the **Password** box. Verify the password by entering it again in the **Verify password** box.

2. In the **PLC Password Alias** area, enter the password alias in the **Alias** edit box. Verify the alias by entering it again in the **Verify alias** box.

When all four edit boxes have been entered, click **OK**. The Password and Verify password entries are compared to ensure they match. The Alias and Verify alias entries are also compared to ensure they match.

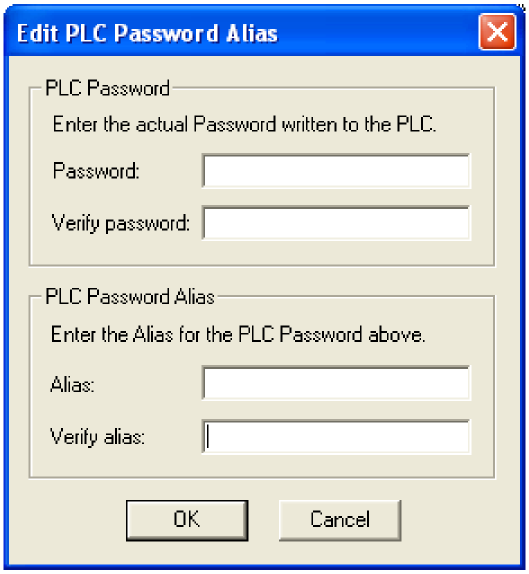
Finally, the Alias is compared to the password aliases already on file. Since each password alias may be associated with only one PLC password, aliases cannot be duplicated. If the entered alias is found in the list, an error message appears and the entered PLC Password/PLC Password Alias pair is not saved.

But, when the entered password and alias are approved, this new PLC Password/PLC Password Alias pair is added to the list and returns to the "PLC Password Alias" dialog.

The Edit Button

To edit a PLC Password/PLC Password Alias pair, highlight the pair in the list box and click the **Edit** button. Alternately, double click a PLC Password/PLC Password Alias pair in the list box.

The PLC password and PLC password alias selected from the list box appear in the **Edit PLC Password Alias** dialog below.



This dialog operates much like the **Enter New PLC Password Alias** dialog. The Password and Verify password entries must match just as the Alias and Verify alias entries must match.

NOTE: If the PLC password remains the same, but the alias changes, the original alias is replaced by the new alias. The PLC password is now associated with a new alias. However, if the alias remains unchanged and the password changes, the alias becomes associated with the new PLC password and is no longer associated with the original PLC password.

The Delete Button

Any or all PLC Password/PLC Password Alias pairs may be permanently removed from the list stored on the PC.

Highlight one or more items from the list box in the PLC Password Aliases dialog and click the **Delete** button. A confirmation message states the selected item(s) will be permanently deleted. When this message is acknowledged, the item(s) are permanently removed from the list.

Powering Up/Restarting the Controller

Power Up Restart

Use **Power Up Restart** to clear all unforced X, Y and non-retentive C elements on power up or restart of the controller. Retentive control relays are not cleared. The WX and WY elements are not affected.

⚠ **Warning**	If you execute **Power Up Restart** with the controller battery switch set to **Off**, all programs residing in the controller will be cleared. Be certain to check battery switch position before using **Power Up Restart**.

To execute Power Up Restart:

1. Click **Power Up Restart** from the PLC Operations dialog box.
2. When you receive the message:`Execute a PLC power up restart?` select either **YES** or **NO**.
3. For 575 controllers, you are also prompted with `Coordinate Reset With Other Applications:` and `Coordinate Reset With Entire System:` For each of these prompts, press **NO** or **YES** as required for your process.

Partial Restart

Use a Partial Restart to clear all discrete elements except retentive C and forced elements. The word elements and presets are not reset.

To execute a Partial Power Up Restart:

1. Click **Partial Restart** from the PLC Operations dialog box.
2. When you receive the message: `Execute a Partial restart?` select either **YES** or **NO**.
3. For 575 controllers, you are also prompted with `Coordinate Reset With Other Applications:` and `Coordinate Reset With Entire SYSTEM:`. For each of these prompts, press **NO** or **YES** as required for your process.

Complete Restart

Use Complete Restart to clear all discrete elements and word elements, including retentive C elements. Complete Restart also clears controller fatal errors. Forced discrete elements and forced word elements are not reset.

To execute Complete Restart:

1. Click **Complete Restart** from the PLC Operations dialog box.
2. When you receive the message: `Execute a Complete restart?` select either **YES** or **NO**.

For 575 controllers, you are also prompted with `Coordinate Reset With Other Applications:` and `Coordinate Reset With Entire System:`. For each of these prompts, press **NO** or **YES** as required for your process.

Clearing Memory

This option allows you to clear all or parts of logic memory, data, tags, and documentation in the current program.

You can use clear memory in either online or offline mode. When programming offline, you clear the entire active program or parts. When programming online, you clear the PLC memory. However, you cannot clear memory online while the processor is in Run mode. You must first stop the processor before clearing the memory online.

The following is a list of parts of memory that can be cleared:

- Ladder
- V Data
- K Data
- Word I/O Data
- TCC/TCP Data
- DSP/DSC Data
- PID Loops
- Analog Alarms
- Special Functions Programs
- Special Functions Subroutines
- U-Memory

To access the Clear Memory option:

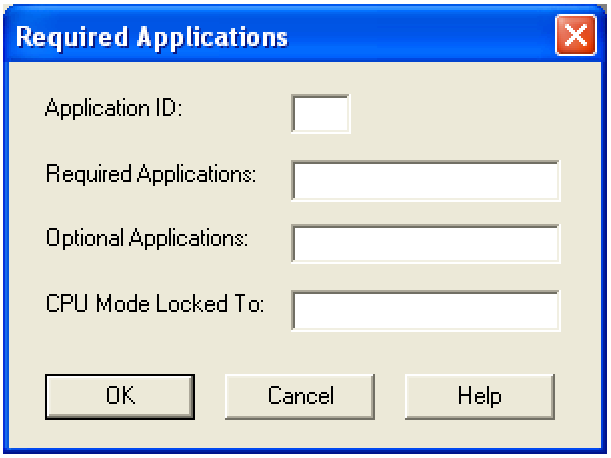
1. If you want to save the changes you have made to your logic and documentation, save them before going to Step 2. Click **Save Program** or **Save Program As** from the **File** menu.
2. Click **Clear Memory** from the **PLC Utilities** menu (**ALT+U, L, A**). A warning message appears stating all program logic, data values, tags, and documentation will be deleted.
3. Click **Yes** to clear all memory. If changes to the program were not saved, another warning message appears stating that changes to your program were not saved; do you wish to continue with the clear memory procedure. Click **Yes** to clear the memory.

Selecting (575) Application

When you configure a 575 controller offline, you must first select the application:

1. Select **PLC Configuration** from the **PLC Utilities** menu. The PLC Configuration dialog box appears.
2. Click **ReqApp** under the Processor Information window on the PLC Configuration dialog box. The Required Application dialog box appears.

You can change the Application ID only during offline configuration. (Configuring the controller online displays the current application.)



The following fields display information about applications. Only the IDs listed in the REQUIRED or OPTIONAL fields are valid for use as G-memory parameters in your RLL program.

- APPLICATION ID displays the ID of the current application.
- REQUIRED APPLICATIONS displays a listing of the application IDs needed for the current application to complete a process.
- OPTIONAL APPLICATIONS displays a listing of the application IDs that are not required, but may be present.
- CPU MODE LOCKED TO displays a listing of the application IDs that must transition to RUN mode at the same time.
- CONNECTING ONLINE displays the current application ID configuration.

After modifying the configuration, click **OK** to enter the new configuration relationships.

Chapter 7 – Documentation

Ladder, Network, and SF Header Editor

Ladder Header

505 WorkShop provides a simple way to document ladder while you are creating or editing your program. The maximum number of characters you can enter for each header is 16K.

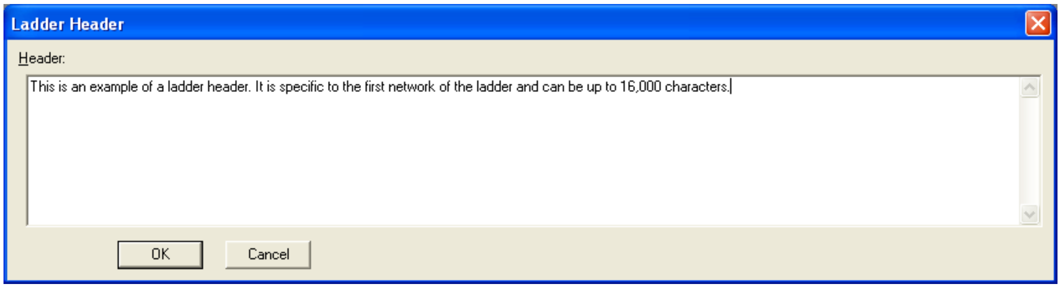
To add or modify a ladder header:

1. Double-click the Ladder Header icon in the active logic program window. The Ladder Header dialog box is displayed.

2. In the **Header** box, type in the header you want to use.

3. Click **OK** when you are finished.

To see ladder headers in the active logic program, click **Program Setup** from the **Options** menu, click the **Logic Windows** tab, and select the **Show All Headers** check box.



This is an example of a ladder header. It is specific to the first network of the ladder and can be up to 16,000 characters.

Network Header

505 WorkShop provides a simple way to document networks while you are creating or editing your logic program. The maximum number of characters you can enter for each header is 16K. The network header is tied to the corresponding network output. If a XCALL, PGSTS OR PGTSZ are the outputs, the header is tied to the first occurrence of an X, Y or C address.

To add or modify a network header:

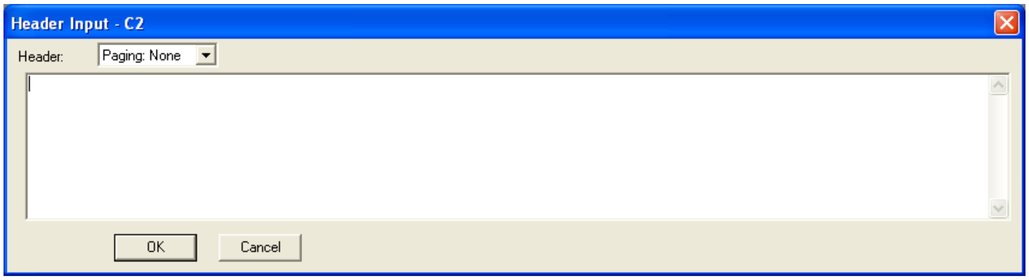
1. Double-click the Network Header Input icon in the active logic program window. The Network Header Input dialog box is displayed. The **Header** box in the top,

left corner controls the page print-out of the particular network header and ladder that is selected.

- If **Paging: None** is selected there will be no page break between the current network and last network printed.
- **Paging: Odd** prints the current selected network on the next odd page.
- **Paging: Before** prints the current selected network on the next blank page.

2. Type in your header. Click **OK** when you are finished.

To see network headers in the active logic program, click **Program Setup** from the **Options** menu, click the **Logic Windows** tab, and select the **Show All Headers**check box.

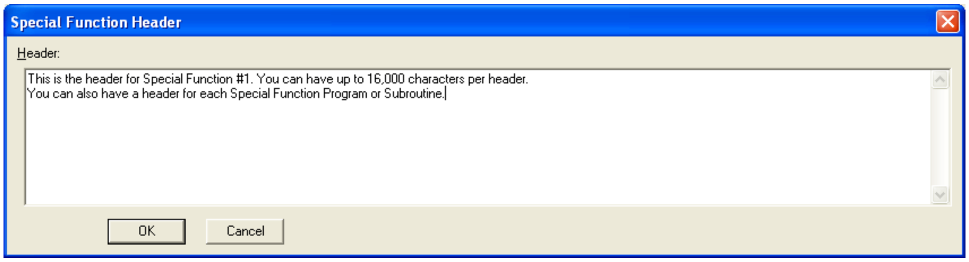


SF Header

505 WorkShop provides a simple way to document SF while you are creating or editing your SF program. The maximum number of characters you can enter for each header is 16K.

To add or modify a SF header:

1. Double-click the SF Header Input icon in the active logic program window. The Network Header Input dialog box is displayed.
2. Enter the header you want to use.
3. Click **OK** when you are finished.



This is the header for Special Function #1. You can have up to 16,000 characters per header.
You can also have a header for each Special Function Program or Subroutine.

To see SF headers in the active logic program, click **Program Setup** from the **Options** menu, click the **Logic Windows** tab, and select the **Show All Headers** check box.

Network Header Editor

Use the Network Header Editor to edit network headers and to quickly go to specific networks.

Information is shown in the following columns:

Network	The number of the network.
Address	The network's address.
Header	The network header

Selecting a Network

1. To select a specific network, enter that network's number in the **Find Network** box, and then click **Find**.

That network is selected and displayed in the Editor window.

Going to a Network

1. To go to a specific network, select the network and then click **Goto Network**.

Editing a Single Network Header

To edit an individual network header, do the following:

1. Select a network and then click **Edit Header**, or double-click a network.

2. In the **Header** box, select the page print-out option you want to use:

   - If **Paging: None** is selected there is no page break between the selected network and the last network printed.

   - If **Paging: Odd** is selected, the selected network is printed on the next odd page.

   - If **Paging: Before** is selected, the selected network is printed on the next blank page.

3. Type the text you want to use for the network header in the empty text box.

Editing Multiple Network Headers

You can edit multiple network headers using the **Cut**, **Copy**, **Paste** and **Delete** buttons.

TO DELETE NETWORK HEADERS:

1. Click **Delete**.

2. Enter the range of network headers you want to delete.
   The network headers are removed from the specified networks.

TO CUT NETWORK HEADERS:

1. Click **Cut**.

2. Enter the range of network headers you want to cut.
   The network headers are removed from the specified networks but remain in memory. They can now be pasted to other networks using the **Paste** button.

TO COPY NETWORK HEADERS:

1. Click **Copy**.

2. Enter the range of network headers you want to copy.
   The network headers are copied. They can now be pasted to other networks using the **Paste** button.

TO PASTE NETWORK HEADERS:

Note: At least one network header must be cut or copied prior to pasting.

1. Click **Paste**.

2. Enter the range of networks.
   Note: Only the **From** network can be entered. The **To** network is automatically calculated.

Documentation Window

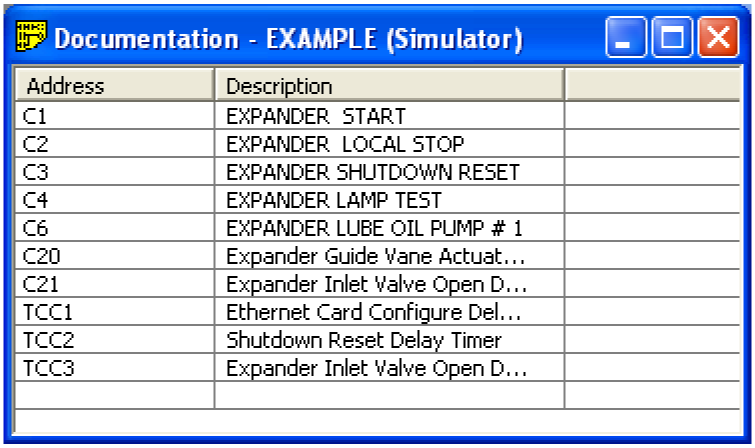
Using the Documentation Window

In both online and offline programming, you can view and edit tags, descriptions, and comments in your program using the Documentation Window.

The Documentation Window allows you to view, create, edit, and delete tags, descriptions, and comments for the active logic program. The maximum number of characters for each item is listed below:

Descriptions	96
Tags	32
Comments	2048

To open the Documentation Window, click on the toolbar, or click **Documentation Window** from the **View** menu.



Address	Description	
C1	EXPANDER START	
C2	EXPANDER LOCAL STOP	
C3	EXPANDER SHUTDOWN RESET	
C4	EXPANDER LAMP TEST	
C6	EXPANDER LUBE OIL PUMP # 1	
C20	Expander Guide Vane Actuat...	
C21	Expander Inlet Valve Open D...	
TCC1	Ethernet Card Configure Del...	
TCC2	Shutdown Reset Delay Timer	
TCC3	Expander Inlet Valve Open D...	

The window shows documented addresses in the current program. The window can be configured to show tags and/or descriptions as well, using the Program Setup dialog box. The information displayed in the documentation window can be sorted according to the address, tag, or description. The default sort order is specified in the Program Setup dialog box. It can also be sorted by the clicking the column header.

NOTE: Only one (1) documentation window can be displayed per program.

The window also can be sized and moved to another location within the viewing area using the standard window features.

Customizing the Display

The Documentation Window can be customized to display tags, descriptions, or both tags and descriptions. The default sorting method can also be customized. Documentation can be sorted by address, by tag, or by description.

To change the display

1. Click **Program Setup** from the **Options** menu or press **ALT+O, P**.

2. Click the **Documentation Window** tab.

3. Under Column Display:

    - Select the **Include Tabs** check box to include tags in the documentation window.

    - Select the **Include Descriptions** check box to include descriptions in the documentation window.

4. Under Sort Order:

    - Select the **Address** check box to sort the information in the Documentation Window in alphanumeric order according to the Address.

    - Select the **Tag** check box to sort the information in the Documentation Window in alphanumeric order according to the Tag.

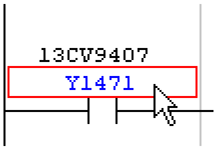
    - Select the **Description** check box to sort the information in the Documentation Window in alphanumeric order according to the Address.

Editing and Creating New Address Documentation

Use the **Edit Documentation** dialog box to create or edit PLC address documentation.

There are several ways to access this dialog box:

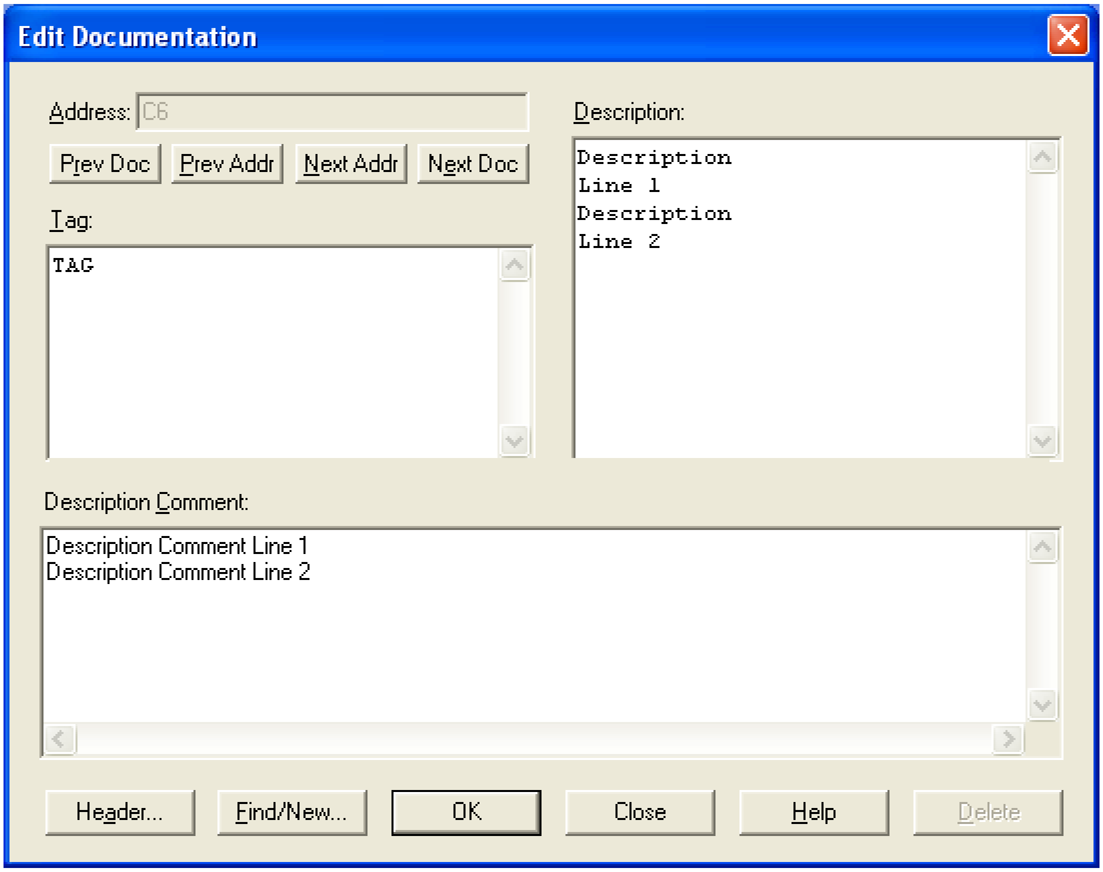
- To create or edit documentation for an address from ladder logic, select the address

  and click **Modify Doc** from the **Edit** menu or press **CTRL+L**.

- To edit documentation from the Documentation Window, select the address you want to edit and click **Modify Doc** from the **Documentation** menu or double-click the address. (The Documentation menu is visible only when the Documentation Window is active.).

- To create new documentation when in theDocumentation Window, click **New Doc** from the **Documentation** menu.



Address: C6

Tag:
TAG

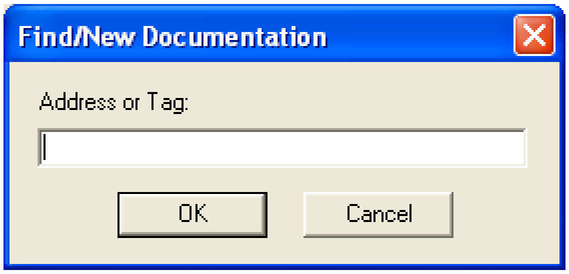
Description:
Description Line 1
Description Line 2

Description Comment:
Description Comment Line 1
Description Comment Line 2

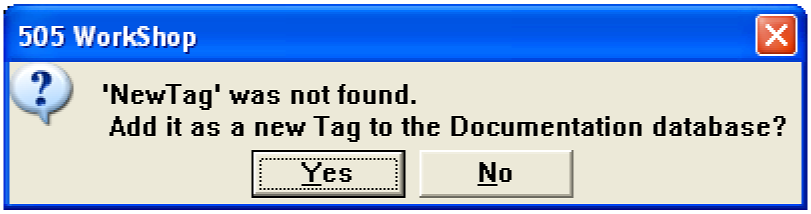
The display width of Tag and Description fields is limited by the Documentation Window Column Width variable in the Program Setup dialog box. The number of lines of description is also controlled in the Program Setup dialog box. The font selected in your program setup will also be used for the tag and description fields. This will show the documentation, as it actually will be displayed in your ladder program.

> **NOTE:** If the font and size selected in the program setup is too large to be represented in the window, a standard font will be used. When this situation occurs, the warning message is displayed. The tag and description will NOT be shown in its actual size in this case.

- **Address**: This box displays the address currently being documented. In some situations, the field can be edited.
- **Prev Doc**: Click this button to go to the previous documented address.
- **Prev Addr**: Click this button to go to the previous address, whether documented or not.
- **Next Addr**: Click this button to go to the next address, whether documented or not.
- **Next Doc**: Click this button to go to the next documented address.
- **Tag**: This field contains the tag for the current address.
- **Description**: This field contains the description for the current address.
- **Description Comment**: This field contains the description comment for the current address.
- **Header**: Click this button to enter a network header for the current address. Network headers are linked to the network by the output coil.
- **Find/New**:Click this button to find a tag or address, or enter a new one.



Type the address or tag in the **Address or Tag** input box, and click the **OK** button. If the tag or address is already documented, the address and documentation are displayed in the documentation editor. If it does not already exist, the documentation editor is cleared for you to create a new documentation record.


505 WorkShop

'NewTag' was not found.
Add it as a new Tag to the Documentation database?

- **Delete**: Click this button to delete the current documentation record. You can also delete the record by clearing all the fields.

Cut, Copy, Paste and Deleting Documentation

Overview of Cut, Copy, Paste, and Deleting Documentation

Probably the most frequently used editing features are the three related commands: Cut, Copy, and Paste. Use these commands to quickly copy documentation to either another location in the same program or another program. The list below describes Cut, Copy, Paste and Deleting Documentation differences.

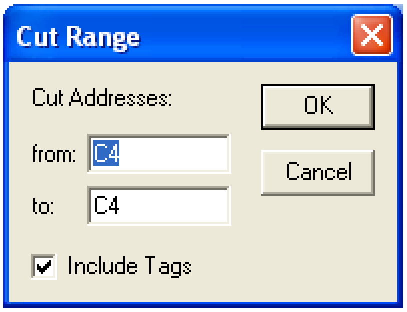
Cut	Removes the selection from the program and places it on the clipboard.
Copy	Copies the selection and places it on the clipboard.
Paste	Inserts clipboard contents into the documentation window at the start and end address.
Delete	Removes selected contents from the documentation window.

The clipboard referred to in the preceding list is the standard Windows clipboard. Refer to your Windows User's Guide for more information.

Cut

To use the cut feature:

1. Click ✂ on the toolbar or click **Cut** from the **Edit** menu. The Cut Range dialog box appears. Enter the start and ending address to cut in the **from:** and **to:** boxes. If tags are to be cut with the address, the **Include Tags** check box must be selected.


Cut Range

Cut Addresses:

from: C4

to: C4

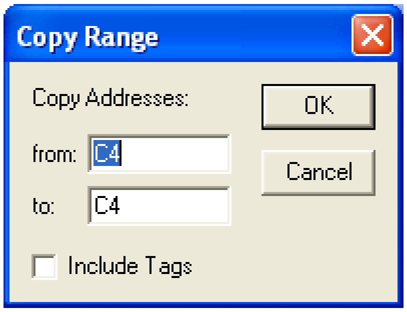
☑ Include Tags

2. Click **OK** and the selected range of addresses are cut out of the Documentation Window and placed into the clipboard.

Copy

To use the copy features:

1. Click ⎘ on the toolbar or click **Copy** from the **Edit** menu. The Copy Range dialog box appears. Enter the starting and ending addresses to copy in the **from:** and **to:** boxes. If tags are to be copied with the address, the **Include Tags** check box must be selected.


Copy Range

Copy Addresses:

from: C4

to: C4

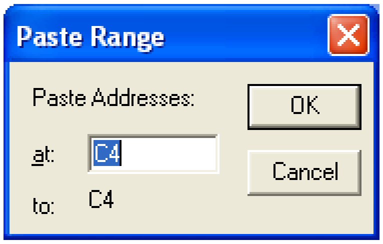
☐ Include Tags

2. Click **OK** and the selected range of address are copied from the Documentation Window and placed into the clipboard.

Paste

To access the paste feature:

1. Click 📋 on the toolbar or click **Paste** from the **Edit** menu. The Paste Range dialog box appears. Enter the starting address to paste to in the **at:** box.



at: C4

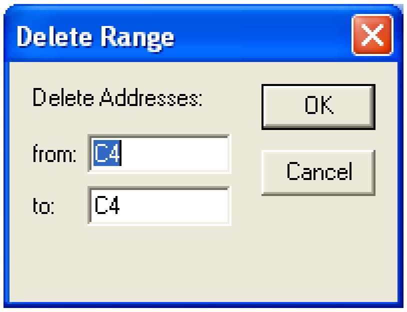
to: C4

2. Click **OK** and the addresses in the clipboard are pasted into the Documentation Window starting with the at address.

Delete

To delete an existing address tag, description, and comment:

1. Click **Delete** from the **Edit** menu or press **ALT+E, D** and the delete dialog box appears.



from: C4

to: C4

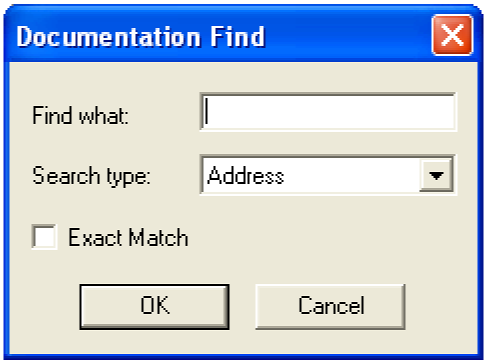
2. Enter the starting and ending addresses to be deleted in the **from:** and **to:** boxes.
3. Click **OK** and the selected range of addresses are deleted from the Documentation Window.

Searching for an Address, Tag, or Description

You can find the documentation associated with a specific address, tag, or description by using the Find option. To find an item, do one of the following:

- From the **Edit** menu, click **Find** (**ALT+E, F**).
- Right-click in the logic window and select **Find** from the shortcut menu.
- Click 🔍 on the toolbar.

After you select **Find**, the Find dialog box appears.



Documentation Find

Find what:

Search type: Address

□ Exact Match

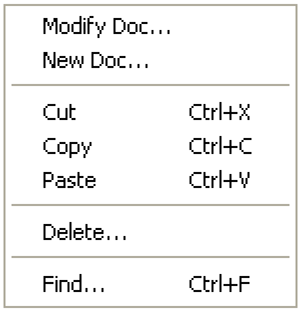
1. Enter the address, tag, or description you want to find in the **Find what** box.

2. In the **Search** type box, select whether you are searching for an address, tag, or description. Find will try to locate the closest match to the entered search information. If you want to find the exact match, select the **Exact Match** check box.

3. Click **OK**, and the search item will be located and displayed in the Documentation Window.

Pop-Up Menus

The menu items available with the right mouse button are displayed below.



Documenting in Ladder

Overview of Documenting in Ladder

In addition to editing and creating new documentation in the Documentation Window, you can also edit and create new documentation in the logic program as you enter and edit your logic. The Documentation Window can also be used to help you program your logic.

In the logic editor, these features are available:

- Assign Tags.
- Assign Addresses.
- Edit and Create Documentation in Ladder.
- Look up tags and use them in ladder.

These items are discussed in the following sections.

Assign Tags

The Assign Tags option allows you to assign tags, descriptions, and comments to an undocumented address that you are currently using in your ladder program. For example, if you enter an address in an ADD instruction and that address does not have a tag or description, the Edit Documentation window will automatically appear when you move off the address.

Enter a tag, description, and comment, and press OK to save the documentation. This allows you to document undocumented addresses as you program without leaving the ladder editor.

To use this feature:

1. Click **Program Setup** from the **Options** menu or press **ALT+O, P**.
2. Click the **Logic Windows** tab.
3. In the **Options for** box, click **Ladder**.

4. Select the **Assign Tags** check box.

5. Click **OK**.

Assign Addresses

The Assign Addresses option allows you to assign addresses, descriptions, and comments to tags as you use them in your ladder program. For example, if you enter the tag NEW_ TAG (and NEW_TAG doesn't exist), the Edit Documentation window will automatically appear with the tag filled in. You can enter the address, description, comment, and press **OK** to save the documentation. This allows you to assign addresses to tags as you program without leaving the ladder editor.

To access the Assign Address feature:

1. Click **Program Setup** from the **Options** menu or press **ALT+O, P**.

2. Select the **Logic Windows** tab.

3. In the **Options for:** box, click **Ladder**.

4. Select the **Assign Addresses** check box.

5. Click **OK**.

Editing Documentation in Ladder Editor

You can automatically assign documentation and edit existing documentation by pressing **CTRL+L** on an address in your ladder program. For example, if you would like to change the documentation for the address 00001 that is used on a contact, move the cursor to that location and press **CTRL+L**. The Edit Documentation window automatically appears. Enter the tag, description, and comment, and click **OK** to save the documentation.

Shared Documentation

Address Documentation can be used in two ways:

- The first is the traditional style. Where a temporary DATABASE file is not shared and all edits are buffered until the file is saved. If the file is not saved then any edits are lost. Upon saving the temporary DATABASE file is copied to the same destination as the logic file.

- A shared file works differently. This file can be shared (opened more then once.) by different programs. Edits are not buffered but are immediately saved. Upon saving a program the Address Documentation DATABASE file does not get saved, thus **Save As** does not affect the file at all. A refresh time can be entered that causes the database to reread the file to acquire any new or changed documentation. Also, a shared database can reference a database created for another purpose as long as the fields are map-able to our defaults. A shared file can be created at user direction, but once created is the responsibility of the user to delete.

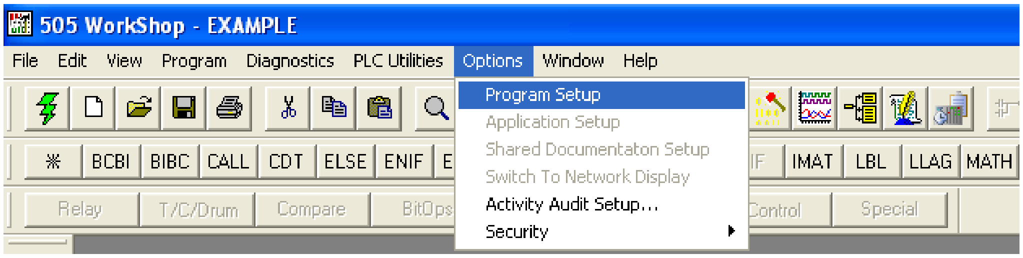
To modify a shared documentation file, click **Shared Documentation Setup** from the **Options** menu.

Toggling the Display of Documentation Components

Network headers and the tag and description components of address documentation can be displayed in the ladder logic program window. You are able to specify which documentation components are displayed using either of the following methods.

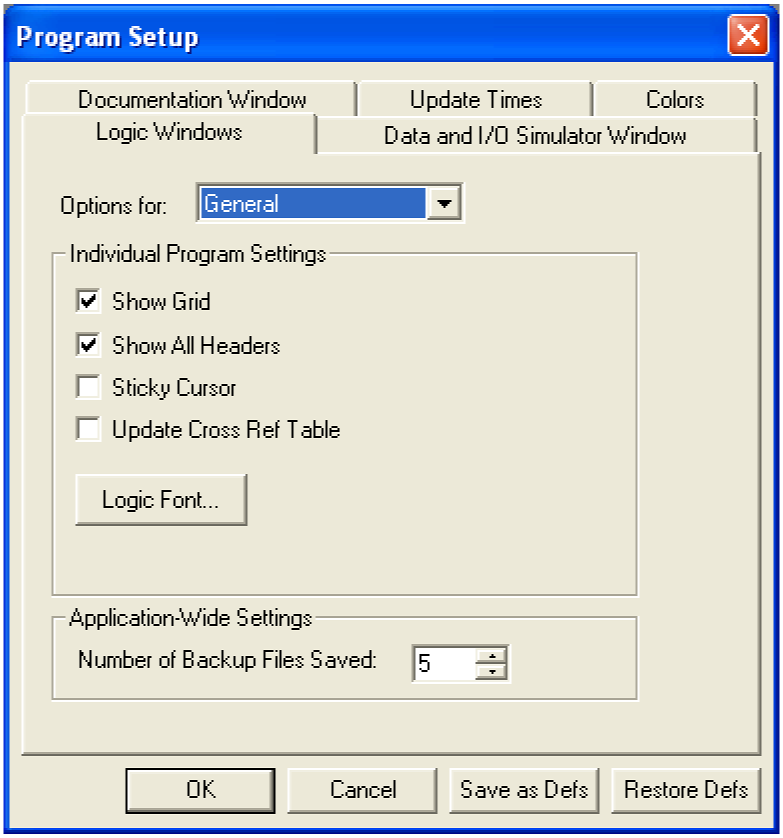
Toggling display through Program Setup

To specify which documentation components appear in the ladder logic program window, click **Program Setup** from the **Options** menu.



1. When the Program Setup dialog box appears, click the **Logic Windows** tab.

2. In the **Options for** box, click **General**.



Options for: General

Individual Program Settings

☑ Show Grid

☑ Show All Headers

☐ Sticky Cursor

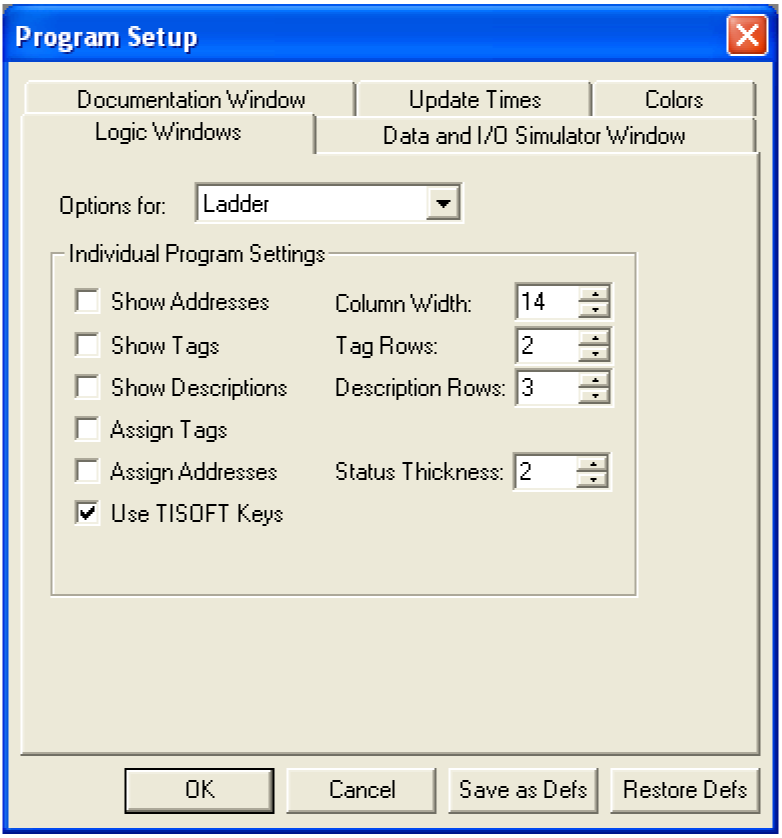
☐ Update Cross Ref Table

Application-Wide Settings

Number of Backup Files Saved: 5

3. Select the **Show All Headers** check box to display network headers in the ladder logic program window.

4. In the **Options for** box, click **Ladder**.



Options for: Ladder

Individual Program Settings

☐ Show Addresses
☐ Show Tags
☐ Show Descriptions
☐ Assign Tags
☐ Assign Addresses
☑ Use TISOFT Keys

Column Width: 14
Tag Rows: 2
Description Rows: 3
Status Thickness: 2

5. Select the **Show Tags** and **Show Descriptions** check boxes to display tag and description information in the ladder logic program window.

6. Click **OK**.

Toggling display with keyboard shortcuts

Network headers and the tag and description components of address documentation can be displayed or hidden in the ladder logic program window using keyboard shortcuts.

ADDRESS DESCRIPTIONS:

Press **F5** to display address descriptions in the ladder logic program window. Press **F5** again to hide the descriptions.

ADDRESS TAGS:

Press **CTRL+F5** to display address tags in the ladder logic program window. Press **CTRL+F5** again to hide the tags.

PROGRAM AND NETWORK HEADERS:

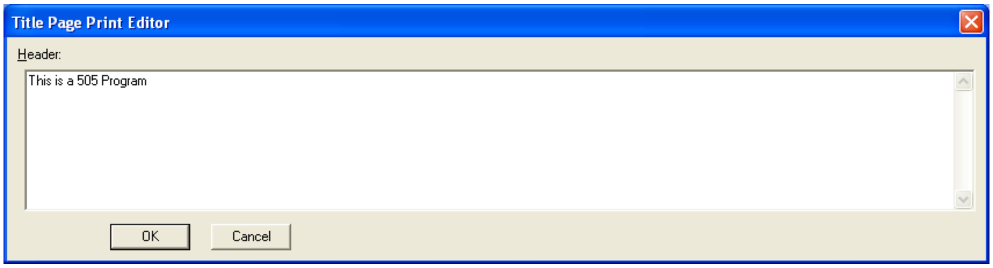
Press **SHIFT+F5** to display program and network headers in the ladder logic program window. Press **SHIFT+F5** again to hide the headers.

Edit Title Page (Print Only)

This option allows you to display descriptive information at the beginning of your printouts.

To access the Edit Title Page option:

1. Click **Title Page Print Editor** from the **View** menu. The following dialog box is displayed:



Header:
This is a 505 Program

2. In the **Header** box, enter the text you want printed at the beginning of every program print out and click **OK**.

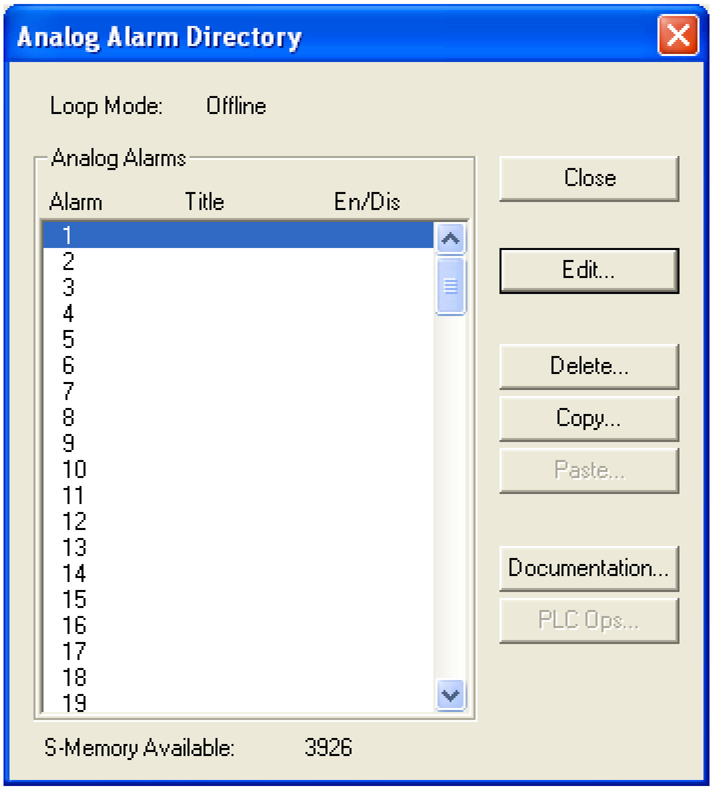
Chapter 8 – Analog Alarms

Analog Alarm Editor

The Analog Alarm Editor gives you the ability to display, access, and/or modify analog alarms.

To access the Analog Alarm Editor:

1. Click **Alarm** from the **View** menu or press (**ALT+V, A**).
2. The Analog Alarm Directory dialog box appears. The dialog box shows the Loop Mode, Alarm number (1-512) depending on the processor type, Alarm Title, and Enable/Disable state.



Analog Alarm Directory

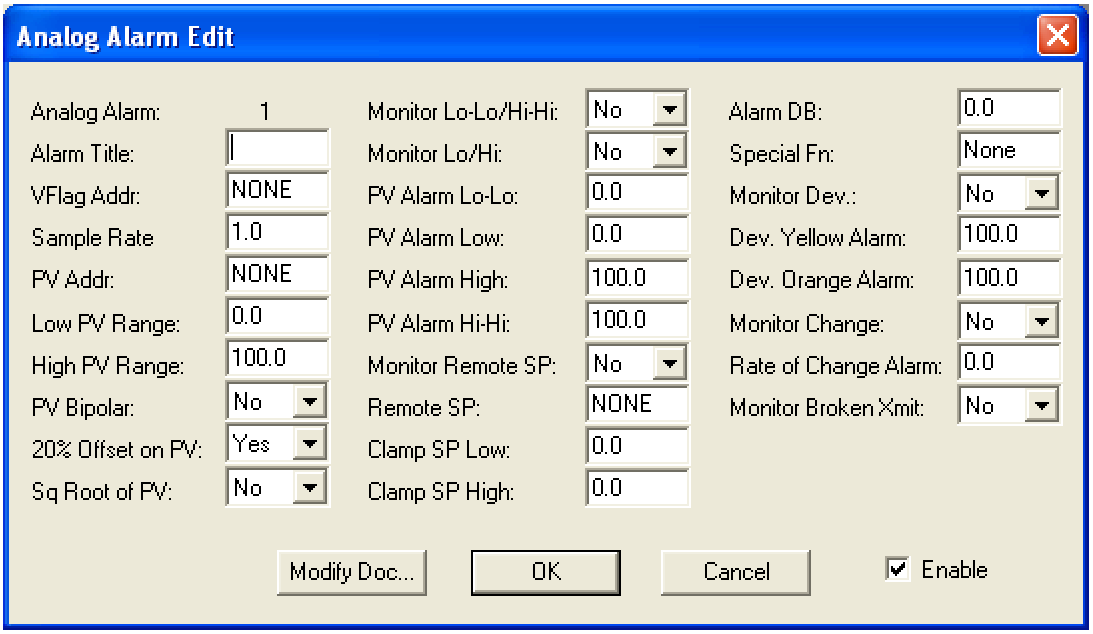
Loop Mode: Offline

Analog Alarms

Alarm	Title	En/Dis
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

S-Memory Available: 3926

3. Select the **Alarm** you want to edit and then click **Edit**. You can also double-click the **Alarm**. The following dialog box appears.



Analog Alarm Edit

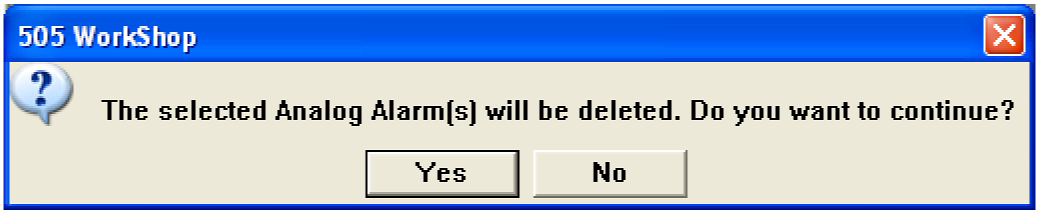
Analog Alarm:	1	Monitor Lo-Lo/Hi-Hi:	No	Alarm DB:	0.0
Alarm Title:		Monitor Lo/Hi:	No	Special Fn:	None
VFlag Addr:	NONE	PV Alarm Lo-Lo:	0.0	Monitor Dev.:	No
Sample Rate	1.0	PV Alarm Low:	0.0	Dev. Yellow Alarm:	100.0
PV Addr:	NONE	PV Alarm High:	100.0	Dev. Orange Alarm:	100.0
Low PV Range:	0.0	PV Alarm Hi-Hi:	100.0	Monitor Change:	No
High PV Range:	100.0	Monitor Remote SP:	No	Rate of Change Alarm:	0.0
PV Bipolar:	No	Remote SP:	NONE	Monitor Broken Xmit:	No
20% Offset on PV:	Yes	Clamp SP Low:	0.0		
Sq Root of PV:	No	Clamp SP High:	0.0		

To delete an Analog Alarm:

1. Click **Alarm** from the **View** menu or press **ALT+V, A**. The Analog Alarm Directory dialog box appears. The dialog box shows the Loop Mode, Alarm number (1-512) depending on the processor type, Alarm Title, and Enable/Disable state.

> **NOTE** To view or edit documentation of a selected address, click **Modify Doc**.

2. Select the **Alarm** you want to delete and then click **Delete**.



505 WorkShop

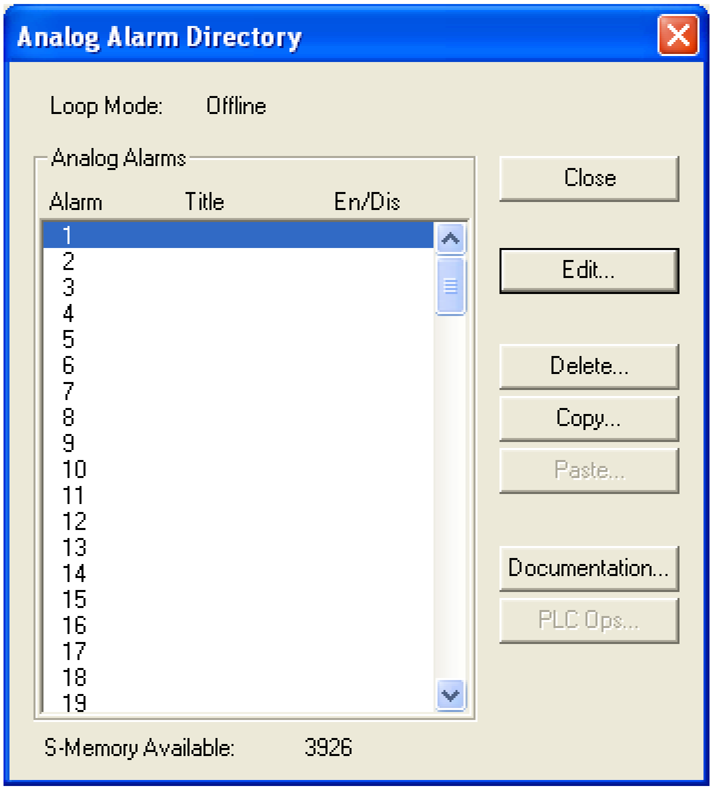
The selected Analog Alarm(s) will be deleted. Do you want to continue?

3. Click **Yes**.

Copy and Paste Alarms

To Copy and Paste Alarms:

1. Click **Alarm** from the **View** menu or press **ALT+V, A**.
2. The Analog Alarm Directory dialog box appears. The dialog box shows the Loop Mode, Alarm number (1-512) depending on the processor type, Alarm Title, and Enable/Disable state.



Analog Alarm Directory

Loop Mode: Offline

Analog Alarms

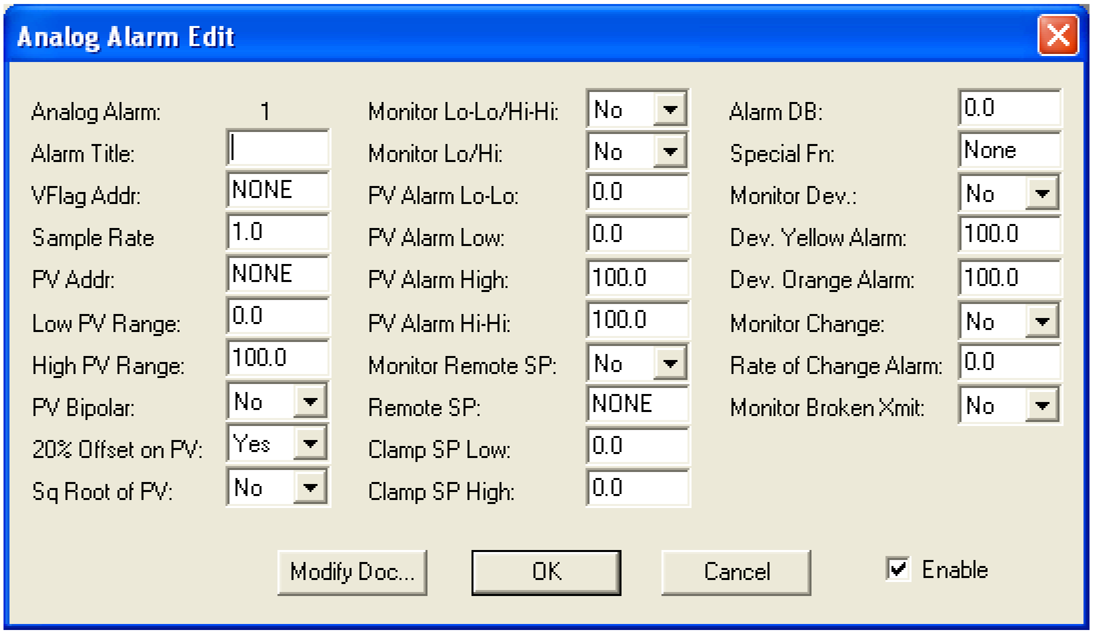
Alarm	Title	En/Dis
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

S-Memory Available: 3926

1. Select the alarm or alarms you want to copy and then click **Copy**. You can drag to select a range of alarms. You can also press the CTRL or SHIFT keys to select more than one alarm.
2. Move the pointer to the alarm where you want to place the copied alarms and click **Paste**.

Analog Parameters

Overview of Analog Alarm Parameters



Analog Alarm:	1	Monitor Lo-Lo/Hi-Hi:	No	Alarm DB:	0.0
Alarm Title:		Monitor Lo/Hi:	No	Special Fn:	None
VFlag Addr:	NONE	PV Alarm Lo-Lo:	0.0	Monitor Dev.:	No
Sample Rate	1.0	PV Alarm Low:	0.0	Dev. Yellow Alarm:	100.0
PV Addr:	NONE	PV Alarm High:	100.0	Dev. Orange Alarm:	100.0
Low PV Range:	0.0	PV Alarm Hi-Hi:	100.0	Monitor Change:	No
High PV Range:	100.0	Monitor Remote SP:	No	Rate of Change Alarm:	0.0
PV Bipolar:	No	Remote SP:	NONE	Monitor Broken Xmit:	No
20% Offset on PV:	Yes	Clamp SP Low:	0.0		
Sq Root of PV:	No	Clamp SP High:	0.0		

Alarm Title

An eight-character title can be entered for each specific Analog Alarm number. The title is optional and can be left blank.

V-Flag Address

Enter a C, Y, V, or WY address: in the **VFlag Addr** box. If you select NONE, no data is written from the V-Flags in the analog alarm.

The V-Flags contains the operational data for an analog alarm. The V-Flags comprises the individual bits making up the 16-bit word. The bits are defined as follows:

Bit	Analog Alarm Function
1	1=Enable alarm.
2	1=Disable alarm.
3	1=Process Variable is in high-high alarm.
4	1=Process Variable is in high alarm.
5	1=Process Variable is in low alarm.
6	1=Process Variable is in low low alarm.
7	1=Process Variable is in yellow deviation alarm.
8	1=Process Variable is in orange deviation alarm.
9	1=Process Variable is in rate of change alarm.
10	1=Broken transmitter alarm.
11	1=Analog alarm is over-running.
12	1=Alarm is enabled.*
13-16	1=Unused.
* If a word is selected for the analog alarm V-Flags, bit 12 is written. If a C or Y is selected, bit 12 is not used.	

NOTE: If you program an analog alarm and do not disable it, the controller begins to monitor the programmed variable as soon as you place the controller in Run mode.

Sample Rate

Enter a time in seconds in the **Sample Rate** box.

The sample rate determines how often deviation alarm bits and associated math are evaluated. Sample rates are programmable in 0.1-second increments, with alarms checked at least once every two seconds. The sample rate can be any floating point number between 0.1 – 1.6772 x 106 seconds.

Process Variable Address

Enter a V, WX, or WY address: in the **PV Addr** box.

A process variable must be specified for each analog alarm. The process variable can be taken from the following:

- **Aword input or output module -** The programming table uses a WX or WY address.
- **A location in V-Memory -** The programming table uses an address in V-Memory.

If you select **NONE**, the analog alarm does not read an address to obtain the Process Variable.

Low Process Variable Range

Enter the low value of the process variable in the **Low PV Range** box.

You must specify the engineering values that correspond to the lower range of the input span.

High Process Variable Range

Enter the high value of the process variable in the **High PV Range** box.

You must specify the engineering values that correspond to the upper range of the input span.

Process Variable Bipolar

Click **YES** or **NO** in the **PV Bipolar** box to specify if the analog inputs are bipolar. Bipolar inputs have spans of -5 – 5 volts, or -10 – 10 volts.

20% Offset

Click **Yes** or **No** in the **20% Offset on PV** box to indicate if a 20% offset should be used.

A span of 0 – 5.0 volts (0 – 20 milliamps) is referred to as a span of 0 – 100%.

A span of 1 – 5.0 volts (4 – 20 milliamps) is referred to as a span of 20% – 100% (20% offset on the process variable).

Square Root of Process Variable

Click **Yes** in the **Sq Root of PV** box if the input for the process variable is from a device (such as an orifice meter) that requires a square root calculation to determine the correct value to use.

Monitor Low-Low/High-High

Click **Yes** in the **Monitor Lo-Lo/Hi-Hi** box to have the controller monitor the Low-Low/High-High Alarm.

Click **No**if the Low-Low/High-High can be entered as values requiring critical action.

Monitor Low/High

Click **Yes** in the **Monitor Lo/Hi** box to have the controller monitor the Low/High Alarm.

Click **No** if the Low/High Alarm can be entered as values requiring remedial action.

Process Variable Alarm Low-Low

Enter a real number in engineering units in the **PV Alarm Lo-Lo** box. This value must be less than or equal to low alarm value, and greater than or equal to low range of the process variable.

Process Variable Alarm Low

Enter a real number in engineering units in the **PV Alarm Low** box. This value must be less than or equal to high alarm value of process variable.

Process Variable Alarm High

Enter a real number in engineering units in the **PV Alarm High** box. This value must be less than or equal to the high-high alarm value of the process variable.

Process Variable Alarm High-High

Enter real number in engineering units in the **PV Alarm Hi-Hi** box. This value must be greater than or equal to the high alarm value, and less than or equal to the high range of the process variable.

Monitor Remote Setpoint

To have the controller monitor the remote setpoint, click **Yes** in the **Monitor Remote SP** box. Click **No** to have the analog alarm use the current value in the analog alarm variable.

Remote Setpoint

Click **NONE** in the **Remote SP** box if there is no remote setpoint. Otherwise, enter a V, K, WX, or WY address, or a value, in the **Remote SP** box.

Clamp Setpoint Low

In the **Clamp SP Low** box, enter values for the low setpoint. If there are no limits, enter zero.

Clamp Setpoint High

In the **Clamp SP High** box, enter values for the high setpoint. If there are no limits, enter zero.

Alarm Deadband

In the **Alarm DB** box, enter a value in engineering units for the alarm deadband. When you specify an alarm deadband, the controller can provide histories on all alarms except the rate of change alarm to prevent them from chattering when the process variable is near one of the alarm limits.

Special Function

In the **Special Fn** box, enter a SF program number. Click **NONE** if no SF program is to be executed.

Monitor Deviation

In the **Monitor Dev** box, click **Yes** if the controller will monitor the deviation alarm limits. Click **No** if the controller will not monitor the deviation alarm limits.

Deviation Yellow Alarm

In the **Dev. Yellow Alarm** box, enter a value in engineering units for the setpoint deviation limit. The deviation alarm bands are always centered around the target or setpoint; that is, the deviation alarm test is actually on the control error. This value indicates the maximum allowable error (SP-PV) that sets the yellow alarm deviation alarm. The yellow deviation limit must be within the span of the process variable, and it must be less than or equal to the orange deviation alarm.

Deviation Orange Alarm

In the **Dev. Orange Alarm** box, enter a value in engineering units for the setpoint deviation limit. The deviation alarm bands are always centered around the target or setpoint; that is, the deviation alarm test is actually on the control error. This value indicates the maximum allowable error (SP-PV) that sets the orange alarm deviation alarm. The orange deviation limit must be within the span of the process variable, and it must be greater than or equal to the yellow deviation alarm.

Monitor Rate of Change

In the **Monitor Change** box, click **Yes** to have the controller monitor the rate of change. Click **No** if the controller will not monitor the rate of change.

Rate of Change Alarm

In the **Rate of Change Alarm** box, enter a value in engineering units for the rate of change alarm.

Monitor Broken Transmitter Alarm

In the **Monitor Broken Xmit** box, click **Yes** to have the controller monitor the Broken Transmitter Alarm. Click **No** if the controller will not monitor the Broken Transmitter Alarm.

If you program the controller to monitor for the broken transmitter condition, an alarm occurs if the raw process variable is outside the valid range designated for the process variable. Valid ranges are:

- Bipolar:-32000 – 32000
- 0% offset: 0 – 32000
- 20% offset: 6400 – 32000

Analog Alarm Data Element Types

Mnemonic	Data Element Type	Data Type
AHA.	High Alarm Limit	Real
ALA.	Low Alarm Limit	Real
APV.	Process Variable	Real
APVH.	PV High Limit	Real
APVL.	PV Low Limit	Real
AODA.	Orange Deviation Alarm Limit	Real
AYDA.	Yellow Deviation Alarm Limit	Real
ATS.	Sample Rate (Seconds)	Real
ASP.	Setpoint	Real
AVF	V-Flags	16-bits Integer
ACF	C-Flags	32-bits Integer
AERR.	Error	Real
AHHA.	High-High Alarm Limit	Real
ALLA.	Low-Low Alarm Limit	Real
ARCA.	Rat-of-Change Alarm Limit in Engineering Units / Minute	Real
ASPH.	Setpoint High Limit	Real
ASPL.	Setpoint Low Limit	Real
AADB.	Alarm Deadband	Real
AHA	Raw High Alarm Limit	Integer
ALA	Raw Low Alarm Limit	Integer
APV	Raw Process Variable	Integer
AODA	Raw Orange Deviation Alarm Limit	Integer
AYDA	Raw Yellow Deviation Alarm Limit	Integer
ASP	Raw Setpoint	Integer
AADB	Raw Alarm Deadband	Integer

Mnemonic	Data Element Type	Data Type
AERR	Raw Error	Integer
AHHA	Raw High-High Alarm Limit	Integer
ALLA	Raw Low-Low Alarm Limit	Integer
ASPL	Raw Setpoint Low Limit	Integer
ASPH	Raw Setpoint High Limit	Integer
ACFH	Most-Significant Word of Alarm C-Flags	Integer
ACFL	Least-Significant Word of Alarm C-Flags	Integer
AACK	Analog Alarm Acknowledge Flags	Integer

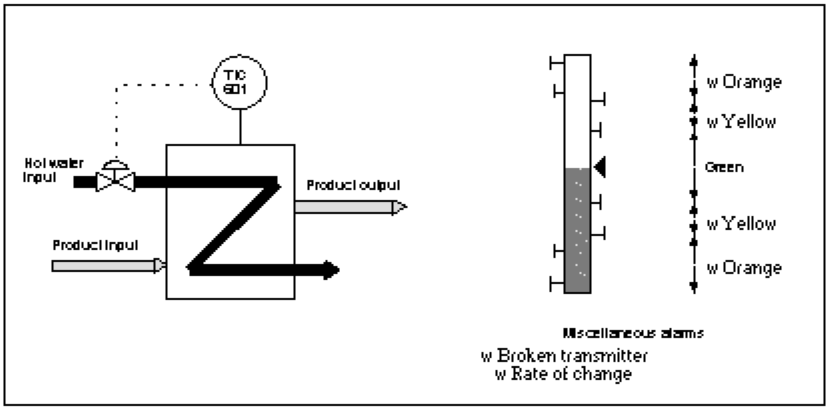
NOTE: Addresses that use a "." notation are real types.

Chapter 9 – PID Loops

Introduction

Process and batch control capability is provided using the controller's proportional-integral-derivative (PID) loop functions. When you program a loop, you can set the same eight alarm types used by analog alarms and described in Analog Alarms.

- High-high alarm point on the process variable (PV).
- High alarm point on the PV.
- Low alarm point on the PV.
- Low-low alarm point on the PV.
- Yellow deviation alarm point referenced to the setpoint (SP).
- Orange deviation alarm point referenced to the SP.
- Rate of change alarm, for a PV changing too rapidly.
- Broken transmitter, for a PV outside the designated valid range.



The high-high, high, low, and low-low alarms are fixed absolute alarms and may correspond to warnings and shutdown limits for the process equipment itself. The yellow and orange deviation alarms move up and down with the setpoint, and may refer to specification tolerances around the setpoint.

A PV alarm deadband is provided to minimize cycles in and out of alarm (chattering) that generate large numbers of messages when the PV hovers near one of the alarm limits.

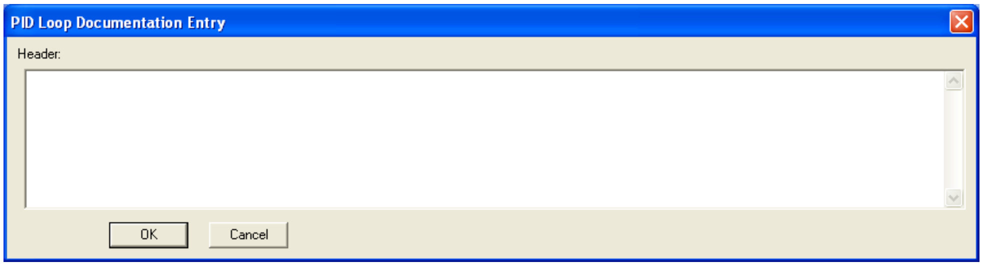
An option is also available to call a Special Function Program to initiate a special function calculation. The SF program call can be scheduled on the PV, the SP, or the output.

PID Documentation

505 WorkShop provides a simple way to document PID Loops while you are creating or editing loops. The maximum number of characters you can enter for each header is 16K.

To document a PID Loop:

1. Click **PID Loop** from the **View** menu or press **ALT+V, P**. The PID Loop Directory dialog box appears. The dialog box shows the Loop Mode, Loop number (1-64), Loop Title, and Enable/Disable state.
2. Select the PID Loop you want to document.
3. Click **Documentation**. The following dialog box appears.



4. In the **Header** box, type the documentation you want associated with the PID loop.
5. Click **OK**.

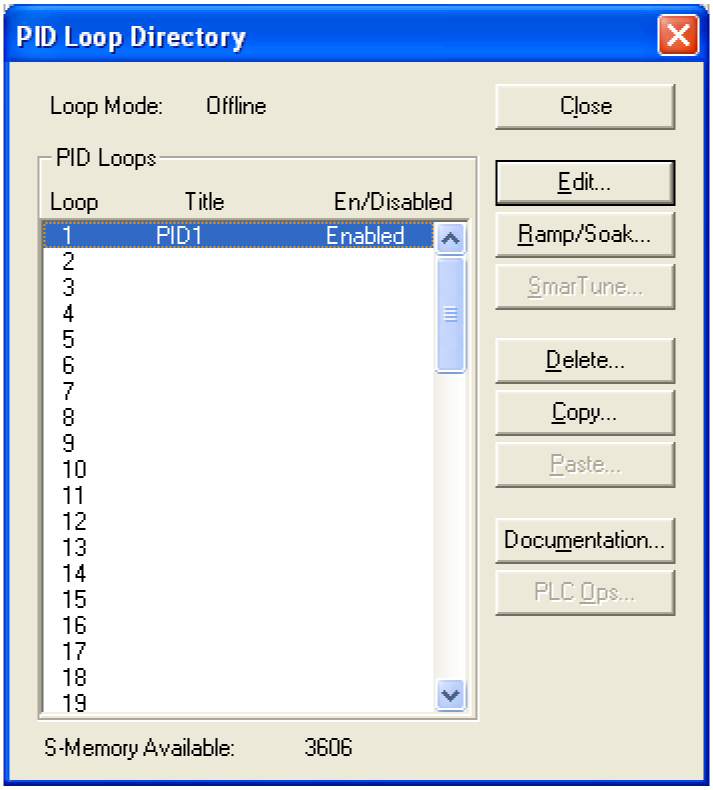
Programming PID Loops

PID Loop Editor

The PID Loop Editor gives you the ability to display, access, and/or modify PID Loops.

To access the PID Loop Editor:

1. Click **PID Loop** from the **View** menu or press **ALT+V, P**. The PID Loop Directory dialog box appears.
2. The dialog box shows the Loop Mode, Loop number (1-512) depending on the processor type, Loop Title, and Enable/Disable state.

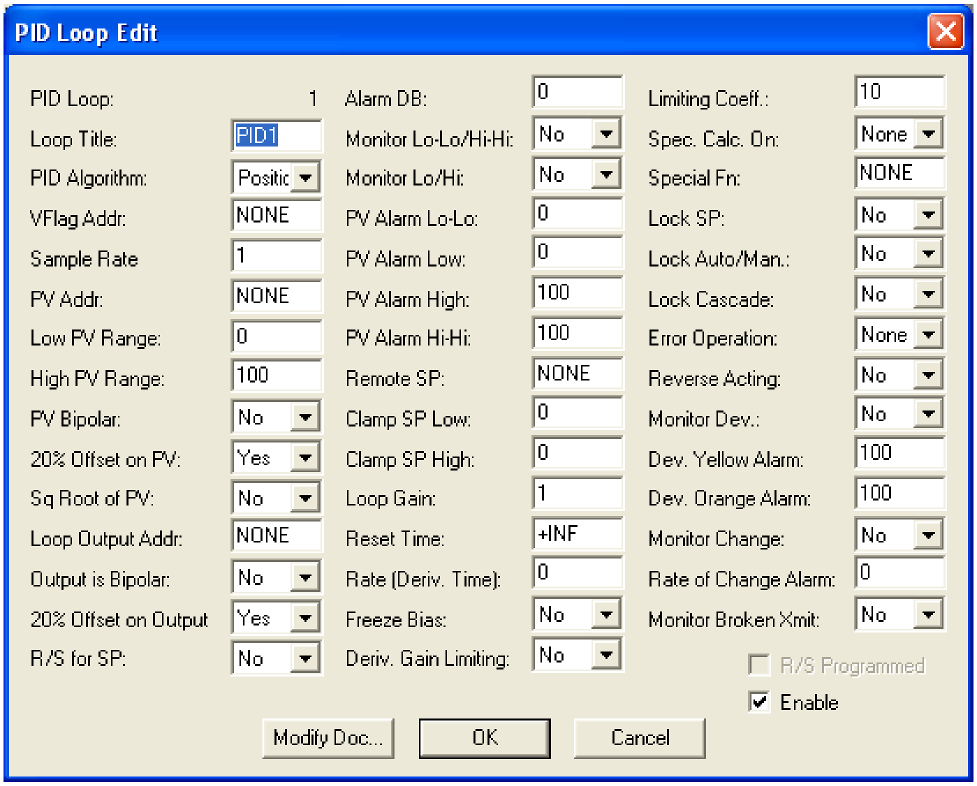


Loop Mode: Offline

Loop	Title	En/Disabled
1	PID1	Enabled
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		

S-Memory Available: 3606

3. Select the PID loop you want to edit and then click **Edit**. You can also double-click the PID loop. The following dialog box appears.



PID Loop:	1	Alarm DB:	0	Limiting Coeff.:	10
Loop Title:	PID1	Monitor Lo-Lo/Hi-Hi:	No	Spec. Calc. On:	None
PID Algorithm:	Positic	Monitor Lo/Hi:	No	Special Fn:	NONE
VFlag Addr:	NONE	PV Alarm Lo-Lo:	0	Lock SP:	No
Sample Rate	1	PV Alarm Low:	0	Lock Auto/Man.:	No
PV Addr:	NONE	PV Alarm High:	100	Lock Cascade:	No
Low PV Range:	0	PV Alarm Hi-Hi:	100	Error Operation:	None
High PV Range:	100	Remote SP:	NONE	Reverse Acting:	No
PV Bipolar:	No	Clamp SP Low:	0	Monitor Dev.:	No
20% Offset on PV:	Yes	Clamp SP High:	0	Dev. Yellow Alarm:	100
Sq Root of PV:	No	Loop Gain:	1	Dev. Orange Alarm:	100
Loop Output Addr:	NONE	Reset Time:	+INF	Monitor Change:	No
Output is Bipolar:	No	Rate (Deriv. Time):	0	Rate of Change Alarm:	0
20% Offset on Output	Yes	Freeze Bias:	No	Monitor Broken Xmit:	No
R/S for SP:	No	Deriv. Gain Limiting:	No		

□ R/S Programmed
☑ Enable

NOTE: To view or edit the documentation of a selected PID, click **Modify Doc**.

Loop Title

In the **Loop Title** box, an eight character title can be entered for each specific PID Loop. The title is optional and can be left blank.

PID Algorithm

In the PID Algorithm box, select the algorithm you want to use.

- Select **Position** for the position algorithm. For the position algorithm, the position of the device being controlled is computed based on the error.
- Select **Velocity** for the velocity algorithm. The velocity algorithm computes the change in the device position based on the error.

V-Flag Address

In the **VFlag Addr** box, enter a C,Y,V, or WY address. If you click **NONE**, no data is written from the V-Flags in the PID Loop. You can still control the loop mode by using a SF program to change the control flag bits in the Loop V Flag.

The V-Flags contains the operational data for a PID Loop. The V-Flags corresponds to individual bits making up the 16-bit word. The bits are defined below.

Bit	PID Loop Function
1	1=Go to manual mode
2	1=Go to auto mode
3	1=Go to cascade mode
4 & 5	4 5 0 0 Loop is in manual mode 1 0 Loop is in auto mode 0 1 Loop is in cascade mode
6	0=Error is positive 1=Error is negative
7	1=Process Variable is in high high Alarm
8	1=Process Variable is in high Alarm
9	1=Process Variable is in low Alarm
10	1=Process Variable is in low low Alarm
11	1=Process Variable is in yellow deviation alarm
12	1=Process Variable is in orange deviation alarm
13	1=Process Variable is in rate of change Alarm
14	1=Broken transmitter alarm
15	1=PID Loop is overrunning
16	1=Unused

Sample Rate

In the **Sample Rate** box, enter a time in seconds.

The sample rate determines how often deviation alarm bits and associated math are evaluated. Sample rates are programmable in 0.1-second increments, with alarms checked at least once every two seconds. The sample rate can be any floating point number between 0.1 – 1.6772 x 106 seconds.

Process Variable Address

In the **PV Addr** box, enter a V, WX, WYaddress or click **NONE**.

A process variable must be specified for each PID Loop. The process variable can be taken from the following:

- **Aword input or output module -** The programming table uses a WX or WY address.
- **A location in V-Memory -** Uses an address in V-Memory in the programming table. When a special calculation is performed on a process variable, the result is stored in V-Memory where the Loop accesses it.

If you select **NONE**, the PID Loop does not read an address to obtain the process variable.

Low Process Variable Range

In the **Low PV Range** box, enter the low value of the process variable. You must specify the engineering values that correspond to the lower range of the input span.

High Process Variable Range

In the High PV Range box, enter the high value of the process variable. You must specify the engineering values that correspond to the upper range of the input span.

Process Variable Bipolar

In the **PV Bipolar** box, click **YES** to specify analog inputs as bipolar. Click **No** if the analog inputs are not bipolar. Bipolar inputs span have spans of -5 – 5 volts, or -10 – 10 volts.

20% Offset of Process Variable

In the **20% Offset on PV** box, click **No** for no offset. Click **Yes** for 20% offset. A span of 0 – 5.0 volts (0 – 20 milliamps) is referred to as a span of 0 – 100%. A span of 1 – 5.0 volts (4 – 20 milliamps) is referred to as a span of 20% – 100% (20% offset on the process variable).

Square Root of Process Variable

In the **Sq Root of PV** box, click **Yes** if the input for the process variable is from a device (such as an orifice meter) that requires a square root calculation to determine the correct value to use.

Loop Output Address

In the **Loop Output Addr** box, enter a V or WY address. This is the address into which the loop writes the value of the output. Click **NONE** when you do not want the loop to write the output to an address, such as with cascaded loops in which the outer loop does not require an output address.

Output is Bipolar

In the **Output is Bipolar** box, click **YES** to use an output range of -32000 – +32000.

20% Offset on Output

In the **20% OFFSET ON OUTPUT** box, click **Yes** to use a 20% offset on the output. .

If you select **No** for both **Output is Bipolar** and **20% Offset on Output**, then the output range is 0 – +32000.

Ramp/Soak for SP

In the **R/S for SP**box, click **YES** to indicate that a ramp/soak program for the loop is to be executed.

Alarm Deadband

In the **Alarm DB** box, enter a value in engineering units for the Alarm deadband. When you specify an Alarm deadband, the controller provides histories on all alarms except the rate of change alarm to prevent chattering when the process variable is near one of the Alarm limits. The loop does not exit the alarm condition until the process variable has come inside the alarm limit minus the deadband.

Monitor Low-Low/High-High

In the **Monitor Lo-Lo/Hi-Hi** box, click **Yes** to have the controller monitor the Low-Low/High-High Loop. Click **No** if the Low-Low/High-High can be entered as values requiring critical action.

Monitor Low/High

In the **Monitor Lo/Hi** box, click **Yes** to have the controller monitor the Low/High Alarm. Click **No** if the Low/High Loop can be entered as values requiring remedial action.

Process Variable Alarm Low-Low

In the **PV Alarm Lo-Lo** box, enter a real number in engineering units. This value must be less than or equal to the low alarm value, and greater than or equal to the low range of the process variable.

Process Variable Alarm Low

In the **PV Alarm Low** box, enter a real number in engineering units. This value must be less than or equal to the high alarm value of the process variable.

Process Variable Alarm High

In the **PV Alarm High** box, enter a real number in engineering units. This value must be less than or equal to the high-high alarm value of the process variable.

Process Variable Alarm High-High

In the **PV Alarm Hi-Hi** box, enter a real number in engineering units. This value must be greater than or equal to the high alarm value, and less than or equal to the high range of the process variable.

Remote Setpoint

In the **Remote SP** box, enter a V, K, WX, WY, or LMN address. Click **NONE** if there is no remote setpoint.

Clamp Setpoint Low

In the **Clamp SP Low** box, enter a value for the low setpoint limit. Enter zero if there is no limit.

Clamp Setpoint High

In the **Clamp SP High** box, enter a value for the high setpoint limit. Enter zero if there is no limit.

Loop Gain

In the **Loop Gain** box, enter the value for the tuning constant.

Reset Time

In the **Reset Time** box, enter the value for the tuning constant Reset Time (integral time).

Rate Derivative Time

In the **Rate (Deriv. Time)** box, enter the value for the tuning constant.

NOTE: It is not always necessary to have full three-mode PID control of a loop. Parts of the PID equation can be eliminated by choosing appropriate values for the gain (Kc), reset (Ti), and rate (Td), thus yielding a P, PI, PD, I, and even an ID or a D loop. To eliminate integral action, set (Ti) to infinity. To eliminate derivative action, set (Td) to zero. To eliminate proportional action, set (Kc) to zero.

Freeze Bias

In the **Freeze Bias** box, click **YES** to have the bias frozen when the output goes out or range. Click **No** to have the bias adjusted when the output goes out of range.

Derivative Gain Limiting

In the **Deriv. Gain Limiting** box, click **Yes** to perform derivative gain limiting. Click **No**if derivative gain limiting is not to be performed, even if a limiting coefficient value is entered in the **Limiting Coeff** box.

Limiting Coefficient

In the **Limiting Coeff.** box, enter a value for the derivative gain limiting coefficient. Typically, the derivative gain limiting coefficient should be in the range of 10 – 20.

In the standard PID algorithm, the algorithm responds excessively to process noise if the coefficient of the derivative term (rate time/sample time) is significantly above the 10 to 20 range. This causes disturbances that lead to erratic behavior of the process.

To solve this problem, the controller allows you the option of selecting a derivative gain limiting coefficient. Using this coefficient enables the process variable to be filtered with a time constant that is proportional to the derivative time. The PID equations with the derivative gain limiting coefficient follow.

Special Calculation On

In the **Spec. Calc. On** box, enter when a SF program is executed.

- Click **PV** to designate a process variable.
- Click **SP** to designate a setpoint.
- Click **Output** to designate output.
- Click **None** if no SF program is to be called.

Special Function

In the **Special Fn** box, enter a SF program number. Click **None** if no SF program is to be called for execution.

Lock Setpoint

In the **Lock SP** box, click **YES** to lock the setpoint. Click **NO** to not lock the setpoint.

Lock Auto/Manual

In the **Lock Auto/Man** box, click **YES** to lock the auto/manual setting. Click **No** to not lock the auto/manual setting.

Lock Cascade

In the **Lock Cascade** box, click **Yes** to lock the cascade. Click **No** to not lock the cascade.

Error Operation

In the **Error Operation** box, click **Squared**, **Deadband**, or **None**. The Error Squared and the Deadband options are mutually exclusive. Click **NONE** if there is be no calculation on the error value.

In calculating the control equation, the controller uses an error value equal to or less than 1.0 (% of PROCESS VARIABLE span over 100). Therefore, selecting error squared gives a lower gain for a higher error. The control equation with error squared is based on signed error squared, instead of the error alone.

To implement a high gain for large errors, and no gain for small errors, incorporate an error deadband. When error deadband is selected, the controller does not take any action on the output if the process variable is within the yellow deviation limits.

Squared error calculation:

```
en = (SP - PVn ) x abs (SP - PVn)
```

Deadband error calculation:

```
en = 0  if abs (SP - PVn) < YDEV

en = (SP - PVn) - YDEV if (SP - PVn) > YDEV

en = (SP - PVn) + YDEV if (SP - PVn) < - YDEV
```

No error calculation:

```
en = (SP - PVn)
```

Reverse Acting

In the **Reverse Acting** box, click **YES** for a reverse-acting loop. Click **No** for a direct-acting loop.

A reverse acting loop is defined to have a negative gain; that is, a positive change in error (SP - PROCESS VARIABLE) results in a negative change in the output from the controller. The value of the output signal decreases as the value of the error increases.

A direct acting loop is defined to have a positive gain; that is, a positive change in error (SP - PROCESS VARIABLE) results in a positive change in the output from the controller. The value of the output signal increases as the value of the error increases.

Monitor Deviation

In the **Monitor Change** box, click **Yes** to have the controller monitor the deviation loop limits. Click **No** if the controller will not monitor the deviation loop limits.

Deviation Yellow Alarm

In the **Dev. Yellow Alarm** box, enter a value in engineering units for the setpoint deviation limit. The deviation alarm bands are always centered around the target or setpoint; that is, the deviation alarm test is actually on the control error. This value indicates the maximum allowable error (SP-PROCESS VARIABLE) that sets the yellow alarm deviation alarm. The yellow deviation limit must be within the span of the process variable, and it must be less than or equal to the orange deviation alarm.

Deviation Orange Alarm

In the **Dev. Orange Alarm** box, enter a value in engineering units for the setpoint deviation limit. The deviation alarm bands are always centered around the target or setpoint; that is, the deviation Alarm test is actually on the control error. This value indicates the maximum allowable error (SP-PROCESS VARIABLE) that sets the orange alarm deviation alarm. The orange deviation limit must be within the span of the process variable, and it must be greater than or equal to the yellow deviation alarm.

Monitor Rate of Change

In the **Monitor Change** box, click **Yes** to have the controller monitor the rate of change.

Rate of Change Loop

In the **Rate of Change Alarm** box, enter a value in engineering units for the rate of change alarm.

Monitor Broken Transmitter Alarm

In the **Monitor Broken Xmit** box, click **Yes** to have the controller monitor the Broken Transmitter Alarm. Click **No** if the controller will not monitor the Broken Transmitter Alarm.

If you program the controller to monitor for the broken transmitter condition, an alarm occurs if the raw process variable is outside the valid range designated for the process variable. Valid ranges are:

- Bipolar: -32000 – 32000
- 0% offset: 0 – 32000
- 20% offset: 6400 – 32000

R/S Programmed

The **R/S Programmed** check box is a read-only value that indicates if a ramp/soak program exists for the loop.

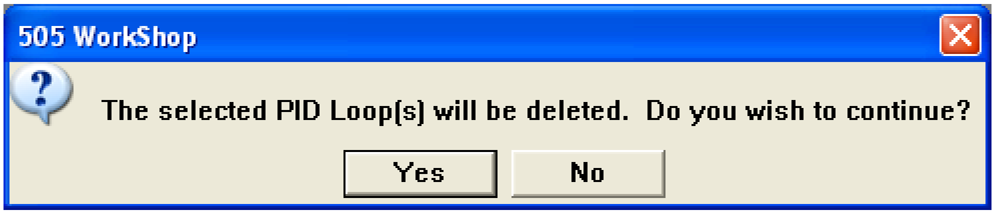
- If the **R/S Programmed** check box is selected, a ramp/soak program exists for the loop.
- If the **R/S Programmed** check box is cleared, a ramp/soak does not exist for the loop.

To create a ramp/soak profile for a loop, exit the PID Loop Edit window and click the **Ramp/Soak** on the PID Loop Directory dialog box.

Deleting a PID Loop

1. To delete a PID Loop, click **PID Loop** from the **View** menu or press **ALT+V, P**. The PID Loop Directory dialog box appears. The dialog box shows the Loop Mode, Loop number (1-64), Loop Title, and Enable/Disable state.

2. Select the loop you want to delete and then click **Delete**. The following dialog box appears.



505 WorkShop

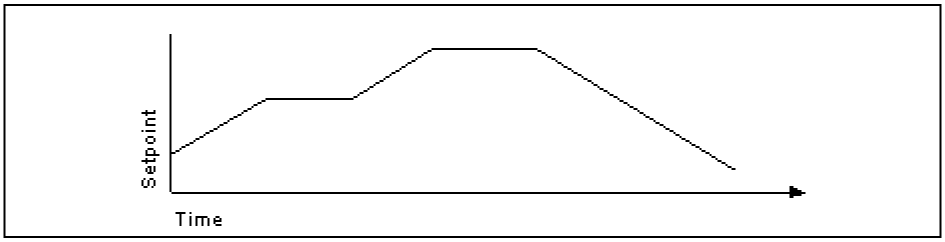
The selected PID Loop(s) will be deleted. Do you wish to continue?

3. Select **Yes** to delete the PID Loop.

Ramp/Soak

Overview of Ramp/Soak

The ramp/soak feature allows you to define a variation for the process variable by specifying the time characteristics of the loop setpoint. The capability of varying the loop setpoint can be useful in a number of processes such as heat treating and batch cooking.



Example Ramp/Soak Cycle

You can use simple ramp operations to improve some process startup procedures. For example, the controllers do a bumpless transfer from manual to automatic mode. This transfer holds the process at the initial state when the mode change occurs. A two-step ramp/soak profile can then move the setpoint to a predefined value following the mode change, with minimal disturbance to the process.

Defining Ramp/Soak Steps:

Ramp/Soak is programmed as a set of time periods, or steps. A step can be one of three types: a ramp, a soak, or an end.

- The ramp step changes the loop setpoint linearly from its current value to a new value, at a specified rate of change.
- The soak step holds the setpoint constant for a specified period of time. You can guarantee a soak period by entering a deadband value. This form of soaking ensures that the process variable is within a specified deadband around the setpoint for a specified period of time.
- The end step terminates a ramp/soak profile. When the program reaches an end step, the loop remains in automatic mode and holds the setpoint constant.

You can program a status bit for each step of the ramp/soak. This bit is set to 1 when the loop is executing this step. It is reset when the loop leaves the step. This allows for easy tracking in the RLL program.

Controlling the Ramp/Soak Operation

Ramp/Soak operation can be controlled by two methods: allowing the profile to be executed automatically, or by writing values to the variables that control ramp/soak.

- **Automatic -** Whenever the loop changes from manual to automatic mode, the loop begins to execute the ramp/soak profile at the initial step (Step 1). The loop continues to execute the profile until an end step is encountered in the profile. At this point, the loop remains in automatic mode, and the setpoint is held at the last value in the profile.

- **Using Ramp/Soak Number -** Each loop ramp/soak profile has a corresponding 16-bit variable, LRSN, that contains the current step. You can monitor LRSN with a SF program and also write a step number to it with a SF program. The ramp/soak profile changes to the step that is currently contained in LRSN. Note that the step number is zero-based. LRSN contains 0 when the profile is on step #1, 1 when the profile is on step #2, and so on.

- **Using the Ramp/Soak Flags -** Each loop ramp/soak profile has a corresponding 16-bit variable, LRSF, that contains operational and status information for the profile.

When you program a ramp/soak profile, you may optionally specify a RAMP/SOAK FLAG ADDRESS. When you enter an address into this field, the controller writes the ramp/soak data from LRSF to this address. You can design your program to write to the first three bits at the specified address. The controller reads these bits and then writes their status over the corresponding bits in LRSF. This enables you to change the ramp/soak operation by setting/clearing the three bits as needed. The controller ignores changes that you make in bits 4-16.

You can also monitor LRSF with a SF program and write changes to bits 1-3 with a SF program.

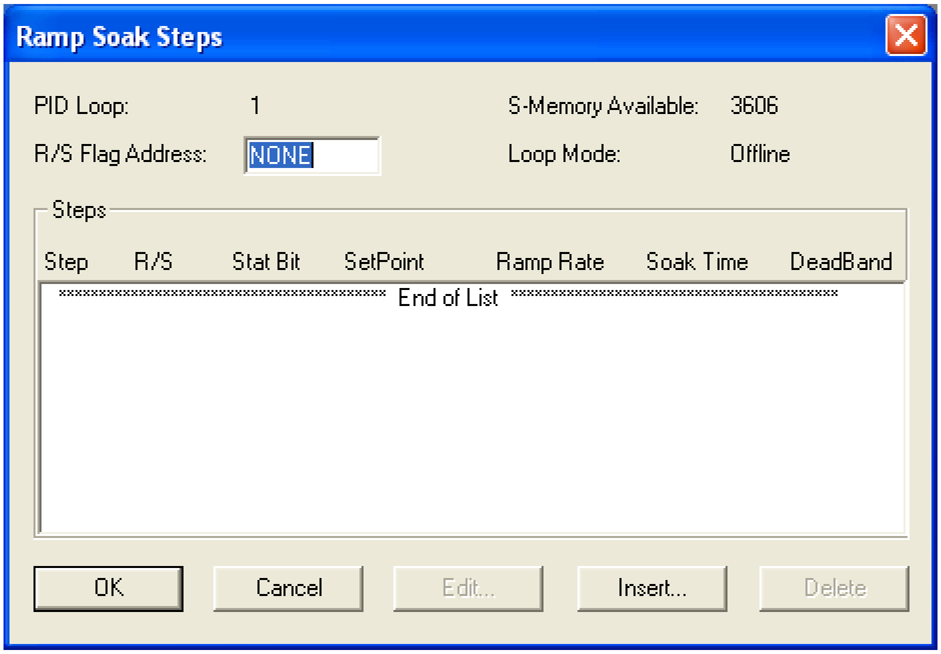
NOTE: The step number is zero-based. LRSN contains 0 when the profile is on step #1, I when the profile is on step #2, etc.

Ramp/Soak Editor

The Ramp/Soak Editor allows you to edit or delete an existing programmed step or insert a new one.

To access the Ramp/Soak Editor:

1. Click **PID Loop** from the **View** menu or press **ALT+V, P**. The PID Loop Directory dialog box appears. The dialog box shows the Loop Mode, Loop number (1-64), Loop Title, and Enable/Disable state.
2. Select a loop whose ramp/soak program you want to create or modify and then click **Ramp/Soak**. The following dialog box appears.



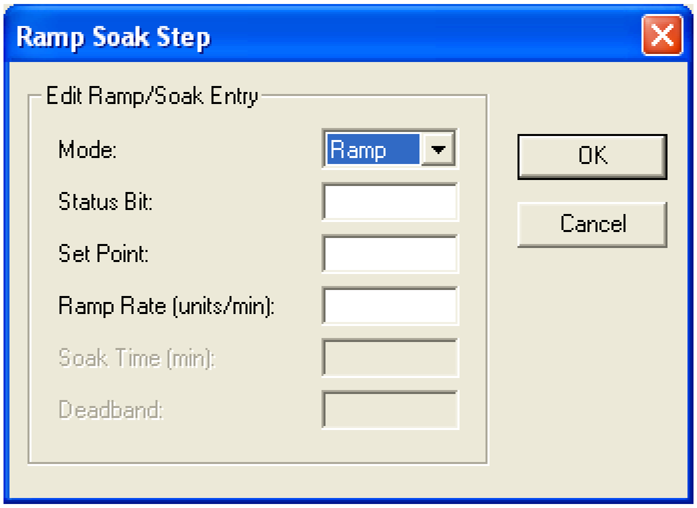
The **R/S Flag Address** box contains the ramp/soak flag address. An entry in this field causes ramp/soak data to be written from the ramp/soak variable (LRSF) to another address. The address can be a bit (Y or C) that allocates 5 contiguous bits, or a word (WY or V) that allocates one word for ramp/soak data. The format of the bits in a ramp/soak flag address correspond to the individual bits making up the 16-bit word LRSF. Bits are defined in the following table.

BIT	LOOP/FUNCTION
1	1= Restart at the first step. To restart, toggle bit off, on, then off again. The restart occurs on the trailing edge of a square wave.
2	1= Hold at current step. To hold, set bit on.
3	1= Jog to next step. To jog, set bit on. Jog occurs on the rising edge of a square wave.

BIT	LOOP/FUNCTION
4	1= Finish. Indicates ramp/soak is completed.
5	1= Wait. This bit is set during a soak period when the process variable is not within a specified deviation from the SP. The loop holds the soak timer when bit 5 is set.
6	1= Hold in progress at current step.
7–8	Unused (always returns 0).
9–16	1= Contains step number loop is currently executing. Step number is zero-based. Step number contains 0 when ramp/soak is on step #1, 1 when the ramp/soak is on step #2 etc.

3. Enter a **C**,**Y**,**V**, or **WY**address: in the **R/S Flag Address** box. If you select **NONE**, no data is written from the Loop Ramp/Soak Flags. Refer to the preceding table for Loop Functions Bits.
4. To add a new Ramp/Soak step number, click **Insert**.
5. To edit the selected Ramp/Soak step number, click **Edit**.

   The following dialog box appears.


Ramp Soak Step

Edit Ramp/Soak Entry

Mode: Ramp

Status Bit:

Set Point:

Ramp Rate (units/min):

Soak Time (min):

Deadband:

6. In the **Mode** box, click **Ramp**, **Soak**, or **End**.

- A Ramp step changes the loop set point (you can enter the set point in the **Set Point** box) linearly from its current value to a new value at a specified rate of change (you can enter the rate of change in the **Ramp Rate** box). You can program a status bit (C or Y) for each step of the ramp/soak. This bit is set to 1 when the loop is executing this step. It is reset when the loop leaves the step.

- A Soak step holds the set point constant for a specified period of time (you can enter a soak time in the **Soak Time** box). You can guarantee a soak period by entering a deadband value (you can enter a deadband in the **Deadband** box). This form of soaking ensures that the PV is within a specified deadband around the set point for a specified period of time.

- An End step terminates a ramp/soak profile. When the program reaches an end step, the loop remains in automatic mode and holds the set point constant.

SmarTune Automatic Loop Tuning

Overview of SmarTune Automatic Loop Tuning

SmarTune is an automatic PID loop tuning process that is built into the new SIMATIC 555 CPUs with Release 5.0 or greater firmware.

SmarTune temporarily puts a loop into manual mode. It makes a selectable change to a loop's output (Mn) to cause a process variable (PV) movement toward the center of the PV span. Resultant PV changes are sampled. After sampling criteria is met, sampled values are used to calculate theoretical optimum gain (Kc), reset (Ti), and rate (Td). Theoretical optimums are converted to pragmatic optimums by a heuristic and assigned. The loop is switched to its previous mode and its previous set point (SP) is re-assigned.

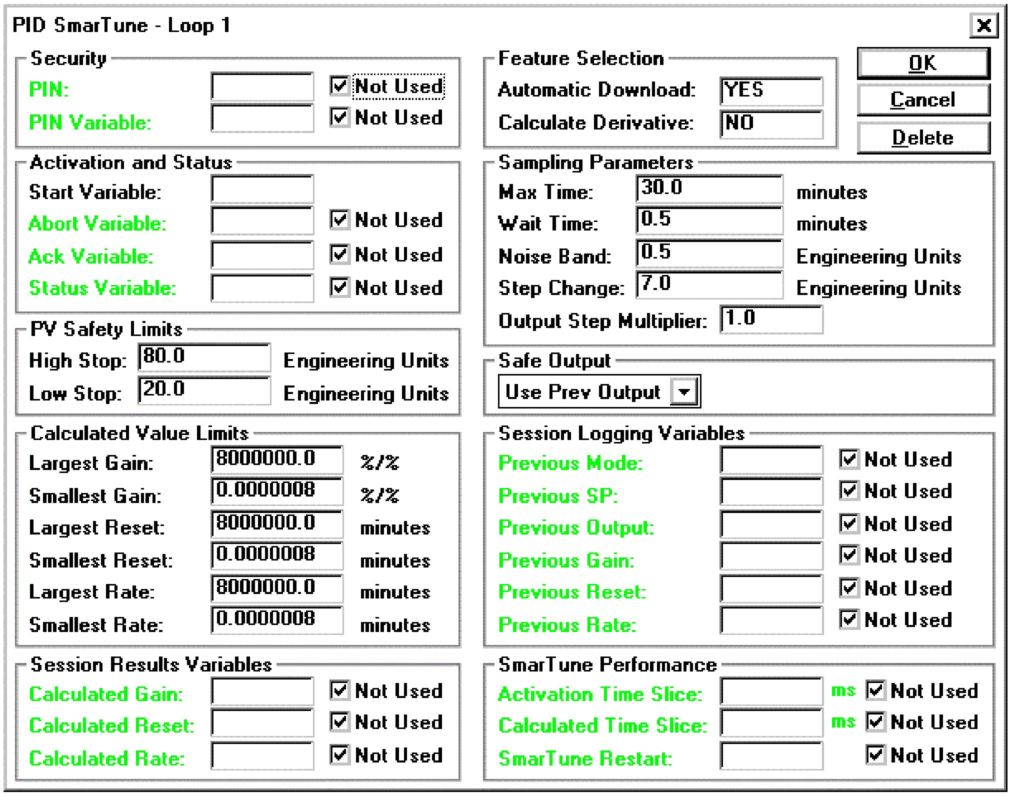
Only one SmarTune session is in progress at a time. Other requests are automatically queued. A SmarTune queue can hold all possible entries. Each entry is processed in the order requested. A session may be aborted at any time, whether in progress or queued.

A SmarTune configuration consists of 33 parameters for each loop, which are either value parameters or variable parameters. These parameters allow you to automate loop tuning as desired. For example, you can choose whether or not to automatically load the new tuning parameters directly into the referenced loop.

NOTE: SmarTune can only be used for position or temperature loops. It is not applicable to velocity loops.

To access the SmarTune Loop Editor:

1. Click **PID Loop** from the **View** menu or press **ALT+V, P**.
2. The PID Loop Directory dialog box appears.
3. The dialog box shows the Loop Mode, Loop number (1-512) depending on the processor type, Loop Title, and Enable/Disable state.
4. Select the loop you want to SmarTune. and then click **SmarTune**. The following dialog box appears.



PID SmarTune - Loop 1

Security
PIN: ☑ Not Used
PIN Variable: ☑ Not Used

Feature Selection
Automatic Download: YES
Calculate Derivative: NO

Activation and Status
Start Variable:
Abort Variable: ☑ Not Used
Ack Variable: ☑ Not Used
Status Variable: ☑ Not Used

Sampling Parameters
Max Time: 30.0 minutes
Wait Time: 0.5 minutes
Noise Band: 0.5 Engineering Units
Step Change: 7.0 Engineering Units
Output Step Multiplier: 1.0

PV Safety Limits
High Stop: 80.0 Engineering Units
Low Stop: 20.0 Engineering Units

Safe Output
Use Prev Output

Calculated Value Limits
Largest Gain: 8000000.0 %/%
Smallest Gain: 0.0000008 %/%
Largest Reset: 8000000.0 minutes
Smallest Reset: 0.0000008 minutes
Largest Rate: 8000000.0 minutes
Smallest Rate: 0.0000008 minutes

Session Logging Variables
Previous Mode: ☑ Not Used
Previous SP: ☑ Not Used
Previous Output: ☑ Not Used
Previous Gain: ☑ Not Used
Previous Reset: ☑ Not Used
Previous Rate: ☑ Not Used

Session Results Variables
Calculated Gain: ☑ Not Used
Calculated Reset: ☑ Not Used
Calculated Rate: ☑ Not Used

SmarTune Performance
Activation Time Slice: ms ☑ Not Used
Calculated Time Slice: ms ☑ Not Used
SmarTune Restart: ☑ Not Used

Now enter each appropriate variable for the autotune process. The following section describes, in general terms, each variable and the PID autotune process for a temperature control loop.

⚠ **Warning**	SmarTune should not be used if a process might experience harmful effects as a result of arbitrary Mn assignment. During a tuning session, Mn values are assigned in such a way as to determine the frequency response of a process. The tuning process may result in process product that does not meet required standards. This product may need to be purged before and/or after a tuning session. Ensure that your process is designed to handle the results of loop tuning.

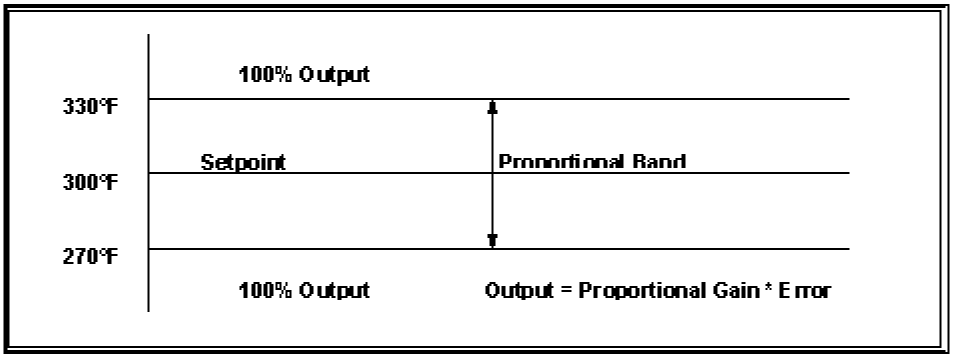
The PID algorithm consists of three components: the Proportional, the Integral (Reset), and the Derivative (Rate). Each component impacts the output to address the varied characteristics of the process variable. The PID expression is:

```
Output = P_Gain * Error + I_Gain *Error (dt) + D_Gain * Error (d /
dt)
where:
Error = Setpoint - Process Variable
P_Gain = Proportional Gain
I_Gain = Integral Gain
D_Gain = Derivative Gain
```

The Proportional Component

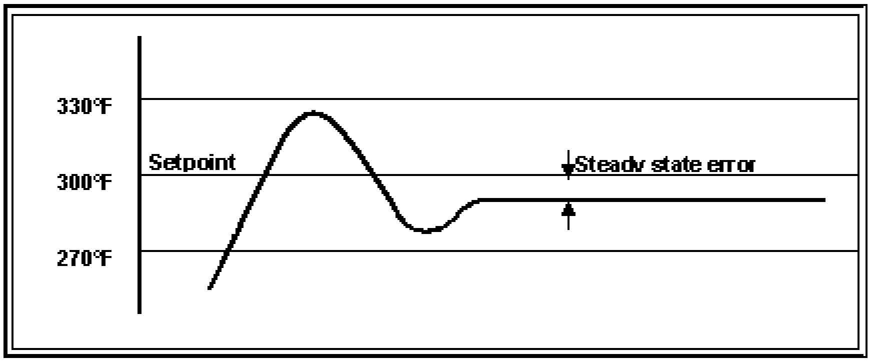
Temperature control with PID has two regions of operation, the proportional band, and the saturated region. The proportional band is the region above and below the setpoint where the controller output is less than 100%. The heat or cooling output is time proportioned as determined by the PID output. The proportional gain value determines the proportional band.

A typical proportional band might be around ±30°F for a given machinery temperature control, as shown below. For example, with a setpoint of 300°F, a proportional band of ±30°F would equate to the region between 270°F and 330°F, where the controller would be in the proportional band. Outside of this region, on either side, is the saturated region where the controller output would be 100%, which equates to 100% heating or cooling.



Proportional Band

A temperature controller using only the proportional component of the PID expression may experience a steady state error, as shown below. This error is induced by thermal loading on a temperature zone. As the thermal loading on a temperature zone increases, the magnitude of the steady state error is increased.



Steady State Error

Thermal loading is induced by energy losses to the surroundings, conduction through the machine, as well as the process. A proportional-only controller can resolve this error only to a limited degree.

The Integral Component

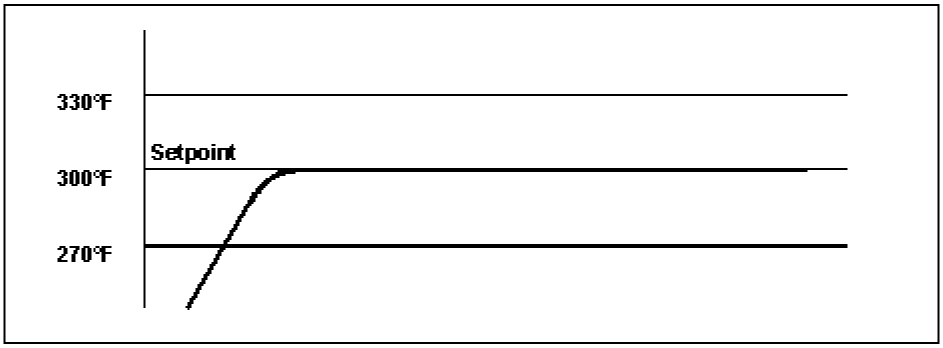
The integral term of the PID expression provides a means to eliminate the error in the proportional band. This term is defined as the Error integrated over time. Thus, in the case of the steady state error, the output would be increased (or decreased depending on the sign of the Error) over time.

The amount of the integral adjustment is determined by the magnitude of the Error, and the Integral gain. Excessive Integral gain would cause an oscillation about the setpoint. Likewise, minimal Integral gain would not reduce the Error in a timely manner and be ineffective.

The Derivative Component

The Derivative term of the PID expression provides a mathematical means for limiting the rate of change of the process variable. As the rate of change becomes larger, the derivative term reduces the output, resulting in the reduction of the rate of change of the process variable. The Derivative gain defines the magnitude of the output reduction as a function of the rate of change of the process variable. Excessive Derivative gain would result in an undesirable output oscillation as the controller continues to eliminate the error.

When the PID gains are set appropriately, the resulting process variable curve would take on the "ideal curve" appearance, as shown below.



Ideal Process Variable Curve

Many factors affect the process variable curve. These factors may take the process beyond where the controller can create the ideal curve. It is the function of the PID SmarTune utility to determine the optimum PID gain values to achieve a response as close to the ideal curve as possible.

Essentially, the SmarTune utility creates a disturbance by initiating a step increase of the PID output. Process variable samples are collected as this increase in output precipitates a change in the process variable. When the sample period is complete, the data collection is analyzed for time lag, gradient, overshoot, steady state error, and oscillation. Using a frequency analysis method, the optimum PID gain values are determined. You can choose to accept the newly calculated gain values, or keep the present PID gain settings.

The SmarTune variable parameters are listed and described in this section. Start Variable is the only variable that must be specified. It names a discrete variable used to activate a SmarTune session. The others may be null.

Variable parameters provide the coupling between a PLC program and SmarTune. If only Start Variable is specified, no program coupling is needed; a session begins when Start Variable becomes true and ends with a loop changing back to its previous mode and SP. Since coupling is done with variables, any program type may be used to monitor and control SmarTune (relay ladder logic, SFPGM, or SFSUB).

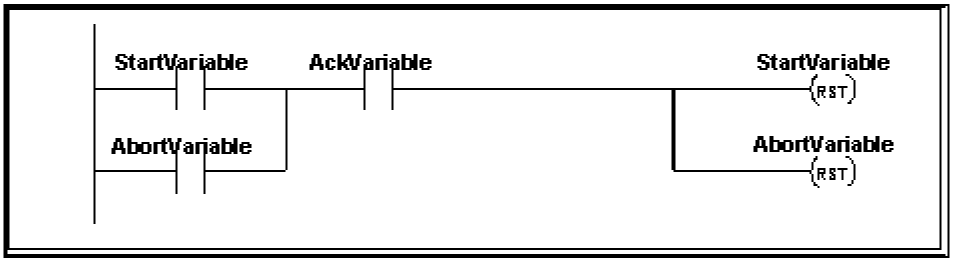
The following table lists the variable parameters used by SmarTune. The following paragraphs describe the parameters.

Name	Type	Allowable Variable Types
Start Variable	discrete	X Y C WX WY V
Abort Variable	discrete	X Y C WX WY V
Ack Variable	discrete	Y C WY V

Name	Type	Allowable Variable Types
SmarTune Restart	discrete	X Y C WX WY V
Status Variable	word	WY V
PIN Variable	word	WX WY V
Previous Mode	Word	V
Previous SP	Real	V
Previous Output	Word	V
Previous Gain	Real	V
Previous Reset	Real	V
Previous Rate	Real	V
Calculated Gain	Real	V
Calculated Reset	Real	V
Calculated Rate	Real	V

Start Variable, Abort Variable, Ack Variable

These three discrete variables allow easy activation/deactivation via an RLL program, as shown below.



Example of Activation/Deactivation of Auto Tuning Process

These variables could just as easily be manipulated with IF, IMATH or MATH statements in an SFPGM or SFSUB. Allowed discrete variables include bits in a V-memory word.

- When Start Variable transitions from a false to a true, a SmarTune session is activated.
- When Abort Variable is true, a SmarTune session is deactivated.

- If both are true, a session is deactivated, and Start Variable must transition before a session will be activated.
- If a SmarTune session is already queued or in progress, Start Variable transitions are ignored.

Ack Variable acknowledges that SmarTune has detected that Start Variable or Abort Variable is true. It is used to synchronize Start Variable and Abort Variable program logic with SmarTune. If not used, Start Variable and Abort Variable should remain true for a relatively large amount of time. What constitutes a large amount of time depends on program size and time slice assignments. See the discussion for Activation Time Slice for further guidance.

SmarTune Restart

If this discrete variable is true, then SmarTune is restarted completely. SmarTune will act as if a run-program-run transition occurred. If SmarTune Restart is specified in more than one configuration, all are tested for true and acted upon.Status Variable

This word variable reports on the current state of a session. Three bits are used in the word to allow easy use by an RLL program. Bit 2 is set when a SmarTune session is completed, with or without errors or warnings. If bit 3 is also set then an error was detected. Similarly, if bit 4 is set, then a warning condition occurred. If only bit 2 is set, then a SmarTune session completed with no errors or warnings. See the following table for a complete listing. Note that entries with X's represent ranges of values.PIN Variable

PIN Variable and PIN are provided to force a two-step procedure to be followed before a loop is tuned. To use this feature, PIN Variable and PIN must both be set. If PIN Variable is a null or PIN is zero, then SmarTune activation is a one-step procedure dependent only on Start Variable. If both are specified, then PIN Variable must equal PIN or a SmarTune session will not be started or queued.Previous Mode

If Previous Mode is used, SmarTune sets it to a value, which will switch a loop to its pre-session mode when written to a loop's LVF. This was conceived for use when Automatic Download has been configured as false, but may be used for other purposes. If Automatic Download is false, a loop is left in manual mode with its output set to Safe Output when a tuning session has completed. When Automatic Download is true, a loop is switched back to its previous mode and is assigned its previous SP on completion.

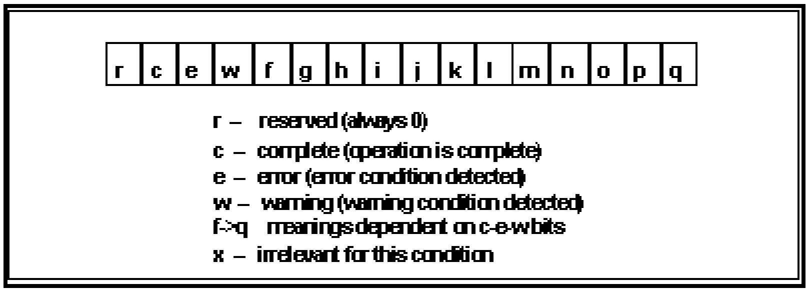
Previous SP, Previous Output, Previous Gain, Previous Reset, Previous Rate

You can use these five parameters to record the prior SP, Mn, Kc, Ti, and Td of a loop before a SmarTune session starts. See Previous Mode for a short discussion on why they would be configured.Calculated Gain, Calculated Reset, Calculated Rate

You can use these three variables to record the tuning values calculated by SmarTune. See Previous Mode for a short discussion on why they would be configured.

The following information lists the loop tuning errors written to the Status Variable word.

STATUS CODE BIT VALUES



r	c	e	w	f	g	h	i	j	k	l	m	n	o	p	q

r – reserved (always 0)
c – complete (operation is complete)
e – error (error condition detected)
w – warning (warning condition detected)
f->q meanings dependent on c-e-w bits
x – irrelevant for this condition

rcew fghi jklm nopq	Description
0000 xxxx xxxx xxxx	SmarTune in progress or not active
0000 0000 0000 0000	Not active
0000 0000 0000 1000	Waiting in SmarTune queue
0000 0000 0001 0000	Waiting for Loop to enter manual mode
0000 0000 0001 1000	Wait 1 (PV value stabilize)
0000 0000 0010 0000	Wait 2 (PV value stabilize)
0000 0000 0010 1000	Wait 3 (PV value stabilize)
0000 0000 0011 0000	Calculating Tuning Parameters
0100 0000 0000 0000	SmarTune complete with no errors or warnings
0101 xxxx xxxx xxxx	SmarTune complete with warning(s)

rcew fghi jklm nopq	Description
0101 xxxx xxxx xx01	Data questionable, tuning may not be reliable
0101 xxxx xxxx xx10	Data questionable, tuning is not reliable
0101 xxxx xxx0 01xx	Sample interval too large for optimal tuning
0101 xxxx xxx0 10xx	Small PV changes; Step too small?
0101 xxxx xxx0 11xx	PV near span low; Range marginal?
0101 xxxx xxx1 00xx	PV near span high; Range marginal?
0101 xxxx xxx1 01xx	Small output change; Step too small?
0101 xxxx xxx1 10xx	Output near span low; Range marginal?
0101 xxxx xxx1 11xx	Output near span high; Range marginal?
0101 xxxx xx1x xxxx	PV changes before output; Noisy signal?
0101 xxxx x1xx xxxx	PV changes inconsistent with output; Noisy signal?
0101 xxxx 1xxx xxxx	Gain clamped to high/low limit
0101 xxx1 xxxx xxxx	Reset clamped to high/low limit
0101 xx1x xxxx xxxx	Rate clamped to high/low limit
0110 xxxx xxxx xxxx	SmarTune complete with error(s)
0110 0000 0000 0000	Unanticipated error

rcew fghi jklm nopq	Description
0110 xxxx xxxx 0001	PIN mismatch
0110 xxxx xxxx 0010	Loop would not go to Manual Mode
0110 xxxx xxxx 0011	Loop not completely under SmarTune control
0110 xxxx xxxx 0100	SmarTune timeout (Maximum time exceeded)
0110 xxxx xxxx 0101	Not enough free memory
0110 xxxx xxxx 0110	Out of required system resources
0110 xxxx xxxx 0111	PV greater than high stop
0110 xxxx xxxx 1000	PV lower than low stop
0110 xxxx xxxx 1001	PV change too small
0110 xxxx xxxx 1010	Operation aborted
0110 xxxx xx01 xxxx	Sample interval (LTS) range error (allowed range: 0.1 ms to 2 hours)
0110 xxxx xx10 xxxx	PV (LPV) or output (LMN) range error (range < 0.00001)
0110 xxxx xx11 xxxx	Sample size too small (probably would never happen) size < 33 (increase STEP or decrease NOISE)
0110 xxx0 01xx xxxx	PV/output inconsistent 1; Noisy PV/output signal?
0110 xxx0 10xx xxxx	PV/output inconsistent 2; Noisy PV/output signal?
0110 xxx0 11xx xxxx	PV/output inconsistent 3; Noisy PV/output signal?

rcew fghi jklm nopq	Description
0110 xxx1 00xx xxxx	PV/output inconsistent 4; Noisy PV/output signal?
0110 xxx1 01xx xxxx	PV/output inconsistent 5; Noisy PV/output signal?

The following information lists the value parameters used by SmarTune, with the default values and the ranges possible for each.

VALUE PARAMETERS

Name	Default Value	Range
Max Time	30.0 minutes	0 – 71582 minutes (maximum is about 49 days)
Noise Band	0.005 of PV range	PV range (engineering units)
Step Change	0.07 of PV range	PV range (engineering units)
Wait Time	0.5 minutes	same as Max Time
PIN	0 (PIN not required)	0 to 32767
Automatic Download	TRUE	TRUE/FALSE
Calculate Derivative	FALSE	TRUE/FALSE
Safe Output	use Previous Output	Previous Output, 0 – 32000
High Stop	0.8 of PV range	PV range (engineering units)
Low Stop	0.2 of PV range	PV range (engineering units)
Largest Gain	8000000.0 %/%	real
Smallest Gain	0.0000008 %/%	real
Largest Reset	8000000.0 minutes	real
Smallest Reset	0.0000008 minutes	real
Largest Rate	8000000.0 minutes	real
Smallest Rate	0.0000008 minutes	real

Name	Default Value	Range
Activation Time Slice	0	0:not configured here, 1 – 255 ms
Calculation Time Slice	0	0:not configured here, 1 – 255 ms

Max Time

Max Time is a time in minutes. When a SmarTune session is started, a timer is set to this value. If that timer expires before the session has completed, the session is aborted with an error.

Noise Band

When electrical signals are converted to values, they vary randomly by insignificant amounts. An insignificant amount is application dependent. Noise Band gives a value in engineering units denoting the boundary between a significant and an insignificant change. If a PV value differs from a prior value by a Noise Band or greater amount, then a PV change has occurred. Otherwise the PV is considered unchanged. An incorrect Noise Band setting could cause some errors and warnings. A correct setting may be calculated from hardware specifications, or determined by experiment and observation, or both.

Step Change

SmarTune works best with a PV change of about 7%. Changing Mn proportional to the ratio between Step Change and PV span accomplish this change. Step Change is specified in engineering units of the PV. If a PV span is 0 – 60 degrees and Step Change is 5 degrees, then Mn would be changed by about 2667 (5/60 * 32000). Due to round-off error, the actual value might be slightly different. This example is based on a Mn span of 0 – 32000. If a 20% offset on output is selected for a loop, a Mn change of about 2133 (Mn span of 25600) would be accomplished. See the preceding table for possible warnings and errors associated with Step Change.

Wait Time

The SmarTune sample algorithm looks for a PV to change by Step Change or to quit changing. Wait Time is required to determine when a PV has quit changing. If a PV value does not change by a Noise Band amount within a Wait Time period, then it has stopped changing.

PIN

PIN and PIN Variable are provided to force a two-step procedure to be followed before a loop is tuned. To use this feature, PIN and PIN Variable must both be set. If PIN is a zero or PIN Variable is a null, then SmarTune activation is a one-step procedure dependent only on Start Variable. If both are specified, PIN Variable must equal PIN or a SmarTune session will not be started or queued.

Automatic Download

If Automatic Download is true, a loop tuning session is accomplished with minimum additional support. After tuning values are calculated, three actions are taken:

- Calculated Kc, Ti, and Td are written to a loop.
- The loop is changed to its prior mode.
- The loop's SP is assigned its prior value.

Calculate Derivative

If Calculate Derivative is false, only Kc and Ti are calculated, and Td is set to zero. If Calculate Derivative is true, Kc, Ti, and Td are calculated.

Safe Output

Safe Output is a Mn value that will not cause any harm to a process. The default is to use the loop Mn value just prior to a tuning session start.

High Stop

If a PV goes above High Stop, Mn is set to Safe Output and an error is declared.

Low Stop

If a PV goes below Low Stop, Mn is set to Safe Output and an error is declared.

Largest Gain, Largest Reset, Largest Rate

If a calculated value is larger than a configured value, then it is reduced to a configured value and a warning is declared.

Smallest Gain, Smallest Reset, Smallest Rate

If a calculated value is smaller than a configured value, then it is increased to a configured value and a warning is declared.

Activation Time Slice, Calculation Time Slice

These two values set how much impact SmarTune will have on PLC scan time. If zero in all configurations, a default will be used (2 milliseconds). Otherwise, in each category, the largest value specified will be used.

Activation Time Slice controls how responsive SmarTune is to tuning session requests. Increase this value if SmarTune is taking an excessive amount of time to start a tuning session. Remember that as this value is increased, PLC scan time will increase.

Calculation Time Slice determines how much real time it will take to calculate tuning parameters. It is possible a calculation might take 20 seconds or more of PLC time. If a PLC has a scan time of 10 milliseconds and Calculation Time Slice is 2 milliseconds, then a 20-second calculation would take about 120 seconds in real time: (10ms + 2ms) / 2ms * 20s = 120s. The above formula is an algebraic simplification of: Xs / (2ms / 12ms) = 20s where X is real time in seconds. This value should be increased if a SmarTune session takes an excessive amount of time with a status of calculating (see Status Variable). Remember that as this value is increased, PLC scan time will increase while a SmarTune session is calculating.

PID Loop Data Element Types

Mnemonic	Data Element Type	Data Type
LKC.	Gain	Real
LTI.	Reset Time (Minutes)	Real
LTD.	Rate Time (Minutes)	Real
LHA.	High Alarm Limit	Real
LLA.	Low Alarm Limit	Real
LPV.	Process Variable	Real
LPVH.	PV High Limit	Real
LPVL.	PV Low Limit	Real
LODA.	Orange Deviation Alarm Limit	Real
LYDA.	Yellow Deviation Alarm Limit	Real
LTS.	Sample Rate (Seconds)	Real
LSP.	Setpoint	Real
LMN.	Output (Percent)	Real
LVF	V-Flags	16-bits Integer
LCF	C-Flags	32-bits Integer
LRSF	RAMP/SOAK Status Flags	16-bits Integer
LERR.	Error	Real
LMX.	Bias	Real
LHHA.	High-High Alarm Limit	Real
LLLA.	Low-Low Alarm Limit	Real
LRCA.	Rate-of-Change Alarm Limit in Engineering Units / Minute	Real
LSPH.	Setpoint High Limit	Real
LSPL.	Setpoint Low Limit	Real

Mnemonic	Data Element Type	Data Type
LADB.	Alarm Deadband	Real
LHA	Raw High Alarm Limit	Integer
LLA	Raw Low Alarm Limit	Integer
LPV	Raw Process Variable	Integer
LODA	Raw Orange Deviation Alarm Limit	Integer
LYDA	Raw Yellow Deviation Alarm Limit	Integer
LMN	Raw Output	Integer
LSP	Raw Setpoint	Integer
LERR	Raw Error	Integer
LHHA	Raw High-High Alarm Limit	Integer
LLLA	Raw Low-Low Alarm Limit	Integer
LADB	Raw Alarm Deadband	Integer
LMX	Raw Bias	Integer
LSPL	Raw Setpoint Low Limit	Integer
LSPH	Raw Setpoint High Limit	Integer

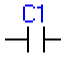
NOTE: Addresses that use a "." notation are real types.

Chapter 10 – RLL Instructions

Relay Instructions

Normal Contact (STR)

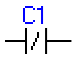
When the referenced address of a Normal Contact is ON, the contact is closed and passes power. When the referenced address is OFF, the Normal contact is open and does not pass power.



	Parameter Type	Valid Parameter Types
STR	Bit Address	X,Y,C,V,K,WX,WY,STW,B,W, TCP,TCC,DCC,DSP,DSC,DCP

Normally Closed Contact

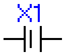
When the referenced address of a Normally Closed contact is ON, the Normally Closed contact is open and does not pass power. When the referenced address is OFF, the Normally Closed contact is closed and passes power.



	Parameter Type	Valid Parameter Types
STRN	Bit Address	X,Y,C,V,K,WX,WY,STW,B,W, TCP,TCC,DCC,DSP,DSC,DCP

Normally Open Immediate Contact

When the discrete point of an I/O module of a Normal Open Immediate Contact is ON, the contact is closed and passes power. When the referenced address is OFF, the Normally Open Immediate contact is open and does not pass power.

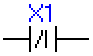


NOTE: Only the power flow for an immediate X contact is updated. The value in the image register table is not updated.

	Parameter Type	Valid Parameter Types
LDI	Bit Address	X

Normally Closed Immediate Contact

When the discrete point of an I/O module of a Normally Closed Immediate contact is ON, the contact is open and does not pass power. When the referenced address is OFF, the Normally Closed Immediate contact is closed and passes power.

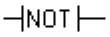


NOTE: Only the power flow for an immediate X contact is updated. The value in the image register table is not updated.

	Parameter Type	Valid Parameter Types
LDNI	Bit Address	X

Logical Not Contact (NOT)

The NOT instruction inverts the power flow to the state opposite its current state. The NOT instruction does not have any parameters

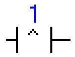


⚠ **Warning**	Do not program a NOT in parallel with any network that does not connect to the power rail.

One Shot Contact (OS)

The One Shot instruction turns on an output for a single scan. The single parameter in the instruction contains the instruction reference number.

When the input transitions from OFF to ON, the output is turned on for exactly one scan. After the One Shot is executed, its input must be off for at least one scan before the instruction can be executed again. If the input is OFF, the instruction is not executed and there is no power flow at the output.



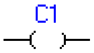
NOTE: Do not assign the same reference number more than once for the One Shot instruction. You can use the same reference number in a One Shot in another instruction in the One Shot group because they use different bits of one byte to store the previous state.

	Parameter Type	Valid Parameter Types
OS	Constant	A valid reference number, 1-1025 Varies with OS configured range

Coil

The Coil is an output instruction used to represent a field device or internal memory location that needs to be controlled. Use a normal coil when your application requires the referenced address to equal ON (1) when the coil has power flow.

When the network logic passed power to the coil, the coil turns on and the address equals 1. When the network does not pass power to the coil, the coil remains OFF (0) and the address equals 0.

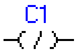


	Parameter Type	Valid Parameter Types
Coil	Bit Address	Form C

Coil Not

The NOT coil is used similarly like the normal coil, but if the referenced address equals OFF (0), the coil has power flow.

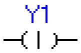
When the network logic does not pass power to the NOT coil, the coil remains energized and the reference address equals ON (1). When the network logic passes power flow to the NOT coil, the coil is de-energized and the referenced address equals OFF (0).



	Parameter Type	Valid Parameter Types
Coil Not	Bit Address	Form C

Immediate Coil

The Immediate coil is used similarly like the normal coil, but the immediate I/O module update is done when the coil is executed. The immediate coil is updated any time during the controller scan and is not limited to the normal I/O update portion of the timeline.

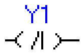


> **NOTE:** Both the image register and the I/O module are updated when the immediate coil is executed.

	Parameter Type	Valid Parameter Types
Immediate Coil	Bit address	Y

Immediate Closed Coil

The Immediate coil is used similarly like the NOT coil, but the immediate I/O module update is done when the coil is executed. The immediate coil is updated any time during the controller scan and is not limited to the normal I/O update portion of the timeline.

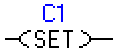


> **NOTE:** Both the image register and the I/O module are updated when the immediate coil is executed.

	Parameter Type	Valid Parameter Types
Immediate Closed Coil	Bit address	Y

Set Coil (SET)

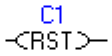
The SET Coil is used to set a specified bit to ON (1) when the network passes power flow. If the network does not have power, the bit remains unchanged.



	Parameter Type	Valid Parameter Types
SET	Bit Address	Form C

Reset Coil (RST)

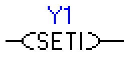
The RST Coil is used to set a specified bit to OFF (0) when the network passes power flow. If the network does not have power, the bit remains unchanged.



	Parameter Type	Valid Parameter Types
RST	Bit Address	Form C

Set Immediate Coil (SETI)

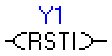
The SETI Immediate Coil is used to set a specified bit to ON (1) when the network passes power flow, and the bit is updated immediately. If the network does not have power, the bit remains unchanged.



	Parameter Type	Valid Parameter Types
SETI	Bit Address	Y

Reset Immediate Coil (RSTI)

The RSTI Immediate Coil is used to set a specified bit to OFF (0) when the network passes power flow, and the bit is updated immediately. If the network does not have power, the bit remains unchanged.



	Parameter Type	Valid Parameter Types
RSTI	Bit Address	Y

Timers, Counters and Drums

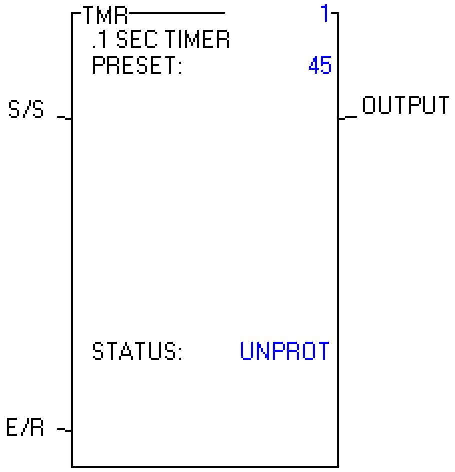
.1 s Timer (TMR)

The Timer instruction (TMR) is used to time events. The timer output is turned on after the timer has timed down, making this an 'on delay' timer. A slow timer is denoted by TMR, a fast timer by TMRF.

The timer times down from the preset value specified by Preset. The Preset value is stored in the TCP memory. The timers current time is stored in the TCC memory area. Timers have the following properties:

- The Enable/Reset must be on for the timer to operate.
- When the Start/Stop input is on and the Enable/Reset is on, the timer begins to time down.
- Timing begins at the preset value Preset and continues down to zero.
- If the Start/Stop input turns off and the Enable/Reset input remains on, the timer stops but it saves the current value, TCC. If the Start Stop input turns on again, the timer resumes timing. TCC is also saved if the Enable/Reset input is on and a loss of power occurs, provided the controller battery backup is enabled.
- If the Enable/Reset input is turned off, the timer is reset to the preset time specified in Preset.
- The output is turned on when the timer reached zero, and it stays on until the timer is reset (the Enable/Reset input is turned off).

Timer On-Delay



Parameter	Type	Valid Values
Timer number:	Constant Only	Varies with configured T/C ranges
Preset:	Constant Only	0000.0 – 3276.7

⚠ **Warning**	Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions. Using the same reference number can cause unpredictable operations.

.001 s Timer (TMRF)

The Timer instruction (TMR) is used to time events. The timer output is turned on after the timer has timed down, making this an 'on delay' timer. A slow timer is denoted by TMR, a fast timer by TMRF.

The timer times down from the preset value specified by Preset. The Preset value is stored in the TCP memory. The timers current time is stored in the TCC memory area. Timers have the following properties:

- The Enable/Reset must be on for the timer to operate.
- When the Start/Stop input is on and the Enable/Reset is on, the timer begins to time down.
- Timing begins at the preset value Preset and continues down to zero.
- If the Start/Stop input turns off and the Enable/Reset input remains on, the timer stops but it saves the current value, TCC. If the Start Stop input turns on again, the timer resumes timing. TCC is also saved if the Enable/Reset input is on and a loss of power occurs, provided the controller battery backup is enabled.
- If the Enable/Reset input is turned off, the timer is reset to the preset time specified in Preset.
- The output is turned on when the timer reached zero, and it stays on until the timer is reset (the Enable/Reset input is turned off).

Retentive Timer On-Delay

Parameter	Type	Valid Values
Timer number:	Constant Only	Varies with configured T/C ranges
Preset:	Constant Only	0000.0 – 32.767

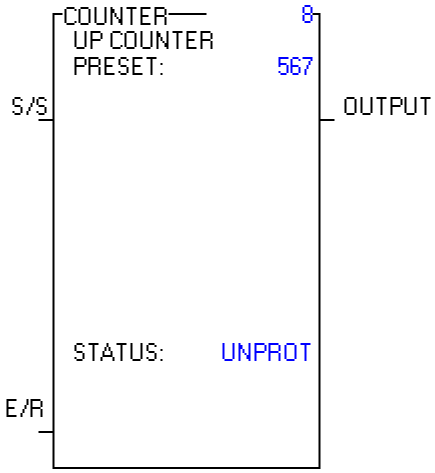
⚠ **Warning**	Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions. Using the same reference number can cause unpredictable operations.

Counter (CTR)

The Counter instruction (CTR), an up counter, counts recurring events. The counter output is turned on after the counter has counted up to a preset value.

The counter counts up to the preset value specified in Preset, which is stored in the TCP-memory. The current count is stored in TCC memory. The counter has these properties:

- The Enable/Reset must be on for the counter to operate.
- When the Enable/Reset is ON, the counter is incremented by one each time the Counter input transitions from off to on.
- Counting begins at zero (0) and continues to the preset value specified by Preset.
- If the Enable/Reset is turned off, the count is reset to zero.
- TCC is saved if the Enable/Reset input is on and loss of power occurs, provided the controller battery backup is enabled.
- The output is turned on when the current count equals the preset count specified by Preset.
- If the Enable/Reset does not receive poser flow, the instruction is not executed and the output does not turn on.



Parameter	Type	Valid Values
Counter Number:	Constant	Depends on configured quantities. (Max. 128)
Preset:	Constant	Counts to this value (0–32767)

⚠ Warning	Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions. Using the same reference number can cause unpredictable operations.

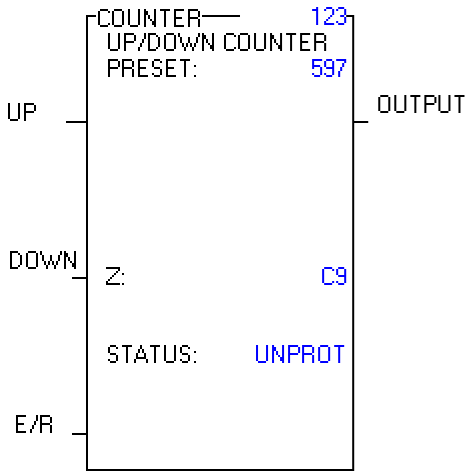
Up/Down Counter (UDC)

The Up/Down Counter (UDC) instruction counts the number of events (up or down) from 0 32767.

When the counter counts up, it counts to the preset value specified in Preset, which is stored in TCP memory. The current count is stored in TCC memory. The UDC instruction has the following properties:

- The Enable/Reset must be on for the counter to operate.
- When the Enable/Reset is on, the counter is incremented by one when the Up input transitions from off to on.
- When the Enable/Reset is on, the counter is decremented by one when the Down input transitions from off to on. The UDC cannot be decremented to a number less than zero.
- TCC does not change if the Up and Down inputs both change from off to on during the same scan.
- If the Enable/Reset turns off, TCC is reset to zero.
- The output specified in Z is turned on whenever TCC equals zero. This output is turned off when TCC does not equal zero.
- The box output is turned on whenever TCC equals zero or TCP.
- After having counted to the preset value (TCP), the box does not require resetting in order to resume counting in the opposite direction. TCC does not ever exceed TCP.

NOTE: If you use an operator interface to change the TCP values, the new TCP values are not changed in the original RLL program until the entire program is downloaded to the PLC.



Parameter	Type	Valid Values
Counter Number:	Constant Only	Varies with T/C configured range
Preset:	Constant Only	0-32767
Z	Bit Addr	Y,C,B

⚠ **Warning**	Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions. Using the same reference number can cause unpredictable operations.

Discrete Control Alarm Timer (DCAT)

The Discrete Control Alarm Timer (DCAT) instruction is used with a single input, double feedback device. The input to the DCAT instruction should be derived from the preceding logic that determines the state of the device. The output of the instruction should control the device.

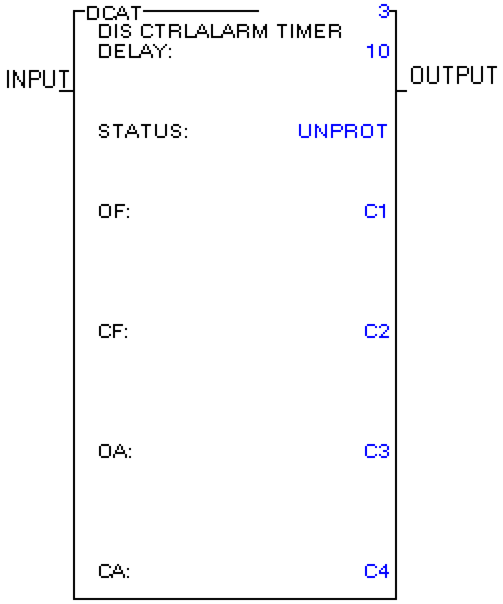
The DCAT timer times down from the preset value (Delay) which is stored in TCP memory. The timer's current time is stored in TCC memory.

When the Open (OA)/Close (CA) input to the DCAT goes from OFF to ON, the following operations occur:

- The time delay is set to the preset value defined by Delay, both outputs OA and CA are turned off and the DCAT output turns on.
- While the Open/Close input to the DCAT remains ON, the timer begins timing until the OF input turns ON or the timer times out.
- If the OF input turns on before the timer times out, the time delay is set to zero and the OA remains off.
- If OF does not turn on before the timer times down, OA is turned on.
- IF OF turns on before the timer times down, but then goes off again while the Open/Close input is ON, OA is turned on. The OA is turned off if OF then turns on again.

When the Open (OA)/Close (CA) input to the DCAT goes from ON to OFF, the following operations occur:

- The DCAT output turns off, the time delay is set to the preset value defined by Delay, and both alarm outputs OA and CA are turned off.
- While the Open/Close input to the DCAT remains off, the timer begins timing until the CF input turns on or the timer times out.
- IF the CF input turns on before the timer times down, the time delay is set to zero and the CA remains off.
- If CF does not turn on before the timer times down, CA is turned on.
- IF CF turns on before the timer times down, but then goes off again while the DCAT input is off, CA is turned on. The CA is turned off if CF turns ON again.



INPUT

DCAT 3

DIS CTRLALARM TIMER

DELAY: 10

STATUS: UNPROT

OF: C1

CF: C2

OA: C3

CA: C4

OUTPUT

> **NOTE:** If both OF and CF are simultaneously ON, the OA and CA turn on.

Parameter	Type	Valid Values
Alarm Number:	Constant Only	Varies with T/C configured range
Delay:	Constant Only	0000.1 – 3276.7
OF:	Bit Addr	X, Y, C, B
CF:	Bit Addr	X, Y, C, B
OA:	Bit Address	Y, C, B
CA:	Bit Address	Y, C, B

⚠ **Warning**	Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions. Using the same reference number can cause unpredictable operations.

Use the following table for state changes.

Input Condition	**IF**			**THEN**		
1 = Open **0 = Close** **X = Don't care**	**Feedback**	**AND**	**Timer Action**	**Alarm Status**		**Output**
	OF	**CF**		**OA**	**CA**	
1	0	1	timing	0	0	1
1	0	0	timing	0	0	1
1	1	0	reset	0	0	1
1	0	0	timed out	1	0	1
0	1	0	timing	0	0	0
0	0	0	timing	0	0	0
0	0	1	reset	0	0	0
0	0	0	timed out	0	1	0
X	1	1	X	1	1	follows input

⚠ **Warning**	Unexpected alarm conditions may occur when the DCAT exists within the zone of control of a JMP or MCR. The DCAT output and alarms are under the control of the JMP or MCR.

Motor Control Alarm Timer (MCAT)

The Motor Control Alarm Timer (MCAT) instruction is designed for use with a double input, double feedback device. The MCAT operates similarly to the DCAT instruction, but the MCAT provides the ability to operate motor-driven devices that drive in opposite direction. You can use the MCAT to replace several networks of logic that are required to time the field device's operation and generate alarms in case of failure.

The MCAT timer times down from the preset value specified in Timer, which is stored in TCP memory. The time current time is stored in TCC memory.

When the Open input transitions from off to on, and the close and Stop inputs are both off, the OO turns on and the timer starts. Once triggered, OO remains on independent of the open input until one of the following event occur:

- The timer times to 0. The OA is turned on and the OO is turned off.
- The OF turns on while the CF remains off. The OO is turned off and the timer resets to 0. If OF turns on and then turns off, the OA comes on immediately (no time delay) the next timer the box is executed.
- The Stop input turns on. The OO, CO, OA, and CA are turned off, and the timer stays where is was when STOP was received. If the Stop inputs turns off while the Open was when Stop was received. If the Stop input turns off while the Open input is on, then the timer starts at the preset value again - not at the value when the Stop input turned on.
- The Close input turns on after the Open turns off. The CO is turned on and the timer starts counting at the preset. The OO is turned off.

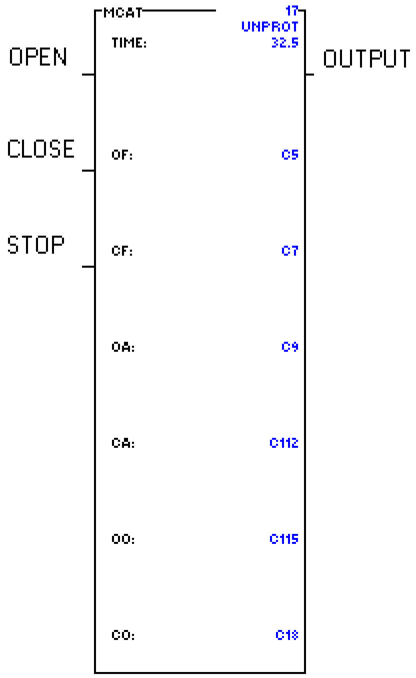
When the Close input transitions from off to on, while the Open command and Stop command inputs are both off, the CO turns on and the timer starts. CO should turn on the motor that closes the valve. Once triggered, the CO remains on independent of the Close input until one of the following events occurs:

- The timer times to 0. The CA is turned on and the CO is turned off.
- The CF turns on while the OF remains off. The CO is turned off and the timer is reset. If \CF turns on and then turns off, the CA comes on immediately the next timer the box is executed.
- The Stop input turns on. The OO, CO, OA, and CA are turned off.
- The Open input turns on after the Close input turns off. The OO is turned on. The CO is turned off.

The condition in which both the Close and Open inputs are on simultaneously is treated as a Stop. The input remaining on when the other turns off is seen as a transition from off to on, and the MCAT enters the appropriate state.

When the Stop input overlaps an Open or Close input, the Stop overrides as long as it is on. When the Stop turns off, the remaining input is seen as a transition from off to on and drives the MCAT to the corresponding state.

The condition in which both Feedback signals are on simultaneously is an error condition. Both open and Close are turned on and both Open and Closed Outputs are turned off. Removing the conflicting feedback signals does not clear the Open and Close Alarms. One of the MCAT inputs (Open, Close or Step) must change state in order to clear the error state.



Parameter	Type	Valid Values
Alarm Number:	Constant Only	Varies with T/C configured ranges
Time:	Constant Only	time, 0000.1 – 3276.7
OF:	Bit Address	open feedback, X, Y, C, B
CF:	Bit Address	closed feedback, X, Y, C, B
AO:	Bit Address	close output, Y, C, B
CA:	Bit Address	close output, Y, C, B
OO:	Bit Address	close output, Y, C, B
CO:	Bit Address	close output, Y, C, B

⚠ **Warning**	Do not use the same reference number more than once for timer, counter, up/down counter, and discrete/motor control alarm timer instructions. Using the same reference number can cause unpredictable operations.

Time Driven Drum (DRUM)

The Drum Instruction (DRUM) simulates an electromechanical stepper switch or drum. It provides 15 output coils and 26 steps which are operated on multiples of the time base setup for the drum. Each step controls all 15 output coils.

When the drum begins to run, it starts at the step specified by the Drum Step Preset, which is stored in DSP memory. The drum current step is stored DSC memory. The counts per step, set in the Count/Step field, is stored in L-memory and cannot be changed without reprogramming the DRUM. The current count (counts remaining for a step) is stored in DCC memory. The drum has these features:

- The drum is enabled when the Enable/Reset input is ON.
- When the Enable/Reset is on and the Start input turns on, the drum begins to run. The drum begins at the step specified by DSP and remains at this step until DCC counts down to zero.
- When DCC for a step reaches zero, the drum advances to the next step, and the coils are turned on/off according to the drum mask for the new step. Each 1 in the mask designates that a coil is to be turned on, while each 0 designates that a coil is to be turned off.
- When the Enable/Reset turns off, the drum output is turned off and the drum returns to the step specified in the DSP.
- If the Start input is turned off but the Enable/Reset remains on, the drum remains at the current step and DCC holds its current count. All coils maintain the condition specified by the drum mask for this step.
- When the drum is at the Preset step, the output coils follow the states specified by the drum mask for that step, even if the Enable/Reset input is off. Take care to program the mask with a bit pattern that is a safe state for the Preset step.

Parameter	Type	Valid Values
Drum Number:	Constant	Varies with drum memory
Preset:	Constant	1-16
Sec:	Constant	0.0 – 32.767

⚠ **Warning**	Do not use the same reference number more than once for any of the drum types. It can cause unpredictable machine operation.

Time/Event Driven Drum (EDRM)

The Time/Event Driven Drum (EDRUM) instruction simulates an electromechanical stepper switch or drum. The EDRUM can be indexed by a timer only, an event contact only or a time and event. A job input enables you to allow either timer or an event to advance the drum a step. The EDRUM provides 15 coils and 16 steps which are operated on multiples of the drum time base. Each step controls all 15 output coils.

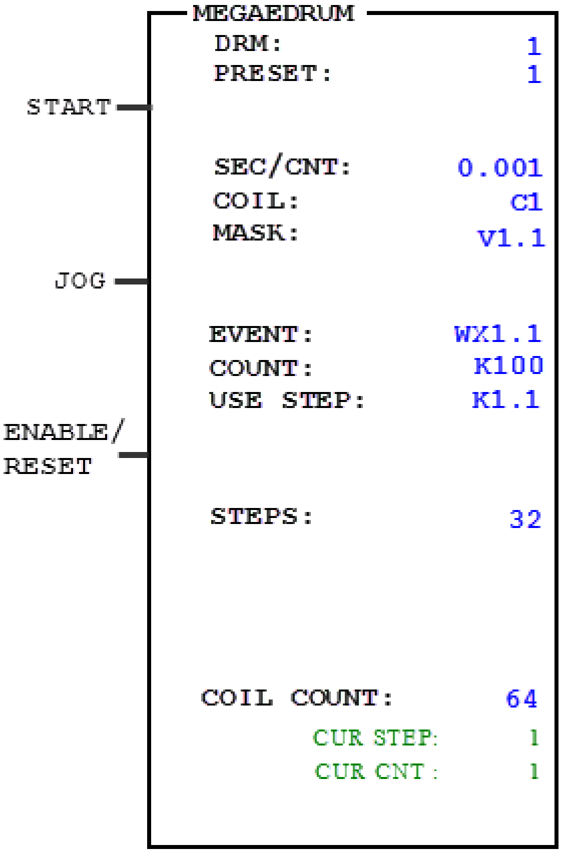
When the drum begins to run, it starts at the step specified by the Drum Step Preset, which is stored in DSP memory. The drum current step is stored in DSC memory. The counts per step, set in the Count/Step field, is stored in DCP memory. The drum current count is stored in DCC memory.

- The drum is enabled when the Enable/Reset input is on.
- When the Enable/Reset is on and the Start input turns on, the drum begins to run. The drum begins at the step specified by DSP and advances to the next step depending upon operation of the timer and/or event.
- When the drum advances a step, coils are turned on or off according to the mask for the new step. Each **1** in the mask designates that a coil is to be turned on, while each **0** designates that a coil is to be turned off.
- The drum output turns on, and remains on, after the last programmed step has been executed. The last programmed step is the last step having an event programmed or having a non-zero Count/Step preset value. The event must be on and the DCC must be zero. If the event turns off after DCC reaches zero, the drum output remains on and the EDRUM remains at the last programmed step until the drum is reset.
- When the Enable/Reset turns off, the drum output is turned off and the drum returns to the step specified in DSP.
- If the Start input turns off and Enable/Reset remains on, the drum remains at the current step (DSC) and DCC holds its current count. All coils maintain the condition specified by the drum mask.
- When the drum is at the preset step, the output coils follow the states specified by the drum mask for that step, even if the Enable/Reset input is off. Take care to program the mask with a bit pattern that is a safe step for the Preset step.
- The drum advances to the next step immediately if the Jog input transitions from off to on and the Enable/Reset input is also on.

Parameter	Type	Valid Values
#	Varies with configured memory	Instruction reference number. Refer to controller user manual for number supported. The assigned instruction number must conform to the requirements of drum memory.
PRESET	1-16	Step to which the drum returns when reset.
SEC/CNT	0-32.767	Time base. Amount of time in seconds for one count.
EVENT	X, Y, C, B	Discrete point that starts countdown of a step and that advances the drum to the next step when count equals zero.
Coils	Y, C, B, or blank	Coils controlled by drum. C0 represents no coil.
STP	1-16	Step number.
CNT	0-32767	Specifies time that drum remains at step. Actual time/step equals CNT × SEC/CNT in seconds.
Mask	0-1	Mask controls coils turned on (1) or off (0).

⚠ **Warning**	Do not use the same reference number more than once for any of the drum types. It can cause unpredictable machine operation.

MegaEDRUM (MEDRM)



The Mega Time/Event Driven Drum (MegaEDRUM) instruction is only compatible with the CTI 2500 family of processors. It requires a CPU firmware of V6.18 or later. It is similar to the EDRUM instruction, but the MegaEDRUM supports more steps and coils. The MegaEDRUM supports up to 128 coils (horizontally) and 128 steps vertically.The EDRUM instruction is limited to 15 coils (horizontally) and 16 steps (vertically).

While the EDRUM instruction is displayed in the ladder as a large box instruction, with a 15 x 16 matrix of coils and steps, space limitations of ladder logic networks prevent depicting the MegaEDRUM instruction as a 128 x 128 matrix. Therefore, the MegaEDRUM box instruction displays only the first address of several ranges of consecutive addresses.

Parameter	Valid Values	Function
DRM #	Varies with configured memory	Instruction reference number. Refer to the controller's user manual for the number supported. The assigned instruction number must conform to the requirements of drum memory. This number provides access to the **DCC** (Drum Count Current), **DSC** (Drum Step Current), and **DSP** (Drum Step Preset)variables.
PRESET	1-128	Step to which the drum returns when reset.
SEC/CNT	0-32.767	Time base. Amount of time in seconds for one count. For example, if SEC/CNT = 1.5, and the COUNT for a step =4, the MegaEDRUM dwells on that step for 6 seconds (1.5 x 4 =6).
COIL	**Y**, **WYx.x**, **C**, and **Vx.x** bit address types, entered in the form of a discrete address or a bit-of-word	The first of several consecutive addresses that are used as output coils. The total number of required consecutive addresses is specified by the COIL COUNT parameter. For example, if COIL COUNT = 64, then 64 consecutive bits are required. The 64 required bits can be held in 64 consecutive **C** or **Y** bit addresses, or 4 consecutive **V** or **WY** word addresses.

Parameter	Valid Values	Function
MASK	**Kx.x**, **Vx.x**, and **C** bit address types, entered in the form of a discrete address or a bit-of-word	The first of several consecutive addresses, containing zeros and ones, that indicate if the corresponding coils are turned OFF or ON in the step. The total number of required consecutive addresses is specified by the STEPS and COIL COUNT parameters. For example, if **STEPS** = **32** and **COIL COUNT** = **64**, the bits required for the **MASK** = **2048** (32 x 64 = 2048). The 2048 required bits can be held in 2048 consecutive **C** bit addresses, or in 128 consecutive **V** or **K** word addresses. If you specify a **MASK** value of **V1.1**, a **STEPS** value of **32**, and a **COIL COUNT** value of **64**, the Mask Addresses are assigned in this way: • In step 1, the Mask Address representing **Output Coil C1** is **V1.1**; the Mask Address representing **Output Coil C64** is **V4.16**. • In step 2, the Mask Address representing **Output Coil C1** is **V5.1**; the Mask Address representing **Output Coil C64** is **V8.16**. **Note:** Unlike the EDRUM instruction (in which the MASK is hard-coded into the instruction), the values of the MegaEDRUM MASK can be changed programmatically in real time because they are held in addresses.

Parameter	Valid Values	Function
EVENT	**X**, **Y**, **C**, **Vx.x**, **WXx.x**, and **WYx.x** bit address types, entered in the form of a discrete address or a bit-of-word	The first of several consecutive addresses, containing zeros and ones, that are used as EVENT flags. A value of **1** starts the countdown of the step and advances to the next step when the countdown reaches zero. A value of **0** will cause the drum to remain on the step. The total number of required consecutive addresses is specified by the STEPS parameter. For example, if STEPS = 32, then 32 consecutive bits are required. The 32 required bits can be held in 32 consecutive **C**, **X**, or **Y** bit addresses, or 2 consecutive **V**, **WX**, or **WY** word addresses.

Parameter	Valid Values	Function
COUNT	0-32767 (specified using **K**, and **V** word address types.	Similar to the EDRUM CNT parameter, COUNT specifies how long a drum remains on a step. Unlike the EDRUM instruction, the Counts per Step (DCP) is represented by the address (and implied addresses) specified in the COUNT parameter. `Actual time/step = COUNT × SEC/CNT (in seconds)` COUNT is a constant from 0–32767 and is held in consecutive addresses. The total number of consecutive addresses is specified by the STEPS parameter. For example, if STEPS = 32, then 32 consecutive **K** or **V** word addresses are required. **Note:** Unlike the EDRUM instruction, if the current step (DSC) is changed during execution, the DCC value is reset to the preset COUNT of the new step.

Parameter	Valid Values	Function
USE STEP	**Kx.x**, **Vx.x**, and **C** bit address types, entered in the form of a discrete address or bit-of-word	The first of several consecutive addresses, containing zeros and ones, that indicate if the drum skips the step or executes it. The drum skips the step when the value is **0** and executes the step when the value is **1**. The total number of required consecutive addresses is specified by the STEPS parameter. For example, if STEPS = 32, then 32 consecutive bits are required. The 32 required bits can be held in 32 consecutive **C** bit addresses, or 2 consecutive **K** or **V** word addresses. **Note:** The USE STEP parameter represents functionality that is not found in the EDRUM instruction. It is important to know how the USE STEP parameter is used in conjunction with the EVENT parameter. Please see the following **EVENT/USE STEP Relationship Table** for more information.
STEPS	16 – 128 (in multiples of 16)	Number of steps in drum
COIL COUNT	16 – 128 (in multiples of 16)	Number of output coils in drum
CUR STEP	16 – 128	When Ladder Status is enabled, indicates which step the drum is currently executing.
CUR CNT	16 – 128	When Ladder Status is enabled, indicates the count of the step the drum is currently executing.

EVENT/USE STEP Relationship Table

When the EVENT is ...	And the USE STEP is ...	The Result is ...
0	0	The step is skipped.
0	1	The step is not executed; the drum remains on the step.
1	0	The step is skipped.
1	1	The step is executed and the drum proceeds to the next step.

Notes:

- The MegaEDRUM uses the same **Start**, **Jog**, and **Enable/Reset** inputs as the EDRUM instruction.

- Like the EDRUM instruction, the MegaEDRUM enables its output when the last programmed step has executed.

- Although WorkShop does store C registers in the offline program, WorkShop does not load C registers when loading a program online. For this reason, if C registers are used for any drum parameters, these values must be initialized using one of the following methods:
  - Write ladder logic to programatically initialize the discrete data tables.
  - Configure an HMI to load the instruction initialization into the controller, once a program has been loaded.
  - Manually configure the data once a program has been loaded (using the Data Window or a pinning chart, for example). An example pinning chart is provided. See **Use a Pinning Chart to Enter Data for MEDRM** on page *449* for additional information.

⚠ **Warning**	Do not use the same reference number more than once for any of the drum types. It can cause unpredictable machine operation.

Use a Pinning Chart to Enter Data for MEDRM

Introduction to the Pinning Chart

A pinning chart can be used to aid in the data entry that is required for the Mega Time/Event Driven Drum (MegaEDRUM – see **MegaEDRUM (MEDRM)** on page *442* for more information). A sample pinning chart, named *MegaEDRUM.xls*, can be found in the 505 WorkShop folder. (In a typical 505 WorkShop installation, this location is `C:\Program Files\FasTrak SoftWorks, Inc\505 WorkShop).`

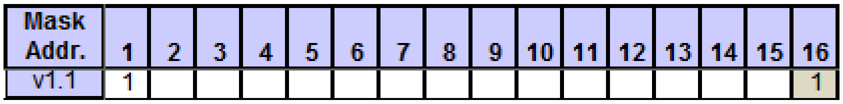
The *MegaEDRUM.xls* pinning chart can also be accessed from the **Start** menu. It is a read-only file. In order to make changes to the file, it must be saved with a different name.

Unlike the EDRUM instruction, where the values of EDRUM parameters are entered directly in the instruction, the values for MegaEDRUM parameters are stored in addresses. For most MegaEDRUM parameters, the MegaEDRUM instruction only specifies the first address, from a range of consecutive addresses, where the values are stored. Consider the following example:

- If an EDRUM instruction consisted of 16 output coils, and you wanted to specify "1000000000000001" as an output mask, you would type "1000000000000001" in the output Mask area of the EDRUM instruction.

- If a MegaEDRUM instruction consisted of 16 output coils, and you wanted to specify "1000000000000001" as an output mask, you would need to specify a starting **C**, **V**, or **K** bit address. You would then need to make sure these addresses contained the correct values. For example, if you specified **V1.1** as the starting **MASK** address in the MegaEDRUM instruction, **V1.1** and **V1.16** would need to be "1"; **V1.2** – **V1.15** would need to be left blank to represent "0".

The pinning chart provides an easy way to enter the correct values into the specified addresses required by the MegaEDRUM instruction. For example, you can specify an output mask of "1000000000000001" in the pinning chart by modifying the cells that represent the corresponding addresses. If your MegaEDRUM instruction consists of 16 output coils, and you designated **V1.1** as the starting **MASK** address, the cells representing **V1.1** and **V1.16** must contain "1"; the cells representing **V1.2** – **V1.15** must be blank to represent "0".



Mask Addr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
v1.1	1															1

Figure 1 – An output mask of "1000000000000001" represented in the pinning chart.

In its default state, the pinning chart represents a MegaEDRUM instruction consisting of a 16 x 16 matrix of coils and steps. The pinning chart can be used to represent any supported size of the MegaEDRUM instruction, however, from 16 x 16 up to the maximum of 128 x 128. In the pinning chart, output coils/addresses are represented by columns and steps are represented by rows. Mask addresses are automatically calculated based on the size of the pinning chart.

The pinning chart requires that the FasTrak 505 communications server is installed on the system that is executing the pinning chart. (The FasTrak 505 communications server is automatically installed with 505 WorkShop or with ControlShop.) By default, the pinning chart is set up to communicate with the 505 Simulator using TCP/IP. In order to use the pinning chart with an actual processor, some communication settings need to be modified. This is accomplished by changing the values of certain cells in the pinning chart. These cells are located in the **Communication Type (Comm Type)** table, which begins in row 12 of the pinning chart.

Overview of Using the Pinning Chart

In order to use the pinning chart, you must perform the following actions. Detailed descriptions of each action are provided later.

1. **Enabling Active Content in Microsoft Excel** – Microsoft Excel may need to be configured to allow active content. If the pinning chart is opened in Microsoft Excel and active content is blocked, the pinning chart will not function properly.

2. **Enter Parameters from the MegaEDRUM Instruction** – The **MASK** , **EVENT**, **COUNT**, and **USE STEP** parameters from the MegaEDRUM instruction are entered into specific cells in the pinning chart.

3. **Modify the Size of the Pinning Chart** – If needed, the size of the pinning chart can be modified to reflect the number of coils and steps used in the MegaEDRUM instruction.

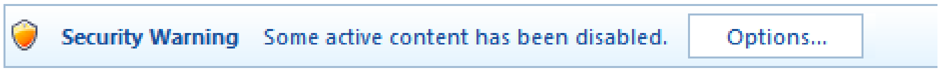
4. **Enter Values in the Pinning Chart** – The values that will be saved to specified addresses are entered in the pinning chart.

5. **Modify Communication Settings** – If needed, the communication parameters can be modified to reflect how the pinning chart will communicate with the PLC.

6. **Write and Read Data** – The information in the pinning chart is sent to the PLC.

Enabling Active Content in Microsoft Excel

Your instance of Microsoft Excel may be set up to disable active content when opening documents, such as the pinning chart, that contain active content. This content *must* be enabled in order for the pinning chart to operate successfully. The following is an example of a security warning that may be displayed when you open the pinning chart.

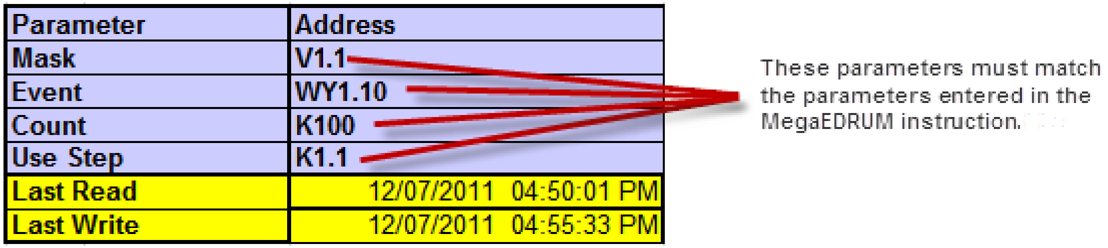


Security Warning Some active content has been disabled.

To enable active content, click **Options** in this Security Warning, and then click **Enable Content** in the Microsoft Office Security Options dialog box. Note that the exact procedure for enabling active content will depend on your version of Windows and your version of Excel. In some instances, active content may be disabled and no notification is given when opening the pinning chart. For more information on enabling active content when opening documents, refer to the Microsoft Office Excel Help for information on "Trust Center."

Enter Parameters from the MegaEDRUM Instruction

The **MASK**, **EVENT**, **COUNT** , and **USE STEP** parameters from the MegaEDRUM instruction in ladder logic must be entered into the pinning chart. This information is entered in the **Parameter/Address** table, which begins in row 2 of the pinning chart. By default, there are sample values entered in these cells. These sample values must be replaced with the actual **MASK**, **EVENT**, **COUNT**, and **USE STEP** parameters that are entered in the MegaEDRUM instruction within ladder logic.



Parameter	Address
Mask	V1.1
Event	WY1.10
Count	K100
Use Step	K1.1
Last Read	12/07/2011 04:50:01 PM
Last Write	12/07/2011 04:55:33 PM

These parameters must match the parameters entered in the MegaEDRUM instruction.

Figure 2 – Parameter/Address Table in MegaEDRUM.xls

Modify the Size of the Pinning Chart

The pinning chart must match the size of the MegaEDRUM instruction contained in the ladder logic.

- The number of columns that represent output coils/addresses in the pinning chart must equal the **COIL COUNT** parameter specified in the MegaEDRUM instruction.

- The number of rows that represent steps in the pinning chart must equal the **STEPS** parameter in MegaEDRUM instruction.

The pinning chart can be made larger by increasing the number of columns representing output coils. It can also be made larger by increasing the number of rows representing steps. The pinning chart can be made smaller by decreasing the number of columns representing output coils. It can also be made smaller by decreasing the number of rows representing steps.

The pinning chart uses column headings to indicate the number of columns used to represent output coils. The pinning chart uses row headings to indicate the number of rows used to represent steps. To match how the MegaEDRUM instruction works, the pinning chart can only be modified in increments of 16. For this reason, you must add or remove column headings in every 16th column. You must add or remove row headings in every 16th row.

Make the Pinning Chart Larger

To modify the pinning chart so it represents a MegaEDRUM instruction greater than 16 x 16, type the next 16-based threshold values in the appropriate column and row headings. These columns and rows are shaded so they are easily identified. Continue entering values in every 16th column and row heading until the pinning chart matches the size of the MegaEDRUM instruction you are using.

For example, to represent a 32 x 32 MegaEDRUM instruction, type **32** in the next shaded column and in the next shaded row. To represent a 48 x 48 MegaEDRUM instruction, type **32** in the first empty shaded column and row, then type **48** in the next empty shaded column and row. This process can be repeated all the way up to the maximum size of the MegaEDRUM instruction (128 x 128).

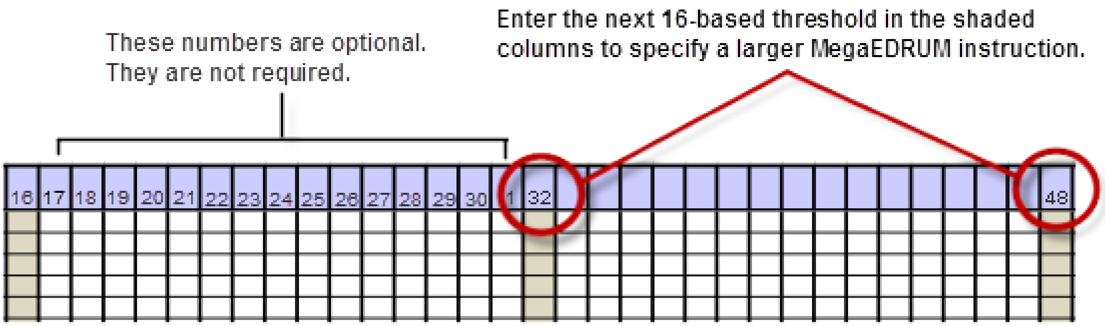
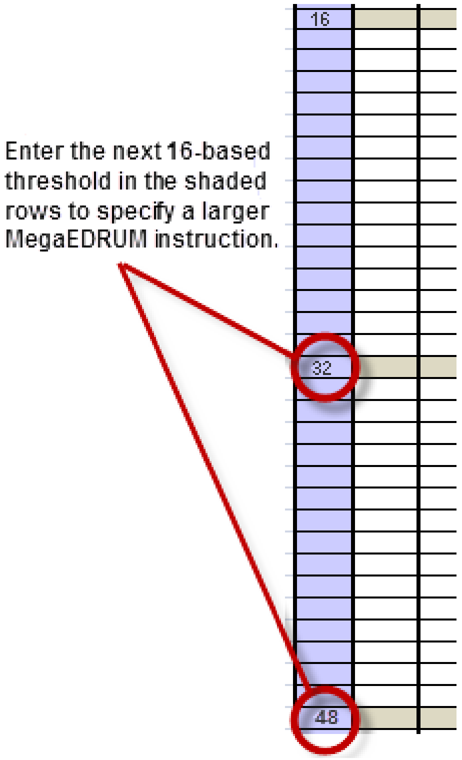

These numbers are optional.
They are not required.
Enter the next 16-based threshold in the shaded
columns to specify a larger MegaEDRUM instruction.
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
1
32
48

Figure 3 – Increasing the number of columns that represent output coils/addresses.



Enter the next 16-based threshold in the shaded rows to specify a larger MegaEDRUM instruction.

Figure 4 – Increasing the number of rows that represent steps.

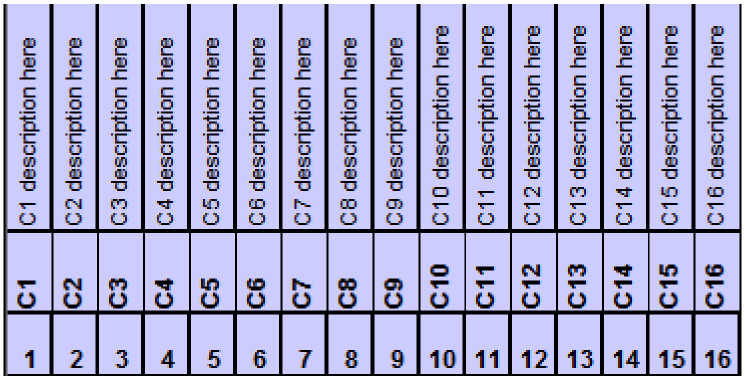
NOTE: You must enter all of the 16-based threshold values in the shaded rows and columns up to the number you want. If you only enter the starting and the ending column/row heading, such as **16** and **128**, the pinning chart will represent only the first 16 columns and rows. The remaining columns/rows are ignored, even if values have been entered in the cells for these columns/rows. The numbers between the 16-based threshold values (for example, 17, 18, 19, and so on) do *not* have to be entered. They are optional.

ENTER ADDRESSES AND DESCRIPTION – COLUMN ADDRESSES (OPTIONAL)

By default, the first 16 columns representing output coils/addresses are identified with **C1 – C16**. You can change these values to represent the actual addresses you are using in your MegaEDRUM instruction. For instance, if your first output coil/address is **C101**, you could change this value from **C1** to `C101`. You could make similar changes to the other columns.

You can also add descriptive information about the address. For instance, if **C101** controls **Tank 3**, you can replace the default text of **C1 description here** with `Tank 3`. Similar descriptions can be added to the other coil/addresses.

The address and description information is for reference only; this means these values can be changed with no impact on the operation of the pinning chart.



C1 description here	C2 description here	C3 description here	C4 description here	C5 description here	C6 description here	C7 description here	C8 description here	C9 description here	C10 description here	C11 description here	C12 description here	C13 description here	C14 description here	C15 description here	C16 description here
C1	**C2**	**C3**	**C4**	**C5**	**C6**	**C7**	**C8**	**C9**	**C10**	**C11**	**C12**	**C13**	**C14**	**C15**	**C16**
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16

Figure 5 – Default column identifiers in the MegaEDRUM.xls.

Entering additional addresses and descriptions are optional; it is not required. If you do decide to add additional addresses and descriptions, however, you can use the fill handle feature of Excel to automate the process. To use the fill handle, select the cells that you want to use as a basis for filling additional cells, and then drag the fill handle across the cells you want to fill. Additional information about the fill handle can be found in the help for Microsoft Excel.

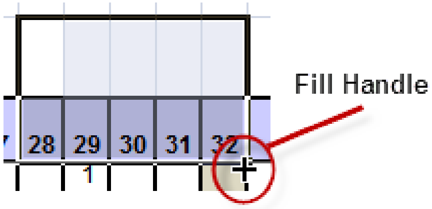
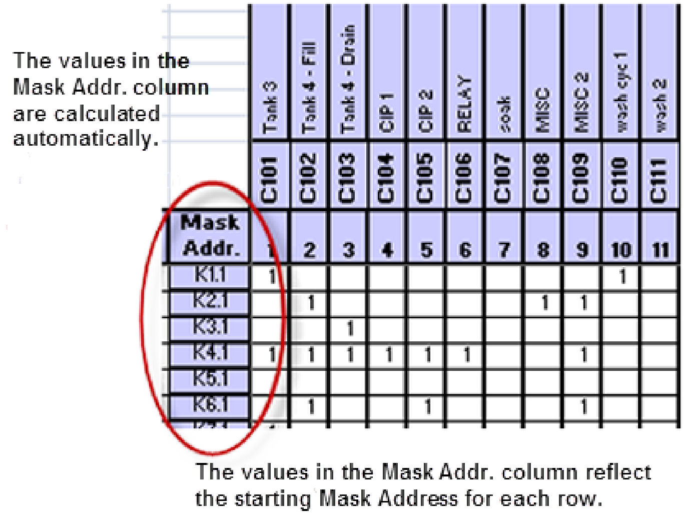


Figure 6 – Use the Fill Handle to Copy Cells.

Mask Address Column

The addresses displayed in the Mask Address (**Mask Addr.**) column are automatically calculated. They are calculated using the starting **Mask** address specified in the **Parameter/Address Table**, the number of output coils/addresses represented in the pinning chart, and the number of steps represented in the pinning chart.

In any row, the addresses used to store mask values are offset from the address displayed in the **Mask Addr.** column. Resizing the pinning chart (by adding or subtracting the number of columns that represent output coils/addresses, or by adding or subtracting the number of rows representing rows), will cause the values in the **Mask Addr.** column to be re-calculated. **The addresses displayed in the Mask Addr. column are recalculated whenever a 16-based threshold value is added to or removed from the pinning chart.**



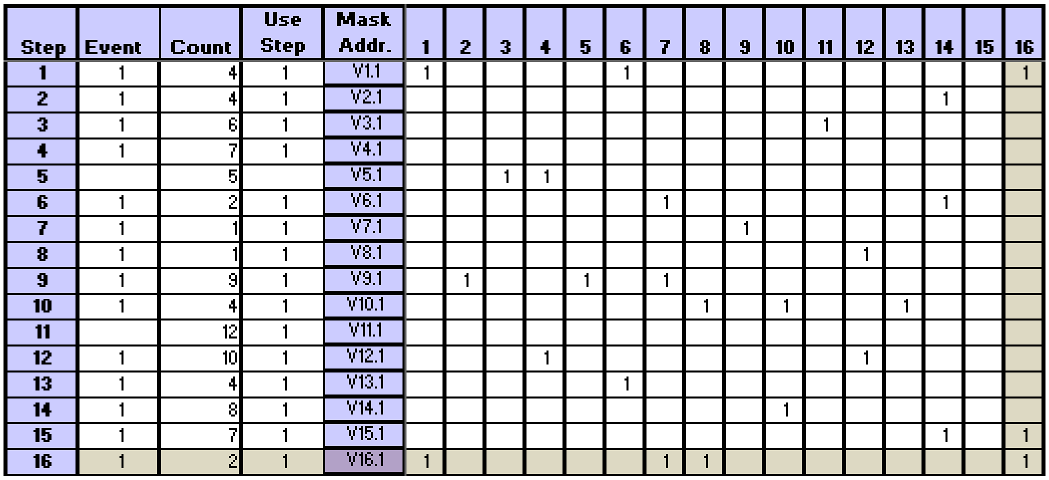
The values in the Mask Addr. column are calculated automatically.

	Tank 3	Tank 4 - Fill	Tank 4 - Drain	CIP 1	CIP 2	RELAY	soak	MISC	MISC 2	wash cyc 1	wash 2
	C101	C102	C103	C104	C105	C106	C107	C108	C109	C110	C111
Mask Addr.	1	2	3	4	5	6	7	8	9	10	11
K1.1	1									1	
K2.1		1						1	1		
K3.1			1								
K4.1	1	1	1	1	1	1			1		
K5.1											
K6.1		1			1				1		

The values in the Mask Addr. column reflect the starting Mask Address for each row.

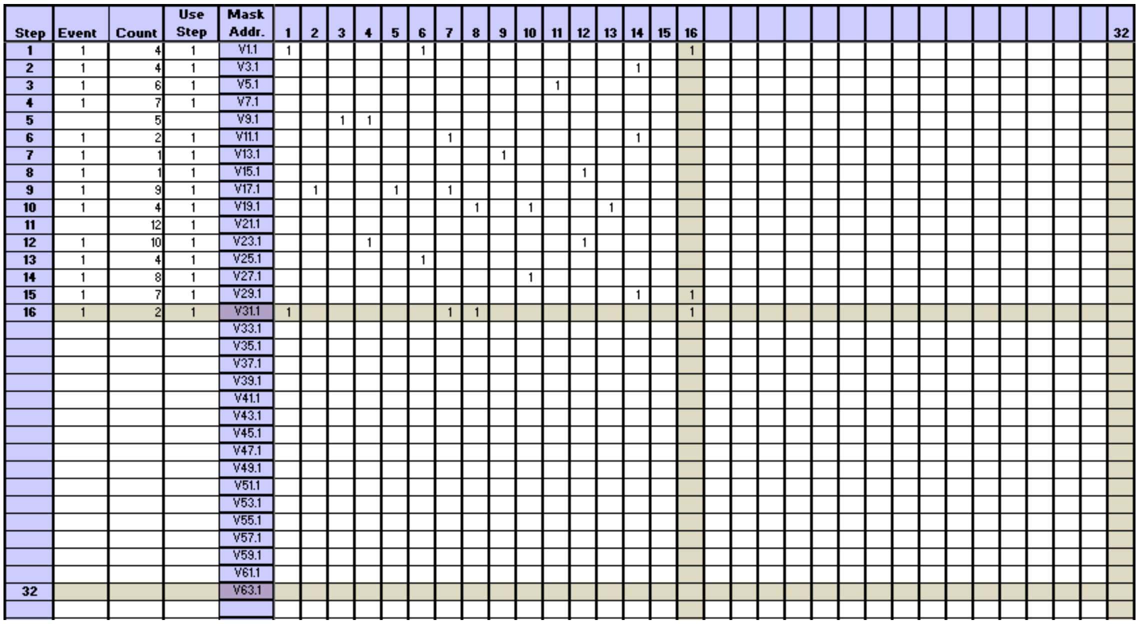
Figure 7 – Mask Addr. Column

The following figures depict a 16 x 16 pinning chart and a 32 x 32 pinning chart. Note how the values in the **Mask Addr.** column change from one chart to the next. When the 16 x 16 pinning chart is resized to 32 x 32, the values in the **Mask Addr.** column are automatically calculated to reflect the additional addresses required in the 32 x 32 pinning chart.



Step	Event	Count	Use Step	Mask Addr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	1	4	1	V1.1	1					1										1
2	1	4	1	V2.1														1		
3	1	6	1	V3.1											1					
4	1	7	1	V4.1																
5		5		V5.1			1	1												
6	1	2	1	V6.1							1							1		
7	1	1	1	V7.1									1							
8	1	1	1	V8.1												1				
9	1	9	1	V9.1		1			1		1									
10	1	4	1	V10.1								1		1			1			
11		12	1	V11.1																
12	1	10	1	V12.1				1								1				
13	1	4	1	V13.1						1										
14	1	8	1	V14.1										1						
15	1	7	1	V15.1														1		1
16	1	2	1	V16.1	1						1	1								1

Figure 8 – A 16 x 16 Pinning Chart. (Mask Addr. V1.1 – V16.1)



Step	Event	Count	Use Step	Mask Addr.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16																32
1	1	4	1	V1.1	1					1										1																
2	1	4	1	V3.1														1																		
3	1	6	1	V5.1											1																					
4	1	7	1	V7.1																																
5		5		V9.1			1	1																												
6	1	2	1	V11.1							1							1																		
7	1	1	1	V13.1									1																							
8	1	1	1	V15.1												1																				
9	1	9	1	V17.1		1			1		1																									
10	1	4	1	V19.1								1		1			1																			
11		12	1	V21.1																																
12	1	10	1	V23.1				1								1																				
13	1	4	1	V25.1						1																										
14	1	8	1	V27.1										1																						
15	1	7	1	V29.1														1		1																
16	1	2	1	V31.1	1						1	1								1																
				V33.1																																
				V35.1																																
				V37.1																																
				V39.1																																
				V41.1																																
				V43.1																																
				V45.1																																
				V47.1																																
				V49.1																																
				V51.1																																
				V53.1																																
				V55.1																																
				V57.1																																
				V59.1																																
				V61.1																																
32				V63.1																																

Figure 9 – A 32 x 32 Pinning Chart. (Mask Addr. V1.1 – V63.1)

The values in the **Mask Addr.** column are included for reference only. Although there is no reason to manually change these values, if the values are changed it will have no impact on the operation of the pinning chart.

Entering Values in the Pinning Chart

You can enter the **EVENT**, **COUNT**, **USE STEP**, and **MASK** values by typing in the appropriate cells. **EVENT**, **USE STEP**, and **MASK** values must be "1" or blank (to represent "0"); no other characters are allowed for the **EVENT**, **USE STEP**, and **MASK** parameters.

Modify Communication Settings

By default, the pinning chart is set up to communicate with the 505 Simulator over TCP/IP using an address of **127.0.0.1**. If you want to connect to an actual PLC over TCP/IP, or connect to a PLC using a serial cable, you need to modify the communication settings recorded in the pinning chart. This information is entered in the **Communication Type (Comm Type)** table, which begins in row 12 of the pinning chart.

The communication settings in the pinning chart reflect the same settings that are used in 505 WorkShop. See **Setting Up Communications** on page *150* for additional information on communication settings. Note that only one set of communication settings can be saved in the pinning chart. For instance, if you changed the communication settings for **TCP/IP**, and also changed settings for **COM2**, only the communication settings that are displayed when the pinning chart is saved are retained in the pinning chart.

Write and Read Data

WRITE TO PLC FROM THE PINNING CHART

Once all of the required information has been successfully entered in the pinning chart, the information in the pinning chart can be written to a PLC. This is done by clicking **Write to PLC**, which is located in row 1 of the pinning chart. The amount of time required to send the information in the pinning chart to a PLC depends on several factors, including the type of communication used, the size of the pinning chart, and the address types used. Word addresses, such as **V**, can be transmitted faster than discrete addresses, such a **C**.

READ FROM PLC TO PINNING CHART

Click **Read From PLC**, which is located in row 1 of the pinning chart, to populate the pinning chart with values from the PLC the pinning chart is currently connected to.

RESET COMMUNICATION WITH SERVER

Click **Reset**,which is located in row 1 of the pinning chart, to reset communication with the 505 communication server.

Maskable Event Drum, Discrete (MDRD)

The Discrete Maskable Event Drum (MADRID) instruction operates similarly to the event drum but is capable of specifying a configurable mask for each step, which allows selection of the coils to be under the control of the fixed mask in each MADRID step.

When the Drum begins to run, it starts at the step specified by the Drum Step Preset, which is stored in DST memory. The current step is stored in DSC. memory. The counts per step, set in the CNN field, is stored in DIP memory. The current count is stored in BCC memory. The MADRID operates as follows:

- The drum is enabled when the Enable/Reset input is on.
- When the Enable/Reset is on and the Start input turns on, the drum beings to run. The drum begins at the step specified by DSP and advances to the next step based on operations of the timer and/or event.
- When the drum advances a step, coils are turned on/off according to the fixed mask and the current bit pattern in the configurable mask.
- The drum output comes on, and remains on, after the last programmed step has been executed. The last programmed step is the last step having an event

programmed or having a non-zero CNT preset value. The event must be on and DCC must be zero. If the event goes off after DCC reaches \zero the drum output remains on and the MDRMD remains at the last programmed step until the drum is reset.

- When the Enable/Reset turns off, the drum output is turned off and the drum returns to the step specified in DSP.
- If the start input turns off and Enable/Reset remains on, the drum remains at the current step(DSC) and DCC holds its current count. All coils specified in the configurable mask maintain the condition specified by the fixed mask.
- When the drum is at the preset step, the coils specified in the configurable mask follow the states specified by the fixed mask for that step, even if the Enable/Reset input is off. Be sure to program the mask with a bit pattern that is a safe state for the preset step.
- The drum advances to the next step immediately if the Jog input transitions from off to on and the Enable/Reset input is also on.

You can use the MDRMD in applications that require a configurable on/off pattern for the drum coils. To do this, specify all 1s for the fixed mask for every programmed step of the MDRMD and precede the MDRMD and MDRMDs coils. The configurable mask table in memory must then contain the on/off patterns that are to be written to the coils for each step.

Parameter	Type	Valid Values
Drum Number:	Constant Only	Varies with Drum configured ranges
Preset:	Constant Only	1-16
Sec:	Constant Only	00.001-32.676
Mask:	Word Address	V,W,G

⚠ **Warning**	Do not use the same reference number more than once for any of the drum types. It can cause unpredictable machine operation.

Maskable Event Drum, Word (MDRMW)

The Maskable Event Drum, Word (MDRMW) instruction operates similarly to the event drum, but the MDRMW writes the date to a word instead of to individual coils. The

MDRMW also is capable of specifying a configurable mask for each step. The allows the selection of the bits in the work to be changed by the fixed mask in each MDRMW step.

When the drum begins to run, it starts at the step specified by the Drum Step Preset, which is stored in DSP memory. The current step is stored in DSC memory. The counts per step, set in the CNT field, is stored in DCP memory. The current count is stored in DCC memory. The MDRMW has the following operations:

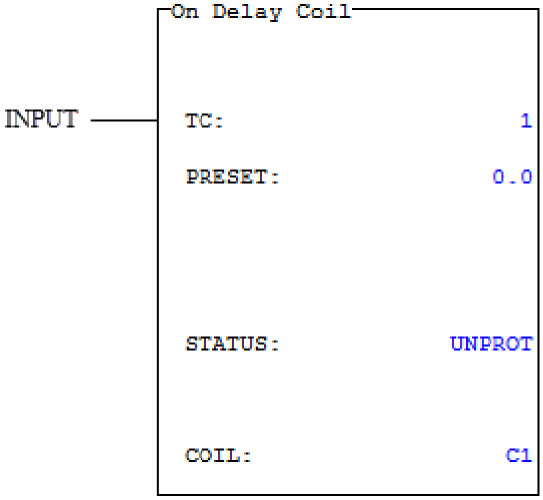
- The drum is enabled when the Enable/Reset input is on.
- When the Enable/Reset is on and the Start input turns of, the drum begins to run. The drum begins at the step specified by DSO and advances to the next step based on operation of the timer and/or event.
- When the drum advances a step, individual bits of the output word are turned on/off based on the fixed mask and the current bit pattern in the configurable mask.
- The drum output comes on, and remains on, after the last programmed step has been executed. The last programmed step is the last step having an event programmed or having a non-zero CNT preset value. The event must be on and DCC must be zero. If the event goes off after DCC reaches zero, the drum output remains on and the MDRMW remains at the last programmed step until the drum is reset.
- When the Enable/Reset turns off, the drum output is turned off and the drum returns to the step specified In DSP.
- If the Start input turns off and the Enable/Reset remains on, the drum remains at the current step and DCC holds its current count. All bits specified in the configurable mask maintain the condition specified by the fixed mask.
- When the drum is at the Preset step, the bits specified in the configurable mask follows the states specified by the fixed mask for that step, even if the Enable/Reset input is off. You should program the mask with a bit pattern that is a safe state for the Preset step.
- The drum advances to the next step immediately if the Jog input transitions from off to on and the Enable/Reset input is also on.

The configurable mask is specified for each step by a memory location in the mask field of the instruction. The configurable mask is located in 16 consecutive memory locations. The first location corresponds to step 1 of the drum, the second to step 2, etc. The mask is defined as being configurable because you can change the mask by writing data to the memory locations.

MDRMW	Parameter Type	Valid Parameter Types
Drum Number:	Constant Only	Varies with Drum configured ranges
Preset:	Constant Only	1-16
Sec:	Constant Only	00.001-32.676
Mask:	Word Address	V,W,G

⚠ **Warning**	Do not use the same reference number more than once for any of the drum types. It can cause unpredictable machine operation.

On Delay Coil (ONDC)



TC: 1
PRESET: 0.0
STATUS: UNPROT
COIL: C1

The On Delay Coil instruction is only compatible with the CTI 2500 family of processors. It requires a CPU firmware of V6.18 or later.

Parameter	Valid Values	Function
TC	Varies with configured memory	Instruction reference number. Refer to the controller's user manual for the number supported. The assigned instruction number must conform to the requirements of TIMER/COUNTER memory.
PRESET	0.0 – 3276.7	Preset value from which the timer times down.
STATUS	PROT UNPROT	**PROT**: Protects the preset values from changes made using an operator interface. **UNPROT**: Allows the preset values to be changed using an operator interface.
COIL	**Y**, **C**, **B**, **Vx.x**, **WYx.x**, **Wx.x**, **DCCx.x**, **TCPx.x**, and **TCCx.x** bit address types, entered in the form of a discrete address or a bit-of-word	Address of the coil to be turned on when the timer reaches zero.

Input

When the input to the On Delay coil is enabled, and the instruction is timing (the CTR value / TCC address is greater than zero):

- The time counts down from the PRESET value / TCP address to zero
- The COIL address is OFF

When the input to the On Delay coil is enabled, and the instruction has timed (the CTR value/TCC address equals zero):

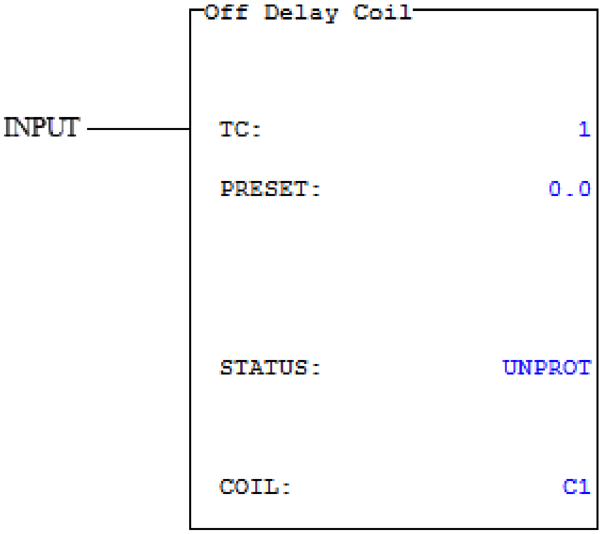
- The COIL address in ON

When the input to the On Delay Coil is disabled:

- The CTR value/TCC address is set to the PRESET value/TCP address

- The COIL address is OFF

Off Delay Coil (OFFDC)



The Off Delay Coil instruction is only compatible with the CTI 2500 family of processors. It requires a CPU firmware of V6.18 or later.

Parameter	Valid Values	Function
TC	Varies with configured memory	Instruction reference number. Refer to the controller's user manual for the number supported. The assigned instruction number must conform to the requirements of TIMER/COUNTER memory.
PRESET	0.0 – 3276.7	Preset value from which the timer times down.

Parameter	Valid Values	Function
STATUS	PROT UNPROT	**PROT**: Protects the preset values from changes made with an operator interface. **UNPROT**: Allows the preset values to be changed using an operator interface.
COIL	**Y**, **C**, **B**, **Vx.x**, **WYx.x**, **Wx.x**, **DCCx.x**, **TCPx.x**, and **TCCx.x** bit address types, entered in the form of a discrete address or a bit-of-word	Address of the coil to be turned off when the timer reaches zero.

Input

When the input on the Off Delay Coil is disabled:

- The COIL address in OFF

When the input to the Off Delay Coil is enabled:

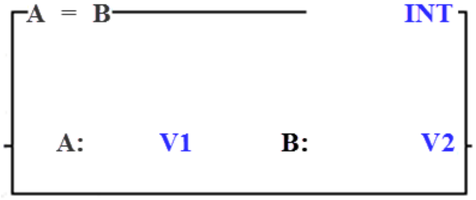
- The CTR value/TCC address is set to the PRESET value/TCP address
- The COIL address is ON

When the input to the Off Delay Coil transitions from enabled to disabled, and the instruction is timing (the CTR value / TCC address is greater than zero):

- The time counts down from the PRESET value / TCP address to zero
- The COIL address is ON

Compare Instructions

Equal To (EQU)



When the input is energized, the EQU instruction compares two integers, two unsigned integers, or two floating point values, and energizes the output if, and only if, the first value (**A**) is equal to the second value (**B**).

Parameter	Valid Values	Description
Data Type (not labelled – located in top-right corner of instruction block)	**INT:** integer **UINT:** unsigned integer **FLOAT:** floating point values **Note:** Floating point values are only compatible with the CTI 2500 family of processors and a CPU firmware of V6.18 or later.	Identifies the type of data being compared in the instruction block.
A, B*	for all data types (**INT**, **UINT**, and **FLOAT**), the following word address types: **WX**, **WY**, **K**, **V**, **STW**, **W**, **TCP**, **TCC**, **DCC**, **DSP**, **DSC**, **DCP** and constants* for **FLOAT** data type only, the following Real address types are also available: **WX.**, **WY.**, **K.**, **V.**, and Real constants*	Memory location of the value being compared.
* Constants and Real Constants available only for the B parameter.		

Notes:

- Integers that are compared with floating point values are converted to floating point values before the comparison is executed.
- The values of the **A** and **B** parameters are displayed when Ladder Status is enabled. See **Ladder Status (Online)** on page *319* for more information on Ladder Status.

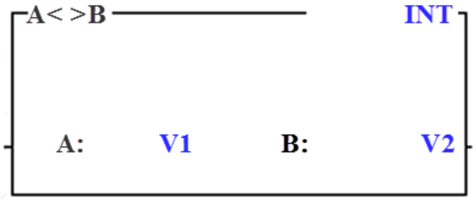
Input

When the input is enabled, the EQU instruction is executed. When the input is disabled, the EQU instruction is not executed.

Output

The output is enabled when the EQU operation is TRUE (A=B).

Not Equal To (NEQ)



When the input is energized, the NEQ instruction compares two integers, two unsigned integers, or two floating point values, and energizes the output if, and only if, the values are not equal.

Parameter	Valid Values	Description
Data Type (not labelled–located in top-right corner of instruction)	**INT:** integer **UINT:** unsigned integer **FLOAT:** floating point values **Note:** Floating point values are only compatible with the CTI 2500 family of processors and a CPU firmware of V6.18 or later.	Identifies the type of data being compared in the instruction block.
A, B*	for all data types (**INT**, **UINT**, and **FLOAT**), the following word address types: **WX**, **WY**, **K**, **V**, **STW**, **W**, **TCP**, **TCC**, **DCC**, **DSP**, **DSC**, **DCP** and constants* for **FLOAT** data type only, the following Real address types are also available: **WX.**, **WY.**, **K.**, **V.**, and Real constants*.	Memory location of the value being compared.
* Constants and Real Constants available only for the B parameter.		

Notes:

- Integers that are compared with floating point values are converted to floating point values before the comparison is executed.
- The values of the **A** and **B** parameters are displayed when Ladder Status is enabled. See **Ladder Status (Online)** on page *319* for more information on Ladder Status.

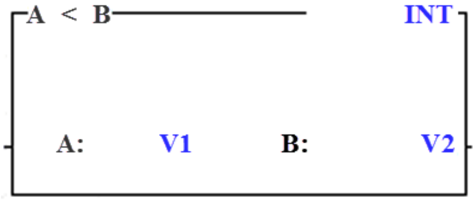
Input

When the input is enabled, the NEQ instruction is executed. When the input is disabled, the NEQ instruction is not executed.

Output

The output is enabled when the NEQ comparison operation is TRUE (A<>B).

Less Than (LESS)



When the input is energized, the LESS instruction compares two integers, two unsigned integers, or two floating point values, and energizes the output if, and only if, the first value (**A**) is less than the second value (**B**).

Parameter	Valid Values	Description
Data Type (not labelled–located in top-right corner of instruction block)	**INT:** integer **UINT:** unsigned integer **FLOAT:** floating point values **Note:** Floating point values are only compatible with the CTI 2500 family of processors and a CPU firmware of V6.18 or later.	Identifies the type of data being compared in the instruction block.

Parameter	Valid Values	Description
A, B*	for all data types (**INT**, **UINT**, and **FLOAT**), the following word address types: **WX**, **WY**, **K**, **V**, **STW**, **W**, **TCP**, **TCC**, **DCC**, **DSP**, **DSC**, **DCP** and constants* for **FLOAT** data type only, the following Real address types are also available: **WX.**, **WY.**, **K.**, **V.**, and Real constants*	Memory location of the value being compared.
* Constants and Real Constants available only for the B parameter.		

Notes:

- Integers that are compared with floating point values are converted to floating point values before the comparison is executed.
- The values of the **A** and **B** parameters are displayed when Ladder Status is enabled. See **Ladder Status (Online)** on page *319* for more information on Ladder Status.

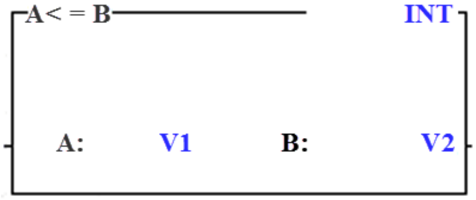
Input

When the input is enabled, the LESS instruction is executed. When the input is disabled, the LESS instruction is not executed.

Output

The output is enabled when the LESS operation is TRUE (A<B).

Less Than or Equal To (LEQ)



When the input is energized, the LEQ instruction compares two integers, two unsigned integers, or two floating point values, and energizes the output if, and only if, the first is value (**A**) less than or equal to the second value (**B**).

Parameter	Valid Values	Description
Data Type (not labelled–located in top-right corner of instruction block)	**INT:** integer **UINT:** unsigned integer **FLOAT:** floating point values **Note:** Floating point values are only compatible with the CTI 2500 family of processors and a CPU firmware of V6.18 or later.	Identifies the type of data being compared in the instruction block.
A, B*	for all data types (**INT**, **UINT**, and **FLOAT**), the following word address types: **WX**, **WY**, **K**, **V**, **STW**, **W**, **TCP**, **TCC**, **DCC**, **DSP**, **DSC**, **DCP** and constants* for **FLOAT** data type only, the following Real address types are also available: **WX.**, **WY.**, **K.**, **V.**, and Real constants*.	Memory location of the value being compared.
* Constants and Real Constants available only for the B parameter.		

Notes:

- Integers that are compared with floating point values are converted to floating point values before the comparison is executed.
- The values of the **A** and **B** parameters are displayed when Ladder Status is enabled. See **Ladder Status (Online)** on page *319* for more information on Ladder Status.

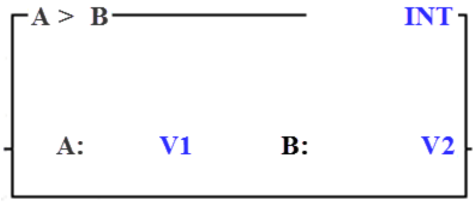
Input

When the input is enabled, the LEQ instruction is executed. When the input is disabled, the LEQ instruction is not executed.

Output

The output is enabled when the LEQ operation is TRUE (A<=B).

Greater Than (GTR)



When the input is energized, the GTR instruction compares two integers, two unsigned integers, or two floating point values, and energizes the output if, and only if, the first value (**A**) is greater than or equal to the second value (**B**).

Parameter	Valid Values	Description
Data Type (not labelled–located in top-right corner of instruction block)	**INT:** integer **UINT:** unsigned integer **FLOAT:** floating point values **Note:** Floating point values are only compatible with the CTI 2500 family of processors and a CPU firmware of V6.18 or later.	Identifies the type of data being compared in the instruction block.
A, B*	for all data types (**INT**, **UINT**, and **FLOAT**), the following word address types: **WX**, **WY**, **K**, **V**, **STW**, **W**, **TCP**, **TCC**, **DCC**, **DSP**, **DSC**, **DCP** and constants* for **FLOAT** data type only, the following Real address types are also available: **WX.**, **WY.**, **K.**, **V.**, and Real constants*.	Memory location of the value being compared.
* Constants and Real Constants available only for the B parameter.		

Notes:

- Integers that are compared with floating point values are converted to floating point values before the comparison is executed.
- The values of the **A** and **B** parameters are displayed when Ladder Status is enabled. See **Ladder Status (Online)** on page *319* for more information on Ladder Status.

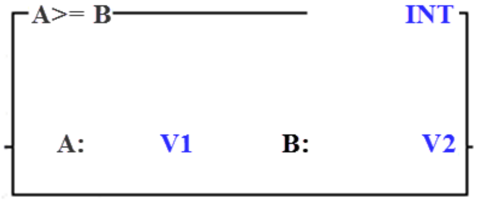
Input

When the input is enabled, the GTR instruction is executed. When the input is disabled, the GTR instruction is not executed.

Output

The output is enabled when the GTR operation is TRUE (A>B).

Greater Than or Equal To (GEQ)



When the input is energized, the GEQ instruction compares two integers, two unsigned integers, or two floating point values, and energizes the output if, and only if, the first value (**A**) is greater than or equal to the second value (**B**).

Parameter	Valid Values	Description
Data Type (not labelled–located in top-right corner of instruction block)	**INT:** integer **UINT:** unsigned integer **FLOAT:** floating point values **Note:** Floating point values are only compatible with the CTI 2500 family of processors and a CPU firmware of V6.18 or later.	Identifies the type of data being compared in the instruction block.

Parameter	Valid Values	Description
A, B*	for all data types (**INT**, **UINT**, and **FLOAT**), the following word address types: **WX**, **WY**, **K**, **V**, **STW**, **W**, **TCP**, **TCC**, **DCC**, **DSP**, **DSC**, **DCP** and constants* for **FLOAT** data type only, the following Real address types are also available: **WX.**, **WY.**, **K.**, **V.**, and Real constants*.	Memory location of the value being compared.
* Constants and Real Constants available only for the B parameter.		

Notes:

- Integers that are compared with floating point values are converted to floating point values before the comparison is executed.
- The values of the **A** and **B** parameters are displayed when Ladder Status is enabled. See **Ladder Status (Online)** on page *319* for more information on Ladder Status.

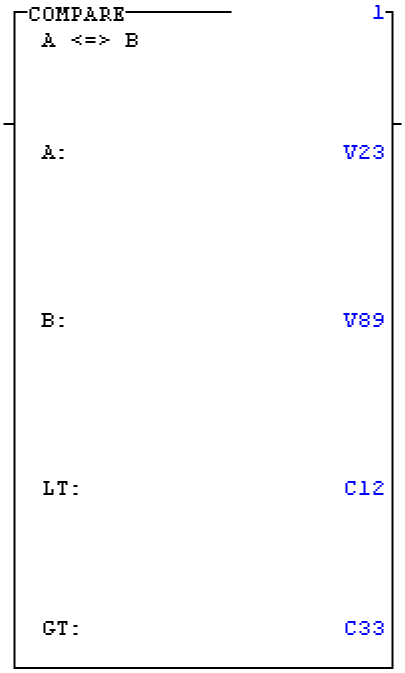
Input

When the input is enabled, the GEQ instruction is executed. When the input is disabled, the GEQ instruction is not executed.

Output

The output is enabled when the GEQ operation is TRUE (A>=B).

Compare (CMP)



```
COMPARE                1
 A <=> B

 A:                  V23

 B:                  V89

 LT:                 C12

 GT:                 C33
```

The Compare instruction (CMP) compares a signed integer value in A with a signed integer value in B. Based upon the comparison, the coil or relay addresses may be turned on or off.

If the input is ON, then the compare instruction will be executed on every scan. The CMP instruction works as follows:

- The value in A is compared against the value in B. A and B are not affected.
- If A < B. LT is turned on (1), GT is turned off (0), there is no power flow.
- If A > B, GT is turned on, LT is turned off and there is no power flow.
- If A = B, GT and LT are turned off and the output is turned on.
- If the input is off, the GT and LT coils are turned off.

Parameter	Parameter Type	Valid Settings
Reference Number	Constant	0-32767
A:	Word Address	Form A

Parameter	Parameter Type	Valid Settings
B:	Word Address	Form A
LT:	Bit Address	Y, C, B
GT:	Bit Address	Y, C, B

Indexed Matrix Compare (IMC)

The Indexed Matrix Compare (IMC) instruction compares a predefined 15-bit mask pattern to the status of up to 15 discrete points. The mask to be compared is selected from a field of up to 16 masks by the step number currently located in Cur Ptr. If a match is found, the output is turned on.

The IMC instruction is described as follows:

- The Enable input must be on for the instruction to be executed.
- When Enable is ON and the Start input is turned on, the instruction is executed.
- The current status of up to 15 X, Y and C points is checked against the predefined bit pattern identified by the step number loaded into Cur Ptr.
- If a match is found, the box output is turned on.
- If no match is found and the Start input remains on, the IMC checks the step selected by the Cur Ptr on every scan.
- If the Cur Ptr value is out of range, the controller automatically writes 16 to the Cur Ptr address. This means that mask 16 is used anytime the Cur Ptr is out of range.

Parameter	Parameter Type	Valid Settings
Reference Number:	Constant	0-32767
CUR PTR:	Word Address	V, W, G
STP	Word Address	1-16
I/O Points (up to 15)	Discrete Points	X, Y C, B or blank

Scan Matrix Compare (SMC)

The Scan Matrix Compare Instruction (SMC) compares up to 16 pre-defined bit patterns to the current states of up to 15 discrete points. If a match is found, the step number that contains the matching bit pattern is entered into the memory location specified by the pointer, and the output is turned on.

The SMC has the following properties:

- The instruction is executed when the Start input is on.
- If the Start input remains on, the SMC instruction checks all programmed steps on every scan.
- The status of up to 15 discrete points is checked against the predefined bit patterns.
- If a match is found, the step number of the matching mask is entered into the memory location specified by CUR PTR, and the output is turned on.
- If no match is found, CUR PTR is cleared to 0 and the output is turned off.

Parameter	Parameter Type	Valid Parameters
Reference Number	Constant	0-32767
LAST STEP	Constant	1-16
CUR PTR	Word Address	V, W, G, VMS, VMM
I/O Points (up to 15)	Discrete Points	X, Y C, B or blank

Bit Operations

Bit Clear (BITC)

The Bit Clear instruction clears a specified bit to zero. When the input is on, the BITC instruction is executed. The output is turned on during each scan in which the instruction is executed. The operation is as follows: Bit N of element A is cleared to 0 is power is passed

BITC	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
Parameter A:	Word Address	**Form B**
Parameter N:	Constant	Bit Number, 1-16 (most significant bit is 1, least significant bit is 16)

Bit Pick (BITP)

The Bit Pick Instruction (BITP) examines the status of a specified bit. When the input is turned on, the BITP instruction is executed. The status of bit N of input element A is checked as follows:

- The output is turned on if the selected bit is 1.
- The output is turned off if the selected bit is 0.

BITP	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
Parameter A:	Word Address	**Form B**
Parameter N:	Constant	Bit Number, 1-16 (most significant bit is 1, least significant bit is 16)

Bit Set (BITS)

The Bit Set Instruction (BITS) sets a specified bit to one. When the input is on, the BITS instruction is executed. The operations executed is as follows: Bit N of word A is set to 1 if power is passed.

BITS	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
Parameter A:	Word Address	**Form B**
Parameter N:	Constant	Bit Number, 1-16 (most significant bit is 1, least significant bit is 16)

Bit Shift Register (SHRB)

The Bit Shift Register (SHRB) instruction creates a bit shift register using a specified number of control relays or points in the discrete image register. The shift register may be up to 1023 bits long.

The SHRB instruction has the following features:

- When the Enable/Reset is turned on, the SHRB instruction is enabled.
- When the clock transitions from zero to one, the following actions occur. The last (highest numbered) bit of the shift register is moved to the output. The data in the shift register is shifted one address. The status of the Data input (0 or 1) is moved into the lower numbered point as specified in the IR field.
- When the clock does not transition from zero to one, the last bit of the shift register is moved to the output. The data is not shifted.
- The Enable/Reset must be kept on as long as the data is be shifted into and kept in the SHRB. When the Enable/Reset loses power flow, the SHRB is cleared, and all control relays or image register points comprising the SHRB are cleared to zero.
- If the Enable/Reset does not receive power flow the instruction is not executed and the output does not turn on.

Parameter	Type	Valid Values
Register Number:	Constant	Varies with configured Shift Register ranges
IR:	Bit Address	Y, C, B
N	Constant	1–1023

⚠ **Warning**	Do not use the same reference number more than once for the SHRB and SHRW instructions. Assigning the same number can cause unpredictable machine operation.

Word Shift Register (SHRW)

The Word Shift Register Instruction (SHRW) copies words from a memory location into a shift register. The shift register is located in V memory and can be up to 1023 words long.

The SHRW instruction has the following features:

- The Enable/Reset inputs must both be on for the SHRW instruction to be executed.
- When the Clock transitions from off to on, the word currently in memory location A is shifted into the shift register at the memory location specified by B. The shift occurs as follows:

Word B + (N-1) is discarded.

Word B + (N-2) is then copied to word B+(N-1); word B+(N-3_ is copied to word B+(N-2), etc.

Word B is copied to word B+1; word A is copied to word B.

- After each shift is completed, the output is turned on for one scan.
- If the Enable tuns off, but the Reset remains on, all words currently in the SHRW are retained, but no words are shifted.
- If the Reset turns off, all words in the shift register are cleared to zero. The instruction is not executed, and there is no power flow at the instruction.

Parameter	Type	Valid Values
Register Number:	Constant Only	Varies with configured Shift Register ranges
A:	Word Addr	Form A
B:	Word Addr	V,W,G
N:	Constant	1-1023

⚠ Warning	Do not use the same reference number more than once for the **SHRB** and **SHRW** instructions. Assigning the same number can cause unpredictable machine operation.

Word Rotate (WROT)

The Word Rotate (WROT) instruction operates on the 4-bit segments of a word, rotating them to the right.

When the input is turned on, the WROT instruction is executed. IF the input remains on, the instruction is executed on every scan. The WROT instruction has the following operation:

- Each 4-bit segment of the word specified in memory location A is shifted to the right.
- A segment may be shifted up to 3 positions as specified by N.
- If A is not zero, the output is turned on when the instruction is executed. If A is zero, the output is turned off.

WROT	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A	Word Address	Form B
B	Constant	1-3

Math and Logic Instructions

Add (ADD)

The Add instruction adds a signed integer (A) to a signed integer (B), and stores the result in R. When the input is ON (1), the ADD box is executed. If the input remains ON (1), the instruction is executed on every scan.

The ADD operation is executed as follows: R = A + B. If the sum is between -32768 and 32767, the output is turned ON (1). Otherwise, the output is turned OFF (0), indicating an addition overflow, and the R (result) contains the truncated sum (16 bits).

ADD	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
Parameter A:	Word Address	Form A
Parameter B:	Word Address/Constant	Form A or Constant (-32768 – 32767)
Parameter R:	Word Address	Form B

Subtract (SUB)

The Subtract instruction (SUB) subtracts a signed integer in memory location B from a signed integer in memory location A and stores the result in memory location C.

When the input has power, the instruction is executed. The operation executed is C = A - B. If the result is less than (or equal to) 32767 or greater than (or equal to) -32767, the output is turned on. Otherwise, the output is turned off and the truncated 16 bit result is stored in R.

SUB	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A:	Word/Constant	Form A or Constant (-32768–32767)

SUB	Parameter Type	Valid Parameter Types
B:	Word/Constant	Form A or Constant (-32768–32767)
R:	Word Address	Form B

Multiply (MUL)

The Multiply (MUL) instruction multiplies a signed integer in location A by a signed integer in location B. The product is stored in on long word, R and R+!.

When power is passed to the input of the MUL, the instruction is executed. The MUL operates as follows:

- The values in A and B are not affected by the operation
- When the multiplication is executed, the output is turned on.

MULT	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A:	Word Address	Form A
B:	Word/Constant	Form A or Constant (-32768-32767)
R:	Word Add	Form B

Divide (DIV)

The Divide Instruction (DIV) divides a 32-bit signed word integer stored in A and A+1 by a 16-bit signed integer in B. The quotient is stored in R and the remainder is stored in R+1.

When the input is on, the DIV instruction is executed. IF B is non-zero, the division is done and the output is turned on. Otherwise, the output is turned off and the contents of R and R+1 do not change.

DIV	Parameter Type	Valid Parameter Types
Reference Number	Constant	0–32767
A:	Word Address or Constant	Form A or Constant (-32768–32767)
B:	Word Address or Constant	Form A or Constant (-32768–32767)
R:	Word Address	Form B

Absolute Value (ABS)

The absolute value instruction calculates the absolute value of a signed integer. When the input is turned ON (1), the absolute value instruction is executed. If the input is OFF (0), the instruction is not executed and there is not power at the output. The absolute value function is executed with the parameter A, as follows:

- If A>=0, A is not changed.
- If -32768 < A < 0, A is replaced with the value (0 - A).
- If A = -32768, A does not change.

ABS	Parameter Type	Valid Parameter Types
Parameter A:	Word Address	**Form B**

Square Root (SQRT)

The Square Root instruction (SQRT) finds the integer square root of a 32-bit (lng word) positive integer stored in memory locations AA and AA + 1. The result is stored in memory location B.

The SQRT instruction has the following properties:

- If the result of the square root is not an integer, the SQRT reports only the integer portion of the root.
- The operations is valid if 0 <= AA <=32767 * 32767.

- If the result is valid, the outputs turned on when the operation is executed. Otherwise, the instructions turned off and the contents of B does not change.

SQRT	Parameter Type	Valid Parameter Types
Reference Number	Constant	1–32767
A	Word Address	Form A
B	Word Address	Form B

Binary to BCD (CBD)

The Convert Binary to BCD instruction converts a binary representation of an integer (BIN) to an equivalent Binary Coded Decimal (BCD) value. It converts a 16-bit integer into a 32-bit BCD word. A BCD word is made up of 4 digits (0-9), with each digit represented by groups of 4 bits. Values up to 32767 can be converted into BCD.

CBD is described as follows:

- IF BIN contains an integer 0-32767, the value is converted to BCD, stored in BCD and (BCD+1) as shown below and the instruction output is turned on.

MSB			LSB		MSB			LSB
0	0	0	Ten Thousands		Thousands	Hundreds	Tens	Ones
BB					(BB+1)			

- If BIN is not within the range 0-32767, BCD and (BCD+1) are not changed and no power is passed.

CBD	Parameter Type	Valid Parameter Types
Instruction reference	Constant	0–32767
Parameter BIN:	Word Address	Form A
Parameter BCD:	Word Address	Form B

BCD to Binary (CDB)

The Convert BCD to Binary Instruction (CDB) converts a BCD element into its integer equivalent. When the input is O, the CDB instruction is executed. The CDB operation is described below:

- The number of digits (N) of the BCD value located in BCD is converted to its equivalent binary integer value stored in BIN.
- N may range from 1-4, and the BCD digit count is from right to left. For example, if N = 2 and the BCD number is A=1234, then 34 is converted and the value stored in B is 00100010.
- The output is turned on after the instruction is executed if the digits of the input words are valid. Each digit of the BCD value in BCD must be less than or equal to 9. The binary values 1010, 1011, 1100, 1101, 1110, and 1111 are invalid.

CDB	Parameter Type	Valid Parameter Types
Instruction reference	Constant	0-32767
Parameter BCD	Word Address	Form A
Parameter BIN	Word Address	Form B
N	Constant	Number of digits converted, 1-4

Word And (WAND)

The Word AND (WAND) instruction logically ANDs a word in memory location **A** with a word in memory location **B**, bit for bit. The result is stored in memory location **C**.

When the input is on, the instruction is executed. If the input remains on, the instruction is executed on every scan. The WAND has the following properties:

- The word stored in the memory location specified by **A** is **AND** with the word stored in the memory location **B**. The operation is done bit by bit. The words in **A** and **B** are not affected by the WAND instruction and will retains their original values.

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

- The result is stored in the memory location **C**.
- If **C** is not zero, the output is turned on when the instruction is executed. If **C** is zero, the output is turned off.

WAND	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A	Word Address	Form A
B	Word/Constant	Form A, Constant -32767–32767
C	Word	Form B

Word Or (WOR)

The Word OR (WOR) instruction logically **ORs** a word in memory location **A** with a word in memory location **B**, bit for bit. The result is stored in memory location **C**.

When the input is on, the instruction is executed. If the input remains on, the instruction is executed on every scan. The WOR has the following properties:

- The word stored in the memory location specified by **A** is **OR** with the word stored in the memory location **B**. The operation is done bit by bit. The words in **A** and **B** are not affected by the **WOR** instruction and will retains their original values.

A	B	C
0	0	0
0	1	1

1	0	1
1	1	1

- The result is stored in the memory location **C**.
- If **C** is not zero, the output is turned on when the instruction is executed. If **C** is zero, the output is turned off.

WOR	Parameter Type	Valid Parameter Types
ReferenceNumber	Constant	0-32767
A	Word Address	Form A
B	Word/Const	Form A, Constant - 32767 - 32767
C	Word	Form B

Word Exclusive Or (WXOR)

The Word Exclusive OR (WXOR) instruction **Exclusive ORs** a word in memory location **A** with a word in memory location **B**, bit for bit. The result is stored in memory location **C**.

When the input is on, the instruction is executed. If the input remains on, the instruction is executed on every scan. The WXOR has the following properties:

- The word stored in the memory location specified by **A** is **XORed** with the word stored in the memory location **B**. The operation is done bit by bit. The words in **A** and **B** are not affected by the WXOR instruction and will retain their original values.

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

- The result is stored in the memory location **C**.
- If **C** is not zero, the output is turned on when the instruction is executed. If **C** is zero, the output is turned off.

WXOR	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A	Word Address	Form A
B	Word/Constant	Form A, Constant -32767–32767
C	Word	Form B

Move Instructions

Move Image Register From Table (MIRFT)

The Move Image Register From Table (MIRFT) instruction allows you to copy information into the control relays or the discrete image register from a table of consecutive word locations.

When the input is on, the MIRFT instruction is executed. The operation of the MIRFT instruction is defined as follows:

- The values of up to 256 (N) words (16-4096 bits) are copied, starting at the memory location specified by TS.
- The copy is placed in the control relays or the discrete image register. The LSB of the first word is copied into the point specified by IR.
- The beginning point in the control relays or the discrete image register must be on a eight point boundary (1, 9, 17, 25, and so on).
- All words are copied into the control relays or the image register during each scan.
- The output is turned on when the instruction is executed.

MIRFT	Parameter Type	Valid Parameter Types
Reference Number TS: IR:	Constant Word Address Bit Address	0-32767 Form A X,Y,C,B *
N:	Constant Only	1-256

Move Image Register to Table (MIRTT)

The Move Image Register to Table (MIRTT) instruction allows you to copy information from the control relays or the discrete image register to a table of consecutive word locations.

When the input has power, the MIRTT instruction is executed. The operation of the MIRTT is defined as follows:

- The On/Off state of up to 4096 bits (256 words X 16 bits) is copied from the control relays or the discrete image register, starting at the bit address specified by IR.
- The starting point must be on a eight point boundary (1,9,17, etc.)/ bits are copied in groups of 16 bits.
- The copy begins with the lowest numbered bit address and is placed into work locations, beginning with the LSB of the word specified by TD.
- All bits are copied into the work locations during each scan. There must be a sufficient number of discrete points to copy all bits into the table of N words.
- The output is turned on when the instruction is executed.

MIRTT	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
IR:	Bit Address	X,Y,C,B *
TD:	Word Address	Form A
N:	Constant Only	1-256

Move Image Register to Word (MIRW)

The Move Image Register to Word (MIRW) instruction copies a specified number of bits from the discrete image register or the control relay memory locations to a designated word memory location. Up to 16 bits can be copied in a single scan.

When power is passed to the input of a MIRW, the instruction is executed. The operation of the MIRW is defined as follows:

- Up to 16 bits (N) are copied, beginning with the lowers numbered address, which is specified by IR.
- The bits are moved into the work memory location specified by A, beginning with the LSB of the word. If fewer than 16 bits are moved, the remaining bits are set to 0. All bits are copied during a single scan.
- The output is turned on when the instruction is executed.

MIRW	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
IR:	Bit Address	X,Y,C,B
A:	Word Address	Form B
N	Constant Only	1-16

Move Byte, Word, Element (MOVE)

The Move Element (MOVE) instruction copies data bytes, word, or long words from a source location to a destination location.

When the input is turned on, the MOVE instruction is executed. The operation of the MOVE is described as follows:

- The elements are specified in TS are copied to the destination specified by TD.
- The output is turned on after the instruction is executed, unless an error occurs.
- When the count is invalid or any reference data element are undefined, bits 6 and 11 in STW01 are set and STW200 contains a value of 5. The contents of the destination are not changed.
- You can specify the type of the data element to be moved. It can be a byte (8 bits long), word (16 bits), or long words (32 bits).
- The source can be specified as a constant value (signed integer), a direct address or an indirect address.

You can specify an index for the source address using SI as an index into a table when you want to copy elements of a table to a destination. SI designates the relative element, in the table reference by TS, which is to be copied. The element TS[0] is the first element in the table. SI can be a Constant, 0-65535. You can leave the field blank or enter a 0 for no indexing. You can enter any readable word (defined in the table below) that gives the element number of the first element to copy. If an indirect source address is used, the controller first resolves the address and then it indexes it.

You can specify a destination address by using the TD field. You can specify a direct address, any writeable word. MOVE copies the source elements into the memory location starting at this address. You can also specify an indirect address. The long word at this indirect address must contain another address, and MOVE copies the source elements into the memory locations start at this second address.

You can specify an index into the destination address using the optional field DI. This is an index into a table when you want to copy an element into a table. DI designates the relative element in a table, referenced by TD, into which the source is copied. The element at TD[0] is the first element in the table. DI can be either a constant (0-65535), blank or 0 for no indexing or you can enter a variable index. A variable index specifies any readable word. The content of this address is an unsigned integer, 0 -65535, that gives the element number of the first element in the table to which the source elements are copied. If an indirect destination address is indexed, the controller first resolves the address and then it indexes it.

You can specify the number of elements to be copied in the count field N. Count is defined as follows:

- A Constant count used to specify an unsigned integer in the range 1-32767.
- A variable count, with any readable word. The value of the count is determined by the contents of this work when the MOVE executes. The count range is 0 - 32767, where 0 means that no elements are moved.

MOVE	Parameter Type	Valid Parameter Types
Reference	Constant	0-32767
TS:	Word/Constant	Form A (direct or indirect) , Constant -2048 – 2047
IS:	Blank/Constant/Word	Form A, Blank, Constant 0-65535
TD:	Word Address	Form A (Indirect address), Form B (Direct Address)
DI:	Blank/Constant/Word	Form A, Blank, Constant 0-65535
N:	Word/Constant	Form A, Constant 0-32767

Move Word (MOVW)

The Move Word (MOVW) instruction copies up to 256 contiguous words from one location to another. The starting address for the words to be moved is specified by **A** and the starting memory location for their destination is specified by **B**. All words are copied in a single scan.

When power is passed to the input of the MOVW, the instruction is executed. The operation of the MOVW is described as follows:

- A table of up to 256 (N) words having a starting memory location specified by A are copied.
- If a constant value is specified in A, then the constant is copied to all destination locations.
- The words are copied to a destination beginning at the memory location designated by B.
- The output is turned on when the instruction is executed.

MOVW	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A:	Word/Constant	Form A, Constant -32768 – 32767
B:	Word	Form B
N	Constant Only	1-256

Move Word From Table (MWFT)

The Move Word from Table instruction (MWFT) copies a word from a table to a V-memory location. A table pointer designates the address of the next word in the table to be copied. One word is copied during each scan.

The MWFT operates as follows:

- When the Enable/Reset is off, the table starting address S is loaded into pointer **A**.
- When the Enable/Reset turns on, the box is enabled. When the input is turned on, the following actions occur.
    - A word is copied from the table address specified by the value contained in pointer **A** to the memory location specified by **B**.
    - After the word is copied, table **A** (which holds the address of the next word in the table to be copied) is incremented by 1.

- If the Input and the Enable/ Reset remain on, one word is copied every scan. As each word is copied, the table pointer is incremented until N words have been copied.
- The output is trend on when the last word has been copied.
- When the instruction is reset, all table values remain unchanged and the destination address **B** contains the last word copied from the table.

Parameter	Type	Valid Values
Table Number:	Constant	Varies with Table Move configured range
A:	Word Address	V,W,G
B:	Word Address	V,W,G
S:	Word Address	V
N	Constant	1-256

⚠ **Warning**	Do not use the same reference number more than once for the **MWTT** and **MWFT** instruction. Assigning the same reference number can cause unpredictable machine operation.

Move Word to Table (MWTT)

The Move Word to Table instruction (MWTT) copies a word from a source in memory to a destination within a table. A pointer designates the memory location in the table into which the next word is copied. One word is copied per scan.

The MWTT instruction works as follows:

- When the Enable/Reset is off, the table starting address S is loaded into pointer **B**.
- When the Enable/Reset runs on, the box instruction is enabled. When the input also turns on, the following can occur.
  - A word is copied from the memory location specified by **A** to the table memory location specified by the value contained in pointer **B**.

  - Pointer **B**, which holds the destination memory location in the table fro the next word, is incremented by 1.

- If the input remains on, one word is copied every scan. As each word is copied, the table pointer is incremented until N words have been copied.
- The output is turned on when the last word has been copied.
- When the instruction is reset, all value in the table remain unchanged.

Parameter	Type	Valid Values
Table Number	Constant	Varies with Table Move configured range
A:	Word Address	V,W,G
B:	Word Address	V,W,G
S:	Word Address	V
N	Constant	1-256

⚠ **Warning**	Do not use the same reference number more than once for the **MWTT** and **MWFT** instruction. Assigning the same reference number can cause unpredictable machine operation.

Move Word with Index (MWI)

The Move Word with Index (MWI) instruction allows you to copy up to 256 words from one area of V-memory to another area of V-memory during a single scan.

When power is passed to the input, the instruction is executed. The MWI has the following features:

- A table of up to 256 memory locations having a starting index specified in **A** is copied.
- The copied words are placed in a destination table in memory, beginning at the start index specified in **B**.
- All words are copied into the destination table each scan.
- The output is turned on when the instruction is executed.

- If either the source or the destination pointer plus table size exceeds memory size, instruction is not executed. The output is turned off and bit 11 in Status Word 1 is set.

MWI	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A	Word Address	V,W,G
B	Word Address	V,W,G
N	Word Address	V,W,G

Move Word to Image Register (MWIR)

The Move Word to Image Register instruction (MWIR) copies a specified number of bits from a word memory location to the discrete image register or into the control relay memory locations. All bits are copied in a single scan.

When power is passed to the input, the instruction is executed. The instruction has the following features:

- Up to 16 bits (N) in word memory location A are copied, beginning with the least significant bit of the word.
- Bits are copied into the discrete image register or into the control relay memory locations, starting at the address designated by IR. The bits are copied during a single scan.
- The output is turned on when the instruction is executed.

MWIR	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
A	Word Address	Form A
IR	Bit Address	Y,C,B
N	Constant Only	1-16

Search Table for Equal (STFE)

The Search Table for Equal (STFE) instruction locates the next occurrence of a word in a table that is equal to a source word. The position of the matching word is shown by an index.

The STFE has the following properties:

- The Reset must be turned off to initialize the index, setting it to -1.
- The Reset must then be turned on before the STFE can operate.
- When the Enable turns on, the index is incremented by one and specifies the next word in the table to be compared with the source word. The value contained by the index ranges from 0 to N-1 while the STFE is being executed. N is the length of the table.
- The source word WS and the word in the table TS specified by the index are compared.
- If the two words are equal, the STFE output turns on for one scan and then turns off. The index contains the position of them attaching word in the table for the duration of the scan. The contents of the index must be used or saved during this scan since the STFE looks for the next match on the next scan as long as the Enable and Reset remains on.
- If the two words are not equal, the index is incremented by one and the next word in the table is compared to the source word.
- If no matches are found in the table, the output remains off. The index contains the position of the last word in the table.
- The entire table is searched ruing one scan until one match or no match is found.
- If the Enable turns off while the Reset is on, the index holds its current value. If the Reset turns off, the index resets to -1.
- After the entire table has been searched, the STFE must be reset in order to be executed again.

STFE	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WS:	Word Address	Form A
TS:	Word Address	Form A
IN:	Word Address	V,W,G
N	Constant Only	1-256

Search Table for Not Equal (STFN)

The Search Table for Not Equal Instruction (STFN) locates the next occurrence of a word in a table that is not equal to a source word. The position of the non-matching word is shown by an index and the value of the non-matching word is copied into a specified memory location.

The STFN has the following properties:

- The Reset must be turned off to initialize the index, setting it to -1.
- The Reset must then be turned on before the STFN can operate.
- When the Enable turns on, the index is incremented by one and specifies the next word in the table to be compared with the source word. The value contained by the index ranges from 0 to N-1 while the STFN is being executed. N is the length of the table.
- The source words WS and the word in the table TS specified by the index are compared.
- If the two words are not equal, the STFN output turns on for one scan then turns off. The value of the non-matching word is copied into another memory location specified by WO. The index contains the position of the non-matching word in the table for the duration of the scan. The contents of the index must be used or saved during the scan since the SRFN looks for the next match on the next scan as long as the Enable and Reset remains on.
- If the two words are equal, the index is incremented by one and the next word in the table is compared to the source word.
- If no mismatches are found in the table, the output remains off. The index contains the position of the last word in the table.

- The entire table is searched during one scan until mismatch or no mismatch is found.
- If the Enable turns off while the Reset is on, the index holds its current value. If the Reset does turn off, the index resets to -1.
- After the entire table has been searched, the STFN must be reset in order to executed again.

STFN	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WS:	Word Address	Form A
TS:	Word Address	Form A
IN:	Word Address	V,W,G
WO:	Word Address	Form B
N	Constant	1-256

Table to Table And (TAND)

The Table to Table AND (TAND) instruction **ANDs** the corresponding bits in two tables and places the results in a specified third table. If both bits are 1, then the resultant bit is set to 1, otherwise, the result bit is 0.

The TAND has the following properties:

- When the input turns on, a comparison is made between each bit of each word in the first (T1) and second (T2) tables.
- Each pair of bits is **ANDed** and the resultant bit is placed in the third table (TD). If both bits are 1, then the resultant bit is set to 1. Otherwise, the resultant bit is set to 0.

TAND	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
T1:	Word Address	Form A
T2:	Word Address	Form A
TD:	Word Address	Form B
N	Constant Only	1-256

Table to Table Or (TOR)

The Table to Table OR (TOR) instruction ORs the corresponding bits in two tables and places the results in a specified third table. If either bit is 1, then the resultant bit is set to 1. Otherwise, the resultant bit is set to 0.

The TOR operation is described as follows:

- When the input is on, a comparison is made between each bit of the each word in the first, T1 and the second. T2 tables.
- Each pair of bits is Ored, and the resultant bit is placed in the third table (TD). If either bit is 1, then the resultant bit is set to 1. Otherwise, the resultant bit is set to 0.
- The bits in all the word of the two tables are Ored each scan.
- The output is turned on when the instruction is executed.

TOR	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
T1:	Word Address	Form A
T2:	Word Address	Form A
TD:	Word Address	Form B
N	Constant Only	1-256

Table to Table Exclusive Or (TXOR)

The Table to Table Exclusive OR (TXOR) instruction executes an Exclusive OR on the corresponding bits in two tables and places the results in a specified third table. If the bits compared are the same, the resultant bit is set to a 0. If the bits compared are different, the resultant bit is set to 1.

The TXOR instruction is described below:

- When the input turns on, a comparison is made between each bit of each word in the first T1 and the second T2 tables.
- An Exclusive OR is executed on each pair of bits, and the resultant bit is placed in the third table (TD). If the bits compared are either both 1 or both 0, the resultant bit is set to a 0. If the bits compared are unlike (1 and 0), the resultant bit is set to 1.
- An Exclusive OR is executed on the bits in all of the words of the two tables each scan.
- The output is turned on when the instruction is executed.

TXOR	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
T1:	Word Address	Form A
T2:	Word Address	Form A
TD:	Word Address	Form B
N	Constant Only	1-256

Table Complement (TCPL)

The Table Complement (TCPL) instruction inverts the status of each bit in a table and places the results in another specified table.

The TCPL instruction has the following operations:

- When the input turns on, each bit in the source table specified by TS is inverted and stored in the destination table specified by TD. A 0 is inverted to 9. A 1 is inverted to 0.

- The bits in ALL words of the table are inverted each scan.
- The output is turned on when the instruction is executed.

TCPL	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
TS:	Word Address	Form A
TD:	Word Address	Form B
N	Constant Only	1-256

Table to Word (TTOW)

The Table to Word (TTOW) instruction copies a word in a table and places it in another location.

The operation of the TTOW instruction is described below:

- The Reset must be on for the instruction to be executed.
- When the Enable turns on, a copy is made of the specified word in the table TS. The index (IN) indicates which word in the table is copied. The value contained by the index ranges from 0 to N-1, when N is the length of the table. If 0 <= IN <= N, the word is copied. If N <= IN or N < 0, the word is not copied.
- The word is placed in the memory location specified by WD. After the word is placed there, the value contained by the index is incremented by one.
- If both Enable and Reset remain on, one word is duplicated each scan.
- If the Enable turns off while the Reset is on, the index holds its current value and the word is not moved. If the Reset turns off, the index resets to 0.
- The TTOW output remains on until the last word in the table is copied, then turns off.
- The TTOW must be reset after the output turns off in order to be executed again.

TTOW	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WD:	Word Address	Form B
TS:	Word Address	Form A
IN:	Word Address	V,W,G
N	Constant only	1-256

Word to Table (WTOT)

The Word to Table (WTOT) instruction places a copy of a word at a specified address within a table.

The operation of the WTOT is described as follows:

- The Reset must be on for the instruction to be executed.
- When the Enable turns on, a copy of the source word WS is placed in the destination table TD.
- The index (IN) indicates where the word is placed in the table. The value contained by the index ranges from 0 to N-1, where N is the length of the table. If 0 <= IN <= N, the word is moved. If N < IN or N < 0, the word is not moved.
- After the word is placed into the table, the value contained by the index is incremented by one.
- If both Enable and Reset remain on, one word is moved each scan.
- If the Enable turns off while the Reset is on, the index holds its current value and the word is not moved. If the Reset turns off, the index resets to 0.
- The WTOT output remains on until a word is placed in the last position in the table. It then turns off.
- The WTOT must be reset after the output turns off in order to be executed again.

WTOT	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WS:	Word Address	Form A
TD:	Word Address	Form B
IN:	Word Address	V,W,G
N:	Constant Only	1-256

Word To Table And (WTTA)

The Word to Table AND (WTTA) instruction ANDs each bit in a source word with the corresponding bit of a designated word in a table. The results are placed in a destination table. If both bits are 1, a 1 is stored in the destination table. Otherwise, the resultant bit is set to 0.

The WTTA instruction is described below:

- The Reset must be on for the instruction to be executed.
- When the Enable turns on, each bit of the source word WS and of the specified word in the table TS is compared. The index (IN) indicates which word in the table is ANDed. The value contained by the index ranges from 0 to N-1, where \N is the length of the table. If 0 <=IN<N, the word in ANDed. If N <= IN or N < 0, the word is not ANDed.
- Each pair of bits is ANDed, and the resultant bit is placed in the destination table TD. If both bits are 1, the resultant bit is set to 1. Otherwise, the resultant bit is set to 0. After a word in the table is compared, the value contained by in the index is incremented by one.
- If both Enable and Reset remain on, the source word and a word in the table are ANDed each scan.
- If the Enable turns off while the Reset is on, the index holds its current value and the AND does not occur. If the Reset turns off, the index resets to 0.
- The WTTA output remains on until the last word in the table has been ANDed with the source word. It then turns off.
- The WTTA must be reset after the output turns off in order to be executed again.

WTTA	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WS:	Word Address	Form A
TS:	Word Address	Form A
TD:	Word Address	Form B
IN:	Word Address	V,W,G
N:	Constant Only	1-256

Word to Table Or (WTTO)

The Word To Table OR (WTTO) instruction ORs each bit in a source word with the corresponding bit of a designated word in a table. The results are placed in a destination table. If either bit is 1, a 1 is stored in the destination table. Otherwise, the resultant bit is set to 0..

The WTTO instruction is described below:

- The Reset must be on for the instruction to be executed.
- When the Enable turns on, each bit of the source word WS and of the specified word in the table TS is compared. The index (IN) indicates which word in the table is Ored. The value contained by the index ranges from 0 to N-1, where N is the length of the table. If 0 <= IN < N, the word is Ored. IF N <= IN or N < 0, the word in not Ored.
- Each pair of bits is Ored, and the resultant bit is placed in the destination table TD. If either bit is 1, then the resultant bit is set to 1. Otherwise, the resultant bit is set to 0. After a word in the table is compared, the value contained by the index is incremented by one.
- If both Enable and Reset remain on, the source word and a word in the table are Ored each scan.
- If the Enable turns off while the Reset is on, the index holds its current value and the OR does not occur.
- If the Reset turns off, the index reset to 0.

- The WTTO output remains on until the last word in the table has been Ored with the source word. It then turns off.
- The WTTO must be reset after the output turns off in order to be executed again.

WTTO	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WS:	Word Address	Form A
TS:	Word Address	Form A
TD:	Word Address	Form B
IN:	Word Address	V,W,G
N:	Constant Only	1-256

Word to Table Exclusive Or (WTTXO)

The Word to Table Exclusive OR (WTTXO) instruction executes an Exclusive OR on each bit in a source word with the corresponding bit of a designated word in a table. The results are placed in a destination table. If the bits compared are the same, the resultant bit is set to a 0. Otherwise, the resultant bit is set to a 1.

The WTTXO instruction is described below:

- The Reset must be on for the instruction to be executed.
- When the Enable turns on, each bit of the source word WS and of the specified word in the table TS is compared. The index (IN) indicates which word in the table is Exclusive Ored. The value contained by the index ranges from 0 to N-1, where N is the length of the table. If 0 <= IN < N, the word is Ored. If N <= IN or N < 0, the word in not Ored.
- Each pair of bits is Exclusive Ored, and the resultant bit is placed in the destination table TD. If the bits compared are the same, the resultant bit is set to a 0. If the bits compared are different, then the resultant bit is set to 1. After a word in the table is compared, the value contained by the index is incremented by one.
- If both Enable and Reset remain on, the source word and a word in the table are Exclusive Ored each scan.
- If the Enable turns off while the Reset is on, the index holds its current value and the Exclusive OR does not occur.
- If the Reset turns off, the index reset to 0.

- The WTTXO output remains on until the last word in the table has been Ored with the source word. It then turns off.
- The WTTXO must be reset after the output turns off in order to be executed again.

WTTXO	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
WS:	Word Address	Form A
TS:	Word Address	Form A
TD:	Word Address	Form B
IN:	Word Address	V,W,G
N:	Constant Only	1-256

Control Instructions

Special Function Program Call (SFPGM)

The Special Function Program Call (SFPGM) instruction is used to call a SF program for execution.

The SFPGM instruction can be used anywhere within the RLL program that a box instruction can be used. When a priority/non-priority or cycle SF program is called by the SFPGM instruction, the SF program is placed in a queue for execution. Up to 32 SF programs of each type (total 96 in 3 queues) can be queued at a given time. If a queue is full, the request for placement in the queue is made again on the next scan. This continues as long as the input to the RLL SFPGM instruction remains on.

Priority/Non-Priority SF Programs. When power flow to the RLL SFPGM instruction transitions from off to on, the output from the instruction is examined. If the output is off, and the SF program is not currently being executed, the SF program is placed in the queue for execution. The SFPGM instruction has the following features:

- After the SF program is executed, the output is turned on.
- The SF Program does not executed again until the input to the SFPGM instruction transitions from off to on.
- If the controller changes from PROGRAM to RUN mode while the input to the RLL SFPGM instruction is on, the SF program is queued for execution.

Cyclic Programs. When power flow to the RLL SFPGM instruction transitions from off to on, the cyclic SF program is placed in the queue for execution. The SF Program has the following features:

- After the cyclic SF program is executed one time, the output is turned on. The SF program is automatically re-queued for execution, based on the programmed cycle time. This process continues as long as the input to the RLL SFPGM instruction is on.
- The output remains on until the input to the RLL SFPGM instruction is turned off.
- A cyclic SF program is removed from the queue when it completes a scheduled cycle, and the SFPGM instruction's input is turned off.

SFPGM	Parameter Type	Valid Parameter Types
SF Program Number	Constant	1-1023

Special Function Subroutine (SFSUB)

The Special Function Subroutine (SFSUB) instruction is used to call a Special Function subroutine for execution. The SFSUB instruction can be used anywhere within the RLL program that a box instruction can be used. When power flow to the SFSUB instruction transitions from off to on, the output from the instruction is examined to determine subsequent actions.

If the instruction is not currently executing, the instruction is placed in one of the SFSUB queues for execution. There are two SFSUB execution queues, one to handle SFSUB 0 instructions (see below) and the other to handle all other SFSUB instructions.

If the subroutine number is 0, only the instruction parameters P[n] are evaluated (this is known as an SFSUB 0). You can use an SFSUB 0 to execute expressions defined in the instruction parameters without calling an actual Special Function subroutine or program. When an SFSUB 0 instruction is pulled off from its execution queue, the instruction parameters are evaluated and the instruction output is turned on. When SFSUB instructions are pulled off from the other execution queue, the instruction parameters are evaluated, statements in the corresponding Special Function subroutine are executed, and the instruction output is turned on.

The programming device may limit the length of the expression that can be placed into the P[n] fields. Multiple SFSUB instructions with the same value of Program Number can be used in your program since your application may require multiple accesses to the same Special Function subroutine but with different parameters for each access.

With Simatic 505 controllers, up to five parameters may be specified per SFSUB. For CTI 2500 Series controllers, 10 parameters may be specified. Upon initial instruction placement, parameters P1 - P5 are visible. Additional parameters up to P10 may be added to the instruction by placing the ladder cursor within the instruction box and selecting the Program \ Add CFUNC/SFSUB Parameter menu item. These additional parameters may be deleted by placing the ladder cursor in the instruction box and selecting the **Program \ Delete Parameter** menu item. Parameters must be specified in sequential order.

⚠ Warning

Specifying more than 5 parameters is valid only with CTI 2500 Series controllers. Attempting to run a program containing an SFSUB with more than 5 parameters on a Simatic 505 series controller will result in the CPU ceasing operation and entering a fatal error state. If this occurs, Auxiliary Function AUX 29 (PLC Operational Status) will report error code 0114 (L-Memory Checksum Error).

Upon encountering this error condition, it will be necessary to disconnect the battery and re-cycle power to the CPU. To prevent this error, do not attempt to load a program containing an SFSUB with more than 5 parameters, or other instructions designed to only be compatible with the CTI 2500 Series controller, into a Simatic 505 series controller.

Each field P[n] can be one of the following types:

- Constant - any integer or real number.
- Discrete or word element.
- Expression - an expression is a logical group of tokens evaluating to an address or a value, where a token is the smallest indivisible unit (element address, operator, constant, and parenthesis).

Parameter	Type	Valid Values	Function
Program Number:	Constant Only	0-1023	If 0, only the instruction parameters will be evaluated. If 1-1023, the Special Function Subroutine to be called.

Parameter	Type	Valid Values	Function
Stop/Continue on Error:		STOP, CONT	Stop on error terminates the subroutine if an error is detected. Continue on error allows the subroutine to continue so that the error is handled within the subroutine
ER:	Bit Address / Blank	C, Y, WY, V or Blank	The location where error status is written if an error is encountered either during parameter evaluation or subroutine execution.
IN-LINE:	-	NO, YES	If **YES**, the subroutine is executed immediately in-line to the ladder program. The result of the execution is available for the next rung of the current scan. In-line execution is only available for compiled Special Function Subroutines and only within controllers that support PowerMath.
P1: P2: etc.	Constant / Bit / Word / Expression	Form A, complex expressions, Constants	The parameters to be evaluated. If the program number is 1–1023, the parameters are passed to the specified subroutine.

End (END)

The END instruction unconditionally terminates the scan. The instruction does not have any parameters.

The END instruction should always be used to terminate your program. When a controlled executes the END instruction, the program scan is terminated. Any instruction after the END are ignored. The END instruction must be the only instruction in the network.

Do not use the END instruction to separate RLL tasks. If you use and RLL subroutine, place an END instruction between the last network of the main RLL program and the first network of the subroutine.

End Conditional (ENDC)

The ENDC instruction can terminate the program scan under specific conditions. Any instruction after the ENDC instruction are not executed.

When the ENDC instruction is executed, the current program scan is terminated. ENDC operates in conjunction with an input and is executed only when there is power at the input. When the input is off, the ENDC instruction is not executed and the program scan is not terminated.

When the ENDC instruction is active, ladder logic following the ENDC is not executed and outputs following the ENDC are frozen. An active ENDC functions as an end statement for MCRs and JMPS that preceded it, if it is in their zones of control. Outputs between the MCR and JMP and the END remain under the control of the MCR or JMP.

For an ENDC contained within a SKP zone of control, the ENDC is overridden if the SKP receives power flow,

Jump (JMP)

The Jump instruction (JMP) is used to freeze the values of the discrete image register points of the controlled outputs in the JMPs zone of control. The instruction can be used when you need to duplicate the outputs when the outputs are controlled by different logic.

The JMP operates as an output update enable instruction. The JMP must have power flow and cannot be nested within the zone of control of a JMP not having power flow (logic in the JMP zone of control changes the status of the outputs). The JMP supports these features:

- Discrete outputs between a JMP and its corresponding JMPE do not change when the JMP loses power flow.
- JMPE marks the end of the zone of control for the JMP having the same reference number. If you do not use the JMPE, the remainder of the program is placed under the control of the JMP. You can make the JMPE conditional by placing a contact on the same network as the JMPE.
- When a MCR loses power flow, JMP instructions within the MCR's zone of control are overridden. This means that all outputs in the MCR's zone of control are turned off when the MCR loses power flow, even when the outputs are frozen in an ON state by a JMP. This includes network outputs with the network.

Jump End (JMPE)

JMPE marks the end of the zone of control for the JMP having the same reference number. If you do not use the JMPE, the remainder of the program is placed under the control of the JMP. You can make the JMPE conditional by placing a contact on the same network as the JMPE.

Master Control Relay (MCR)

The Master Control Relay is used to turn off blocks of outputs controlled by segments of RLL programs. This is done by clearing the discrete image register points of the controlled outputs to zero.

Although the MCR controls the coils and discrete outputs of box instruction within its zone of control, it does not control the power rail. This means that box instructions will continue to operate normally. In order to disable a box, use an MCR controlled coil output as a normal contact on the same network that contains the box.

The MCR operates as an output/enable instruction with the following features:

- The MCR must have power flow, and not be nested within the zone of control of an MCR not having power flow, for discrete outputs in the MCR zone of control to turn on or stay on.
- The MCR controls the coils and discrete outputs of box instruction in its zone of control.

MCR	Parameter Type	Valid Parameter Types
Reference Number	Constant	1-8

Master Control Relay End (MCRE)

MCRE marks the end of the zone of control for the MCR having the same reference number. If you do not use the MCRE, the remainder of the program is placed under the control of the MCR. You can make the MCRE conditional by placing a contact on the same network as the MCRE. Make user that the contact that controls the MCRE is not controlled by the MCR.

Return From Subroutine (RTN)

The Return from Subroutine (RTN) instruction ends the execution of a RLL subroutine, and returns program execution to the network following the GTS instruction.

A RLL subroutine is executed until a RTN instruction is encountered. When an active RTN is reached in the subroutine, execution is returned to the first instruction following the GTS instruction in the RLL program. The RTN instruction can be either unconditional or conditional. The conditional RTN can be used within a subroutine to satisfy a condition that requires termination of the subroutine. The unconditional RTN must be use d as the last instruction in a subroutine.

> **NOTE:** RTN requires no parameters.

Go to Subroutine (GTS)

The **Go to Subroutine (GTS)** allows you to write RLL programs preceded by a subroutine number and call them to be used where they are needed. A reference number is entered to designate the subroutine number.

When power is passed to the input of the GTS instruction, the RLL program calls the subroutine indicated by the reference number. If there is no power flow to the GTS instruction, the subroutine is not called.

⚠ **Warning**	When online, it is important to create the subroutine and all of the instructions required to define a subroutine (END, RTN, SBR, GTS/PGTS/PGTSZ) BEFORE placing the processor in RUN mode. If you enter a call to a subroutine that does not exist, unpredictable PLC results may occur.

Parameter	Type	Valid Values
Reference Number	Constant	Subroutine number, 1-255

Call Subroutine (SBR)

The Subroutine (SBR) instruction is used before a set of RLL instructions (the RLL subroutine) to be executed only when they are called by the GTS, PGTS, or PGTSZ instruction. When a subroutine is called, it executes until either a conditional RTN with power flow or an unconditional RTN is encountered. When this occurs, RLL execution returns to the instruction following the calling GTS, PGTS or PGTSZ instruction.

Subroutines have the following features:

- Place all subroutines at the end of the main RLL program.
- Separate the main RLL program from the subroutines with an unconditional END instruction.
- A subroutine must be terminated by an unconditional RTN instruction, or a compile error will be generated. An END within a subroutine also generates an errors.
- The unconditional RTN instruction separates a subroutine from a subsequent subroutine.
- You can nest subroutines to 32 levels. A run-time nonfatal errors occurs when you exceed 32 levels (bit 7 in STW1 is set indicating a stack overflow).
- When you pass parameters to the subroutine by calling the subroutine from a PGTS instruction, refer to discrete parameters as Bn and word parameters as Wn, where n is the number of the parameter in the PGTS.
- MCRs, JMPs and SKPs are effected with subroutines. All MCRs and JMPs in a subroutine remain active after a RTN if the instruction within the SBR do not turn them off before the RTN. MCRs and JMPs that are active at the time that the subroutine is called, remain active while the SBR is executing. A SKP/LBL pair must be defined within the same SBR or a compile error occurs.

Parameter	Type	Valid Values
Subroutine Number	Constant	1-255 (GTS) 1-32 (PGTS or PGTSZ)

⚠ **Warning**	Do not use the same subroutine number more than once. Assign the same subroutine number more than once can cause unpredictable machine operation.

Skip (SKP)

The SKP and LBL instructions provide a means of enabling or disabling program segments during a scan. These instructions are often used when duplication of outputs is required and those outputs are controlled by different logic. These instructions can be used to decrease scan time since the interactions between any active SKP and LBL instructions are not executed.

The SKP and LBL support the following features:

- The SKP and LBL instruction must be used together. The LBL must appear before the instruction that terminates the current program segment (TASK, END, RTN). A SKP without a LBL generates a compile error.
- If you use RLL subroutines, you can use up to 255 SKP/LBL instructions within each subroutine and up to 255 SKP/LBL instructions for each TASK segment in the program.
- The reference numbers for the SKP/LBL instruction range from 1 to 255, and numbers cannot be duplicated within a given subroutine or TASK segment.
- The subroutine set distance from the main RLL program and reference numbers used in the subroutine can also be used in the main program. That is SKP23 is the main program does not interfere with a SKP23 in the subroutine.
- When the SKP receiver power flow, all ladder logic between the SKP and its associated LBL is ignored by the controller. Output between the SKP and the LBL are frozen in their current states.
- All ladder logic within the SJP zone of control is executed normally when the SKP does not have power flow.
- For a SKP to LBL function located within the zone of control of an MCR or JMP, the SKP or LBL function overrides the MCR or JMP when the SKP has power flow.
- The zone of control for a SKP is limited to the task segment or subroutine in which the SJP is used; the matching LBL must be defined after the SJP and be located in the same task segment or subroutine as the SKP.
- For a JMPE or MCRE contained within a SKP's zone of control, the program functions as if the JMPE or MCRE is located at the end of the program whenever the SKP is active.

NOTE: When a SKP is active, timers between the SKP and its LBL do not run. Be careful when using timer and drum instructions if you want them to operate while a SKP is active.

SKP	Parameter Type	Valid Parameter Types
Reference Number	Constant	1-255

Label (LBL)

The SKP and LBL instructions provide a means of enabling or disabling program segments during a scan. These instructions are often used when duplication of outputs is required and those outputs are controlled by different logic. These instructions can be used to decrease scan time since the interactions between any active SKP and LBL instructions are not executed.

The SKP and LBL support the following features:

- The SKP and LBL instruction must be used together. The LBL must appear before the instruction that terminates the current program segment (TASK, END, RTN). A SKP without a LBL generates a compile error.
- If you use RLL subroutines, you can use up to 255 SKP/LBL instructions within each subroutine and up to 255 SKP/LBL instructions for each TASK segment in the program.
- The reference numbers for the SKP/LBL instruction range from 1 to 255, and numbers cannot be duplicated within a given subroutine or TASK segment.
- The subroutine set distance from the main RLL program and reference numbers used in the subroutine can also be used in the main program. That is, SKP23 is the main program and does not interfere with a SKP23 in the subroutine.
- When the SKP receiver power flow, all ladder logic between the SKP and its associated LBL is ignored by the controller. Output between the SKP and the LBL are frozen in their current states.
- All ladder logic within the SJP zone of control is executed normally when the SKP does not have power flow.
- For a SKP to LBL function located within the zone of control of an MCR or JMP, the SKP or LBL function overrides the MCR or JMP when the SKP has power flow.

- The zone of control for a SKP is limited to the task segment or subroutine in which the SKP is used; the matching LBL must be defined after the SKP and be located in the same task segment or subroutine as the SKP.
- For a JMPE or MCRE contained within a SKP's zone of control, the program functions as if the JMPE or MCRE is located at the end of the program whenever the SKP is active.

LBL	Parameter Type	Valid Parameter Types
Reference Number	Constant	1-255

Scan Synchronization Inhibit (SSI)

560/565 only

Prevents Hot Standby Unit (HBU) from synchronizing with the current PLC preventing it from coming online.

NOTE: SSI requires no parameters.

Parameterized Go to Subroutine (PGTS)

The PGTS instruction operates similarly to the GTS instruction. The PGTS is used to call a section of the RLL program that is preceded by a subroutine number and executes it. Unlike the GTS, the PGTS allows you to pass parameters to a subroutine. These parameters allow you to write a generic subroutine using parameter identified (IN1-IN20) instead of specific memory locations. Several PGTS instruction using different memory locations as parameters can then call the same general subroutine number.

To Program the Instruction:

To program the instruction, first insert the instruction into the ladder network. Using the Program menu, new parameters may be added or deleted by clicking the appropriate menu option. Once a parameter has been added, it can be selected and edited by clicking once on said parameter from within the box instruction. To delete a parameter, use the menu selection found in the Program menu.

The PGTS instruction works as follows:

- When the input is turned on, the contents of each parameter are set equal to the contents of the memory location specified in the parameter field. Then the subroutine indicated by the PGTS number is called.
- When the subroutine returns control to the main RLL program, the contents of the memory location specified in each read write (IO) parameter field is set equal to the contents of the parameter. The contents of memory locations designated IN are not changed.
- Contents of parameters are stored in PGTS discrete and word parameter areas. When you use a parameter in the subroutine, refer to discrete points as B[n] and words as W[n] where n = number of the parameter.
- You must enter the parameters consecutively. An error will be displayed if you do not.
- If you do not need to specify parameters, it is recommended that you use the GTS instruction instead. The GTS instruction uses less L memory.
- While you can still access any memory location from a subroutine, the PGTS allows you create a generic subroutine that is called by multiple PGTS instruction, varying the parameters.
- If you use an instruction that copies long words into or from the subroutine, you need to allocate a parameter for each word of each long word that is copied.

NOTE: Avoid a direct reference in a subroutine to a memory location that is also identified as a parameter in the PGTS instruction. If you don't, you may create a condition where the value of the parameter and the value in the memory location do not agree.

PGTS	Parameter Type	Valid Parameter Types
Program Number:	Constant	1-32
IN: (input)	Word/Bit	Form A (Word), Form C (Bit)
I0: (output)		

Parameterized Go to Subroutine 0 (PGTSZ)

The PGTSZ instruction operates similarly to the PGTS instruction. The PGTSZ calls an RLL subroutine for execution and passes parameters to it. Unlike PGTS, the PGTSZ clears all discrete I/O parameters when the input to the PGTSZ is off.

When the input is turned on, operation is identical to that of the PGTS. If the input is turned off, all discrete I/O parameters are turned off, and the subroutine is not called.

PGTSZ	Parameter Type	Valid Parameter Types
Program Number:	Constant	1-32
IN: (input)	Word/Bit	Form A (Word), Form C (Bit)
I0: (output)		

External Subroutine Call (XSUB)

The External Subroutine Call (XSUB) allows you to pass parameters to a subroutine that is developed offline in a non-RLL programming language such as C or Pascal, and then call the subroutine for execution.

The operation of the XSUB is described below:

- Parameters must be numbered consecutively.
- When the input is turned on, the parameters are pushed on the user stack in order from the last parameter to the first parameter and then the subroutine is called. When a discrete data element (X,Y,C,B) is specified as an IN parameter, the discrete value is passed in the least significant bit of a long word. All other bits of the long word are unspecified. When a discrete data element is specified as an I/O parameter, the address of the data element is passed. The actual value of the data element is contained in the least significant bit of the byte at this address. Other bits of this byte are unspecified. When a word data element (V,K) is specified as an IN parameter, the value of the long word at this specified data element and the specified data element + 1 is passed. The addressed word is in the most significant half, and the next consecutive word is in the least significant half. Any readable data element is allowed. When a word data element is specified as an IO parameter, the address of the data element is passed. The value of the parameter is contained at this address.

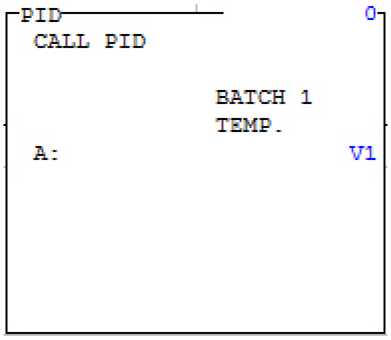
- An XSUB in RLL with no external subroutine causes the user program error bit 6 to be set in STW1. The reason is defined as 6 in STW200. The controller remains in RUN mode.

XSUB	Parameter Type	Valid Parameter Types
Program Number: IN: I0: IN	Constant Only Bit/Word	1-32767 or 1-65535 (software) Form A (Word), Form C (Bit) (No Bit of Words)

PID Loop (PID)

Description

The PID instruction schedules a PID fast loop for immediate execution.



```
PID                        0
 CALL PID

              BATCH 1
              TEMP.
 A:                       V1
```

Field	Valid Values	Function
#	0-65535	Instruction reference number for documentation purposes only. This number can be repeated.
A	Any read-able word	Word that contains a valid fast loop number (129 to 512)
	Any read-able constant	Valid fast loop number (129 to 512)

NOTE: The PID instruction is only supported in controllers that support loop numbers of 129 or higher.

PID Operation

When the input is on, the referenced fast loop executes immediately. The loop algorithm executes for the specific fast loop (129-512) referenced in the instruction box, and turns the output on. If the input stays on, the instruction will continue to execute for every scan, with the following exceptions:

- User program error 13 is logged in STW200 if the fast loop is not configured, and no power is passed to the output.
- User program error 14 is logged in STW200 if the fast loop is disabled, and no power is passed to the output.

Otherwise, the result of the fast loop execution is made available to the next element of the current rung.

Programming fast loops is accomplished in the same manner as loops 1-128, using the **PID Loop Editor**. See **PID Loops** for complete information on programming loops.

New Task (TASK)

The Start New RLL Task (TASK) instruction is used to delimit the main RLL task and the cyclic RLL task.

The TASK instruction is described as follows:

- The Task instruction indicates the RLL instruction which follow it comprise an RLL task segment, where Task Number = 1 for segments of the main RLL task, = 2 designates segments of the cyclic RLL task, and = 8 designates segments of the interrupt task.
- Task 1 is assumed when the first rung does not contain a TASK instruction. A task can consist of multiple segments, each preceded by a TASK instruction. The segments do not have to be contiguous. Terminate an RLL task with another TASK instruction or with the END instruction.
- Task 2 is executed with a higher priority than Task 1. Therefore, normal RLL execution is interrupted by a cyclic RLL task.
- Task 8 is executed with a higher priority than Task 1 or Task 2. Therefore, both the normal RLL and the cyclic RLL are interrupted by a configured I/O interrupt.

- If you specify the cycle time T for a Task 2 task as a readable word, you can change the cycle time on a cycle-by-cycle basis. When T = 0, the default time of 10 ms is used.
- When the normal RLL task fails to complete executed within the specified cycle time, Bit 1 is set in STW219 and Bit 14 is set in STW1 on the next Task 1 scan. When the cyclic RLL task fails to completed execution within the specified cycle time, Bit 2 is set in STW219 on the next Task 2 scan. When a cyclic task overruns, the cycle on which the overrun is detected, is skipped.
- You can display the peak execution times for a task using the Data Window and specifying TPET1 or Task 1 or TPET2 for Task 2.
- You can call any subroutine from a task and the normal subroutine nesting rules apply. A given subroutine should be called from only one task. Subroutines are not re-entrant and subroutine execution initiated by a second task.

TASK	Parameter Type	Valid Parameter Types
Task Number	Constant Only	1,2,8
T	Word/Const	Form A Const 0 – 32767

Special Instructions

Immediate I/O Read/Write (IORW)

The Immediate I/O Read/Write (IORW) instruction allows you to perform an immediate read or write to a discrete or word I/O module on the local base. For inputs, the data transfer is directly from the I/O modules into the image register. For outputs, the data transfer is directly from the image register to the I/O modules.

When the instruction has power, the IORW instruction is executed. The IORW supports these features:

- The data transfer takes place when the instruction is executed in RLL.
- For inputs (X and WX), the status of the specified number of points is copied from the I/O module to the image register.
- For outputs (Y and WY), the status of the specified number of points is copied from the image register to the I/O module.
- Output status follows input status, unless an error occurs.
- For inputs, when the module is not preset or does not match I/O configuration, the specified input points in the image register are cleared to zero and the output turns off.
- For outputs, when the module is not present or does not match I/O configuration, the status of the specified output points in the image register is not copied to the I/O module and the output turn off.

NOTE: When the IORW copies Y values from the image register to a module, the current state of the Y points in the image register are written to the module. IF you want these Ys to be controlled by an MCR or a JMP, the MCR or JMP must be used to control the coils which write to the Ys. The IORW operation is not directly affected by MCRs and JMPs.

IORW	Parameter Type	Valid Parameter Types
Reference Number	Constant	0–32767
ST	Bit Address	Starting address, X, Y, WX, WY
Points	Constant	Number of points to move, 1–64

NOTE: The number of points to move must be a multiple of 8. All points must reside in the same I/O module.

No Operation (NOP)

NOTE: NOP requires no parameters.

Date Compare (DCMP)

The Date Compare instruction (DCMP) compares the current date of the real-time clock with the values contains in the designated memory locations.

When power is passed to the DCMP instruction, the current date in the real-time clock is compared to the date stored in the memory location in the instruction. If the dates match, the output of the instruction is turned on.

DCMP	Parameter Type	Valid Parameter Types
Reference Number	Constant	0–32767
Date:	Word Address	V, W, G

The Data parameter uses 4 words to represent the actual date. These are defined as follows:

- Date = Year - CDB 0000-0099
- Date + 1 = Month - BCD 0001- 0012
- Date + 2 = Day of Month - BCD 0001-0031
- Date + 3 = Day of Week - BCD 0001-0007

Date Set (DSET)

The Date Set (DSET) instruction sets the date portion of the real-time clock to the values contained in the designated address.

When the input to the DSET instruction goes from off to on, the date portion of the real-time clock is set to the values in the memory locations designated by Date and the output is turned on.

DSET	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
Date:	Word Address	V, W, G

The Data parameter uses 4 words to represent the actual date. These are defined as follows:

- Date = Year - CDB 0000-0099
- Date + 1 = Month - BCD 0001- 0012
- Date + 2 = Day of Month - BCD 0001-0031
- Date + 3 = Day of Week - BCD 0001-0007

Time Set (TSET)

The Time Set (TSET) instruction sets the time portion of the real time clock to the values contained in designated memory locations.

When the input to the TSET instruction transitions from off to on, the time portion of the real time clock is set to the values contained within the three consecutive V-memory locations designated by TM, and the output is turned on for one scan.

TSET	Parameter Type	Valid Parameter Types
Reference Number	Constant Only	Varies with configured One shot range
TM	Word Address	V,W,G

The TM parameter uses 3 words to represent the actual time. These are defined as follows:

- TM = Hour - BCD 0000-0023
- TM + 1 = Minute - BCD 0000- 0059
- TM + 2 = Second - BCD 0000-0059

Time Compare (TCMP)

The Time Compare instruction (TCMP) compares current time in the real time clock with values in the designated V-memory locations.

When power is passed to the input, the TCMP instruction is executed. It compares the current hours, minutes and seconds in the real time clock to the values in the designated memory location, TM. If a match occurs, the output of the instruction is turned on. If the time represented by the memory location is less than the real time value in the clock, the bit designated by LT is turned on. If the time represented by the memory locations is greater than the real time value in the clock, the bit designated by GT is turned on.

TCMP	Parameter Type	Valid Parameter Types
Reference Number	Constant	0-32767
TM:	Word Address	V,W,G
LT:	Bit Addr/Blank	Y,C,B, Blank
GT:	Bit Addr/Blank	Y,C,B, Blank

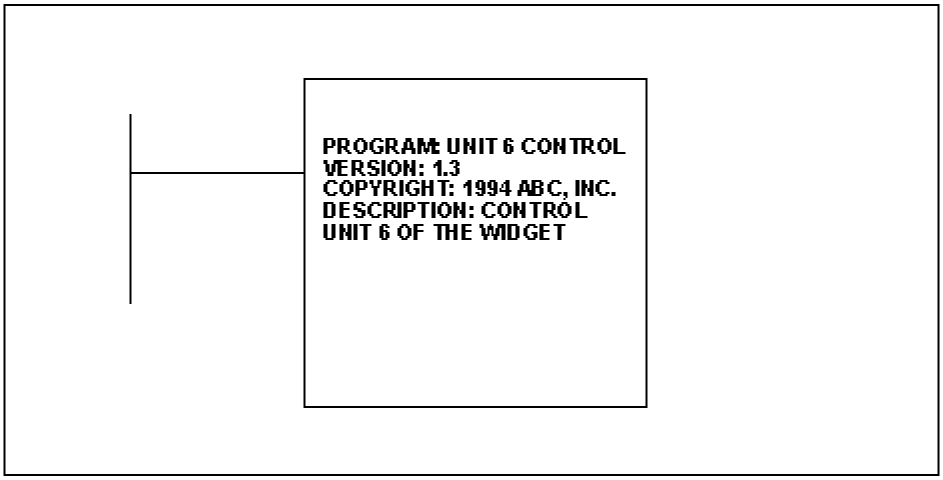
The TM parameter uses 3 words to represent the actual time. These are defined as follows:

- TM = Hour - BCD 0000-0023
- TM + 1 = Minute - BCD 0000- 0059
- TM + 2 = Second - BCD 0000-0059

Text Box Description (TEXT)

The Text box allows you to place textual information, such as copyright, software version, or other text into your RLL program. The instruction forms a single network and takes no action. The Text Box's sole purpose is for documentation.

The text box can hold up to five lines of 40 characters each. Characters allowed in the text box are: A through Z, 0 through 9, space, and printable special characters. Text must be entered within quotation marks.



PROGRAM: UNIT 6 CONTROL
VERSION: 1.3
COPYRIGHT: 1994 ABC, INC.
DESCRIPTION: CONTROL
UNIT 6 OF THE WIDGET

Load Address (LDA)

The Load Address instruction (LDA) copies the logical address of a memory location into a specified memory location (a long or double word). The LDA instruction can be used to before a MOVE instruction, when the indirect addressing method is needed.

When power is passed to the LDA instruction, the LDA instruction is executed. The LDA instruction works as follows:

- The address of the memory location specified in A is copied to the destination specified by BB.
- The output is turned on after the instruction is executed (unless an error occurs).
- If the destination location is invalid, bits 6 and 11 in STW01 are set and the STW200 address contains a value of 5. The destination address is not changed.
- If the input is off, the instruction is not executed and power does not pass to the output.
- The source address should be a direct or indirect address – specify any readable word. For a direct address, LDA copies the logical address for this word into the destination. For an indirect address, precede the address with the @ character. The long word at this indirect address must contain another address, and the LDA copies this second logical address into the destination.

⚠ **Warning**	The address that is copied to the destination is the logical address and NOT the physical address. To avoid unpredictable machine operation, do not use this address as a pointer within an external subroutine.

Parameter	Type	Valid Values
Reference Number	Constant only	0-32767
A:	Word Address	Source address, Form A
AI:	Blank/Word	Source Index, Form A, Blank, -32768 – 32767
BB:	Word Address	Destination address: Form B (direct addr), Form A (indirect addr)
BI:	Blank/Word	Destination Index, Form A, Blank, -32768 - 32767

You can specify the field AI as an index into the source address when you want to copy an address that is in a table. AI should designate the relative word in the table referenced by A. The element A[0] is the first element in the table. The following is a list of valid types for AI:

- Enter a constant 0-65535. If you leave the field blank or enter a 0, then no indexing will be done.
- Enter any readable word (see table above). The contents of this word should be an unsigned integer (0-65535) that gives the value of the index.

If an indirect source address is indexed, the controller first resolves the address, then it indexes it.

You can specify the field B1 as an index into the destination address when you want to copy an address into a word in a table. BI should designate the relative work in a table referenced by BB. Element BB[0] is the first element in the table. The following is a list of valid types for BI:

- Enter a constant 0-65535. If you leave the field blank or enter a 0, then no indexing will be done.
- Enter any readable word (see table above). The contents of this word should be an unsigned integer (0-65535) that gives the value of the index.

If an indirect destination address is indexed, the controller first resolves the address, then it indexes it.

Load Constant (LDC)

The Load Data Constant instruction (LDC) loads a positive integer constant into the designated memory location.

When the input receives power, the LDC instruction is executed. The data constant designated by N is loaded into the memory location specified by A. When the function is executed, the output is turned on.

LDC	Parameter Type	Valid Parameter Types
Reference Number:	Constant	0-32767
A:	Word Address	Form B
N:	Constant Only	0-32767

Lock Memory (LOCK)

The LOCK instruction works with the UNLCK instruction to provide a means in which multiple application in the TI575 coordinate access to shared resources, generally G-memory data blocks.

The LOCK can be either Exclusive or Shared. An Exclusive lock signals other application programs that the resource is unavailable for reading or writing. A shared lock signals other application programs that the resource locations are available for reading only.

The LOCK instruction does not specify the G-memory locations that are protected, nor does the LOCK actually prevent an application from reading or writing to these memory locations. You should write your programs so that the G-memory locations are protected when you gain control of a LOCK. When you program an exclusive lock, no other application program can acquire control of the lock. When you program a shared lock, more than one application program can acquire control of the lock. Use these capabilities in programs that update the shared resource protected by the lock.

In order to use a lock properly, follow these steps:

- AA and (AA+1) must be initialized to 0 prior to the first time.
- When the input is on, the application attempts to acquire the lock. If the lock is not available, the application continues to attempt acquisition of the lock until the lock is acquired or the specified time-out has expired. A value of 0 for T results in

a single attempt to obtain the lock. A value of 3276.7 indicates that the application should try until it obtains the lock or the scan watchdog fatal error occurs.

- If an application obtains the lock before the time-out expires, the output is turned on and the scan continues.
- If the time-out expires before the application obtains the lock, the output is turned off and the scan continues.
- When an application program attempts to acquire control of the lock, the value in AA and AA+1 is examined. If this value indicates that the lock is free, control of the lock passes to the inquiring application program, the output is turned on, and RLL execution continues at the next network.
- When an application program obtains control of the lock, the LOCK instruction increments the value of a lock/unlock counter. The UNLCK instruction decrements the lock/unlock count when an application program relinquished control of a lock. If the counter is not equal to zero at the end of the RLL scan, Bit 6 in STW01 is set to 1 and a value of 3 is written to STW200.

Paramter	Type	Valid Values
Reference Number:	Constant	0-32767
T	Constant Only	time, in ms, 0 – 3276.7
AA	Word Address	V,G (W, doesn't work) Must be 2 words

Unlock Memory (UNLCK)

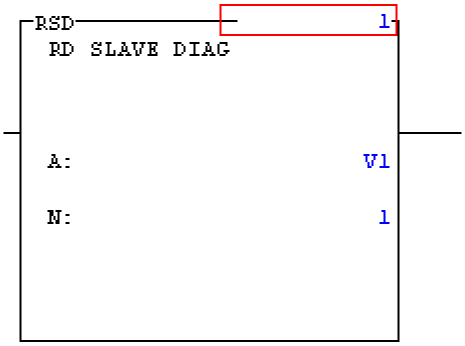
The UNLCK instruction works with the LOCK instruction to provide a means in which multiple application in the TI575 coordinate access to shared resources, generally G-memory data blocks.

UNLCK	Parameter Type	Valid Parameter Types
Reference Number:	Constant	0-32767
AA	Word Address	V,G (W, doesn't work) Must be 2 words

Read Slave Diagnostic (RSD)

Description

The Read Slave Diagnostic instruction transfers a PROFIBUS-DP slave's diagnostic buffer to user memory.



```
RSD                1
RD SLAVE DIAG

A:                V1

N:                 1
```

Parameter	Valid Values	Function
#	1 - 112	Instruction reference number. The number entered indicates the address of the PROFIBUS-DP slave whose diagnostic is to be read. Numbers can be repeated.
A	Any writeable word	Starting memory location for the destination.
N	1 - 256	Maximum number of words to be read.

The diagnostic buffer, whose address in user memory is specified by A, is formatted as shown below.

Word	Byte	Content
A	0	Status as follows: **0 –** Transfer successful. **1 –** Transfer successful. A previous diagnostic was signaled and not read. **2 –** Transfer failed. The specified slave has not signaled a diagnostic.
	1	Length, in bytes, of actual diagnostic.
A+1...A+N-1	all	Diagnostic area

> **NOTE:** The length (byte 1 of word A) indicates the actual diagnostic length, as signaled by the PROFIBUS-DP slave. If the size [(N-1)*2] of the destination buffer's diagnostic area is less than the actual diagnostic length, the diagnostic is truncated by the transfer.

RSD Operation

- When the input is on, the RSD box executes. If the input remains on, the operation executes on every scan. The operation of RSD is as follows:
- If the PROFIBUS-DP I/O subsystem is stopped or if the indicated slave has not signaled a diagnostic since the last execution of an RSD instruction for the slave, the destination buffer's status byte is set equal to 2 and the length is set equal to 0.
- If the slave has not signaled more than one diagnostic since the last execution of an RSD instruction for the slave, the destination buffer's status byte is set equal to 0, the length byte is set equal to the length of the last diagnostic signaled, and the value (possibly truncated) of the latest signaled diagnostic is copied to the diagnostic area.
- If the slave has signaled more than one diagnostic since the last execution of an RSD instruction for the slave, the destination buffer's status byte is set equal to 1, the length byte is set equal to the length of the last diagnostic signaled, and the value (possibly truncated) of the latest signaled diagnostic is copied to the diagnostic area.

If the input is off, the instruction does not execute and the output is off.

NOTE: Status words STW232 through STW238 indicate the PROFIBUS-DP slaves that have signaled a diagnostic that has not been read by an RSD instruction. Use a bit-of-word contact specifying the slave's status word bit as the input to the RSD instruction. Do this in order to execute the instruction whenever there is a diagnostic for the slave corresponding to the bit.

NOTE: The format of a slave's diagnostic buffer is dependent upon the PROFIBUS-DP slave type. See the user documentation for your slave(s).

Force Role Swap (FRS)

The Force Role Swap (FRS) instruction allows you to design a program to switch the active controller with the standby controller in hot backup configurations. The role swap may be the result of programmed diagnostic processors that detect a switch over convert. You can also use the instruction to allow routine maintenance processors. The role swap may be initiated by having a switch close in the I/O or by using a timer to trigger the swap.

The FRS instruction depends upon the current power flow, the power flow on the previous scan and the current state of the controller. This instruction will only work in online only. If no standby controller is preset, the active controller interprets this instruction as a NOP.

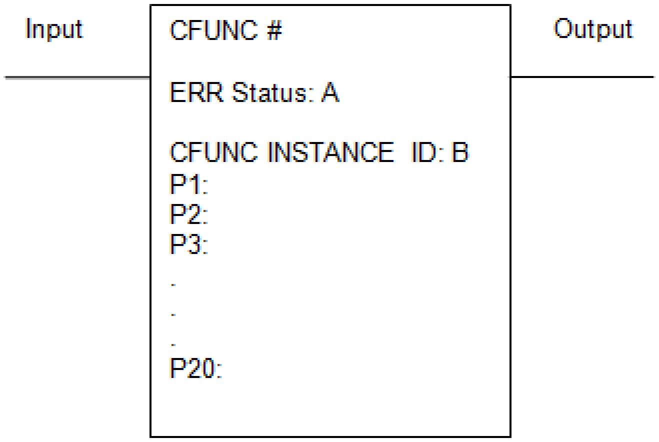
If the active controller with a standby detects an off to on transition on the input, it queues a role swap to occur at the beginning of the next scan. Upon completing the swap, both controllers write the instruction reference number in the assigned memory address. This value can be used to indicate why the role swap occurred.

On each scan, the FRS address is compared to the specified memory location. The output turns on independent of its input whenever the memory location contents match the instruction reference number.

Parameter	Type	Valid Values
Instruction Reference	Constant	Depends on configured One-shot memory configuration
ST	Word Address	V

CTI 2500 Custom Function (CFUNC)

The CFUNC (Custom FUNCtion) RLL instruction initiates custom functionality programmed into the CTI 2500 firmware. This instruction provides a means to implement customer-requested enhancements or complex functions (such as Ethernet client communication operations) that are difficult to implement in ladder logic.



Parameter	Valid Values	Function
#	1-32767	Designates a unique custom function to be called for execution.
A	V	Error Status Starting Address. Starting location in V-memory to write error code(s). Three consecutive 16 bit V memory locations must be reserved. A specific CFUNC may or may not make use of these three error status words.

Parameter	Valid Values	Function
P1 - P20	Any valid 505 memory type or signed long constant (-2147483647 to+2147483646) Run-time error checking validates that parameters entered match function requirements.	Designates memory type/address/data format or 32-bit signed integer value for parameters to be read and/or written by the Custom Function. A maximum of 20 parameters are used. If a parameter is unused for a given CFUNC then a value of 0 will be used as the default. Add a parameter by selecting the **Program \ Add CFUNC Parameter** menu item.

The CFUNC instruction is used to execute a wide variety of functions during the RLL scan time. Some functions can be executed very quickly and will be run to completion in a single scan. Other functions perform communication sequences or complex mathematical operations that require extended period (multiple PLC scans) to complete. The CFUNC instruction does not support automatic “cyclic” operation based on a user-specified time interval. If operation on a specific time interval is desired, the user must use a timer and manually trigger the instruction from RLL.

The CFUNC instruction number (CFUNC#) specifies the function to be called. It is possible for the user to place multiple instances of the same CFUNC# instruction in the RLL program and run them concurrently. Therefore, each instance of the instruction must have a unique instance ID and executes independently. The number of instances for a given CFUNC will depend upon the requirements of the given CFUNC.

Address / Constant Forms Table

The following are valid address types based on address form and PLC type.

Constant Form	520, 530	520C, 525, 530C, 535, 560, 565, 560T, 565T, 545, 555, 575
Form CX	0 - 255	0 - 32737

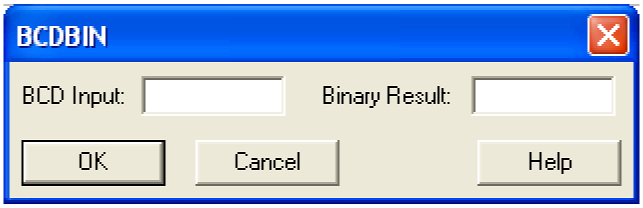
Address Form	520, 530, 520C, 525, 530C, 535	560, 565, 560T, 565T	545, 555	575
Form A	WX, WY, V, TCP, TCC, STW, DSP, DCP, DSC, DCC	WX, WY, V, TCP, TCC, STW, DSP, DCP, DSC, DCC, K, W	WX, WY, V, TCP, TCC, STW, DSP, DCP, DSC, DCC, K, W	WX, WY, V, TCP, TCC, STW, DSP, DCP, DSC, DCC, K, W, G, VMM, VMS
Form B	WY, V, TCP, TCC, DSP, DCP, DSC, DCC	WY, V, TCP, TCC, DSP, DCP, DSC, DCC, W	WY, V, TCP, TCC, DSP, DCP, DSC, DCC, W	WY, V, TCP, TCC, DSP, DCP, DSC, DCC, W, G, VMM, VMS
Form C	Y, C	Y, C, V, WY, B, W, DCC, TCP, TCC	Y, C, V, WY, B, W, DCC, TCP, TCC	Y, C, V, WY, B, W, DCC, TCP, TCC, G

Form D		X, Y, C, V, K, WX, WY, STW, B, W, TCP, TCC, DCC, DSP, DSC, DCP	X, Y, C, V, K, WX, WY, STW, B, W, TCP, TCC, DCC, DSP, DSC, DCP	X, Y, C, V, K, WX, WY, STW, B, W, TCP, TCC, DCC, DSP, DSC, DCP, G
Form E	V	W, V	W, V	W, V, G, VMS, VMM
Form F	X, Y, C	X, Y, C, V, K, WX, WY, STW, B, W, TCP, TCC, DCC	X, Y, C, V, K, WX, WY, STW, B, W, TCP, TCC, DCC	X, Y, C, V, K, WX, WY, STW, B, W, TCP, TCC, DCC, G
Form G	Y, C	Y, C, B	Y, C, B	Y, C, B
Form H	X, Y, C	X, Y, C, B	X, Y, C, B	X, Y, C, B
Form I		X, Y, WX, WY	X, Y, WX, WY	X, Y, WX, WY
Form J		C, Y, WY, V	C, Y, WY, V	C, Y, WY, V

Chapter 11 – Special Functions

Convert BCD To Binary (BCDBIN)

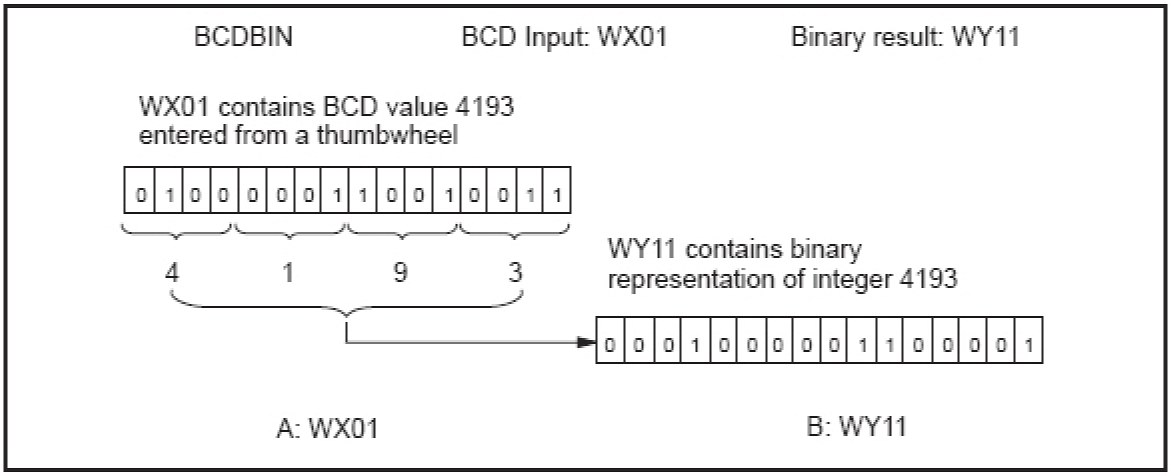
The Convert BCD to Binary statement converts binary coded decimal (BCD) inputs to a binary representation of the equivalent integer.



- **BCD Input -** the memory location of the BCD word to be converted. Valid field descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77).
- **Binary Result -** the memory location of the integer value after conversion. Valid descriptors are writeable integer addresses (addresses containing a writeable integer value such as V101 or WY11).

BCDBIN Operation

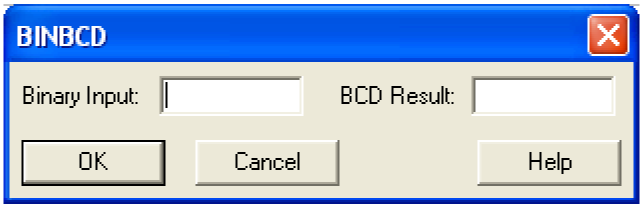
When the BCDBIN statement executes, the four digits of the BCD value located in the address specified BCD Input (A) are converted to the binary form of the equivalent integer value. The result is stored in the address specified in Binary Result (B).



BCD to Binary Statement Operation Example

Convert Binary To BCD (BINBCD)

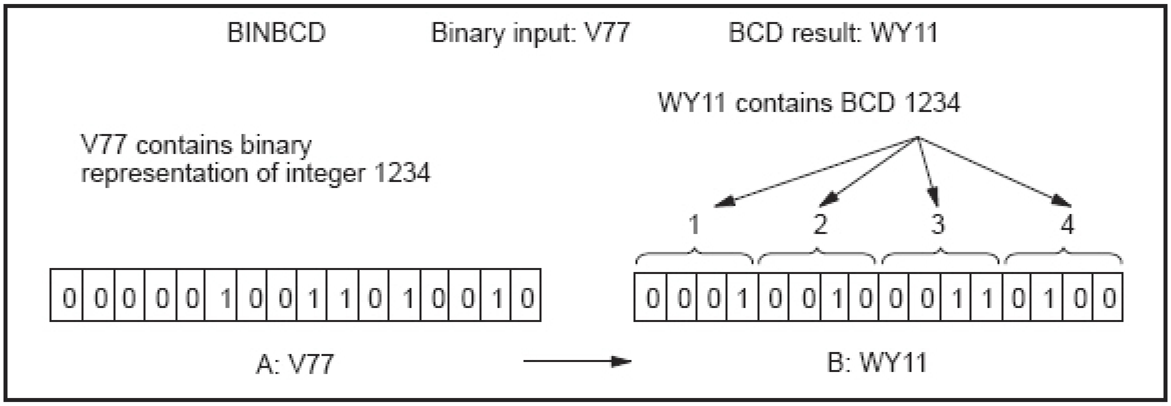
The Convert Binary to BCD statement converts the binary form of an integer to the equivalent Binary Coded Decimal (BCD) value. Values up to 9999 are converted to equivalent BCD values.



- **Binary Input** - the memory location of the binary word to be converted. Valid field descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77).
- **BCD Result** - the memory location of the integer value after conversion. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11).

BINBCD Operation

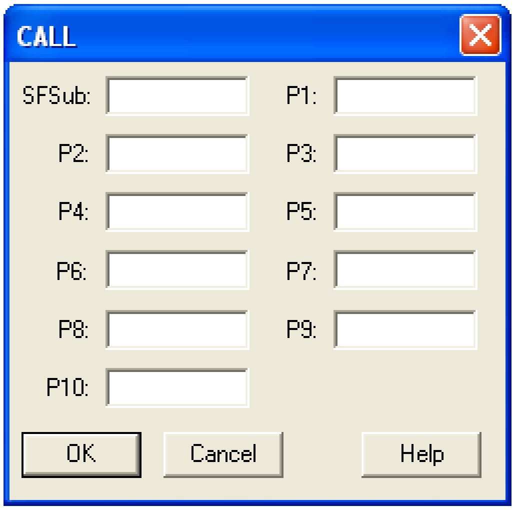
Each time the BINBCD statement executes, the integer located in the address specified in Binary Input (A) is converted to BCD. An error occurs if the input value contained in Binary Input is less than zero or greater than 9999. The BCD value is stored in the address specified in BCD Result (B).



Binary to BCD Statement Operation Example

Call Subroutine (CALL)

The call statement calls a Special Function subroutine for execution. Up to five parameters may be passed to the subroutine by the Call statement.



- **SFSub** - the number of the SF subroutine to be called and ranges from 1 to 1023. The valid field descriptor is an integer literal constant.
- **P1** - a value or constant to be passed between the SF subroutine that is called, and the SF program or subroutine that contains the Call statement. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77), or real addresses or values (any real value or address containing a real value such as 33.642, V100.(2), or V120.); optionally, the field can be left blank.
- **P2** – **P10** an additional value or constant to be passed between the SF subroutine that is called, and the SF program or subroutine that contains the Call statement. Valid descriptors are identical to **P1**. This field may be left blank. Please note that while CTI 2500 PLCs support up to 10 parameters, Simatic 505 PLCs only allow up to 5 parameters (P1-P5).

CALL Operation

Each time the CALL statement executes, control is transferred to the subroutine specified in SFSub. Parameters entered in P1-P10 are read by the specified subroutine. The statements within SFSub are executed, and the parameters entered in P1-P10 that are modified by SFSub are updated. Control is then transferred back to the SF program that called the subroutine.

- P1-P10 are optional fields and can be left blank. Up to five parameters may be entered in these fields. If less than five parameters are entered, they must be entered in order; that is, do not skip P fields when entering parameters.

- To enter a real value instead of an integer, place a **period** after the variable (V100.). To specify a long (32-bit) signed integer, place an **L** after the variable (PowerMath CPUs only). To specify an unsigned 16-bit integer, place a **U** after the variable (PowerMath CPUs only).

> **NOTE**: Specifying a real data type for a parameter in the CALL statement will instruct the controller to ignore the parameter's data type as specified in the SF subroutine and use the parameter as a real number. Conversely, specifying a real data type for a parameter in the subroutine will instruct the controller to ignore the parameter's data type specified as specified in the CALL statement, and use the parameter as a real number.

CALL Subroutine Statement Execution

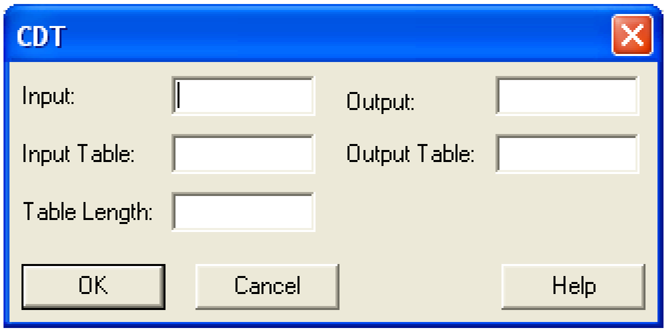
- **CALL Subroutine statement in an interpreted Special Function program or subroutine** - The subroutine parameters are evaluated by the SF interpreter. If the subroutine does not exist or is not enabled, an error is logged in the program's Error Status Address and the subroutine is not executed. Otherwise, if the subroutine has been compiled, its compiled code is executed to completion as part of the call statement. It cannot be interrupted by a higher priority cyclic program, loop, or analog alarm executing from the same queue. If the subroutine has not been compiled, it is executed by the SF interpreter and can be interrupted between statements by a higher priority process in its queue.

- **CALL Subroutine statement in a compiled Special Function program or subroutine** - The subroutine parameters are evaluated by the compiled SF program or subroutine. If the subroutine does not exist, is not compiled, or is not enabled, an error is logged in the program's Error Status Address and the subroutine is not executed. Otherwise, the subroutine's compiled code is executed to completion and cannot be interrupted by a higher priority process in its queue.

NOTE: Subroutines can only be nested to a limit of four levels. Exceeding the limit of for nested levels will result in an error, and the Special Function program and all subroutines below the limit threshold will terminate. CONTINUE ON ERROR will not override this condition.

Correlated Data Table (CDT)

The Correlated Data Table statement compares an input value (the input) to a table of values (the input table), and locates a value in the input table that is greater than or equal to the input. The CDT then writes the value located in a second table (the output table), that is correlated with the value located in the input table, to an output address (the output).



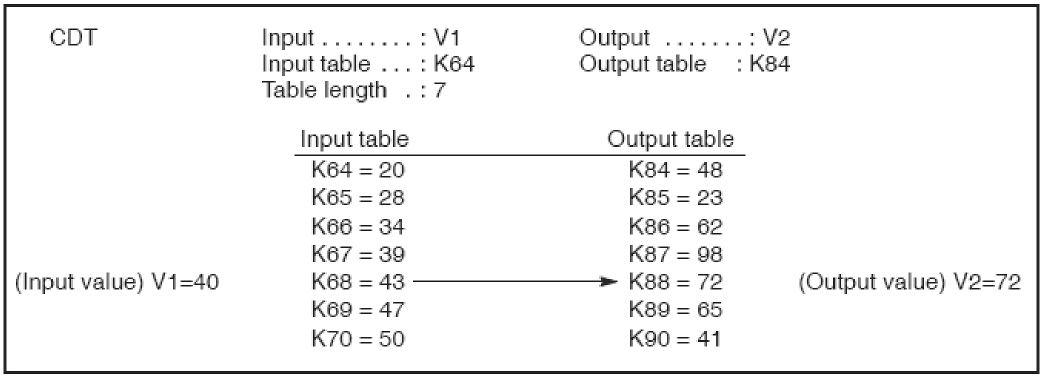
- **Input -** the input address. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77), or real addresses (addresses containing a real value such as 33.642, V120., V100.(2), or WY55).
- **Output -** the address to which the output value is written. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), and writeable real addresses (writeable addresses containing a real value such as V120.).
- **Input Table -** the starting address for the input table. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77), or real addresses (addresses containing a real value such as 33.642, V120., V100.(2), or WY55).
- **Output Table -** the starting address for the output table. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77), or real addresses (addresses containing a real value such as 33.642, V120., V100.(2), or WY55).
- **Table Length -** the length of each table and must be a value greater than zero. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).

NOTE: When used in a compiled Special Function program or subroutine, Input Table and Output Table must be static tables (the table's base address must be a V, K, G, VMS, or VMM address), and Table Length must be specified as a value.

CDT Statement Operation

- When CDT is executed, the CDT compares the value of an input. The element specified in Input is compared to a pre-existing table of values having a starting address specified in Input Table. The first value in the input table that is greater than or equal to the input is located. A value in a second pre-existing table (starting address specified in Output Table) that correlates with the selected value in the input table is written to an output address specified in Output.
    - The input table must be in ascending order. That is, the lowest value is located in the lowest memory location and the highest value is located in the highest memory location.
    - The Table Length depends upon the memory location that you choose, and how much memory you allocated if the memory is user configurable.
    - Both tables must have the same number of entries.

The input address V1 below contains the value 40. The value in the input table that is greater than or equal to 40 is 43, contained in K68. The correlated value in the output table is in K88. The value written to the output address V2 is 72.

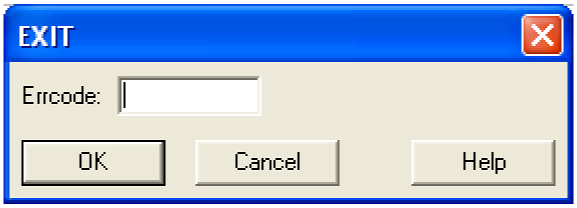


```
CDT                    Input . . . . . . . . : V1         Output  . . . . . . . : V2
                       Input table  . . . : K64           Output table    : K84
                       Table length  . : 7

                          Input table                      Output table
                          K64 = 20                          K84 = 48
                          K65 = 28                          K85 = 23
                          K66 = 34                          K86 = 62
                          K67 = 39                          K87 = 98
(Input value) V1=40       K68 = 43 ──────────────────────►  K88 = 72        (Output value) V2=72
                          K69 = 47                          K89 = 65
                          K70 = 50                          K90 = 41
```

Correlated Data Table Statement Operation Example

Exit on Error (EXIT)

The EXIT statement allows you to terminate a SF program or SF subroutine and have an error code logged. The EXIT format is shown below.



- Errcode - contains the value of the error code and can range from 0 to 255. The valid field descriptor is an integer literal constant. Optionally, this field may be left blank.

Operation of EXIT

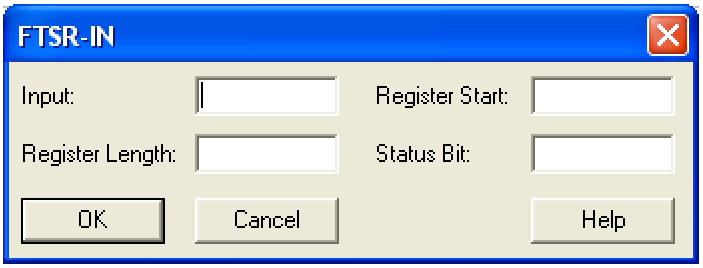
When the SF program encounters the EXIT statement, program execution terminates. If an SF subroutine encounters the EXIT statement, control returns to the statement in the SF program following the SF subroutine call. If you use the EXIT statement in conjunction with an IF statement, you can terminate the program under specific conditions.

- Leaving the Errcode blank writes the current error code to the ERROR STATUS ADDRESS that you specify in the SF program header. If this address is a discrete point, it turns on.

- You can define an error condition and assign it an error code 200-255 (codes 0-199 are reserved). When the EXIT statement executes, the program terminates and this error code is written to the ERROR STATUS ADDRESS. If this address is a discrete point, it turns on.

Fall Through Shift Register–Input (FTSR-IN)

The Fall Through Shift Register Input statement operates an asynchronous shift register. The shift register is essentially a table of 16-bit words. The FTSR-IN moves a word into the shift register each time the statement executes. The FTSR-IN is used in conjunction with the Fall Through Shift Register Output statement (FTSR-OUT) that moves words out of the shift register.



- **Input -** the input address from which the words are moved. Valid field descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77).
- **Register Start -** the starting address for the shift register. Four words (Register Start through Register Start + 3) are automatically reserved for the operation of the statement and make up the header of the shift register. The first word of data shifts into address Register Start + 4. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11).

NOTE: Do not write data to the header fields. The shift register does not operate correctly if any of these fields is modified by an external action. These fields may be redefined in future software releases.

- **Register Length -** the length of the table. If a constant is used, in must be greater than zero. The total length of the shift register is Register Length + header. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Status Bit -** the status bit. This can be either a C or Y. The bit specified by Status Bit turns on when the register is full. The bit Status Bit + 1 is automatically reserved as a second status bit. The bit specified by Status Bit + 1 turns on when the register is empty. Valid descriptors are writeable bit elements (writeable bit ad-

dresses or temporary bit-of-word addresses that are not part of expressions such as C200 or T15.1).

Operation of the FTSR-IN

FTSR-IN is used in conjunction with an FTSR-OUT; you must use the same corresponding values for register start, register length, and status bit in the two FTSR statements. Input is the input address from which the words are moved into the shift register. The starting address Register Start determines the memory area in which the shift register is located. The first word of your data shifts into address Register Start + 4. The four words (Register Start through Register Start + 3) are automatically reserved for the operation of the shift register:

- Register Start contains the Count, which equals the current number of entries in the shift register.
- Register Start + 1 contains the Index, which acts like a pointer to indicate the next available location of the shift register into which a word can be shifted. When Index equals one, the next available location is Register Start + 5, and so on.
- Register Start + 2 contains the Length, which equals the maximum size of the shift register in words.
- Register Start + 3 contains the Checkword. The checkword is used internally to indicate whether the FTSR is initialized.

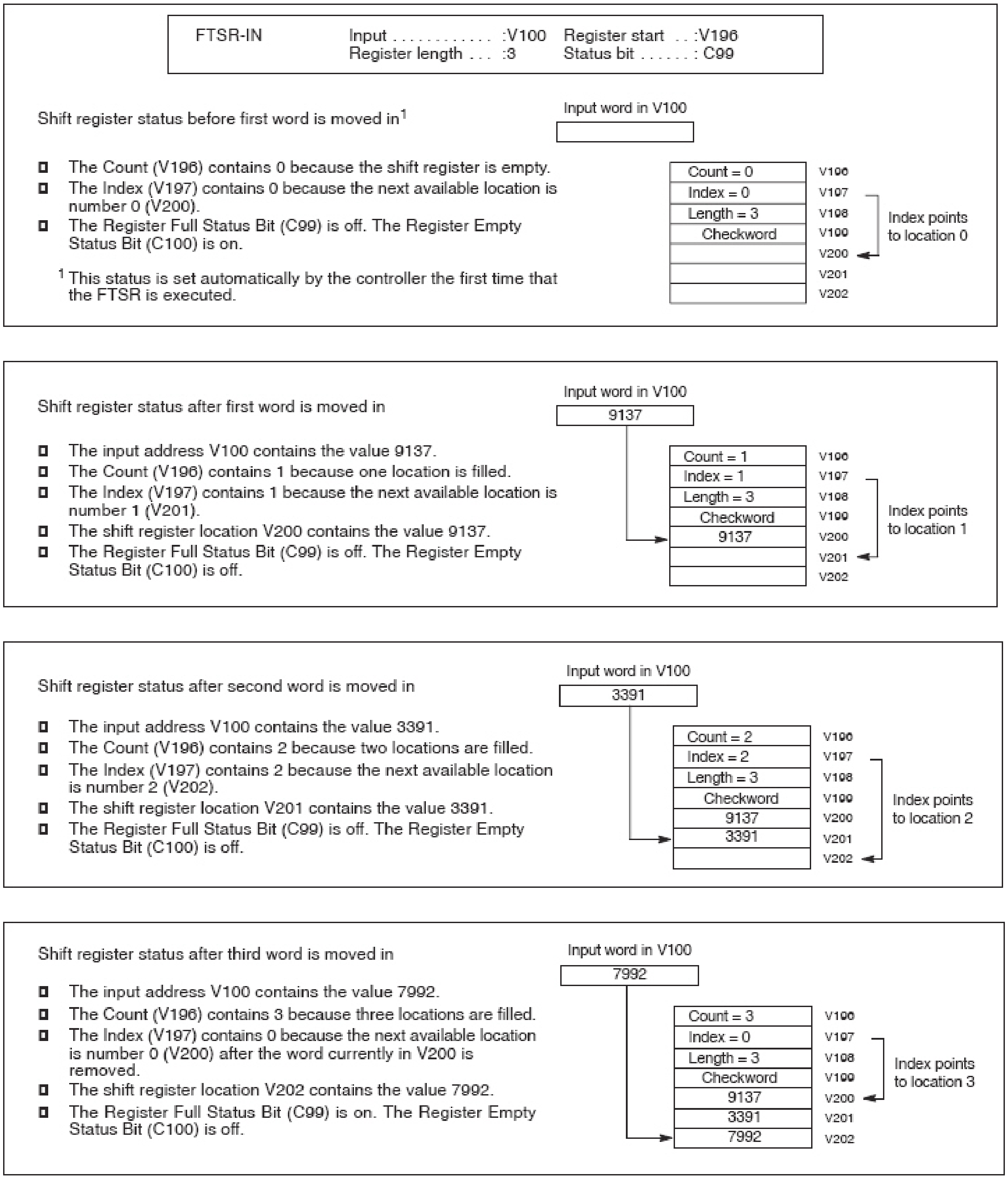
The Register Length determines the size of the shift register. The register length depends upon the memory location that you choose and how much memory you have allocated (if the memory is user-configurable). The Status Bit is turned on to indicate that the register is full. Status Bit + 1 is automatically reserved as a second status bit and turns on whenever the shift register is empty.

Use the same status bits for FTSR-IN that you use for the FTSR-OUT. FTSR-IN sets Status Bit + 1 when the register is empty. FTSR-IN clears this bit. If the shift register is empty, status bit Status Bit is off and Status Bit + 1 is on. When the FTSR-IN executes, the following actions occur:

- The word currently in memory location A is shifted into the location specified by the Index.
- The Count and the index are each incremented by one.
- Status Bit + 1 turns off.

Each time the FTSR-IN executes, another words moves into the next available location; the Index and the Count increment by one. When the Index equals the length, it resets to zero after the next execution by the FTSR-IN. When the shift register is full, another word cannot be shifted in until one is shifted out by the FTSR-OUT statement. Also when the shift register is full, Status Bit turns on. If you attempt to shift in another word, an error generates (error 87).

Use FTSR-OUT to remove words from the shift register before all locations are full. Use FTSR-IN to shift more words into the shift register before all words are removed.



FTSR-IN Input . . . . :V100 Register start . . :V196
Register length . . . :3 Status bit . . . . . . : C99

Shift register status before first word is moved in[1]

- ◘ The Count (V196) contains 0 because the shift register is empty.
- ◘ The Index (V197) contains 0 because the next available location is number 0 (V200).
- ◘ The Register Full Status Bit (C99) is off. The Register Empty Status Bit (C100) is on.

[1] This status is set automatically by the controller the first time that the FTSR is executed.

Shift register status after first word is moved in

- ◘ The input address V100 contains the value 9137.
- ◘ The Count (V196) contains 1 because one location is filled.
- ◘ The Index (V197) contains 1 because the next available location is number 1 (V201).
- ◘ The shift register location V200 contains the value 9137.
- ◘ The Register Full Status Bit (C99) is off. The Register Empty Status Bit (C100) is off.

Shift register status after second word is moved in

- ◘ The input address V100 contains the value 3391.
- ◘ The Count (V196) contains 2 because two locations are filled.
- ◘ The Index (V197) contains 2 because the next available location is number 2 (V202).
- ◘ The shift register location V201 contains the value 3391.
- ◘ The Register Full Status Bit (C99) is off. The Register Empty Status Bit (C100) is off.

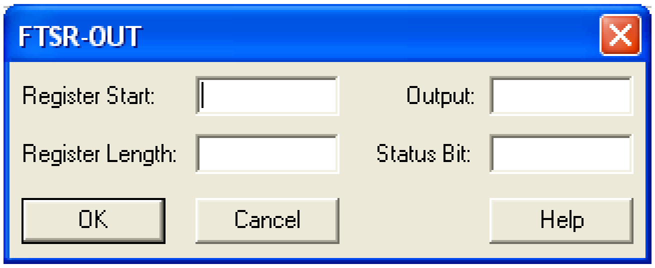
Shift register status after third word is moved in

- ◘ The input address V100 contains the value 7992.
- ◘ The Count (V196) contains 3 because three locations are filled.
- ◘ The Index (V197) contains 0 because the next available location is number 0 (V200) after the word currently in V200 is removed.
- ◘ The shift register location V202 contains the value 7992.
- ◘ The Register Full Status Bit (C99) is on. The Register Empty Status Bit (C100) is off.

Fall Through Shift Register - Input Statement Operation Example

Fall Through Shift Register–Output (FTSR-OUT)

The Fall Through Shift Register Output statement operates an asynchronous shift register. The shift register is essentially a table of 16-bit words. The FTSR-OUT moves data out of the shift register each time the statement executes. The FTSR-OUT is used in conjunction with the Fall Through Shift Register Input statement (FTSR-IN) that moves words into the shift register.



- **Register Start -** the starting address for the shift register. The four words (Register Start through Register Start + 3) are automatically reserved for the operation of the statement and make up the header of the shift register. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11).

> **NOTE:** Do not write data to the header fields. The shift register does not operate correctly if any of these fields is modified by an external action. These fields may be redefined in future software releases.

- **Output -** the output address to which the words are moved. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11).
- **Register Length -** the length of the table. If a constant is used, it must be greater than 0. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Status Bit -** the status bit. This can be either a C or Y. The bit specified by Status Bit is turned on when the register is full. The bit Status Bit + 1 is automatically reserved as a second status bit. The bit specified by Status Bit + 1 is automatically reserved as a second status bit. The bit specified by Status Bit + 1 is turned on when the register is empty. Valid descriptors are writeable bit elements (writeable

bit addresses or temporary bit-of-word addresses that are not part of expressions such as C200 or T15.1).

Operation of the FTSR-OUT

FTSR-OUT is used in conjunction with an FTSR-IN; you must use the same corresponding values for register start, register length, and status bit in the two FTSR statements. Starting address Register Start determines the memory area in which the shift register is located. The first word of user data is located in address Register Start + 4. The four words (Register Start through Register Start + 3) are automatically reserved for the operation of the shift register:

- Register Start contains the Count, which equals the current number of entries in the shift register.
- Register Start + 1 contains the Index, which acts like a pointer to indicate the next available location of the shift register into which a word can be shifted. When the Index equals zero, the next available location is Register Start + 4; when the Index equals one, the next available location is Register Start + 5, and so on.
- Register Start + 2 contains the length, which equals the maximum size of the shift register in words.
- Register Start + 3 contains the Checkword. The checkword is used internally to indicate whether the FTSR has been initialized.

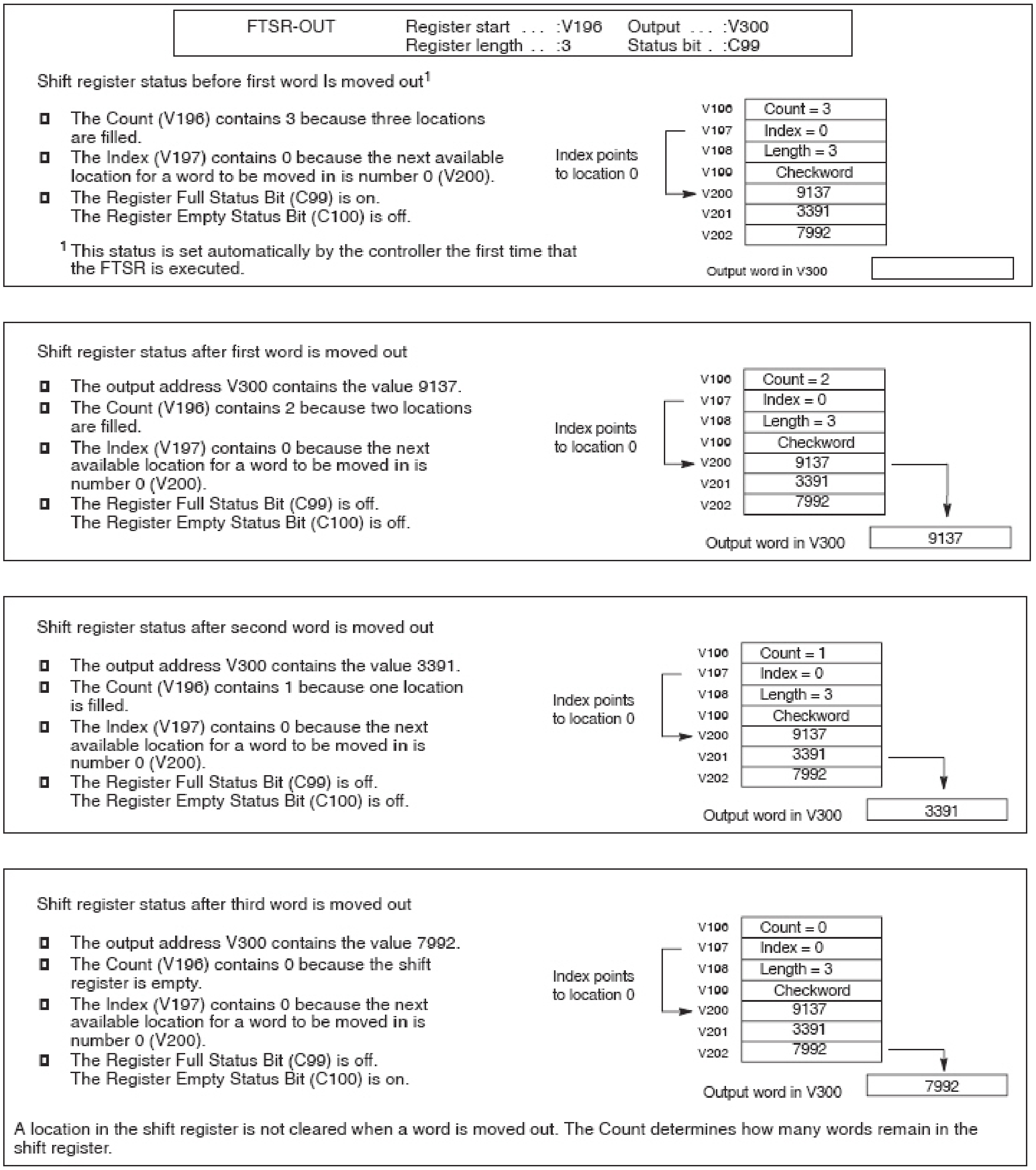
Output is the output address into which the words are moved. The register length Register Length determines the size of the shift register. The register length depends upon the memory location that you choose and how much memory you allocated (if the memory is user configurable). Status Bit turns on to indicate that the register is full. Status Bit + 1 is automatically reserved as a second status bit and turns on whenever the shift register is empty.

Use the same status bits for the FTSR-OUT that you use for the FTSR-IN. FTSR-IN sets Status Bit when the register is full. FTSR-OUT clears this bit as the function executes. FTSR-OUT sets Status Bit + 1 when the register is empty. FTSR-IN clears this bit. If the shift register contains one or more words, the Count equals the number of current entries. The Index points to the next available location of the shift register into which a word can be moved. Status Bit + 1 is off. Status Bit is on if the shift register is full. When the FTSR-OUT executes, the following actions occur:

- The oldest word in the shift register shifts into memory location Output.
- The Count decrements by one.
- The Index is unchanged and continues to point to the next available location into which a word can be moved.

Each time the FTSR-OUT executes, another word moves out of the shift register and the Count is decremented by one. The Index remains unchanged. After the shift register is empty, the Index and Count contain zero. Status Bit turns off and Status Bit + 1 turns on. If you attempt to shift a word out of an empty shift register, an error is generated (error 86).

Use FTSR-OUT to remove words from the shift register before all locations are full. Use FTSR-IN to shift more words into the shift register before all words are removed.



```
FTSR-OUT          Register start  . . . :V196     Output  . . . :V300
                  Register length . .   :3        Status bit .  :C99
```

Shift register status before first word Is moved out[1]

- The Count (V196) contains 3 because three locations are filled.
- The Index (V197) contains 0 because the next available location for a word to be moved in is number 0 (V200).
- The Register Full Status Bit (C99) is on.
  The Register Empty Status Bit (C100) is off.

[1] This status is set automatically by the controller the first time that the FTSR is executed.

V196	Count = 3
V197	Index = 0
V198	Length = 3
V199	Checkword
V200	9137
V201	3391
V202	7992

Shift register status after first word is moved out

- The output address V300 contains the value 9137.
- The Count (V196) contains 2 because two locations are filled.
- The Index (V197) contains 0 because the next available location for a word to be moved in is number 0 (V200).
- The Register Full Status Bit (C99) is off.
  The Register Empty Status Bit (C100) is off.

V196	Count = 2
V197	Index = 0
V198	Length = 3
V199	Checkword
V200	9137
V201	3391
V202	7992

Shift register status after second word is moved out

- The output address V300 contains the value 3391.
- The Count (V196) contains 1 because one location is filled.
- The Index (V197) contains 0 because the next available location for a word to be moved in is number 0 (V200).
- The Register Full Status Bit (C99) is off.
  The Register Empty Status Bit (C100) is off.

V196	Count = 1
V197	Index = 0
V198	Length = 3
V199	Checkword
V200	9137
V201	3391
V202	7992

Shift register status after third word is moved out

- The output address V300 contains the value 7992.
- The Count (V196) contains 0 because the shift register is empty.
- The Index (V197) contains 0 because the next available location for a word to be moved in is number 0 (V200).
- The Register Full Status Bit (C99) is off.
  The Register Empty Status Bit (C100) is on.

V196	Count = 0
V197	Index = 0
V198	Length = 3
V199	Checkword
V200	9137
V201	3391
V202	7992

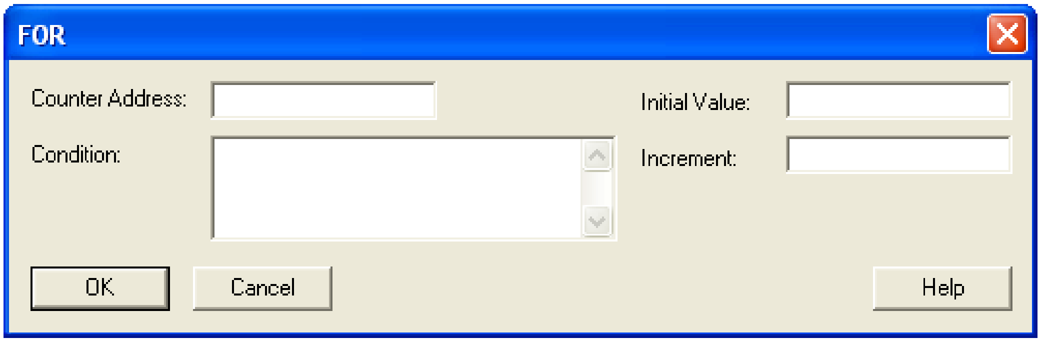
A location in the shift register is not cleared when a word is moved out. The Count determines how many words remain in the shift register.

Fall Through Shift Register - Output Statement Operation Example

For/Next (FOR/NEXT)

The FOR instruction is used in conjunction with a NEXT instruction. The program iterates (loops) between the two statements for a user-specified number of steps. Unlike the WHILE loop, the FOR loop contains an explicit counter to allow the sequencing and number of iterations of the code between the FOR and NEXT instructions to be known. The NEXT instruction is used to designate the end of a FOR loop block. Each FOR instruction must be followed somewhere in the program by exactly one NEXT instruction, and a NEXT instruction cannot be encountered before a corresponding FOR instruction.

Each FOR/NEXT block has a counter that is initialized on entry, an incremental value that is applied at each iteration, and a terminating conditional statement.



- **Counter Address** - the address in which the Initial Value and incremental values upon each iteration are stored. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11).

- **Initial Value** - the value used to initialize the Counter Address. Valid descriptors are integer addresses, values, (any integer value or address containing an integer value such as V100, V100(2), or WX77) or IMATH expressions.

- **Increment** - this value is added to the value stored in the Counter Address upon each NEXT operation. Valid descriptors are integer addresses, values, (any integer value or address containing an integer value such as V100, V100(2), or WX77) or IMATH expressions.

- **Condition** - this statement determines whether or not the FOR loop continues to iterate or terminates to the next statement. Valid descriptors for this field are boolean IMATH expressions.

FOR/NEXT Operation

Upon first pass of the execution loop, the FOR statement initializes the value within the Counter Address to the Initial Value. If this value is true (non-zero), the Condition statement is evaluated. If this value is true, program execution advances to the first instruction after the FOR statement. If this value is false, program execution advances to the first instruction after the NEXT statement.

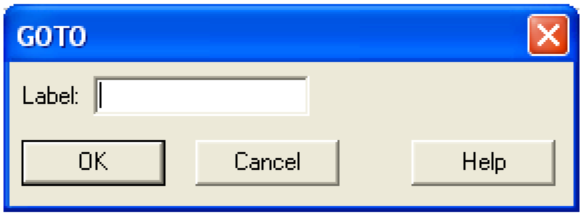
The NEXT statement adds the value of the Increment to the Counter Address and stores the value back to the Counter Address. It then unconditionally jumps back to the corresponding FOR.

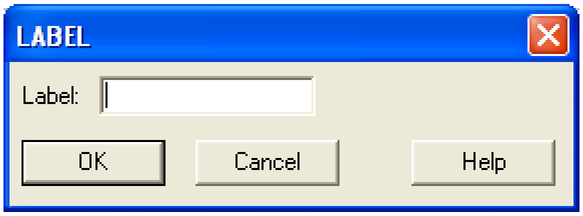
NOTE: If a GOTO instruction is used to jump outside the loop, the Counter Address will reinitialize upon reentry. FOR loops may be nested four levels deep, for a maximum of five levels.

⚠ **Warning**	This instruction is compatible with CTI 2500 Series controllers only. Attempting to run a program with this instruction on a Simatic 505 series controller will result in the CPU ceasing operation and entering a fatal error state. If this occurs, Auxiliary Function AUX 29 (PLC Operational Status) will report error code 020C (Invalid Control Block). Upon encountering this error condition, it will be necessary to disconnect the battery and re-cycle power to the CPU. To prevent this error, do not attempt to load a program containing this or other instructions designed to only be compatible with the CTI 2500 Series controller into a Simatic 505 series controller.

Go To/Label (GOTO/LABEL)

The GOTO statement continues program execution at a specified LABEL statement. The GOTO and the LABEL statements are always used together. The format of the two statements is shown below.



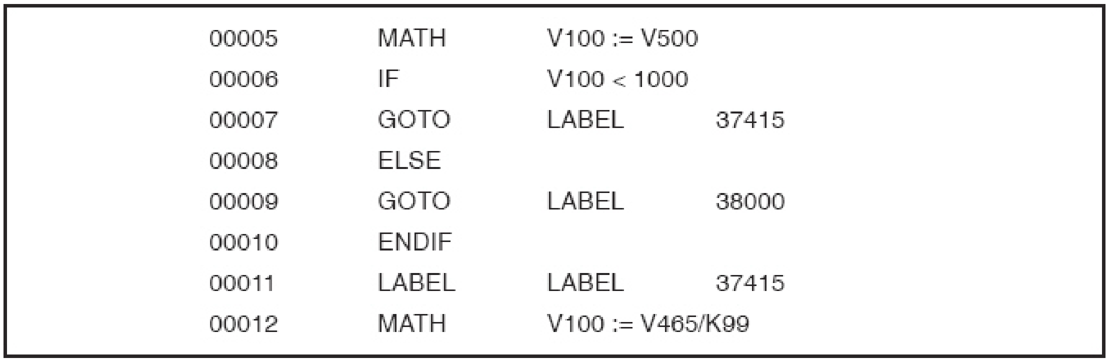


- **Label** - the label can range from 0 to 65535. The valid field descriptor is an integer literal constant.

Goto/Label Operation

When the Special Function program encounters the GOTO, program execution continues at the specified label.

Label 37415 below exists on line 11 and is referenced by the GOTO statement on line 7. If V100 is less than 1000, program execution continues at line 11. Otherwise, program execution continues wherever the program encounters label 38000.



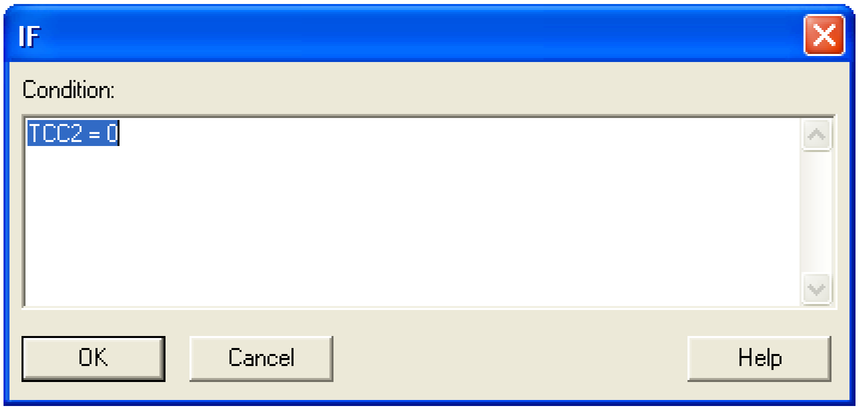
```
00005     MATH     V100 := V500
00006     IF       V100 < 1000
00007     GOTO     LABEL     37415
00008     ELSE
00009     GOTO     LABEL     38000
00010     ENDIF
00011     LABEL    LABEL     37415
00012     MATH     V100 := V465/K99
```

Goto/Label Statement Operation Example

NOTE: Do not repeat label definitions or leave a label undefined. To do so may cause the controller to enter FATAL ERROR mode, freeze analog outputs, and turn off discrete outputs. Ensure all labels have unique definitions.

If Functions (IF/IIF/THEN/ELSE/ENDIF)

The IF or IIF (Integer IF) statement is used for the conditional execution of statements.



Condition:

TCC2 = 0

- **Condition** - Any MATH expression(or any IMATH expression for IIF). The use of the assignment operator (:=) is optional.

IF/THEN/ELSE/ENDIF Operation

IF and IIF operate in conjunction with the ELSE and the ENDIF statements. When an IF statement is used, a THEN result is understood. The IF format is shown below.

```
IF                  Free format based on the following structure.

            IF    <valid MATH expression>  . . .  <THEN understood>
                      <SF statement>
                      <SF statement>
                      ...
                      <SF statement>
            ELSE
                      <SF statement>
                      <SF statement>
                      ...
                      <SF statement>
            ENDIF
```

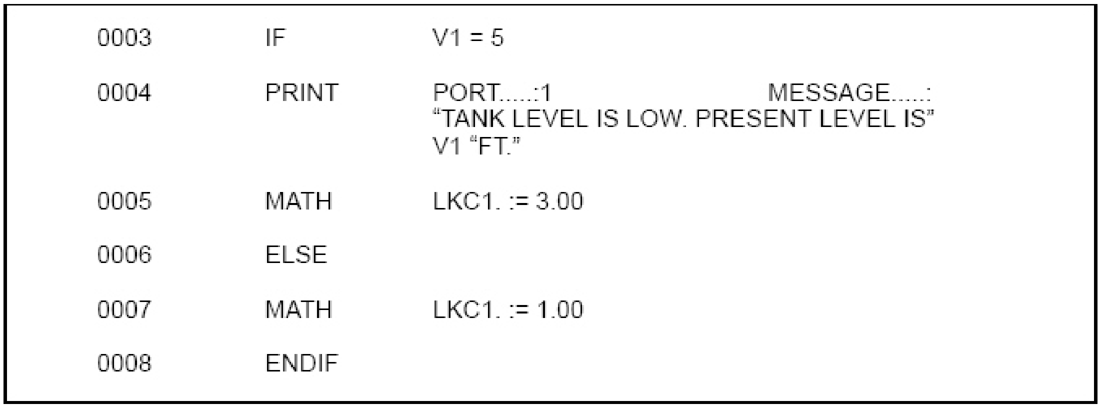
IF/THEN/ELSE/ENDIF Format

In this format, the **SF statement** may be any Special Function program statement. Each time IF executes, the condition defined within the statement is tested. If the MATH expression is true (non-zero), statements in the THEN section execute; any statements in the ELSE section are skipped. If the MATH expression is false (zero), statements in the THEN section are skipped; any statements in the ELSE section execute.

The IF statement operates in conjunction with the ENDIF statement and an optional ELSE statement. ENDIF indicates the end of an IF-THEN-ELSE structure. If there is no ELSE statement, the statements between the IF and the ENDIF are treated as THEN statements. If an ELSE statement is used, any statements between IF and ELSE constitute a THEN section. An ELSE statement indicates the end of the THEN section and the beginning of the ELSE section in an IF-THEN-ELSE structure. Statements between ESLE and ENDIF constitute the ELSE section in the IF statement.

IF, ELSE and ENDIF statements may be nested to any level.

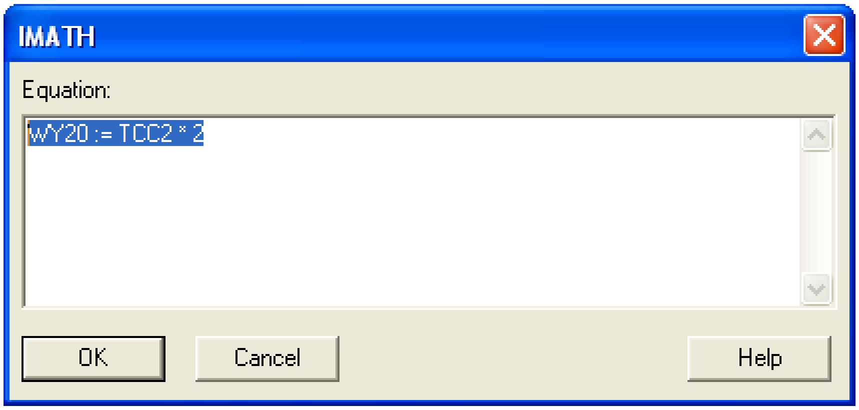
> **NOTE:** Integer IF operations are available only in CPUs that support PowerMath.



```
0003        IF          V1 = 5

0004        PRINT       PORT.....:1                  MESSAGE.....:
                        "TANK LEVEL IS LOW. PRESENT LEVEL IS"
                        V1 "FT."

0005        MATH        LKC1. := 3.00

0006        ELSE

0007        MATH        LKC1. := 1.00

0008        ENDIF
```

Integer Math (IMATH)

The Integer Math statement executes integer arithmetic computations.



WY20 := TCC2 * 2

- **Equation** - Entered as an **A := B** format using the operators below. Valid descriptors for **A** are writeable integer addresses (addresses containing a writeable integer value such as V101 or WY11) and writeable integer bit-of-word addresses. Valid descriptors for **B** are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77) or integer bit-of-word addresses or values.

IMATH Operation

The IMATH format is based on the following operators:

Operator	Description
NOT	Unary Not-The expression "NOT X" returns the one's complement of X.
>>	Shift right (arithmetic)
<<	Shift left (arithmetic)
*	Multiplication
/	Integer division-Any remainder left over after the division is truncated.
MOD	Modulo arithmetic-The expression "X mod Y" returns the remainder of X after division by Y.

Operator	Description
+	Addition
-	Subtraction/unary minus (negation)
=	Equal. The expression X = Y returns 1 if X equals Y, and zero if not.[1]
<>	Not equal. The expression X <> Y returns 1 if X is not equal to Y, and zero if so.[1]
<	Less than. The expression X < Y returns 1 if X is less than Y, and zero otherwise.[1]
<=	Less Than or Equal. The expression X <= Y returns 1 if X is less than or equal to Y, and zero otherwise.[1]
>	Greater Than. The expression X > Y returns 1 if X is greater than Y, and zero otherwise.[1]
>=	Greater Than or Equal. The expression X >= Y returns 1 if X is greater than or equal to Y, and zero otherwise.[1]
AND	Logical AND. The expression X AND Y returns 1 if both X and Y are non-zero, and zero otherwise.[1]
OR	Logical OR. The expression X OR Y returns 1 if either X or Y is non-zero, and zero otherwise.[1]
&	Bit-by-bit AND of two words[1]
|	Bit-by-bit OR of two words[1]
^	Bit-by-bit exclusive OR of two words[1]
:=	Assignment[1]
ABS	Math intrinsic function Absolute Value[1]

[1] Supported by PowerMath CPUs only.

> **NOTE:** Non-PowerMath CPUs do not support the following operators:= <> < <= > >=, AND, OR, and the ABS intrinsic function.

Each time the IMATH statement executes, the calculations within the statement are made. The IMATH computations are executed using the rules of precedence for arithmetic operations listed in the table below.

Functions within a group are equivalent in precedence. Execution takes place from left to right. For example, in the operation (X * Y / Z), X is multiplied by Y, and the result is divided by Z. A subexpression enclosed in parentheses is evaluated before surrounding operators are applied, e.g., in (X+Y) * Z, the sum of X + Y is multiplied by Z. Parentheses, constants, and subscript variables are allowed in the expressions.

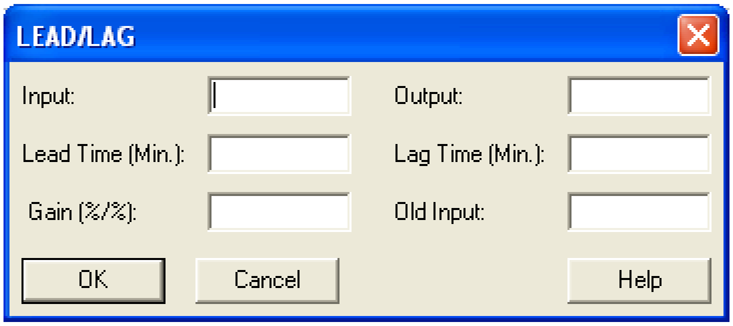
You can use only integers in an IMATH statement. Mixed mode operation (integer and real numbers) is not supported. Denote a binary number by the prefix OB (e.g. 0B10111), a hexadecimal number by the prefix 0H (e.g. 0H7FFF). The programming device checks to see if a statement is valid as you enter the statement and reports an error by placing the cursor in the field where the error occurs.

Order of Precedence for IMATH Operators

Highest Precedence	Intrinsic function ABS[1] , NOT, Negation NOT –
	Multiplication, Division, MOD * / MOD
	Addition, Subtraction + –
	Shift left, Shift right << >>
	Relational Operators (= < < = >= <>)
	&, Logical AND[1]
	|, ^, Logical OR[1]
Lowest Precedence	Assignment :=
[1]Supported by PowerMath CPUs only.	

Lead/Lag (LEAD/LAG)

Use the LEAD/LAG statement to filter an analog variable. This procedure calculates an output based on an input and the specified gain, lead, and lag values. The LEAD/LAG statement can only be used with cyclic processes, such as loops analog alarms, and cyclic Special Function programs.



- **Input** - the location of the input value of the current sample period that is to be processed. Valid field descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77), or real addresses (addresses containing a real value such as 33.642, V120., V100.(2), or WY55).

- **Output** - the location of the output variable; the result of the LEAD/LAG operation. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), and writeable real addresses (writeable addresses containing a real value such as V120.).

- **Lead Time** - the lead time in minutes. Valid descriptors are real addresses or values (any real value or address containing a real value such as 33.642, V100.(2), or V120.).

- **Lag Time** - the lag time in minutes. Valid descriptors are real addresses or values (any real value or address containing a real value such as 33.642, V100.(2), or V120.).

- **Gain** - the ratio of the change in output to the change in input at a steady state, as shown in the following equation:

Gain = Δ output / Δ input

The constant must be greater than zero. Valid descriptors are real addresses or values (any real value or address containing a real value such as 33.642, V100.(2), or V120.).

- **Old Input** - the memory location of the input value from the previous sample period. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), and writeable real addresses (writeable addresses containing a real value such as V120.).

Lead/Lag Operation

For sample time, LEAD/LAG algorithm uses the sample time of the loop, analog alarm, or cyclic SF program from which it is called.

The first time it executes, LEAD/LAG is initialized equals input.

The LEAD/LAG algorithm uses the following equation:

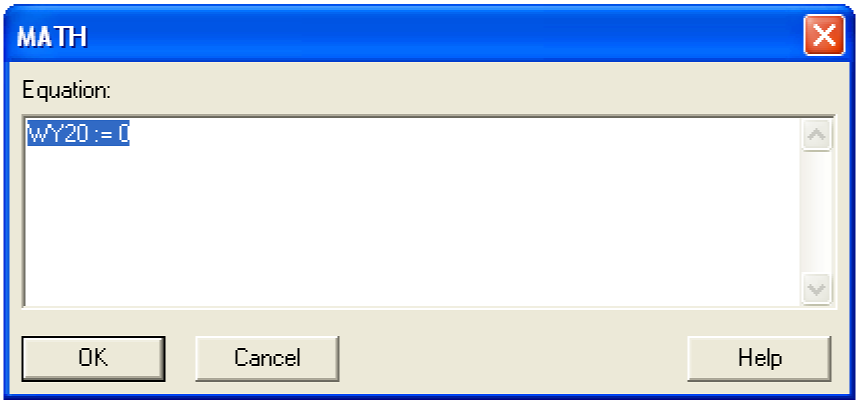
$$Y_n = \left(\frac{T_{Lag}}{T_{Lag} + T_s}\right) Y_{n-1} + \text{Gain}\left(\frac{T_{Lead} + T_s}{T_{Lag} + T_s}\right) X_n - \text{Gain}\left(\frac{T_{Lead}}{T_{Lag} + T_s}\right) X_{n-1}$$

Where:

- **Yn** = present output
- **Yn - 1** = previous output
- **Xn** = present input
- **Xn - 1** = previous input
- **Ts** = sample time in minutes

Real/Integer Math (MATH)

The MATH statement executes arithmetic computations involving both integers and real numbers.



Equation:

WY20 := 0

- **Equation** - Entered as an **A := B** format using the operators below. The **Assignment Operator** (**:=**) is required. Valid descriptors for **A** are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), writeable real addresses (writeable addresses containing a real value such as V120.), and writeable bit-of-word addresses.

  Valid descriptors for **B** are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77), or real addresses or values (any real value or address containing a real value such as 33.642, V100.(2), or V120.), and bit-of-word addresses or values.

MATH Operation

The MATH format is based on the following operators:

Operator	Description
**	Exponentiation
*	Multiplication
/	Division
+	Addition
–	Subtraction / Unary Minus (negation)

Operator	Description
:=	Assignment
>>	Shift right (arithmetic). The sign bit is shifted into the vacated bits.
<<	Shift left (arithmetic). Zeros are shifted into the vacated bits.
=	Equal. The expression X = Y returns 1 if X equals Y, and zero if not.
<>	Not equal. The expression X <> Y returns 1 if X is not equal to Y, and zero if so.
<	Less than. The expression X < Y returns 1 if X is less than Y, and zero otherwise.
<=	Less Than or Equal. The expression X <= Y returns 1 if X is less than or equal to Y, and zero otherwise.
>	Greater Than. The expression X > Y returns 1 if X is greater than Y, and zero otherwise.
>=	Greater Than or Equal. The expression X >= Y returns 1 if X is greater than or equal to Y, and zero otherwise.
MOD	Modulo arithmetic. The expression X mod Y returns the remainder of X after division by Y.
NOT	The expression NOT X returns 1 if X is equal to zero, and returns zero otherwise.
AND	Logical AND. The expression X AND Y returns 1 if both X and Y are non-zero, and zero otherwise.
OR	Logical OR. The expression X OR Y returns 1 if either X or Y is non-zero, and zero otherwise.
&	Bit-by-bit AND of two words
|	Bit-by-bit OR of two words
^	Bit-by-bit exclusive OR of two words

Parentheses, constants, subscript variables, and the following set of intrinsic functions are allowed in the expressions:

Function	Description
ABS	Absolute Value
ARCCOS	Inverse Cosine in Radians
ARCSIN	Inverse Sine in Radians
ARCTAN	Inverse Tangent in Radians
CEIL	CEIL(X) returns the smallest integer that is greater than or equal to X
COS	Cosine in Radians
EXP	Exponential
FLOOR	FLOOR(X) returns the largest integer that is less than or equal to X
FRAC	FRAC(X) returns the fractional portion of X
LN	Natural (base e) Logarithm
LOG	Common (base 10) Logarithm
SIN	Sine in Radians
TAN	Tangent in Radians
ROUND	ROUND(X) returns the integer closest to X
SQRT	Square Root
TRUNC	TRUNC(X) returns the integer portion of X

Each time the MATH statement is executed, the calculations within the statement are made. The MATH computations are executed using the rules of precedence for arithmetic operations listed in the table below. Functions within a group are equivalent in precedence. Execution takes place from left to right for all operators except exponentiation. For example, in the operation (X * Y / Z), X is multiplied by Y, and the result is divided by Z. A subexpression enclosed in parentheses is evaluated before surrounding operators are applied. For example, in (X + Y) * Z, the sum of X and Y is multipled by Z.

The MATH computations are executed using the rules of precedence for arithmetic operations listed in the table below. Functions within a group are equivalent in precedence. Execution takes place from left to right for all operators except exponentiation.

MATH Operator Order of Precedence

Highest Precedence	Intrinsic functions , NOT, Negation NOT –
	Exponentiation[1] **
	Multiplication, Division, MOD * / MOD
	Addition, Subtraction + –
	Shift left, Shift right << >>
	Relational Operators (= < < = >= <>)
	&, Logical AND
Lowest Precedence	|, ^, Logical OR
	Assignment :=

[1] Execution of exponentiation takes place from right to left. For example, in the operation (X ** Y ** Z), Y is raised to the power of Z; and then X is raised to the power determined by the result.

When you read a discrete point in a Special Function program expression, a zero is returned if the discrete bit is off; a one is returned if the discrete bit is on. When you write to a discrete point in an expression, the discrete bit turns off if the value is zero; the discrete bit turns on if the value is non-zero.

The MATH statement accepts both integers and real numbers. The controller executes this mixed-mode operation by converting all integers to real on input and rounding the resulting real to integer if the destination is an integer. The MATH statement also accepts mixed data types. By default, all values are interpreted as integers. Designate values as other data types using the table below.

MATH Data Types

Data Type	Designation	Example
Integer	Default, no designation required	V100
Bit-of-Word[1]	Period, followed by a decimal	V100.1
Real	Period (.) Suffix	LPV35.
Binary	0B Prefix	0B1100100
Hexadecimal	0H Prefix	0H3E8
32-bit Unsigned Integer[2]	U Suffix	V105U
16-bit Signed Integer[2]	L Suffix	-200L
[1]Supported by CTI 2500 Series CPUs only.		
[2]Supported by PowerMath CPUs only.		

The MATH statement accepts two types of subscripted variables: **word indexing** and **element indexing**. Use word indexing to access the nth word from variable Z using the expression **Z(n)**:

Integer	Real	32-bit Unsigned Integer
V100(1) ≡ V100	V100.(1) ≡ V100.	V100L(1) ≡ V100L
V100(2) ≡ V101	V100.(2) ≡ V101.	V100L(2) ≡ V101L
V100(3) ≡ V102	V100.(3) ≡ V102.	V100L(3) ≡ V102L

Use element indexing to access the nth element of array Z using the expression **Z(:n:)**. The actual variable access depends on the type of array:

Integer	Real	Bit-of-Word	32-bit Unsigned Integer
V100(:1:) ≡ V100	V100.(:1:) ≡ V100.	V100.1(:1:) ≡V100.1	V100L(:1:) ≡ V100L
V100(:2:) ≡ V101	V100.(:2:) ≡ V102.	V100.1(:2:) ≡V100.2	V100L(:2:) ≡ V102L
V100(:3:) ≡ V102	V100.(:3:) ≡ V104.	V100.1(:3:) ≡V100.3	V100L(:3:) ≡ V104L

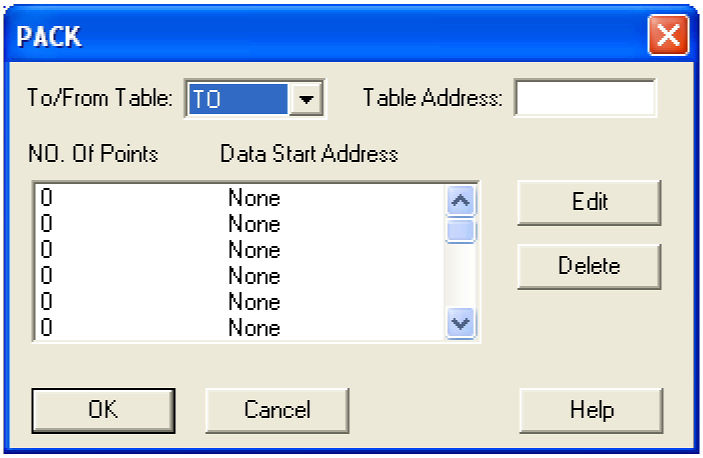
For loop and analog alarm variables, the two types of indexing are equivalent:

LPV1(1) ≡ LPV1(:1:) ≡ LPV1	LPV1.(1) ≡ LPV1.(:1:) ≡ LPV1.
LPV1(2) ≡ LPV1(:2:) ≡ LPV2	LPV1.(2) ≡ LPV1.(:2:) ≡ LPV2.
LPV1(3) ≡ LPV1(:3:) ≡ LPV3	LPV1.(3) ≡ LPV1.(:3:) ≡ LPV3.

NOTE: WorkShop does not support multiple subscripts such as Z(n)(m) or Z(:n:)(:m:). Equivalent expressions are Z(n + m - 1) and Z(:n + m -1:), respectively.

Pack Data (PACK TO/FROM)

The Pack Data statement moves discrete and/or word data to or from a table. You can access the image register directly by using the PACK statement. PACK is primarily intended for use in consolidating data so that it can be efficiently transmitted to a host computer.



PACK

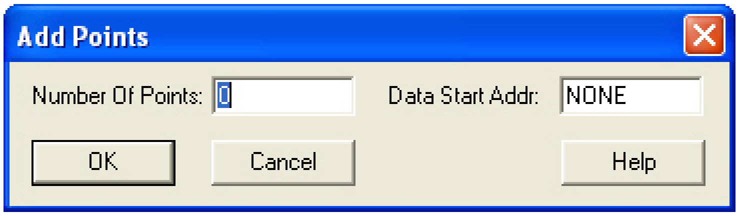
To/From Table: TO   Table Address:

NO. Of Points	Data Start Address
0	None
0	None
0	None
0	None
0	None
0	None

- **To/From Table** - specifies whether you are writing data to or from the table.
- **Table Address** - specifies the address of the table, to or from which data are written or read. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77) if reading from the table, or writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11) if writing to the table.
- **Number Of Points** - specifies how many words or points are to be moved. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Data Start Address** - if writing to the table, specifies the starting address of the points or words that are to be written to the table. If reading from the table, it specifies the starting address in memory into which data is to be read from the table. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77), or real addresses or values (any real value or address containing a real value such as 33.642, V100.(2), or V120.) if writing to the table, or writeable real/integer addresses or values if reading from the table.

PACK Operation

To add points to the PACK operation, select **TO** or **FROM** from the **To/From Table** list box, select a line from the **NO. of Points / Data Start Address** field and click the **Edit** button. The **Add Points** dialog appears.


Add Points

Number Of Points: 0

Data Start Addr: NONE

Up to 20 points may be specified in one PACK operation. The sum of **Data Start Addr** and **Number of Points - 1** must be within configured memory range.

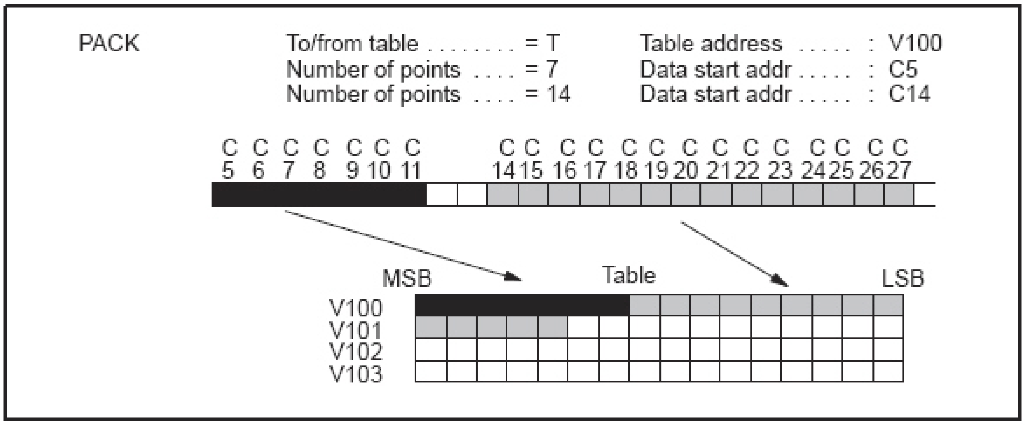

PACK
To/from table .... = T
Number of points .... = 7
Number of points .... = 14
Table address ..... : V100
Data start addr ..... : C5
Data start addr ..... : C14
C 5
C 6
C 7
C 8
C 9
C 10
C 11
C 14
C 15
C 16
C 17
C 18
C 19
C 20
C 21
C 22
C 23
C 24
C 25
C 26
C 27
MSB
Table
LSB
V100
V101
V102
V103

Figure 10 – PACK Statement Operation Example

PACK TO Operation

For a TO table, data are written into a table. This write operation begins with the data starting at the first Data Start Address and writes the specified number of points or words into the table, beginning with the first word of the table. Bits are written sequentially as illustrated below.

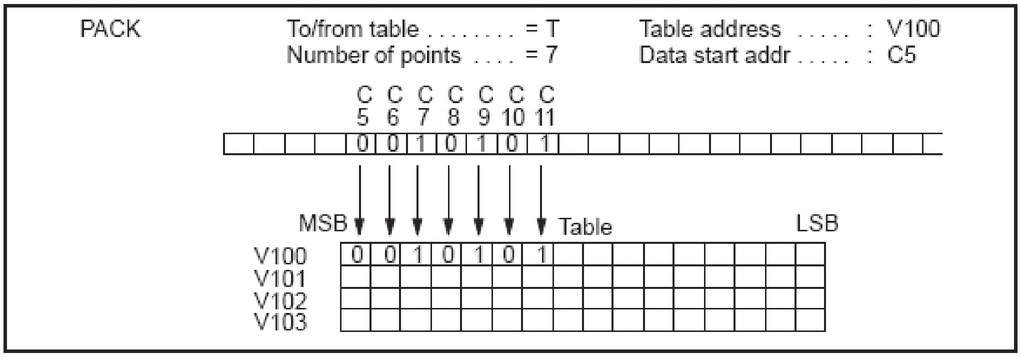

PACK
To/from table . . . . = T
Number of points . . . . = 7
Table address . . . . . : V100
Data start addr . . . . . : C5
C 5
C 6
C 7
C 8
C 9
C 10
C 11
0 0 1 0 1 0 1
MSB
Table
LSB
V100
V101
V102
V103
0 0 1 0 1 0 1

Figure 11 – Example of PACKing Bits To a Table

You can specify multiple blocks of data to be written into the table. When the first word of the table is full, PACK begins to fill the second word. Words are written sequentially into the table, as illustrated below. You can also PACK multiple blocks of words.

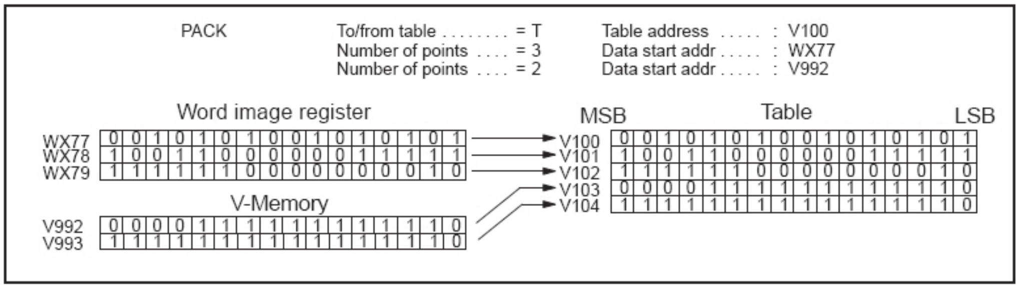
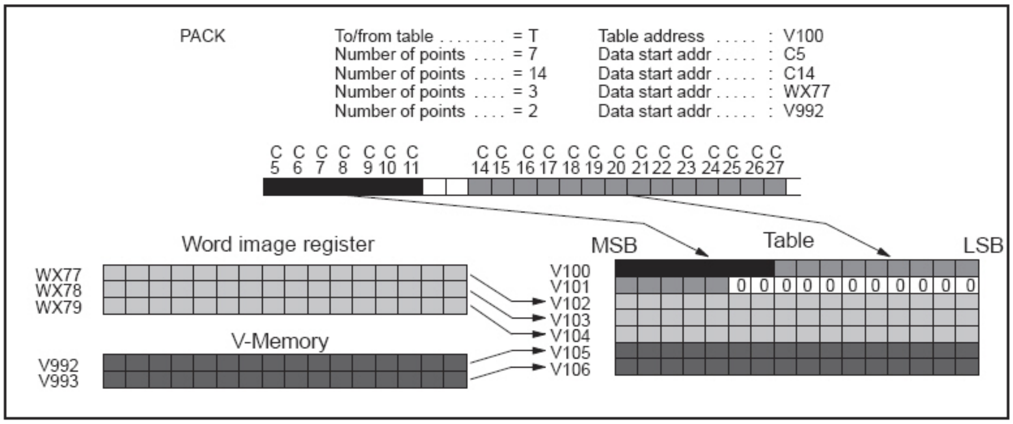

PACK
To/from table . . . . = T
Number of points . . . . = 3
Number of points . . . . = 2
Table address . . . . . : V100
Data start addr . . . . . : WX77
Data start addr . . . . . : V992
Word image register
WX77 0 0 1 0 1 0 1 0 0 1 0 1 0 1 0 1
WX78 1 0 0 1 1 0 0 0 0 0 0 1 1 1 1 1
WX79 1 1 1 1 1 1 0 0 0 0 0 0 0 0 1 0
V-Memory
V992 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0
V993 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
MSB
Table
LSB
V100 0 0 1 0 1 0 1 0 0 1 0 1 0 1 0 1
V101 1 0 0 1 1 0 0 0 0 0 0 1 1 1 1 1
V102 1 1 1 1 1 1 0 0 0 0 0 0 0 0 1 0
V103 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0
V104 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0

Figure 12 – Example of PACKing Words To a Table

You can PACK blocks of words and blocks of bits into a table with one PACK statement. The data are PACKed according to these rules. Discrete points are PACKed into the next available bit in the table. Words are PACKed into the next available word in the table. Unused bits in the previous word fill with zeros when a word is written to the table.

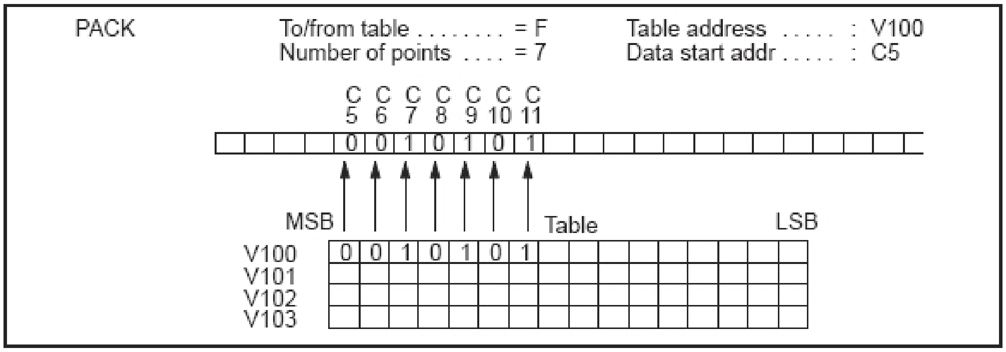


```
PACK    To/from table ........ = T     Table address ..... : V100
        Number of points .... = 7      Data start addr ..... : C5
        Number of points .... = 14     Data start addr ..... : C14
        Number of points .... = 3      Data start addr ..... : WX77
        Number of points .... = 2      Data start addr ..... : V992
```

Figure 13 – Example of PACKing Bits and Words To a Table

PACK FROM Operation

For a FROM Table, data are read from a table. This read operation begins with the table starting address and reads the specified number of points or words from the table. PACK then writes this data, starting with the address designated in the Data Start Address. Bits are written sequentially as illustrated below.



```
PACK    To/from table ........ = F     Table address ..... : V100
        Number of points .... = 7      Data start addr ..... : C5
```

Figure 14 – Example of PACKing Bits From a Table

You can specify multiple blocks of data to be PACKed from the table. You cannot skip sections of the table to PACK data located within the table. If the data that you want to read are located in the least significant nine bits of V100 and the most significant five bits of V101, you must still PACK out the first seven bits of V100 and discard them.

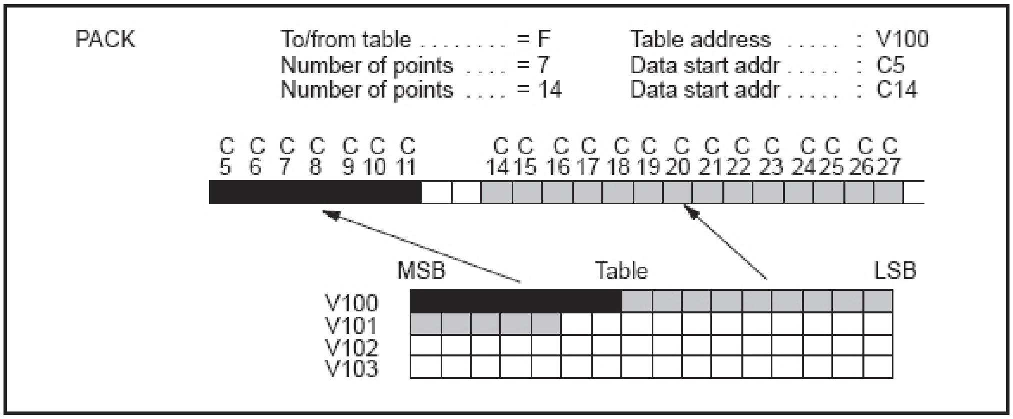

PACK
To/from table . . . . = F
Number of points . . . . = 7
Number of points . . . . = 14
Table address . . . . . : V100
Data start addr . . . . . : C5
Data start addr . . . . . : C14
C 5
C 6
C 7
C 8
C 9
C 10
C 11
C 14
C 15
C 16
C 17
C 18
C 19
C 20
C 21
C 22
C 23
C 24
C 25
C 26
C 27
MSB
Table
LSB
V100
V101
V102
V103

Figure 15 – Example of PACKing Multiple Blocks of Bits From a Table

Words are read sequentially from the table, as illustrated below. You can also PACK multiple blocks of words.

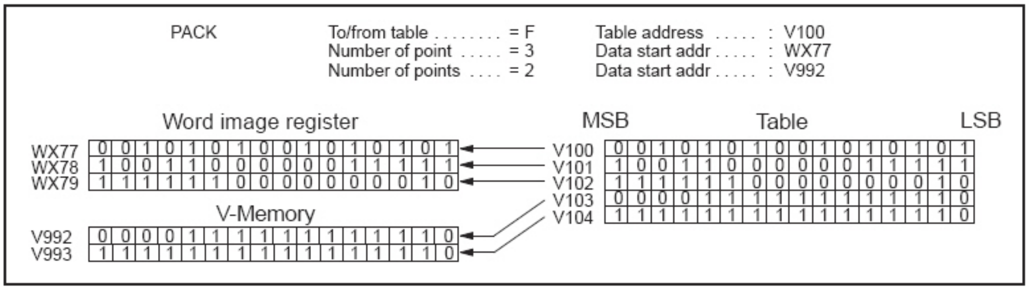

PACK
To/from table . . . . = F
Number of point . . . . . = 3
Number of points . . . . = 2
Table address . . . . . : V100
Data start addr . . . . . : WX77
Data start addr . . . . . : V992
Word image register
WX77 0 0 1 0 1 0 1 0 0 1 0 1 0 1 0 1
WX78 1 0 0 1 1 0 0 0 0 0 0 1 1 1 1 1
WX79 1 1 1 1 1 1 0 0 0 0 0 0 0 0 1 0
V-Memory
V992 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0
V993 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0
MSB
Table
LSB
V100 0 0 1 0 1 0 1 0 0 1 0 1 0 1 0 1
V101 1 0 0 1 1 0 0 0 0 0 0 1 1 1 1 1
V102 1 1 1 1 1 1 0 0 0 0 0 0 0 0 1 0
V103 0 0 0 0 1 1 1 1 1 1 1 1 1 1 1 0
V104 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 0

Figure 16 – Example of PACKing Words From a Table

You can PACK blocks of words and blocks of bits from a table with one PACK statement. All discrete points designated in the Number of Points field are packed from the table. Words are packed from the first available word in the table. Unused bits in the previous word of the table are not included as part of a word that is PACKed from the table.

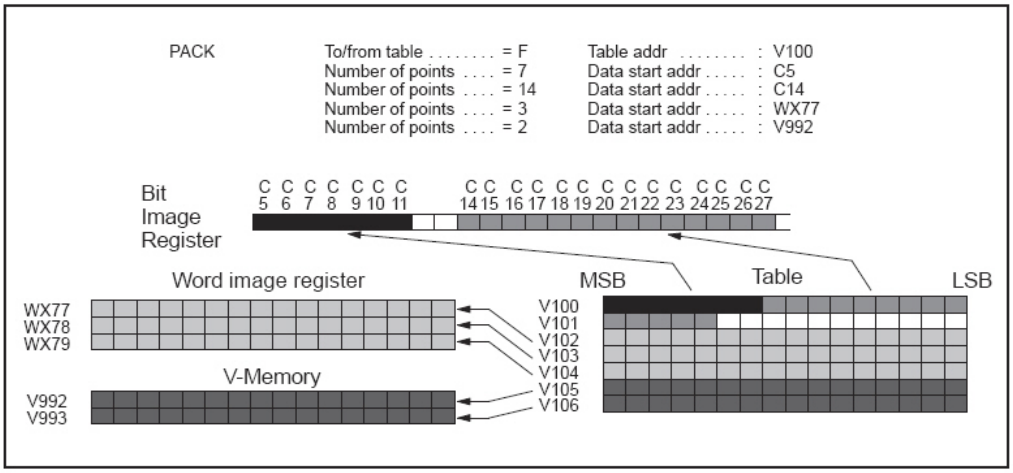
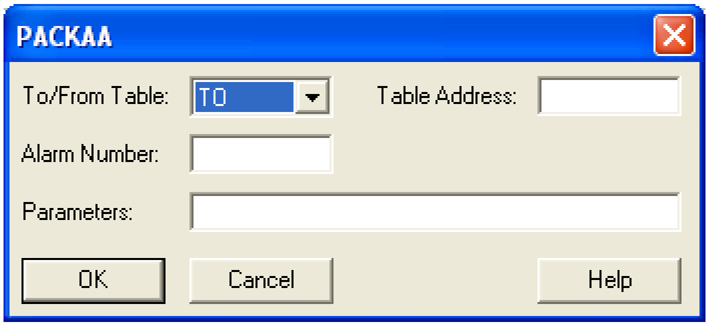

PACK
To/from table . . . . = F
Number of points . . . . = 7
Number of points . . . . = 14
Number of points . . . . = 3
Number of points . . . . = 2
Table addr . . . . : V100
Data start addr . . . . . : C5
Data start addr . . . . . : C14
Data start addr . . . . . : WX77
Data start addr . . . . . : V992
Bit Image Register
C 5
C 6
C 7
C 8
C 9
C 10
C 11
C 14
C 15
C 16
C 17
C 18
C 19
C 20
C 21
C 22
C 23
C 24
C 25
C 26
C 27
Word image register
WX77
WX78
WX79
V-Memory
V992
V993
MSB
Table
LSB
V100
V101
V102
V103
V104
V105
V106

Figure 17 – Example of PACKing Bits and Words From a Table

Pack Analog Alarm Data (PACKAA)

The Pack Analog Alarm Data statement moves analog alarm data to or from a table. PACKAA is primarily intended for use in consolidating analog alarm data to be accessed from an operator interface.



PACKAA

To/From Table: TO

Table Address:

Alarm Number:

Parameters:

- **To/From Table** - specifies whether data is to be written to, or read from, the table.
- **Table Address** - specifies the address of the table, to or from which data are moved. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77) if reading from the table, or writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11) if writing to the table.
- **Alarm Number** - specifies the number of the alarm to be processed. The Alarm Number range is from 1 to the maximum number of alarms. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Parameters**: Specifies the alarm variables. Up to 8 variables can be specified by their mnemonics. Valid descriptors are integer or real analog alarm variable elements (writeable if reading from the table). See the table below for the analog alarm variables.

Analog Alarm Variables

Mnemonic	Variable Name	Mnemonic	Variable Name
AACK	Acknowledge	APV*	Process Variable
AADB*	Deadband	APVH.	Process Variable High Limit
ACF	C-Flags (32 bits)	APVL.	Process Variable Low Limit
ACFH	Most Significant Word of C-Flags	ARCA.	Rate of Change Alarm Limit
ACFL	Least Significant Word of C-Flags	ASP*	Set Point
AERR*	Error	ASPH*	Set Point High Limit
AHA*	High Alarm Limit	ASPL*	Set Point Low Limit
AHHA*	High-High Alarm Limit	ATS.	Sample Rate
ALA*	Low Alarm Limit	AVF	Flags
ALLA*	Low-Low Alarm Limit	AYDA*	Yellow Deviation Alarm Limit
AODA*	Orange Deviation Alarm Limit		

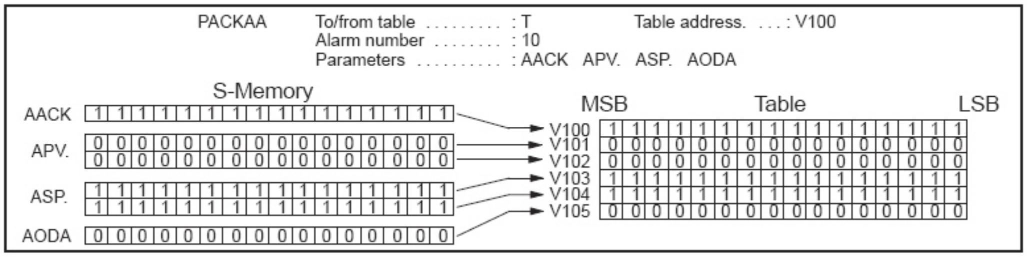
* Variables with an asterisk can be either a real number or an integer. Variables followed by a period are real numbers. Variables not followed by a period are integer. Real addresses use twice the memory integers use.

PACKAA Operation

When the PACKAA statement executes, the following actions occur:

- For a TO Table, the value of the analog alarm variable specified in Parameters is written into the Table Address.

- If additional variables are specified in Parameters, the second variable is written to (Table Address + 1), the third to (Table Address + 2), and so on up to eight variables.



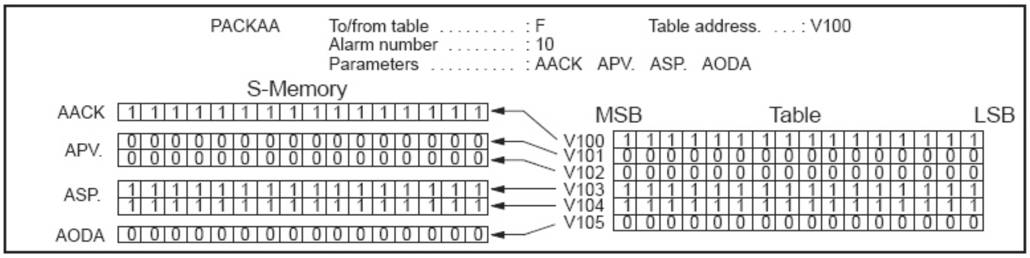
PACKAA To/from table . . . . : T Table address. . . . : V100
Alarm number . . . . : 10
Parameters . . . . : AACK APV. ASP. AODA

S-Memory
AACK 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
APV. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
ASP. 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
AODA 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
MSB
Table
LSB
V100 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
V101 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
V102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
V103 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
V104 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
V105 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Figure 18 – Example of PACKAA To Table Operation

- For a FROM Table, PACKAA writes the word in the Table Address into the specified analog alarm variable.

- If additional variables are specified, the second word in the table is written to the second variable, and so on up to eight variables.



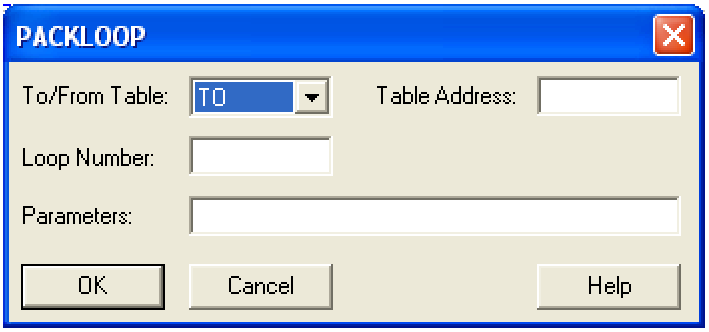
PACKAA To/from table . . . . : F Table address. . . . : V100
Alarm number . . . . : 10
Parameters . . . . : AACK APV. ASP. AODA

S-Memory
AACK 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
APV. 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
ASP. 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
AODA 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
MSB
Table
LSB
V100 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
V101 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
V102 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0
V103 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
V104 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1
V105 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

Figure 19 – Example of PACKAA From Table Operation

Pack Loop Data (PACKLOOP)

The PACKLOOP statement moves loop data to or from a table. PACKLOOP is primarily intended for use in consolidating loop data to be accessed from an operator interface.



- **To/From Table** - specifies whether you are writing data to or from the table.
- **Table Address** - specifies the address of the table, to or from which data are moved. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77) if reading from the table, or writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11) if writing to the table.
- **Loop Number** - specifies the number of the loop to be accessed. The Loop Number range is from 1 to the maximum number of loops. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Parameters** - specifies the loop variables. Up to eight variables can be designated. Valid descriptors are integer or real loop variable elements (writeable if reading from the table). See the table below for the loop variables.

Loop Variables

Mnemonic	Variable Name
LACK	Alarm Acknowledge
LADB*	Alarm Deadband
LCF	C-Flags (32 bits)
LCFH	Most Significant Word of C-Flags
LCFL	Least Significant Word of C-Flags
LERR*	Error

Mnemonic	Variable Name
LHA*	High Alarm Limit
LHHA*	High-high Alarm Limit
LKC.	Gain
LKD.	Derivative Gain Limiting Coefficient
LLA*	Low Alarm Limit
LLLA*	Low-low Alarm Limit
LMN*	Output
LMX*	Bias
LODA*	Orange Deviation Alarm Limit
LPV*	Process Variable
LPVH.	Process Variable High Limit
LPVL.	Process Variable Low Limit
LRCA.	Rate of Change Alarm Limit
LRSF	Ramp/Soak Flags
LRSN	Ramp/Soak Step Number
LSP*	Set Point
LSPH*	Set Point High Limit
LSPL*	Set Point Low Limit
LTD.	Rate
LTI.	Reset
LTS.	Sample Rate
LVF	V-Flags
LYDA*	Yellow Deviation Limit

*Variables with an asterisk can be either a real number or an integer. Variables followed by a period are real numbers. Variables not followed by a period are integers. When you execute PACKLOOP using real numbers, two memory locations are allocated for each real number.

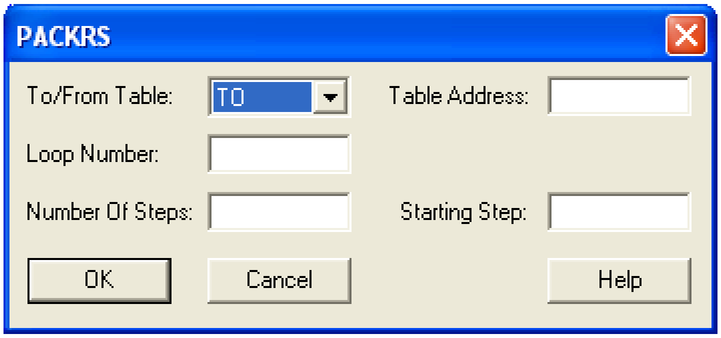
PACKLOOP Operation

When the PACKLOOP statement executes the following actions occur:

- For a TO Table, the value of the loop variable specified in Parameters is written into the table at the Table Address.
- If additional variables are specified, the second variable is written to (Table Address + 1), the third to (Table Address + 2), and so on up to eight variables.
- For a FROM Table, PACKLOOP writes the word in the Table Address into the specified loop variable.
- If additional variables are specified, the second word in the table is written to the second variable, and so on up to eight variables.

Pack Ramp/Soak Data (PACKRS)

The Pack Ramp/Soak Data statement moves one or more steps of the ramp/soak profile for a given loop to or from a table. PACKRS is primarily intended to make the ramp/soak profiles accessible to an operator interface and to provide a method for dynamic ramp/soak profiling.



To/From Table: TO

- **To/From Table** - specifies whether you are writing data to or from the table.
- **Table Address** - specifies the address of the table, to or from which data are moved Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77) if reading from the table, or writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11) if writing to the table.
- **Loop Number** - specifies the loop number whose ramp/soak profile is involved in the pack operation. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Number of Steps** - specifies the number of ramp/soak steps to pack. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Starting Step** - specifies the starting step in the ramp/soak profile at which the pack operation will begin. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).

PACKRS Operation

The number of steps in a ramp/soak profile is established when it is programmed using the Ramp/Soak Editor. The PACKRS instruction cannot expand or shorten the ramp/soak profile for a given loop. This instruction can only read or modify existing steps in a preexisting profile. PACKRS instructions that specify operations on non-existent profile steps are invalid, and the execution of this instruction terminates.

If **TO Table** is specified, this instruction copies the specified number of steps from the ramp/soak profile of a given loop, starting at the specified step number, to a table in memory whose starting address is indicated in the instruction. If **FROM Table** is specified, this instruction copies the specified number of profile steps from a memory table into the ramp/soak profile for the indicated loop starting at the specified step number. The new step values overwrite the affected step values in the profile.

> **NOTE**: Care should be taken when using the PACKRS instruction with a FROM Table specified. If the ramp/soak profile being modified is in progress when the PACKRS instruction executes, then your process could react erratically due to the sudden replacement of values in the profile steps. You can use one of the following methods to ensure that the profile update is done when the current profile is not in progress:

- In your program, check the state of the profile finished bit (bit 4) in LRSF for the corresponding loop. Do not execute the PACKRS statement unless the finished bit is set.

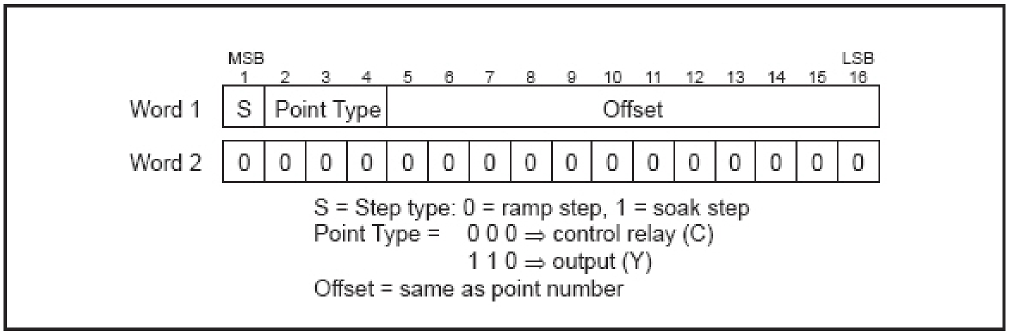
- In your program, place the loop in the manual mode, execute the PACKRS to update the ramp/soak profile, then return the loop to automatic mode. (Remember, this causes the ramp/soak profile to be restarted at the initial step.)

When stored in a memory table, ramp/soak profile steps are six words long and have the following format:

- Word 1 (bit 1): Step type — 0 = ramp step, 1 = soak step (bit)
- Word 1 (bits 2-16) + Word 2: Address of status bit (special address format)
- Words 3/4: Setpoint, if ramp step, or Soak time, if soak step (REAL number)
- Words 5/6: Ramp rate, if ramp step, or Deadband, if soak step (REAL number)

The status bit address points to either an output point (Y) or a control relay (C). This address takes a short form for point numbers C1 - C512 and Y1 - Y1024. Higher point numbers use a long form of address. If all bits of the status bit address field are 0, then no status bit is selected for the step.

The short address form is shown below.

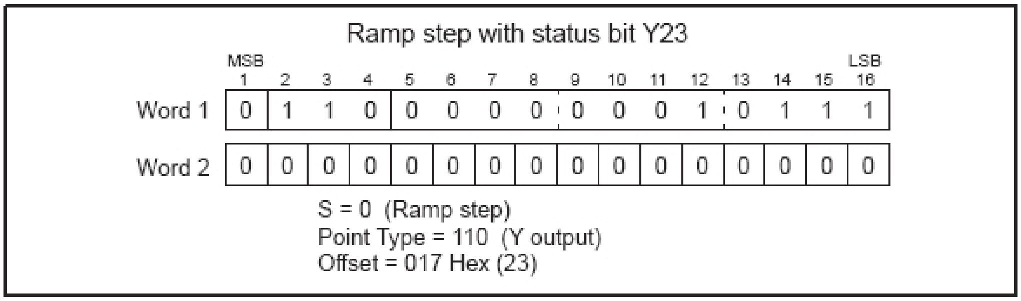


	MSB 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	LSB 16
Word 1	S	Point Type			Offset											
Word 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

S = Step type: 0 = ramp step, 1 = soak step
Point Type = 0 0 0 ⇒ control relay (C)
1 1 0 ⇒ output (Y)
Offset = same as point number

Figure 20 – PACKRS Address Format - Short Form

For example, the encoded address for Y23 using the short form is shown in the following illustration.



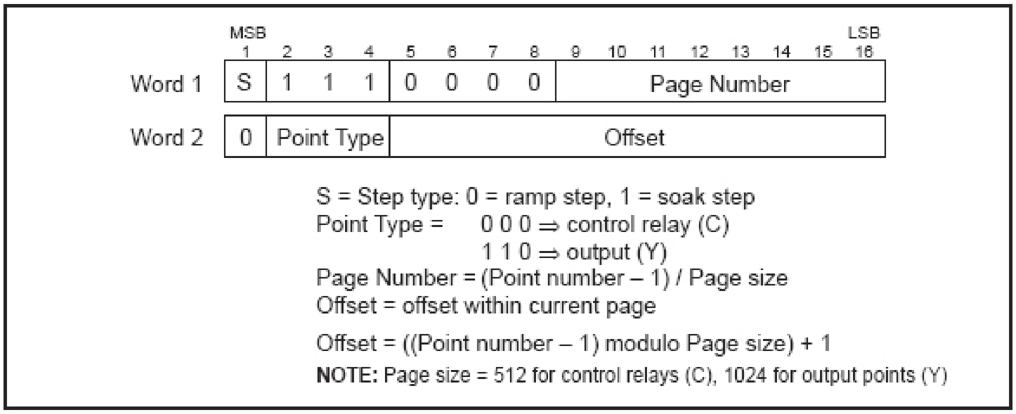
Ramp step with status bit Y23

	MSB 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	LSB 16
Word 1	0	1	1	0	0	0	0	0	0	0	0	1	0	1	1	1
Word 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

S = 0 (Ramp step)
Point Type = 110 (Y output)
Offset = 017 Hex (23)

Figure 21 – PACKRS Short Form Address Example

The long address form is shown below.



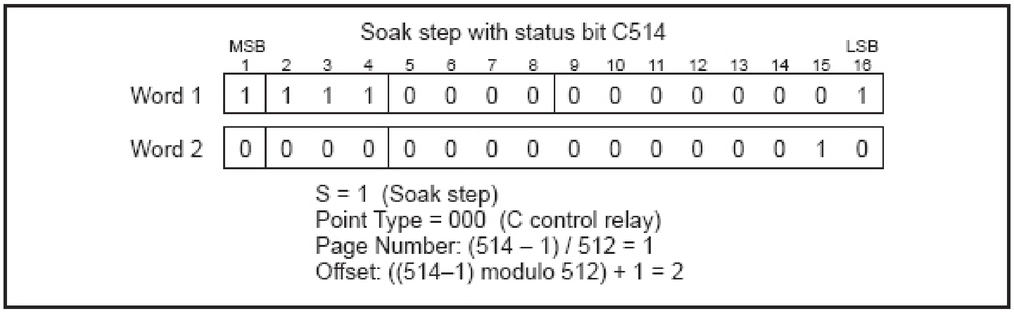
	MSB 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	LSB 16
Word 1	S	1	1	1	0	0	0	0	Page Number							
Word 2	0	Point Type			Offset											

S = Step type: 0 = ramp step, 1 = soak step
Point Type = 0 0 0 ⇒ control relay (C)
1 1 0 ⇒ output (Y)
Page Number = (Point number – 1) / Page size
Offset = offset within current page

Offset = ((Point number – 1) modulo Page size) + 1
NOTE: Page size = 512 for control relays (C), 1024 for output points (Y)

Figure 22 – PACKRS Address Format - Long Form

For example, the encoded address for C514 using the long form is shown below.



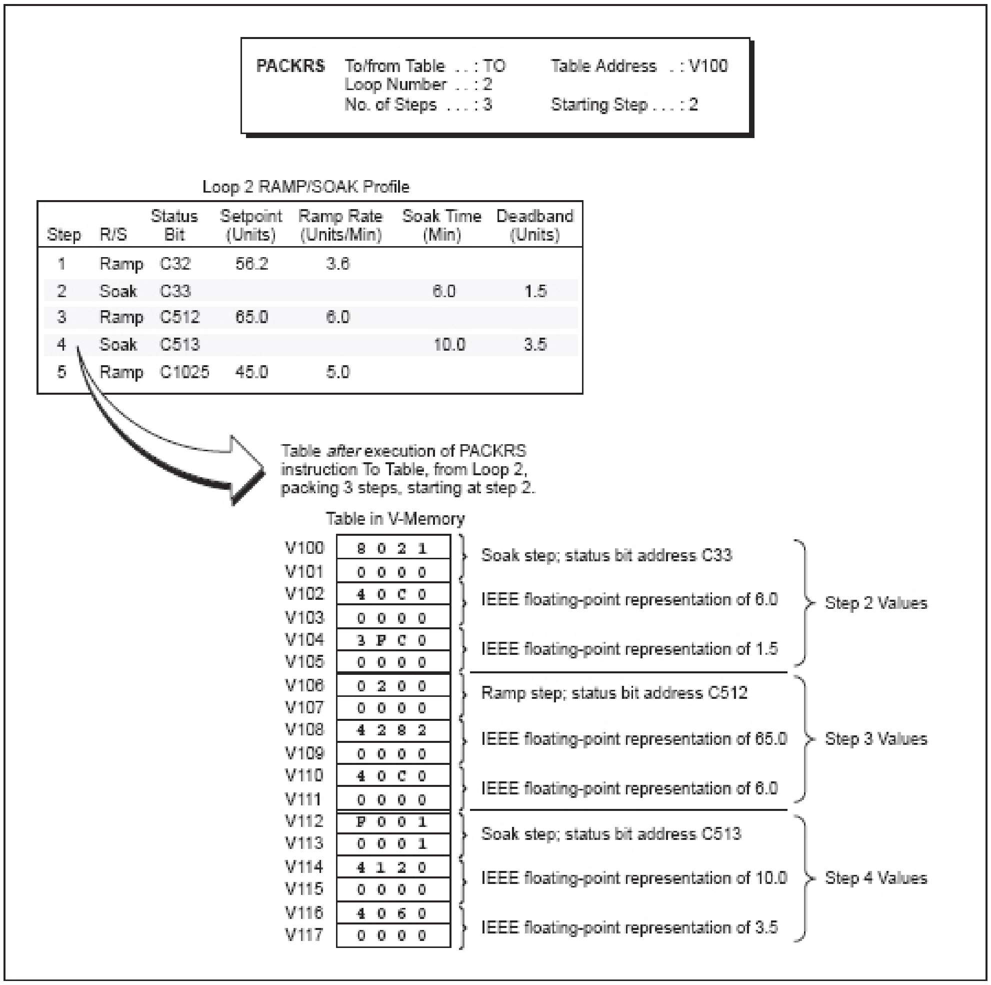
Soak step with status bit C514

	1 (MSB)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16 (LSB)
Word 1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1
Word 2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

S = 1 (Soak step)
Point Type = 000 (C control relay)
Page Number: (514 – 1) / 512 = 1
Offset: ((514–1) modulo 512) + 1 = 2

Figure 23 – PACKRS Long Form Address Example

The next example shows an example of the PACKRS instruction moving values from a ramp/soak profile to a V-memory table.



PACKRS To/from Table . . : TO Table Address . : V100
Loop Number . . : 2
No. of Steps . . . : 3 Starting Step . . . : 2

Loop 2 RAMP/SOAK Profile

Step	R/S	Status Bit	Setpoint (Units)	Ramp Rate (Units/Min)	Soak Time (Min)	Deadband (Units)
1	Ramp	C32	56.2	3.6		
2	Soak	C33			6.0	1.5
3	Ramp	C512	65.0	6.0		
4	Soak	C513			10.0	3.5
5	Ramp	C1025	45.0	5.0		

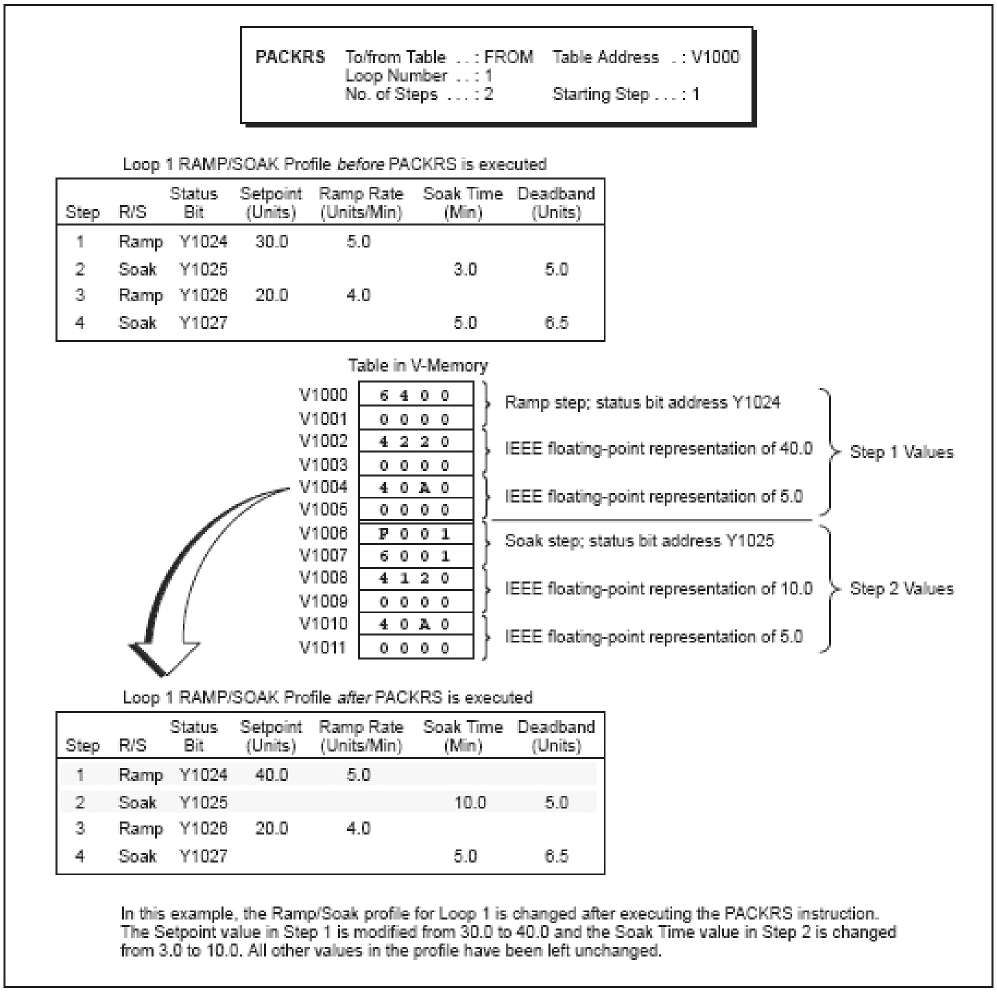
Table *after* execution of PACKRS instruction To Table, from Loop 2, packing 3 steps, starting at step 2.

Table in V-Memory

V100	8 0 2 1	Soak step; status bit address C33	Step 2 Values
V101	0 0 0 0		
V102	4 0 C 0	IEEE floating-point representation of 6.0	
V103	0 0 0 0		
V104	3 F C 0	IEEE floating-point representation of 1.5	
V105	0 0 0 0		
V106	0 2 0 0	Ramp step; status bit address C512	Step 3 Values
V107	0 0 0 0		
V108	4 2 8 2	IEEE floating-point representation of 65.0	
V109	0 0 0 0		
V110	4 0 C 0	IEEE floating-point representation of 6.0	
V111	0 0 0 0		
V112	F 0 0 1	Soak step; status bit address C513	Step 4 Values
V113	0 0 0 1		
V114	4 1 2 0	IEEE floating-point representation of 10.0	
V115	0 0 0 0		
V116	4 0 6 0	IEEE floating-point representation of 3.5	
V117	0 0 0 0		

Figure 24 – Example of PACKRS to a Table in V-Memory

The following shows an example of the PACKRS instruction moving values from a V-memory table to a Loop Ramp/Soak profile, changing two of the values in the profile, and leaving the remaining values unchanged.



PACKRS	To/from Table . . : FROM	Table Address . : V1000
	Loop Number . . : 1	
	No. of Steps . . . : 2	Starting Step . . . : 1

Loop 1 RAMP/SOAK Profile *before* PACKRS is executed

Step	R/S	Status Bit	Setpoint (Units)	Ramp Rate (Units/Min)	Soak Time (Min)	Deadband (Units)
1	Ramp	Y1024	30.0	5.0		
2	Soak	Y1025			3.0	5.0
3	Ramp	Y1026	20.0	4.0		
4	Soak	Y1027			5.0	6.5

Table in V-Memory

V1000	6 4 0 0	Ramp step; status bit address Y1024	Step 1 Values
V1001	0 0 0 0		
V1002	4 2 2 0	IEEE floating-point representation of 40.0	
V1003	0 0 0 0		
V1004	4 0 A 0	IEEE floating-point representation of 5.0	
V1005	0 0 0 0		
V1006	F 0 0 1	Soak step; status bit address Y1025	Step 2 Values
V1007	6 0 0 1		
V1008	4 1 2 0	IEEE floating-point representation of 10.0	
V1009	0 0 0 0		
V1010	4 0 A 0	IEEE floating-point representation of 5.0	
V1011	0 0 0 0		

Loop 1 RAMP/SOAK Profile *after* PACKRS is executed

Step	R/S	Status Bit	Setpoint (Units)	Ramp Rate (Units/Min)	Soak Time (Min)	Deadband (Units)
1	Ramp	Y1024	40.0	5.0		
2	Soak	Y1025			10.0	5.0
3	Ramp	Y1026	20.0	4.0		
4	Soak	Y1027			5.0	6.5

In this example, the Ramp/Soak profile for Loop 1 is changed after executing the PACKRS instruction. The Setpoint value in Step 1 is modified from 30.0 to 40.0 and the Soak Time value in Step 2 is changed from 3.0 to 10.0. All other values in the profile have been left unchanged.

Figure 25 – Example of PACKRS from a Table in V-Memory

Pet Scan Watchdog (PETWD)

The PETWD (Pet Scan Watchdog) allows you to extend the scan watchdog limit while performing an in-line Special Function program or subroutine from an RLL program. When the PETWD instruction executes, the scan watchdog timer is reset at that instance of time during the scan, therefore extending the scan watchdog limit beyond the configured scan watchdog limit.

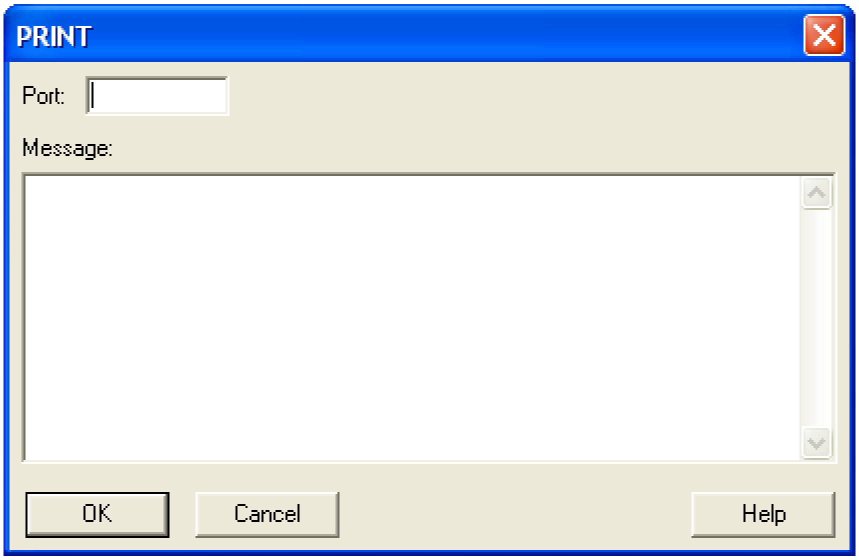
The PETWD statement has no subfields.

NOTE: PETWD is available only for in-line compiled Special Function programs or subroutines in CPUs that support PowerMath.

⚠ **Warning**	The PETWD instruction allows you to place the PETWD instruction in an infinite loop, therefore preventing the scan watchdog limit from ever being reached. If the PETWD instruction is in an infinite loop, the PLC would not issue a scan watchdog FATAL ERROR to shut the process down, therefore leaving your process uncontrolled. An uncontrolled process could result in death or serious injury to personnel, and/or damage to equipment. Ensure that the PETWD instruction is not located in an infinite loop. To ensure that the PETWD instruction is not located in an infinite loop within an SF program or subroutine, place the PETWD instruction without a label at the beginning of the SF program or subroutine.

Printing (PRINT)

The Print statement sends a message to the ASCII communication ports. This statement can be used to print both text and the contents of integer and real variables.



- **Port** - the ASCII communications port number. Legal port numbers are 1 - 3.
- **Message** - the message to be printed. Element addresses and expressions are separated by a space. Embedded spaces or assignment operator (:=) within expressions are not accepted.

NOTE: The CTI 2500 Series of processors supports the PRINT instruction differently than Simatic 505. See the *CTI 2500 Controller Programming Reference Manual* for more information.

PRINT Operation

When the PRINT statement executes, the message is sent to the port specified.

The maximum message length is 1019 characters, with characters counted in entries as follows:

- Each text character = 1 character
- Each variable entry = 6 characters

- Each variable text entry = 6 characters
- Carriage Return & Linefeed = 2 characters

Text entries contain ASCII text to be printed. The following examples illustrate how text is displayed using the Print statement.

- Text entries are enclosed in quotation marks: "END OF SHIFT REPORT"
- Variable entries print the contents of variables in either integer or real format. Variables must be separated by spaces. Real numbers are indicated by following the address with a period (.). Integers are printed right-justified in a six-character field with a floating minus sign. Real numbers are printed right-justified in a twelve-character field using a FORTRAN G12.5 format: "THE VALUES ARE WX5 V104"
- Time entries are used to print out a variable in time format. The variable is printed out as hh:mm:ss. Time entries are indicated by following the address of the variable (EL or EXP) with :TIME, as follows: "THE TIME IS NOW" STW141:TIME
- Date entries are used to print out a variable in date format. The variable is printed out as yy/mm/dd. Date entries are indicated by following the address of the variable (EL or EXP) with :DATE, as follows:
  "THE DATE IS NOW" STW141:DATE
- Variable text entries are used to print out text stored in either V or K memory. Variable text entries are indicated by following the address of the text (EL or EXP) to be printed with a percent sign (%) and the number of characters to be printed. If the number is coded as zero, PRINT assumes that the first word of the indicated variable contains the number of characters to print:

  "BOILER" V250%16

  "DESCRIPTION" V102%0

  - "BOILER" V250%16 causes the 16 characters in V-Memory locations V250-V257 to be printed. Each word contains two 8-bit characters
  - "DESCRIPTION" V102%0 causes the number of characters specified in V102 to be printed. If V102 contains 5, then the characters in V103-V105 are printed.

- Use variable text entries to embed control characters, such as form feeds and carriage returns, used by the device receiving the ASCII characters. Enter the form feed indicator "<FF>" as follows:

```
"THERE IS A FORMFEED
 AFTER THIS <FF>"
```

- To enter a <CR><LF> (Carriage return/Linefeed), press **ENTER** during text entry:

```
 "THERE IS A CARRIAGE RETURN
 LINE FEED AFTER THIS
"
```

- To print double quotes, precede it with another double quote:

""THIS QUOTED TEXT IS PRINTED INSIDE DOUBLE QUOTE CHARACTERS""

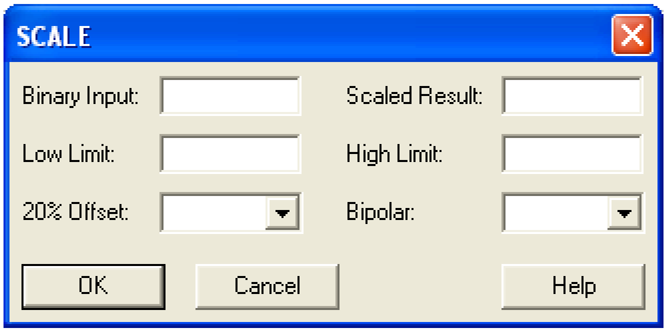
Return from SF Program/Subroutine (RETURN)

The RETURN statement is used to terminate a Special Function program or subroutine. If invoked from a Special Function program, the program terminates. If invoked from a subroutine, control returns to the statement in the Special Function program following the subroutine call.

The return format has no subfields. If there is no RETURN statement, the program terminates after the last statement.

Scaling Values (SCALE)

The Scale statement uses as input an integer input and converts it to engineering units scaled between high and low limits.



- **Binary Input** - the memory location of the input. Valid field descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77).
- **Scaled Result** - the memory location of the result after conversion. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), and writeable real addresses (writeable addresses containing a real value such as V120.).
- **Low Limit** - the lower limit to which Binary Input can be scaled. The valid descriptor is a real literal constant that is less than or equal to the **High Limit** value.
- **High Limit** - the upper limit to which Binary Input can be scaled. The valid descriptor is a real literal constant that is greater than or equal to the **Low Limit** value.
- **20% Offset** - indicates if Binary Input is 20% offset (YES) or 0% offset (NO).
- **Bipolar** - indicates if Binary Input is bipolar (YES) or not (NO).

NOTE: You cannot choose both bipolar and 20% offset for an input.

SCALE Operation

Each time the SCALE statement executes, an integer located in the Binary Input converts to an integer or real number in engineering units, scaled between the High and Low Limits.

- If the input is a variable that could range from -32000 to +32000, the variable is bipolar. Set the Bipolar option to YES.

- If the input is a variable that could range from 0 to 32000, the variable is unipolar. Set the option to NO.

- If the input is a variable that has a 20% offset (ranges from 6400 to 32000), set the 20% Offset option to YES.

- If the input is a variable that has a 0% offset, set the option to NO. The result is stored in the address specified in Scaled Result.

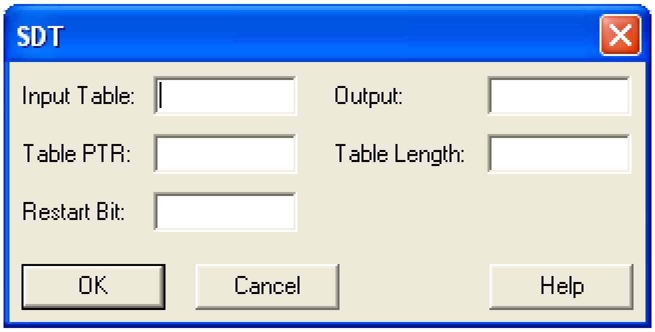
The specified low and high limits specified determine the range of the converted number. The values of the Low Limit and the High Limit may fall within the following range:

$$\text{Range} = \begin{array}{lcl} 5.42101070 * 10^{-20} & \text{to} & 9.22337177 * 10^{18} \\ -\ 9.22337177 * 10^{18} & \text{to} & -\ 2.71050535 * 10^{-20} \end{array}$$

An error is logged if the input value is outside the low-limit to high-limit range, and the output is clamped to the nearer of either the low limit or the high limit.

Sequential Data Table (SDT)

The Sequential Data Table statement moves words one at a time from an existing table to a destination address. A pointer designates the address of the next word in the table to be moved. Each time the statement is executed, one word moves and replaces the word at the destination address. The SDT format is shown below.



- **Input Table** - the starting address for the table. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77), or real addresses (addresses containing a real value such as 33.642, V120., V100.(2), or WY55).
- **Output** - the output address to which the words are moved. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), and writeable real addresses (writeable addresses containing a real value such as V120.).
- **Table PTR** - the address of the Table Pointer. Valid descriptors are writeable integer addresses.
- **Table Length** - the length of the table and must be a value greater than zero. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).
- **Restart Bit** - the address of the restart (status) bit; can be a C or Y. Valid descriptors are writeable bit elements (writeable bit addresses and temporary bit-of-word addresses that are not part of expressions such as C200 or T15.1).

NOTE: When using the SDT statement in a compiled Special Function program or subroutine, a static table must be specified. The table's base address must be a V, K, G, VMS, or VMM address, and the Table Length must be specified as a value.

SDT Operation

Before the SDT is executed, the Table Pointer is set to zero by the program. Each time the SDT is executed, the table pointer is incremented by 1, and the word value in the Table Pointer address is moved to the Output. The process is repeated until the number of words specified in Table Length has been moved. When the last word has been moved, the Table Pointer is reset to zero.

The Restart Bit is set to ON, except for the following conditions:

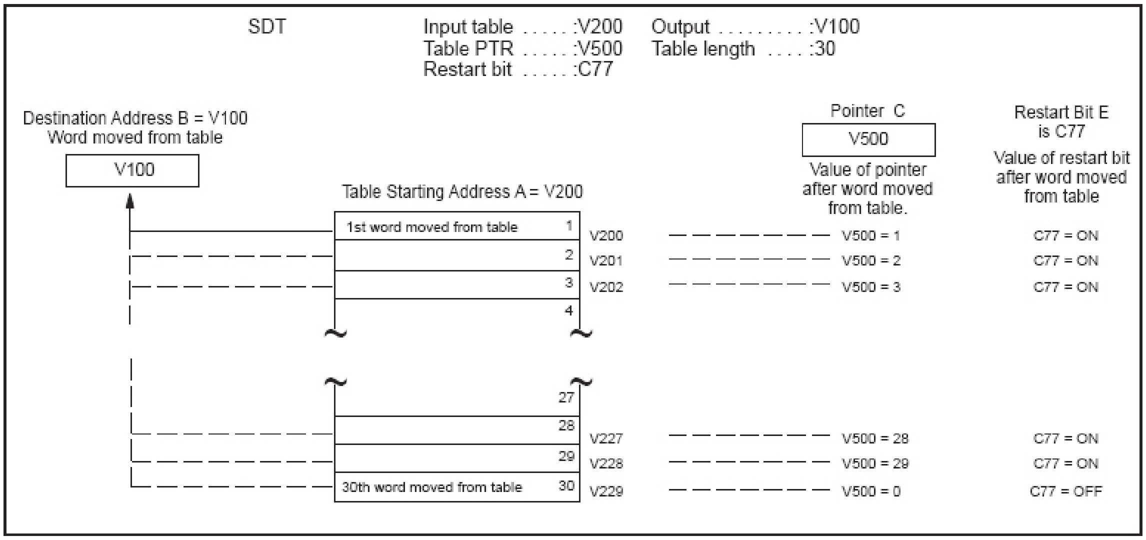
- When the SDT execution resets the Table Pointer, the Restart Bit turns OFF.
- Prior to the first execution of the SDT, the bit could be either off or on depending upon prior usage.

NOTE: Logic can be used to reset the Table Pointer to zero, but the Restart Bit will not turn OFF unless the pointer is reset by the SDT execution.

The value of the Table Pointer does not change during SDT execution. All values in the table remain the same, and the Output contains the value of the last word moved from the table.

SDT Statement Example

Before the SDT executes, Table Pointer V500 contains 0 (zero). When the statement executes, the pointer increments by 1, and the value in V200 is moved to V100. This process repeats each time the statement executes. After the last word is moved, the pointer resets to 0. and Status Bit C77 is turned OFF.

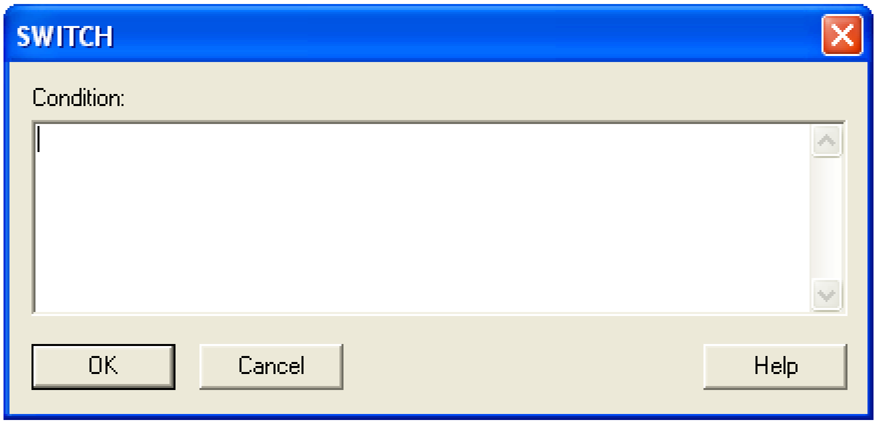

SDT
Input table . . . . . :V200
Table PTR . . . . . :V500
Restart bit . . . . . :C77
Output . . . . :V100
Table length . . . . :30
Destination Address B = V100
Word moved from table
V100
Table Starting Address A = V200
Pointer C
V500
Value of pointer after word moved from table.
Restart Bit E is C77
Value of restart bit after word moved from table
1st word moved from table
1
2
3
4
27
28
29
30th word moved from table
30
V200
V201
V202
V227
V228
V229
V500 = 1
V500 = 2
V500 = 3
V500 = 28
V500 = 29
V500 = 0
C77 = ON
C77 = ON
C77 = ON
C77 = ON
C77 = ON
C77 = OFF

SDT Statement Operation Example

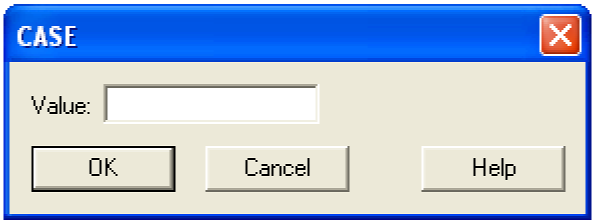
Switch Functions

(SWITCH/CASE/BREAK/DEFAULT/ENDSWITCH)

SWITCH statements are used to compare the result of a single expression against a field of possible condition states. These statements are ideally used in place of large nested IF/ELSE statement sequences, which are inefficient in terms of execution time and memory usage.



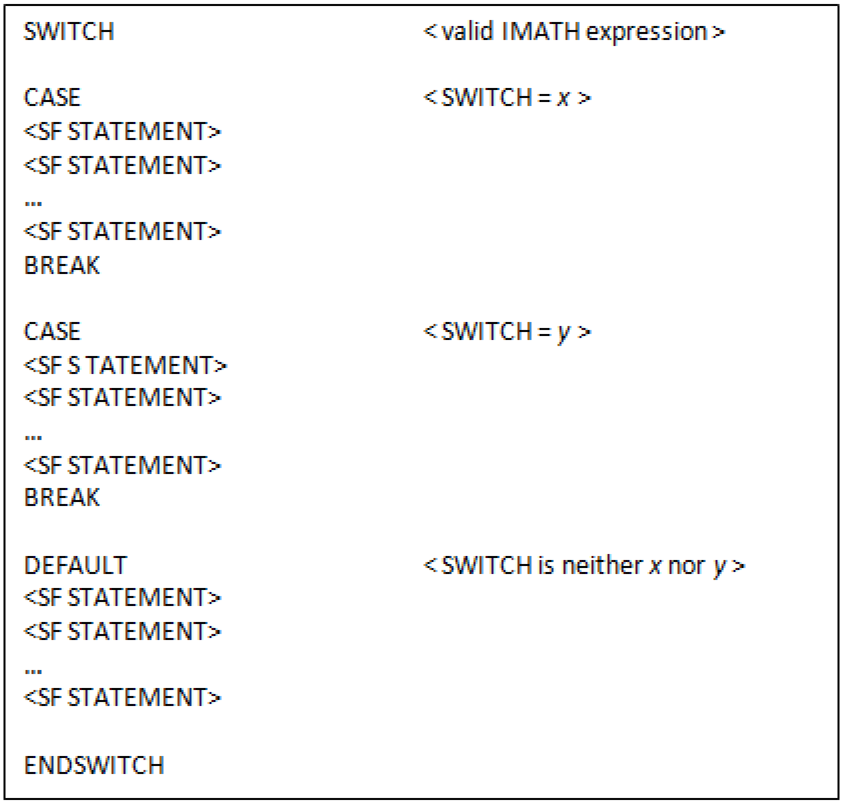
- **Condition** - this statement is evaluated against the constant variable(s) declared in the corresponding CASE statements. Valid descriptors for this field are IMATH expressions.



- **Value** - a constant that is matched by the result of the corresponding SWITCH Condition statement. Valid descriptors are any long constant value.

SWITCH Operation

SWITCH operates in conjunction with CASE, BREAK, DEFAULT, and ENDSWITCH. At least one CASE and one ENDSWITCH statement is required for each SWITCH statement. The SWITCH format is illustrated below.



```
SWITCH                          < valid IMATH expression >

CASE                            < SWITCH = x >
<SF STATEMENT>
<SF STATEMENT>
...
<SF STATEMENT>
BREAK

CASE                            < SWITCH = y >
<SF S TATEMENT>
<SF STATEMENT>
...
<SF STATEMENT>
BREAK

DEFAULT                         < SWITCH is neither x nor y >
<SF STATEMENT>
<SF STATEMENT>
...
<SF STATEMENT>

ENDSWITCH
```

SWITCH Block Format

Upon execution of the initial SWITCH statement, the Condition expression is evaluated and compared to the declared values in each CASE statement defined in the SWITCH block. If a matching CASE statement is found, program execution unconditionally advances to the next instruction after the matched CASE statement (similar to a LABEL instruction), until a BREAK statement is encountered. Upon encountering a BREAK statement, the execution sequence will jump to the next instruction after the corresponding ENDSWITCH statement. If a corresponding BREAK statement is omitted, program execution will fall through to the next CASE statement.

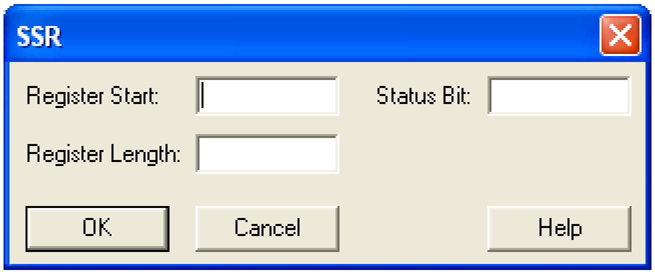
If a matching CASE statement is not found, program execution jumps to the next instruction after a DEFAULT statement (if any). If a matching CASE statement is not found and no DEFAULT statement exists in the SWITCH block, program execution jumps to the next instruction after the corresponding ENDSWITCH statement.

NOTE: The constant value in each CASE statement in a SWITCH block must be unique. SWITCH blocks may be nested to 7 levels (for a total of 8 nested levels).

⚠ **Warning**	This instruction is compatible with CTI 2500 Series controllers only. Attempting to run a program with this instruction on a Simatic 505 series controller will result in the CPU ceasing operation and entering a fatal error state. If this occurs, Auxiliary Function AUX 29 (PLC Operational Status) will report error code 020C (Invalid Control Block). Upon encountering this error condition, it will be necessary to disconnect the battery and re-cycle power to the CPU. To prevent this error, do not attempt to load a program containing this or other instructions designed to only be compatible with the CTI 2500 Series controller into a Simatic 505 series controller.

Synchronous Shift Register (SSR)

The Synchronous Shift Register statement builds a table that functions as a synchronous shift register. The SSR format is shown below.



- **Register Start** - the starting address for the shift register. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11), and writeable real addresses (writeable addresses containing a real value such as V120.) This field also accepts bit-of-word addresses - in this case shifting starts from the specified bit within the word variable.
- **Status Bit** - the status bit (C or Y). This is turned on when the register is empty. Valid descriptors are writeable bit elements (writeable bit addresses and temporary bit-of-word addresses that are not part of expressions such as C200 or T15.1).
- **Register Length** - the length of the shift register, and the maximum number of elements stored in the register. If a constant value is entered, it must be greater than zero. Valid descriptors are integer addresses or values (any integer value or address containing an integer value such as V100, V100(2), or WX77).

SSR Operation

The Register Start address is empty until an element moves into the address from another source. Each time the SSR executes, the element currently stored in the Register Start address shifts to Register Start + 1. The element in Register Start + 1 shifts to Register Start + 2.

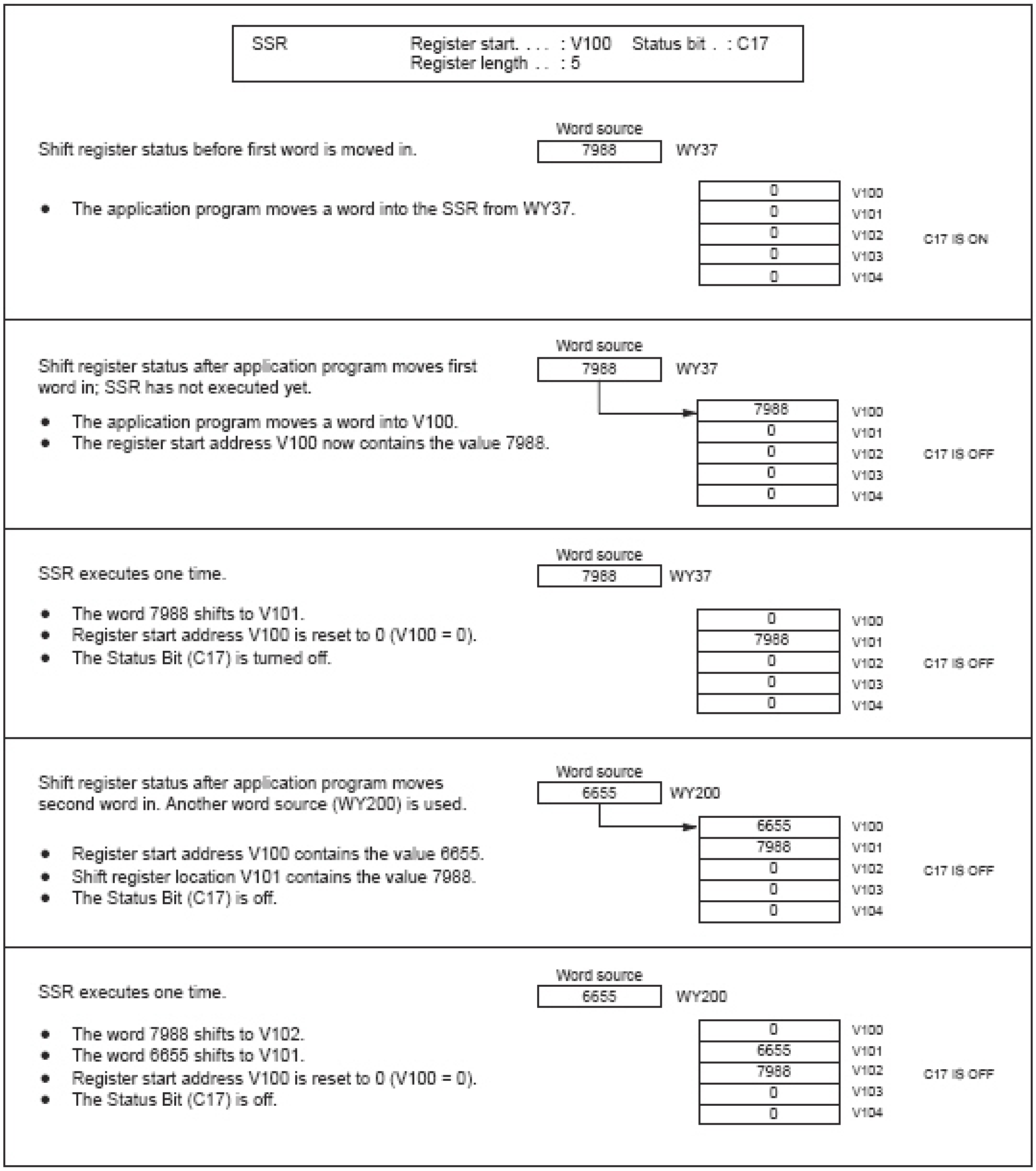
Elements move down the shift register until they reach the Register Length, and the Register Start address resets to zero. After the register is full, shifting in a new word causes the loss of the last word in the register (Register Start + (Register Length - 1)). The register is considered empty when it contains all zeros. The status bit turns on when the register is empty.

NOTE: If the register contains the value -0.0, the register is not recognized as empty, and the status bit does not turn off.

SSR Statement Example

In the example below, the Register Start address is V100 and the Register Length is 5, designating the register in this operation to be V100 - V104. Before the SSR operation begins, all five register addresses are 0, and the Status Bit C17 is ON. When a word is moved into the Register Start address, making its value 7988, SSR executes one time. The word 7988 shifts to the next step in the register, V101, and the Register Start address resets to zero. Because the register is not empty, the Status Bit is turned OFF.

When a second word is moved into the Register Start address, its value becomes 6655. The SSR operation executes again, shifting the word 7988 to V102 and shifting the word 6655 to V101. The Register Start address is reset to zero, and the Status Bit remains OFF.



Shift register status before first word is moved in.

- The application program moves a word into the SSR from WY37.

Shift register status after application program moves first word in; SSR has not executed yet.

- The application program moves a word into V100.
- The register start address V100 now contains the value 7988.

SSR executes one time.

- The word 7988 shifts to V101.
- Register start address V100 is reset to 0 (V100 = 0).
- The Status Bit (C17) is turned off.

Shift register status after application program moves second word in. Another word source (WY200) is used.

- Register start address V100 contains the value 6655.
- Shift register location V101 contains the value 7988.
- The Status Bit (C17) is off.

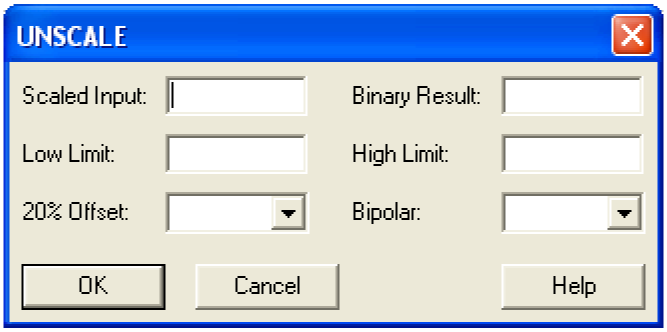
SSR executes one time.

- The word 7988 shifts to V102.
- The word 6655 shifts to V101.
- Register start address V100 is reset to 0 (V100 = 0).
- The Status Bit (C17) is off.

SSR Statement Operation Example

Unscaling Values (UNSCALE)

The UNSCALE statement takes an input value in engineering units, scaled between high and low limits, and converts it to an integer.



- **Scaled Input -** the memory location of the input. Valid descriptors are integer addresses (addresses containing an integer value such as V100, V100(2), or WX77), or real addresses (addresses containing a real value such as 33.642, V120., V100.(2), or WY55).
- **Binary Result -** the memory location of the result after conversion. Valid descriptors are writeable integer addresses (writeable addresses containing an integer value such as V101 or WY11).
- **Low Limit -** the lower limit of the Scaled Input. The valid descriptor is a real literal constant that is less than or equal to the High Limit value.
- **High Limit -** the upper limit of the Scaled Input. The valid descriptor is a real literal constant that is greater than or equal to the Low Limit value.
- **20% Offset -** indicates if the output is 20% offset (YES) or 0% offset (NO). If the output is a variable that has a 20% offset (ranges from 6400 to 32000), set the option to **YES**. If the output is a variable that has a 0% offset, set option to **NO**.
- **Bipolar -** indicates if the output is bipolar (YES) or not (NO). If the output is a variable that could range from -32000 to +32000, the variable is bipolar. Set option to **YES**. If the output is a variable that could range from 0 to 32000, the variable is unipolar. Set option to **NO**.

NOTE: The output cannot be both bipolar and 20% offset.

Operation of UNSCALE

Each time the UNSCALE statement executes, the Scaled Input value is converted to a scaled integer. The high and low limits of the Scaled Input are specified in their respective fields. These limits fall within the real number range:

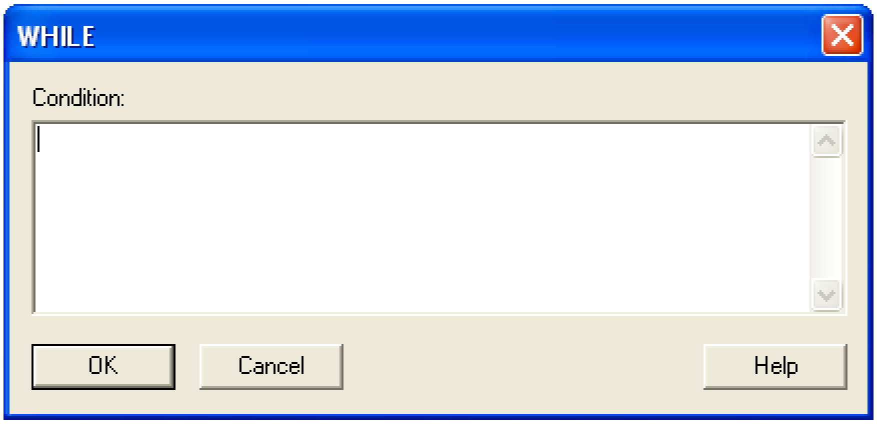
$$\text{Range} = \begin{array}{lcl} 5.42101070 * 10^{-20} & \text{to} & 9.22337177 * 10^{18} \\ -\ 9.22337177 * 10^{18} & \text{to} & -\ 2.71050535 * 10^{-20} \end{array}$$

The result is stored in the address specified in Binary Result. An error is logged if the scaled value of the input is outside the set ranges, and the input is clamped to nearer of either the low limit or the high limit.

While/End While (WHILE/ENDWHILE)

The WHILE instruction is used on conjunction with an ENDWHILE instruction. The two statements are used to create a structured loop that allows the user to repeat a sequence of actions, ideally under conditions where an exact number of iterations may not be known. Unlike the FOR loop, which allows the user to specify the number of iterations, the WHILE loop only allows the user to specify a condition that terminates the loop when the condition is no longer true.

Each WHILE instruction must be followed somewhere in the program by exactly one ENDWHILE instruction, and an ENDWHILE instruction cannot be encountered before a corresponding WHILE instruction.



- **Condition** - this statement determines whether or not the WHILE loop continues to iterate or terminates to the next statement. Valid descriptors for this field are boolean IMATH expressions.

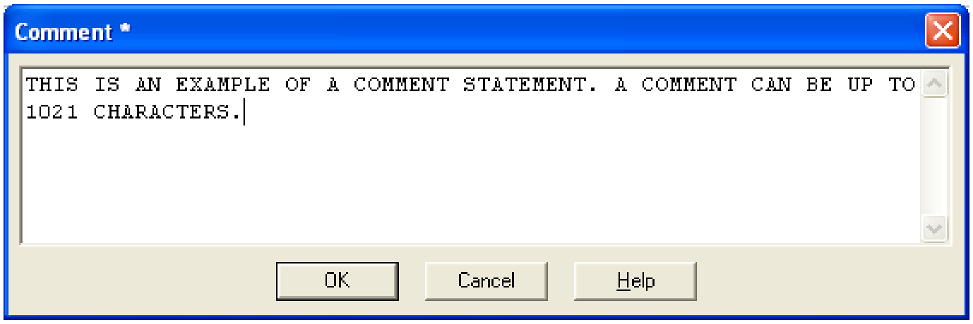
WHILE/ENDWHILE Operation

Upon first pass of the execution loop, the Condition statement is evaluated. If this value is true, program execution advances to the first instruction after the WHILE statement. If this value is false, program execution advances to the first instruction after the ENDWHILE statement.

The ENDWHILE statement unconditionally jumps back to its corresponding WHILE instruction.

⚠ **Warning**	This instruction is compatible with CTI 2500 Series controllers only. Attempting to run a program with this instruction on a Simatic 505 series controller will result in the CPU ceasing operation and entering a fatal error state. If this occurs, Auxiliary Function AUX 29 (PLC Operational Status) will report error code 020C (Invalid Control Block). Upon encountering this error condition, it will be necessary to disconnect the battery and recycle power to the CPU. To prevent this error, do not attempt to load a program containing this or other instructions designed to only be compatible with the CTI 2500 Series controller into a Simatic 505 series controller.

Comment (*)



THIS IS AN EXAMPLE OF A COMMENT STATEMENT. A COMMENT CAN BE UP TO 1021 CHARACTERS.

The comment statement inserts a comment in a program for documentation purposes. The comment statement is ignored during program execution. A comment statement can contain a maximum of 1021 characters.

Chapter 12 – Auditing

Introduction

The Activity Audit contains records which list programming and setting changes made by users while running WorkShop. These records contain:

- The date and time the activity occurred
- A general description of the activity
- The machine name of the computer on which the activity occurred
- If available, the name of the user who performed the activity

Some of the activities recorded in the Activity Audit file include:

- Going online with a PLC
- Loading and saving PLC programs
- PLC operations
- Changes to ladder logic and special functions
- Edits to alarms, PID loops, etc.
- Changing values via the data window
- Forcing and clearing forces
- Changes to documentation

Activity Audits can be written to Microsoft Access files, Structured Query Language (SQL) files or the Windows Activity Log (when the **FT Security Server** is running on an accessible computer).

Activity audit information may be written to Microsoft Access and SQL files may be read with many popular viewers. Audits written to the Windows Activity Logs may be read with the Windows Event Viewer which is found in the Windows NT/2000/XP "Administrative Tools" menu.

The Activity Audit feature may be used in conjunction with Password Security but can used independently from security.

See Activity Audit Setup Dialog for details on configuring activity auditing.

Activity Audit Setup Dialog

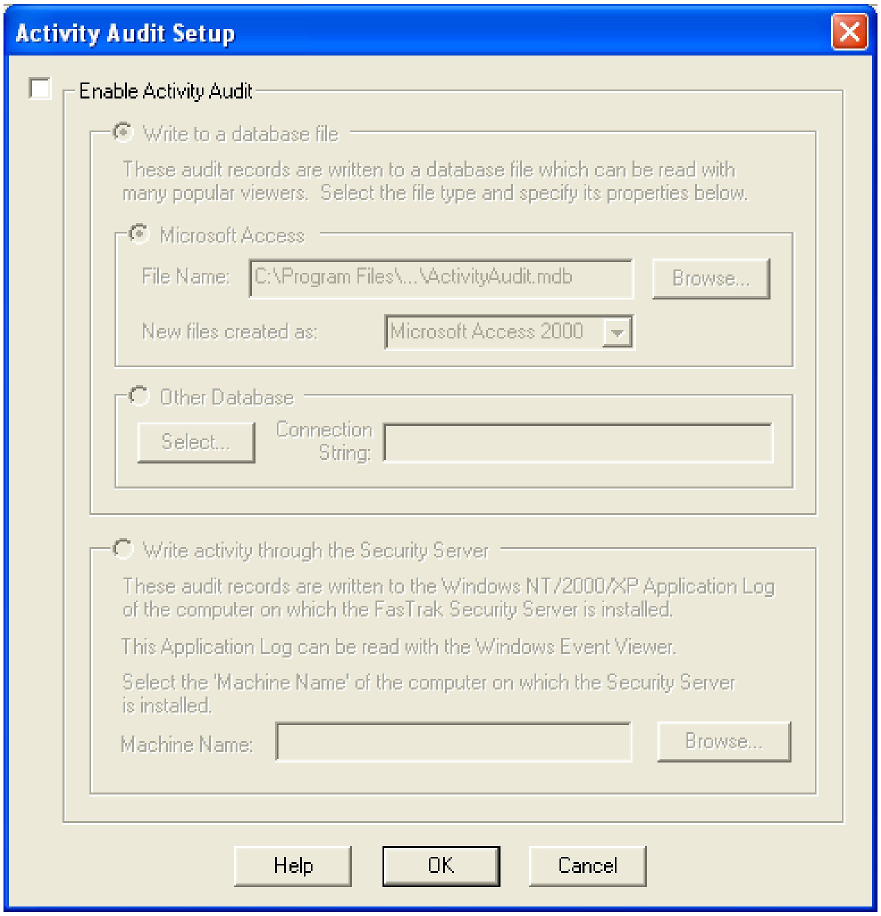
If the computer is running Windows NT, 2000, XP, or Vista, PLC WorkShop determines whether the user logged into the operating system is an administrator. If the user is an administrator, the **Activity Audit Setup** dialog appears. If security is enabled but the user logged into the operating system is not an administrator, access is not granted to the **Activity Audit Setup** dialog.

There are two ways audit information can be stored:

- Database File - Microsoft Access or SQL
- NT Activity Log

To configure activity auditing:

1. Select the **Options \ Activity Audit Setup** menu item. The **Activity Audit Setup** dialog appears.


Activity Audit Setup

□ Enable Activity Audit

● Write to a database file

These audit records are written to a database file which can be read with many popular viewers. Select the file type and specify its properties below.

● Microsoft Access

File Name: C:\Program Files\...\ActivityAudit.mdb

New files created as: Microsoft Access 2000

○ Other Database

Connection String:

○ Write activity through the Security Server

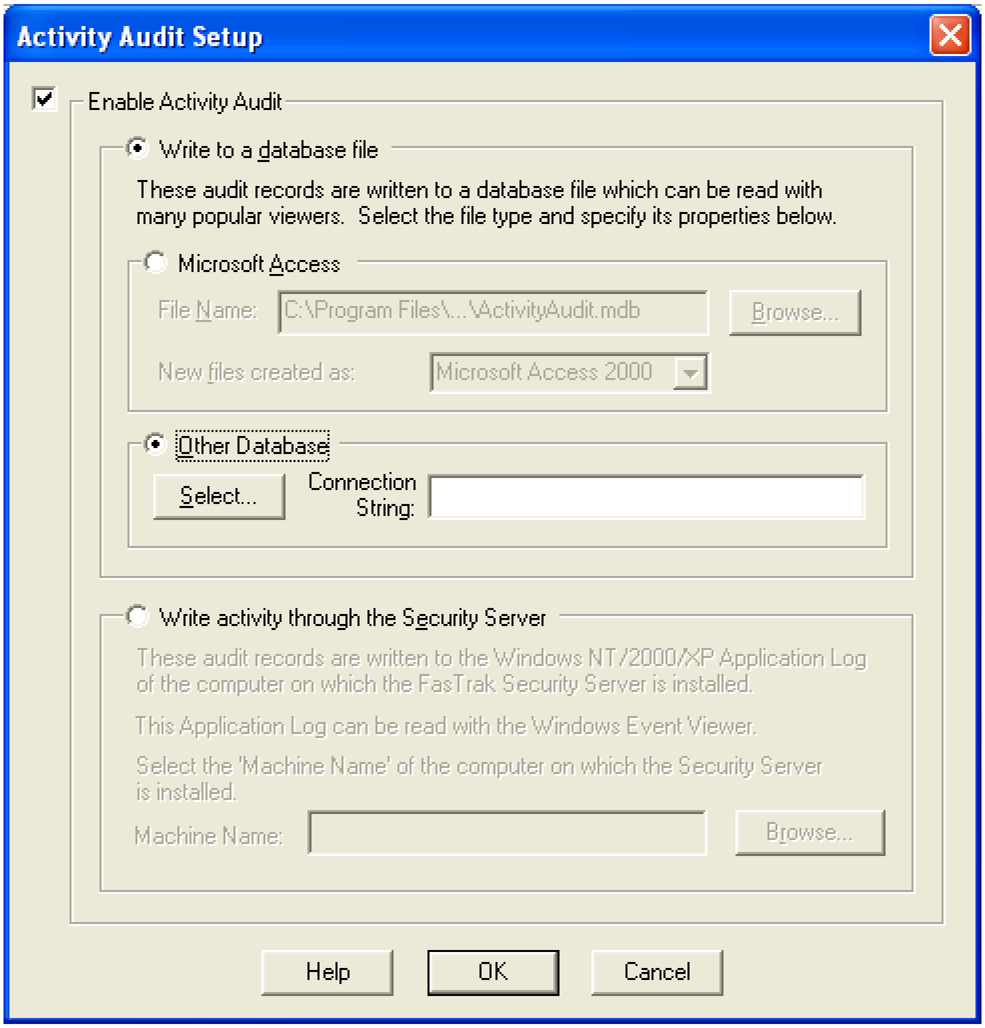
These audit records are written to the Windows NT/2000/XP Application Log of the computer on which the FasTrak Security Server is installed.

This Application Log can be read with the Windows Event Viewer.

Select the 'Machine Name' of the computer on which the Security Server is installed.

Machine Name:

2. Select the **Enable Activity** Audit check box.
3. Select the **Write to a database file** option button to record the activity audit information to a database file, either Microsoft Access or Structured Query Language (SQL).
4. Select the **Microsoft Access** option button to write audit records to a Microsoft Access file. Enter the file name or click the **Browse** button to specify the Access file name to which activity records will be written. Use the **New files created as** drop-down list to select the format of Microsoft Access files desired.
5. Select the **Other Database** option button to record the activity audit information to a SQL file.



Activity Audit Setup

☑ Enable Activity Audit

● Write to a database file

These audit records are written to a database file which can be read with many popular viewers. Select the file type and specify its properties below.

○ Microsoft Access

File Name: C:\Program Files\...\ActivityAudit.mdb

New files created as: Microsoft Access 2000

● Other Database

Connection String:

○ Write activity through the Security Server

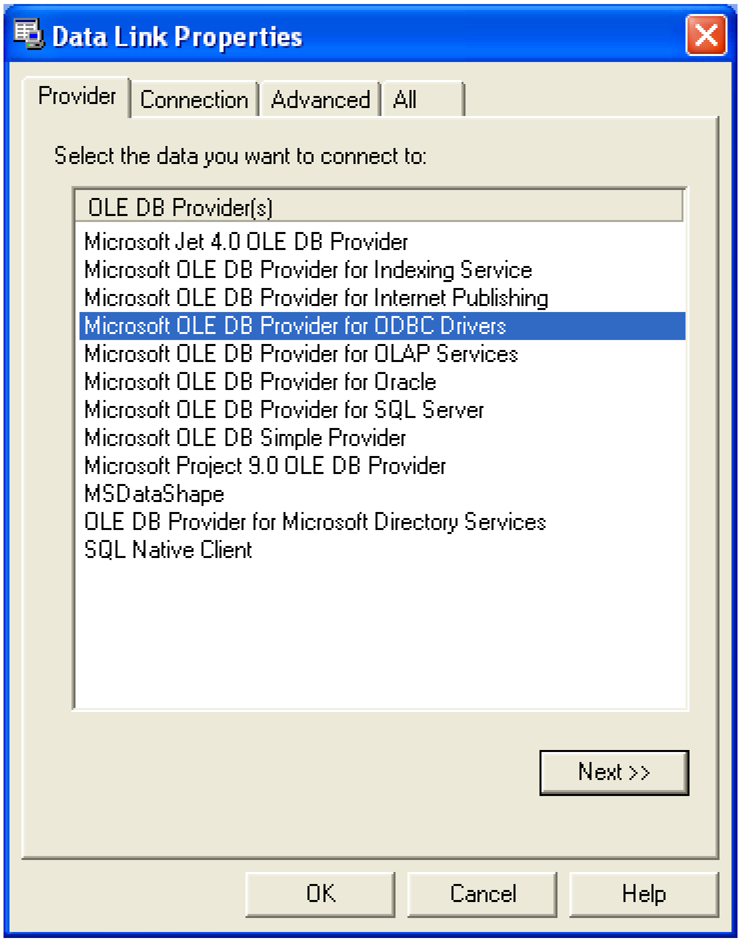
These audit records are written to the Windows NT/2000/XP Application Log of the computer on which the FasTrak Security Server is installed.

This Application Log can be read with the Windows Event Viewer.

Select the 'Machine Name' of the computer on which the Security Server is installed.

Machine Name:

6. Enter the **Connection String** in the edit box or click the **Select** button in the Other Databases group box to display the **Data Link Properties** wizard dialogs below to assemble the SQL file connection string.



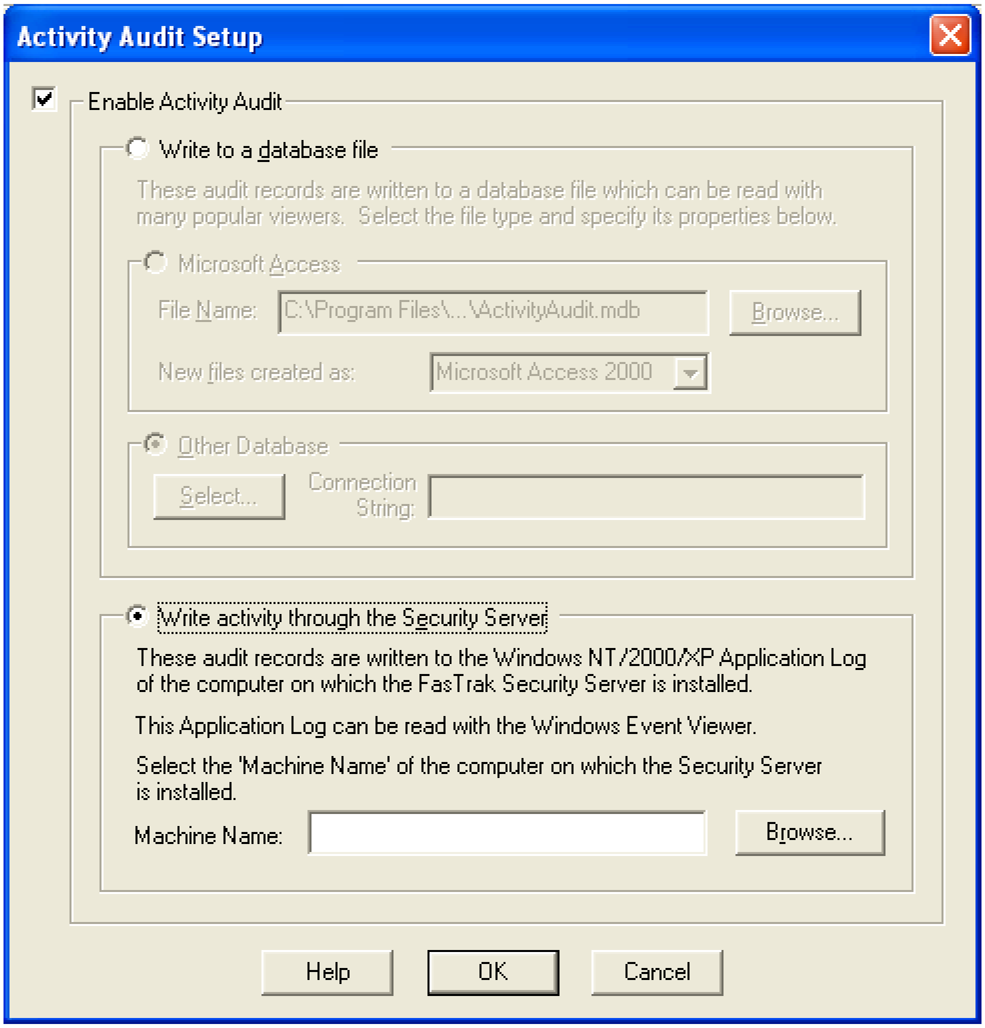
Select the data you want to connect to:

OLE DB Provider(s)

Microsoft Jet 4.0 OLE DB Provider
Microsoft OLE DB Provider for Indexing Service
Microsoft OLE DB Provider for Internet Publishing
Microsoft OLE DB Provider for ODBC Drivers
Microsoft OLE DB Provider for OLAP Services
Microsoft OLE DB Provider for Oracle
Microsoft OLE DB Provider for SQL Server
Microsoft OLE DB Simple Provider
Microsoft Project 9.0 OLE DB Provider
MSDataShape
OLE DB Provider for Microsoft Directory Services
SQL Native Client

7. The activity audit can also be written to the Application Log of the computer running the FasTrak Security Server. Select the **Write activity through the Security Server** option button.

8. Enter the **Machine Name** or click the **Browse** button to select the computer on which the FasTrak Security Server is installed.



☑ Enable Activity Audit

○ Write to a database file

These audit records are written to a database file which can be read with many popular viewers. Select the file type and specify its properties below.

○ Microsoft Access

File Name: C:\Program Files\...\ActivityAudit.mdb

New files created as: Microsoft Access 2000

● Other Database

Connection String:

● Write activity through the Security Server

These audit records are written to the Windows NT/2000/XP Application Log of the computer on which the FasTrak Security Server is installed.

This Application Log can be read with the Windows Event Viewer.

Select the 'Machine Name' of the computer on which the Security Server is installed.

Machine Name:

Audits written to Windows Activity Logs may be read with the Windows Event Viewer which is found in the Windows Control Panel under **Administrative Tools**.

Chapter 13 – FasTrak Authentication and NT Security

Introduction

The WorkShop Password Security features allows one or more security administrators to maintain a list of users and their access privileges. Access privileges restrict which functions of the application (such as online and offline editing, I/O forcing, loading, saving changes to disk etc.) individual users can perform.

WorkShop supports two types of password security: FasTrak Authentication and NT Authentication. Both provide user- and group-level security; which authentication type you choose will depend on your specific needs as well as the features of your network. See the following sections for more information.

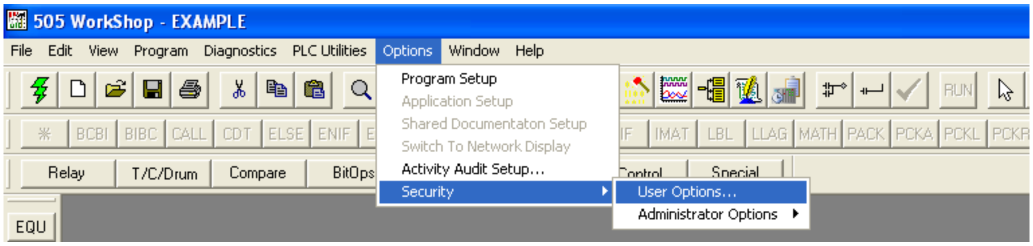
- FasTrak Authentication
- NT Authentication

Additional on-line security can be achieved using PLC Password Aliases. For more on this subject, see **PLC Password Aliases**.

Security Setup

Password security in WorkShop is disabled by default. Without password security enabled, any user may access any portion of the programming package.

Before the password security feature can be used, establish a security administrator by selecting the Options \ Security menu item.



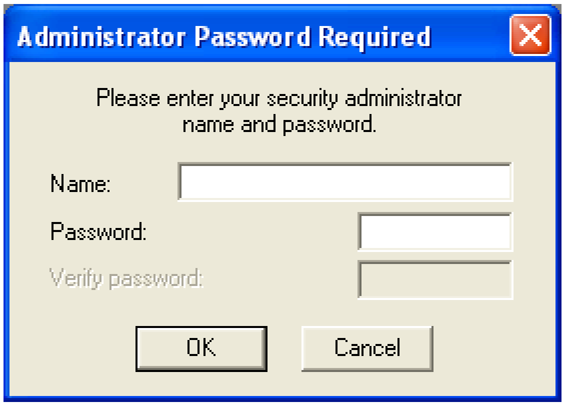
Under Security, select from two menu items:

- **User Options -** Allows users to change their own passwords or allow other users to enter their password without having to exit and restart WorkShop.

- **Administrator Options -** Allows the security administrator to add, edit and delete users and their access privileges to specific features in WorkShop.

Administrator Options

By default, there is no security administrator and the password security feature is not enabled. Therefore, the **User Options** menu item is disabled until a security administrator is established. Select **Administrator Options** to establish a security administrator. The **Password Required** dialog appears.



Administrator Password Required

Please enter your security administrator name and password.

Name:

Password:

Verify password:

The security administrator is required to enter a name and password. The administrator name can be up to twenty characters long. The password can be up to fourteen characters long. Valid characters for both fields are alpha-numerics and the other keyboard-entered characters (! @ # $ %, etc.).

The first time a security administrator is established, the password must be entered twice. This original security administrator can add other security administrators through the **Security Administration** dialog discussed below.

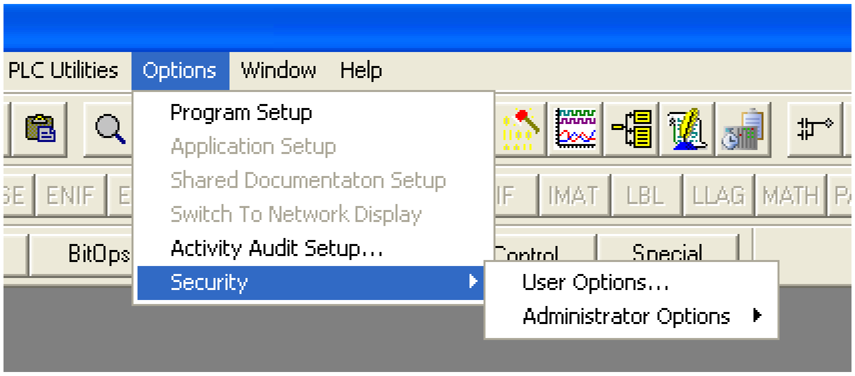
If a security administrator has already been established, the password does not need to be entered a second time for verification. When a security administrator exists, **Verify password** is disabled as illustrated below.

Enter the security administrator name and password, then click **OK**. If the two passwords match, the **Security Administration** dialog appears.

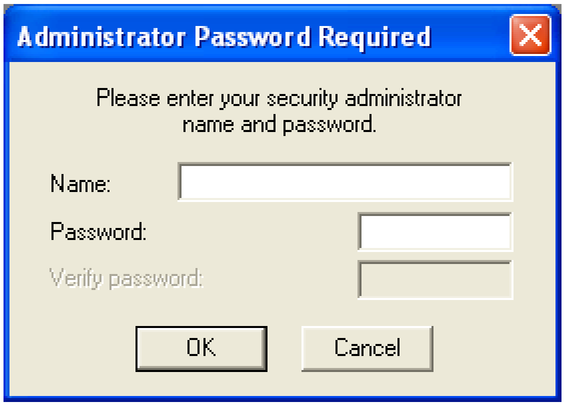
Choosing a Security Type

PLC WorkShop offers two unique security systems for use. If the computer on which PLC WorkShop is installed is running under Windows NT, 2000, XP, or Vista, PLC WorkShop determines if the user currently logged in to the operating system is an administrator (or belongs to the Administrator group).

To activate the security feature of PLC WorkShop, select the **Options \ Security \ Administrator Options** menu item.

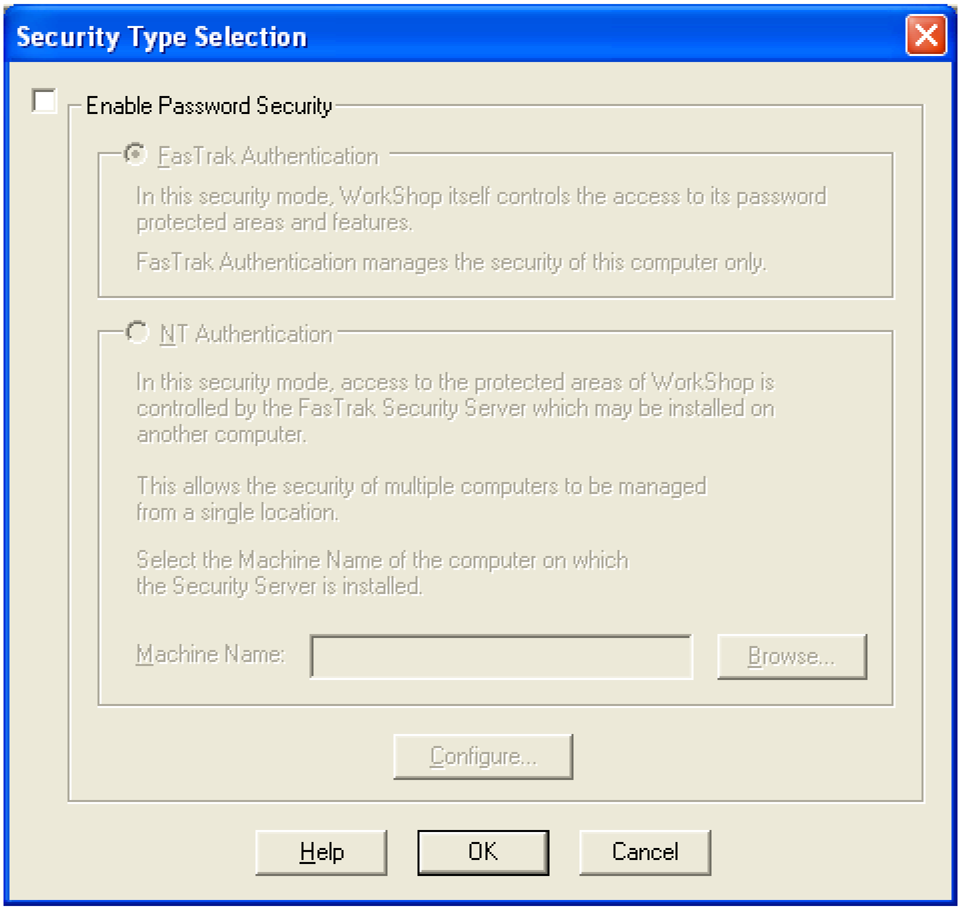


If PLC WorkShop is running under Windows 95, 98, or ME, the **Password Required** dialog appears. This dialog allows the user to become the first security administrator.


Administrator Password Required

Please enter your security administrator name and password.

If the user belongs to the Administrator group, then the fields above are filled in and the dialog is used to verify the user's password. Clicking **OK** launches the **Security Type Selection** dialog.



□ Enable Password Security

● FasTrak Authentication

In this security mode, WorkShop itself controls the access to its password protected areas and features.

FasTrak Authentication manages the security of this computer only.

○ NT Authentication

In this security mode, access to the protected areas of WorkShop is controlled by the FasTrak Security Server which may be installed on another computer.

This allows the security of multiple computers to be managed from a single location.

Select the Machine Name of the computer on which the Security Server is installed.

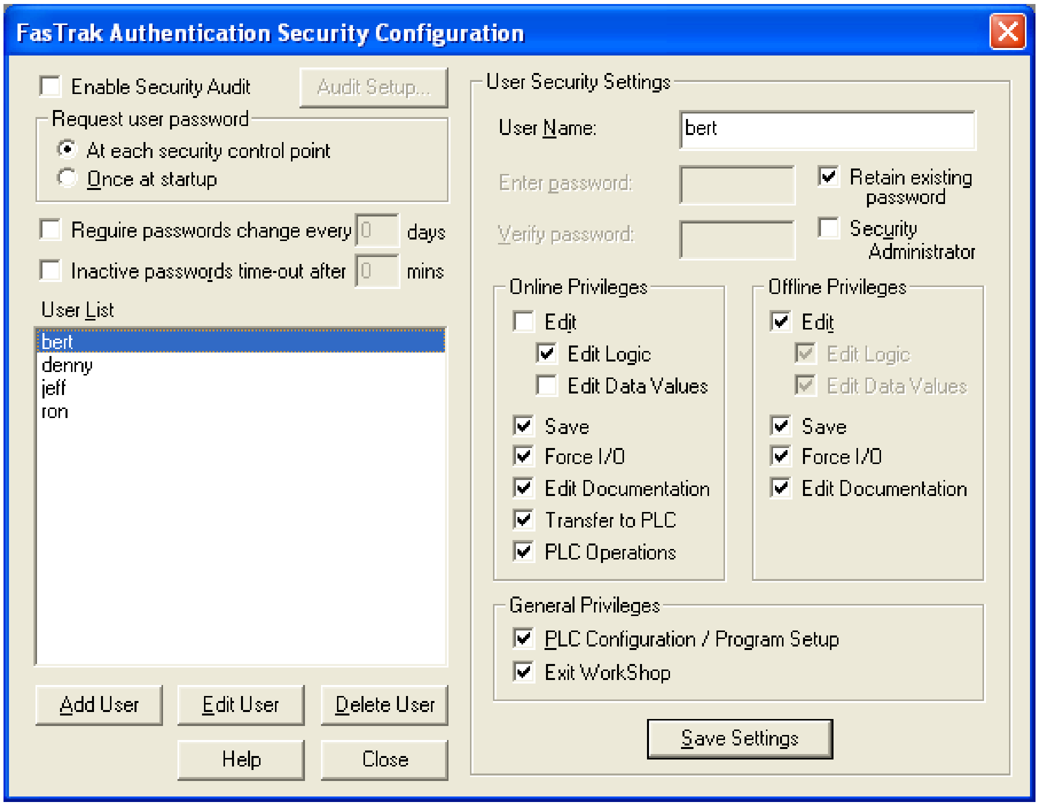
Clicking on **Enable Password Security** activates security and the user is free to choose from either FasTrak Authentication or NT Authentication.

- **FasTrak Authentication** - When you select this option, the WorkShop application itself regulates user access to password-protected areas. Management takes place on the local computer only. **For more on this area of Security, click** here**.**
- **NT Authentication** - When enabled, PLC WorkShop requests permission to access password-protected areas from the FasTrak Security Server. This server is a separate application which can be installed on the local computer or on any other computer running under Windows, NT, 2000, XP, or Vista. This server is capable of managing multiple computers from a single, central location. **Click** here **to go to the chapter on this feature.**

FasTrak Authentication Security

Introduction to FasTrak Authentication Security

Access FasTrak Authentication Security by selecting **FasTrak Authentication** from the Security Type Selection dialog and clicking the **Configure** button. The FasTrak Soft-Works, Inc. Authentication Security Configuration dialog appears.


FasTrak Authentication Security Configuration

□ Enable Security Audit

Request user password
● At each security control point
○ Once at startup

□ Require passwords change every 0 days
□ Inactive passwords time-out after 0 mins

User List
bert
denny
jeff
ron

User Security Settings
User Name: bert
Enter password:
Verify password:
☑ Retain existing password
□ Security Administrator

Online Privileges
□ Edit
☑ Edit Logic
□ Edit Data Values
☑ Save
☑ Force I/O
☑ Edit Documentation
☑ Transfer to PLC
☑ PLC Operations

Offline Privileges
☑ Edit
☑ Edit Logic
☑ Edit Data Values
☑ Save
☑ Force I/O
☑ Edit Documentation

General Privileges
☑ PLC Configuration / Program Setup
☑ Exit WorkShop

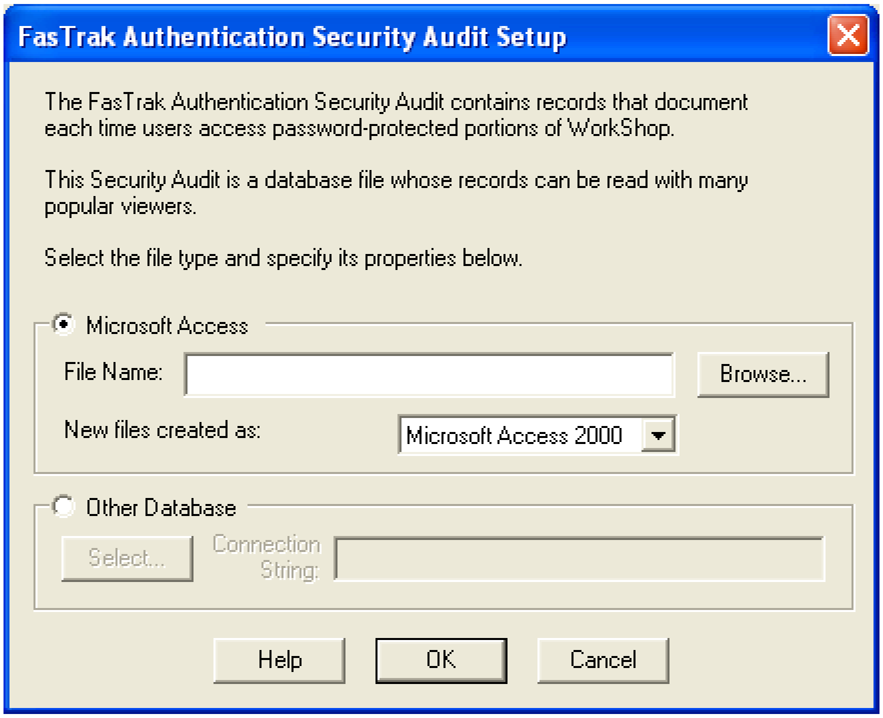
In addition to controlling user access, this security mode also can record each attempt to access protected portions of WorkShop made by users. To enable this, click the **Enable Security Audit** check box and the **Audit Setup** button.

NOTE: If, when exiting this dialog with the check box checked but having not setup the security log, PLC WorkShop will warn the user that no log file had been configured and the check box selection will not be retained.

To learn more about setting up the FasTrak **Authentication Log**, please refer to **FasTrak Security Audit Setup** on page *627*.

FasTrak Security Audit Setup

The following dialog is launched from the **FasTrak Authentication Configuration** dialog by clicking on **Audit Setup**.



FasTrak Authentication Security Audit Setup

The FasTrak Authentication Security Audit contains records that document each time users access password-protected portions of WorkShop.

This Security Audit is a database file whose records can be read with many popular viewers.

Select the file type and specify its properties below.

● Microsoft Access

File Name:

New files created as: Microsoft Access 2000

○ Other Database

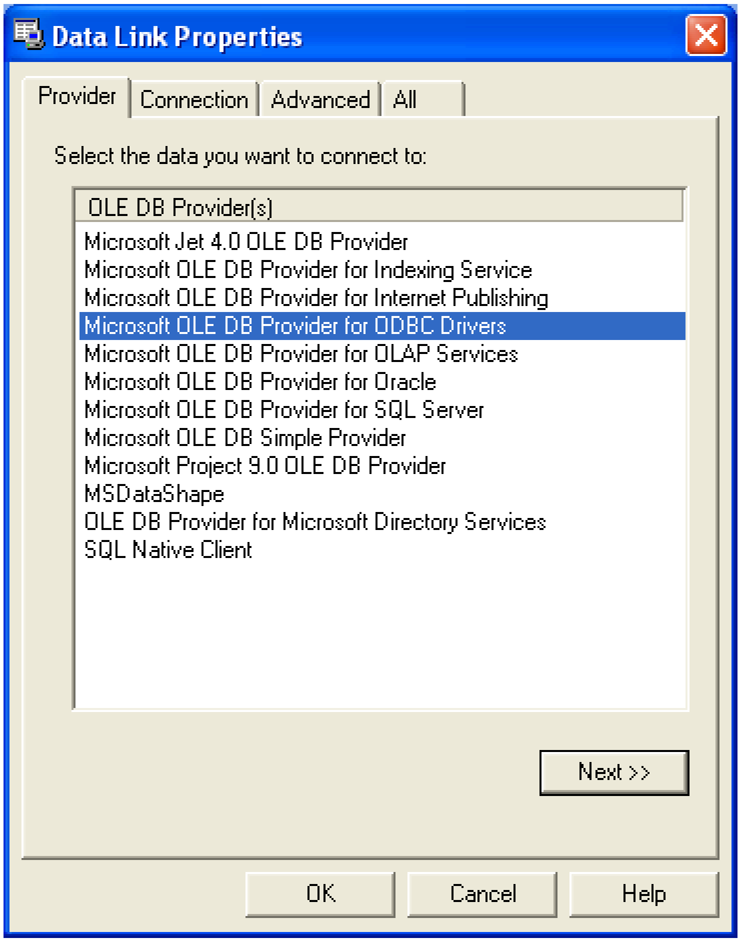
Connection String:

To write the local security log to a Microsoft Access database file, click the **Microsoft Access** radio button. Type the name of the Access file in the **File Name** text box or click **Browse** to locate the file. Select the proper file format from the **New files created as** group box.

To write the local security log to an SQL database file, select the **Other Database** radio button. Enter the file **Connection String** in the text box.

Data Link Properties Dialog

If choosing a database other than Microsoft Access, and the user does not provide a connection string, click the **Select** button. The **Data Link Properties** dialog appears.



Select the data you want to connect to:

OLE DB Provider(s)

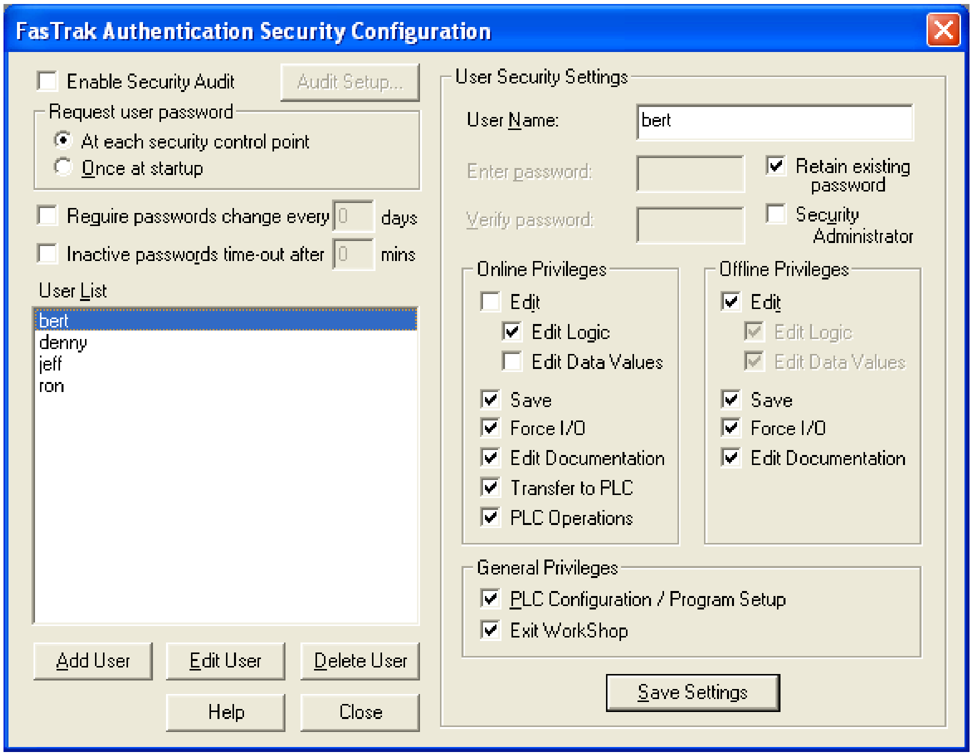
Microsoft Jet 4.0 OLE DB Provider
Microsoft OLE DB Provider for Indexing Service
Microsoft OLE DB Provider for Internet Publishing
Microsoft OLE DB Provider for ODBC Drivers
Microsoft OLE DB Provider for OLAP Services
Microsoft OLE DB Provider for Oracle
Microsoft OLE DB Provider for SQL Server
Microsoft OLE DB Simple Provider
Microsoft Project 9.0 OLE DB Provider
MSDataShape
OLE DB Provider for Microsoft Directory Services
SQL Native Client

This dialog is the first in a series of tabbed dialogs which help the users create the necessary string of the local security log file Follow the prompts to create the connection string to the database.

Security Administration

Introduction to FasTrak Authentication Security Configuration

Security administrators control the password security feature of WorkShop using the **FasTrak Authentication Security Configuration** dialog.


FasTrak Authentication Security Configuration

□ Enable Security Audit

Request user password
● At each security control point
○ Once at startup

□ Require passwords change every 0 days
□ Inactive passwords time-out after 0 mins

User List
bert
denny
jeff
ron

User Security Settings
User Name: bert
Enter password:
Verify password:
☑ Retain existing password
□ Security Administrator

Online Privileges
□ Edit
☑ Edit Logic
□ Edit Data Values
☑ Save
☑ Force I/O
☑ Edit Documentation
☑ Transfer to PLC
☑ PLC Operations

Offline Privileges
☑ Edit
☑ Edit Logic
☑ Edit Data Values
☑ Save
☑ Force I/O
☑ Edit Documentation

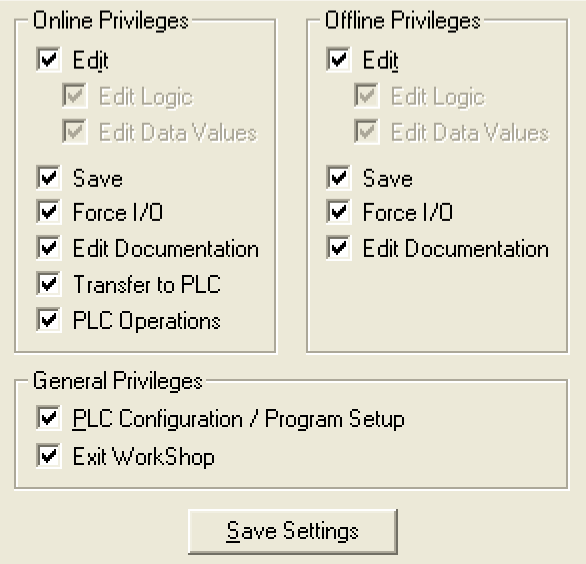
General Privileges
☑ PLC Configuration / Program Setup
☑ Exit WorkShop

The security feature can be enabled and disabled and the places at which user passwords are requested can be specified through this dialog. The list of users and their rights to access specific features within WorkShop are managed within this dialog.

User Privileges

The administrator can set a variety of individual user security settings, or *privileges*, in the **Security Configuration** dialog. Setting access privileges allows the administrator to restrict critical functions users can access within WorkShop.

For example, a user may have permission to edit information in both the Logic and Data Windows while online, but may not have permission to edit data values while offline.



Online Privileges

- ☑ Edit
  - ☑ Edit Logic
  - ☑ Edit Data Values
- ☑ Save
- ☑ Force I/O
- ☑ Edit Documentation
- ☑ Transfer to PLC
- ☑ PLC Operations

Offline Privileges

- ☑ Edit
  - ☑ Edit Logic
  - ☑ Edit Data Values
- ☑ Save
- ☑ Force I/O
- ☑ Edit Documentation

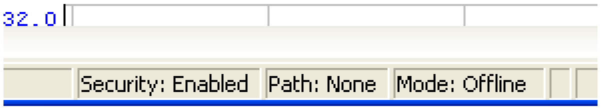
General Privileges

- ☑ PLC Configuration / Program Setup
- ☑ Exit WorkShop

Enable Password Security

The password security feature is disabled in WorkShop by default. The security administrator can turn this feature on by checking **Enable password security**. When this box is checked, users are requested to enter their passwords either once each time WorkShop is started or each time they attempt to enter a password-protected section of the application.

The current security mode is indicated in the status bar at the bottom of the WorkShop window as seen in the example below. **Security:Enabled** appears when security is enabled. **Security:Disabled** appears when security is disabled.



32.0

Security: Enabled | Path: None | Mode: Offline

Inactive Passwords Timeout in N Minutes.

Once users enter their passwords, they can operate PLC WorkShop indefinitely (within their access privileges). However, if PLC WorkShop runs unattended for a designated number of minutes without user interaction, the password under which the application is running can time out.

Click **Inactive passwords time-out after N mins** to activate this feature. Enter the number of minutes PLC WorkShop may remain inactive before the current password times-out. The default number of minutes is 30 but the valid range is 1 – 999.

Request User Password

Once password security is enabled, PLC WorkShop requests users to enter their passwords at various times to operate the software.

Passwords can be requested each time users attempt to enter a password-protected portion of the application. Alternately, passwords may be requested only once when WorkShop is first started.

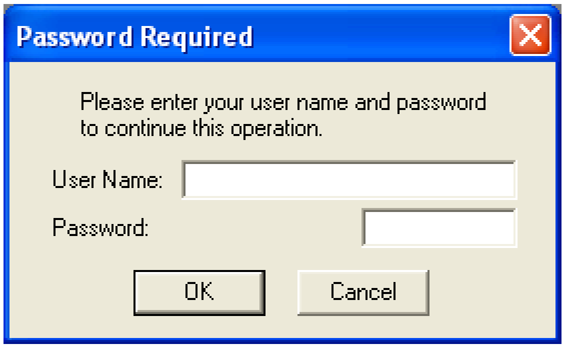
At Each Control Point

Password control points are designated as privileges within the **User Security Settings** group box illustrated in the following pages. Specifying that passwords are requested at these control points requires users to enter their name and password every time they attempt to use these features.

The advantage of this selection is that multiple users can operate WorkShop without having to exit and restart the application under another user name and password. Once a user has completed a password protected operation and exits that function, other users can access password protected operations by entering their own user names and passwords.

The disadvantage of this selection is that it requires users – even the same user – to reenter user names and passwords each time they attempt to access one of the password controlled features.

For example, saving a program to disk is one of these control points. Assume a user edits a ladder program. The user then selects the **File \ Save** menu item to write the changes to disk. The **Password Required** dialog appears, requesting the user name and password to access the save feature.


Password Required

Please enter your user name and password to continue this operation.

User Name:

Password:

Upon entering a valid user name and password (and the security administrator has given this user privileges to this feature), the user is granted access to the save feature. After saving, the user immediately returns to the program, makes another change, then selects the

File \ Save menu item again. Even though the user was just granted access to the Save feature, the **Password Required** dialog reappears requesting the user name and password.

Once At Startup

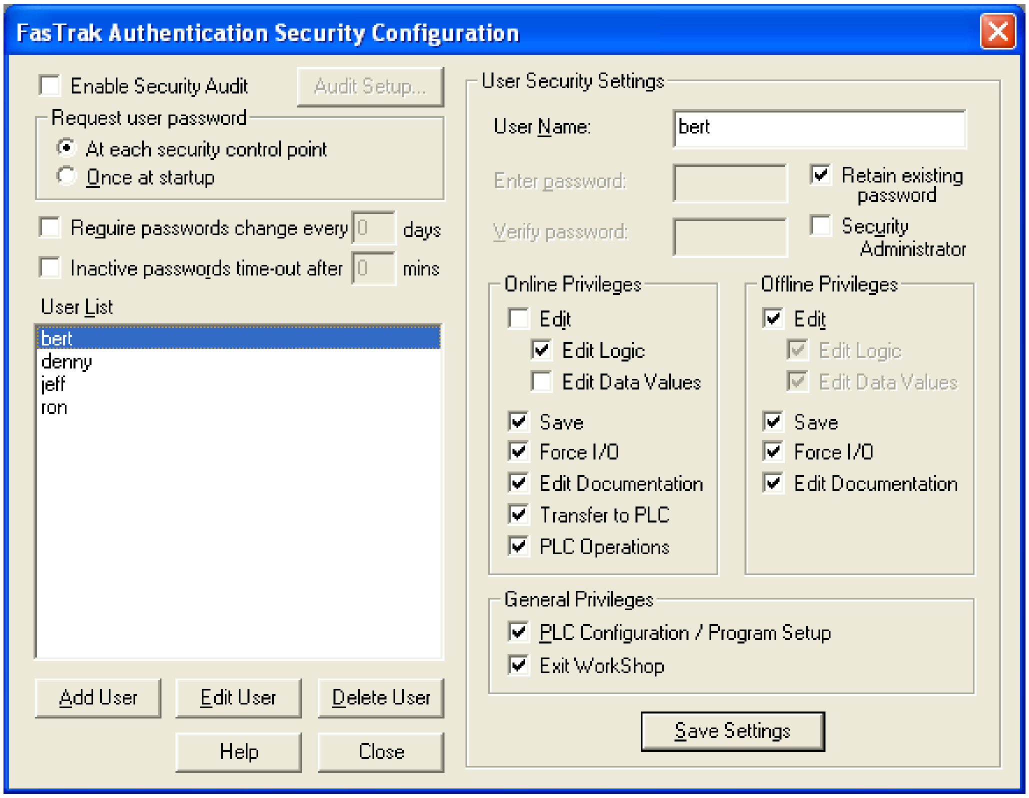
Alternately, user name and password can be requested once when WorkShop is started – or after selecting **Switch user** in the **User Security Setup** dialog, illustrated later in this document. Upon entering a valid user name and password, the new user can access each password-controlled feature (to which the security administrator has granted privileges) without having to re-enter the user name and password.

The advantage of this selection is that users enter their names and passwords once at startup and are not required to re-enter them each time they choose a password-controlled feature.

The disadvantage of this selection is that one user can start WorkShop with a correct name and password but another operator can continue to use the application with all the original user’s access privileges.

Adding Users

Click the **Add User** button to add a new user to the list. The dialog controls for a new user are set as illustrated below.



FasTrak Authentication Security Configuration

☐ Enable Security Audit

Request user password
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User List
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User Security Settings
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Enter password:
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☑ Retain existing password
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☑ Edit Logic
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☑ Save
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☑ PLC Operations

Offline Privileges
☑ Edit
☑ Edit Logic
☑ Edit Data Values
☑ Save
☑ Force I/O
☑ Edit Documentation

General Privileges
☑ PLC Configuration / Program Setup
☑ Exit WorkShop

User names can be up to twenty characters long. Passwords can be up to fourteen characters long. Valid characters for both fields are alpha-numerics and the other keyboard-entered characters (! @ # $ %, etc.).

Enter the user name then enter and re-enter the password.

All privileges are initially checked for new users. Check/uncheck the privileges appropriate for the user.

Security administrators can create other security administrators. Check the **Security Administrator** box to grant the new user all administrator rights and privileges.

Click **Save Settings**. The list of existing users is checked to assure the new user name is not a duplicate. If the new user name is unique, the two password entries are compared. Finally, the new user name is added to the **User List** box.

Editing Users

There are two ways to select an existing user to edit. Either double click a user name from the **User List** box or highlight a user name in the **User List** box and click the **Edit User** button.

By default, **Retain existing password** is checked and the password edit boxes are disabled. This allows the security administrator to modify privileges without needing to re-enter the user identity information (the user name and password).

To change the user name, type an alternate entry in the **User Name** edit box.

To change an existing user password, uncheck **Retain existing password** to enable the password edit boxes. Enter and verify a new password. Both password entries must match in order to save the new password.

Security administrator rights may be granted to or revoked from the user by checking or un-checking **Security Administrator**.

Deleting Users

To remove a user, highlight a name in the **User List** box and click the **Delete User** button. A verification message appears which asks to confirm the deletion. Click **OK** and the user is removed.

User Security Setup

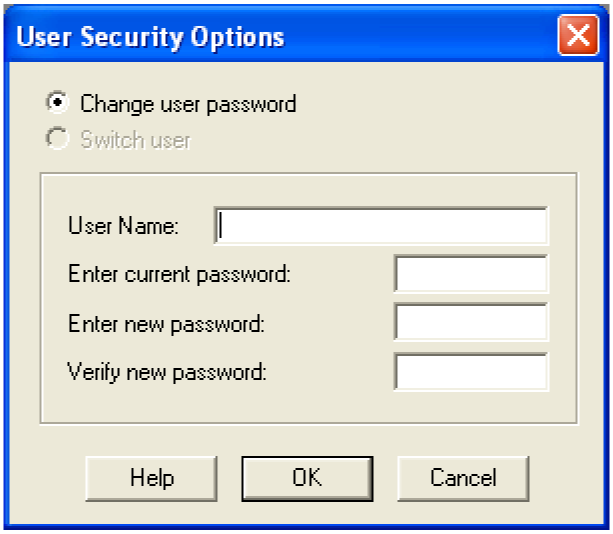
Introduction to User Security Setup

Once the security administrator adds users, their initial passwords and access privileges, the **User Options** item of the **Security Setup** menu (as illustrated earlier) is enabled. Users can select this menu item to change their passwords through the **User Security Setup** dialog box..

If the security administrator elects to request user passwords once at startup, the **Switch User** radio button is enabled. Otherwise, if passwords are requested at password control points, this radio button is disabled.

Changing the User's Password

Users may change their own passwords. Security administrators may also change their passwords. Click the **Change user password** radio button and the dialog controls are set as illustrated to the left.



User Security Options

● Change user password
○ Switch user

User Name:
Enter current password:
Enter new password:
Verify new password:

Enter the user name and current password. Then enter and verify the user's new password and click **OK**.

If the entered user name is in the list of users previously added by the security administrator, the **Enter current password** text box is compared to the password already associated with that user.

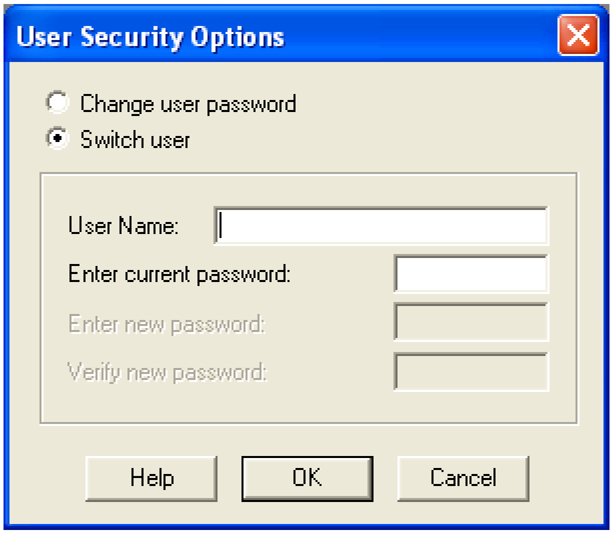
If the **Enter current password** matches the existing password for that user, the **Enter new password** and **Verify new password** are compared with each other. If the two new passwords match, then the new password replaces the current.

Switching the User

If the security administrator specifies user passwords are requested only once when WorkShop is started, the password entered at startup (and the access privileges associated with it) is in effect until WorkShop is exited. Another password is not requested until WorkShop is restarted.

However, the Switch user name and option allows another user to enter another password without requiring the application be exited and restarted.

Enter the user name and password of the user who will assume operational control of WorkShop. If a valid user name and its matching password are entered, the security access privileges are reset to those of the new user.



User Security Options

○ Change user password
● Switch user

User Name:

Enter current password:

Enter new password:

Verify new password:

NT Authentication Security Server

Introduction to FasTrak NT Authentication Security Server

The FasTrak NT Authentication Security uses Windows NT security. NT Security is a feature that is part of the Windows NT Operating System and is also found in Windows 2000, XP, and Vista. The server must therefore be installed on a machine running Microsoft Windows NT (3.1 or later), Windows 2000, Windows XP, or Windows Vista. The following hardware requirements are recommended.

- A personal computer with an Intel Pentium 100 processor or higher.
- 32 MB or more of RAM.
- An 800 X 600 VGA monitor with at least 256 colors.
- 100 MB free disk space on your hard drive.

Both the **FasTrak Security Server** (FTSecSvr.exe) and the **FasTrak Security Configurator** (FTSecCfg.exe) must be installed and configured prior to activating and utilizing these features.

The Security Server application (FTSecSvr.EXE) handles all client requests to access secured FasTrak features. The server grants or denies access to a feature request depending on the configuration provided by FTSecCfg. When security is enabled for FasTrak applications, all secure features are unaccessible unless security is configured via FTSecCfg and the security server is running. All NT auditing including security and application audits are handled by the server. Security audits are configured in FTSecCfg and application audits are configured in the FasTrak applications that support security.

The following breakdown of steps will aid the user as they go through the installation, configuration, and use of these parts as found in this help manual. They are:

1. **Installation:** The procedure for installing both the Security Server and Configurator on local and remote machines (the Sever must be installed regardless of operating system and whether it is ran locally or remotely)
2. **WorkGroups and Domains:** Details to how both relate to NT Security
3. **Configuring Users and Groups:** Procedures for adding and setting up groups for the variety of supported Operating Systems
4. **Configuring User's Rights and Audit Policy:** Instructions for configuring specific user rights and audit policy on the machine to which the server will be running from

5. **DCOM (Distributed Component Object Module) Configuration:** Instructions for configuring DCOM on the available variety of Operating Systems and how to setup the Security Administrator
6. **Security Configuration:** Specific instructions for how to setup, configure and launch the Security Configurator. Also, instructions for configuring the users, groups and auditing features as well as the Event Viewer, used to view generated logs.

Installing the Security Server

If the FasTrak client applications are installed on a machine other than the one FTSecSvr is running on (remote security), users may want to install FTSecCfg on the client machine(s) as well as the server machine so that the server can be configured locally or from the client machine.

FasTrak security must be installed on a machine running Windows NT (3.1 or later), 2000, XP, or Vista. Two applications get installed to a user-selected directory on the local machine. These files are FTSecCfg.exe and FTSecSvr.exe. If running Windows XP, FTSecSvr.exe can only be installed on the Professional version, not on the Home version.

Regardless of what Operating System the user has, they still must install the server (FTSecSvr.exe) locally on the client machine as well as on the remote machine. This is true even if the client machine is a non-NT type machine. By default, all "checkable" items get installed including FTSecSvr.exe (under NT Security\Server) and FTSecCfg.exe (under NT Security\Configurator). If installing to Win9x or Me, NT Security\Configurator is not listed and therefore FTSecCfg.exe does not get installed.

Installing to a Local Machine

If the user wishes to install the Security Server locally, this may be achieved by installing from off of CD or from a self-extracting executable file available from FasTrak's Website.

A CD installation requires only that all items for security be checked during the InstallShield process. If a client software application has been previously installed, and it supports NT Security, then re-inserting the installation CD or running the self-extracting executable and unchecking the client during the InstallShield process is all that is required.

Installing to a Remote Machine

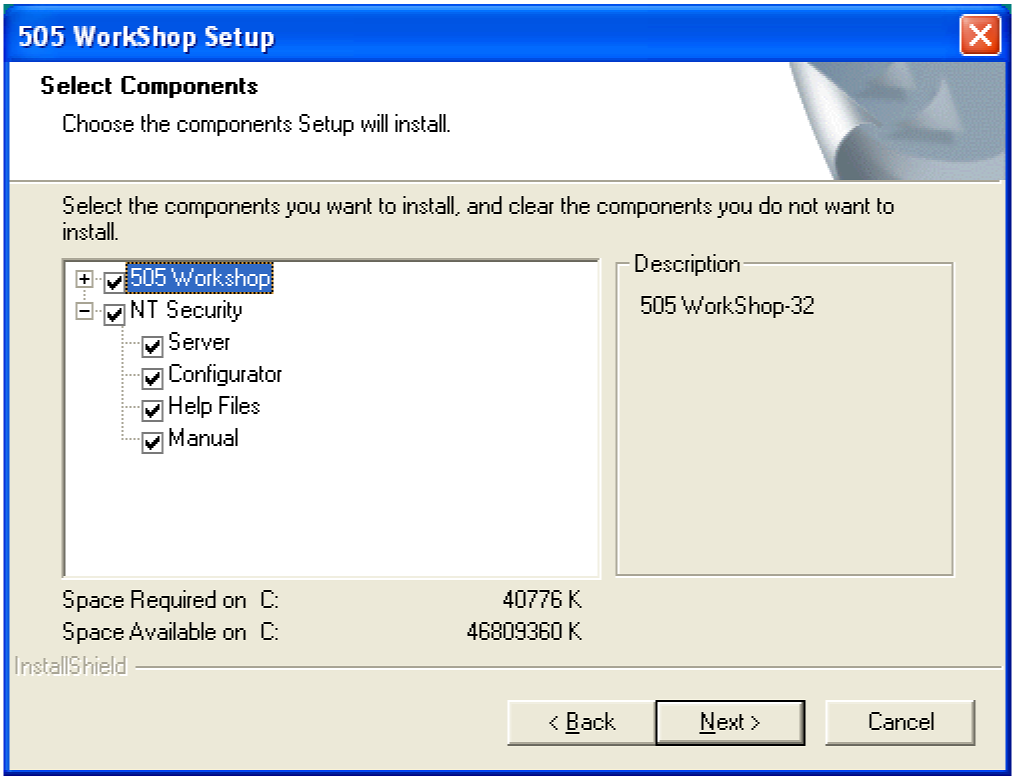
Installation begins with the installation of the client (ie. PLC WorkShop) to a local, or client, machine. In this case, installing the Security Configurator is an option.

After this installation is complete, the user must install to the machine which will act as the remote server. Installation is identical to the above with the exception that the client need not be installed and therefore may be unchecked from InstallShield. It is recommended that both the Security Server (FTSecSrv) and Configurator (FTSecCfg) be installed.

If a client software application is already installed to the machine which the user wishes to run as the remote security server, installation of security is identical to installing to a local machine.

Installation Dialog

The following dialog is an example of what a user should expect to see during installation. Below is the dialog whereby the user selects to install the client application, security, or both.



505 WorkShop Setup

Select Components

Choose the components Setup will install.

Select the components you want to install, and clear the components you do not want to install.

- ☑ 505 Workshop
- ☑ NT Security
  - ☑ Server
  - ☑ Configurator
  - ☑ Help Files
  - ☑ Manual

Description

505 WorkShop-32

Space Required on C: 40776 K
Space Available on C: 46809360 K

To add or remove which component of security the user wishes, click the plus sign next to **NT Security**. The NT Security installation components appear. Select which components to install by checking or un-checking the check box next to each component.

Workgroups and Domains

Workgroups

NT security works slightly different in workgroups than in domains. This difference is only a factor when using the security server remotely. When a computer is part of a Workgroup and a user enters their user name and password to log onto the operating system, the user name they logged in as, the rights they have, and groups they belong to are known only to the local computer.

When a local computer (running a client application such as WorkShop) connects to a remote computer running the security server, it tries to log on to the remote computer with the same user name and password. If the exact user name and password cannot be found on the remote computer, the client (local computer) gets logged onto the remote computer as

"Guest". For this reason, a guest user normally has minimal rights. This account is disabled by default. If a guest account is enabled, anyone can log on to the computer because a password is not required for this account. In general, when using workgroups, all users that need to get security clearance from FasTrak's security server must exist on the server machine. The rights a user has on the local machine may differ than the rights they have on a remote machine. Similarly, the groups a user belongs to on the local machine may differ than the groups they belong to on a remote machine.

Domains

When a computer is part of a Domain and a user logs onto any computer that's a member of the domain, the user name and password they supply is stored on the domain controller vs. the local machine. There is no "re-logging" when connecting to a remote machine on a domain. The rights a user has and the groups they belong to are the same amongst all the machines on the domain. This eliminates the need to declare users twice. Once on the local machine and once on the remote machine. When setting up a server on a domain, its important to choose the domain controller machine because this machine holds all the domain users and groups.

Configuring Users and Groups to the Operating System

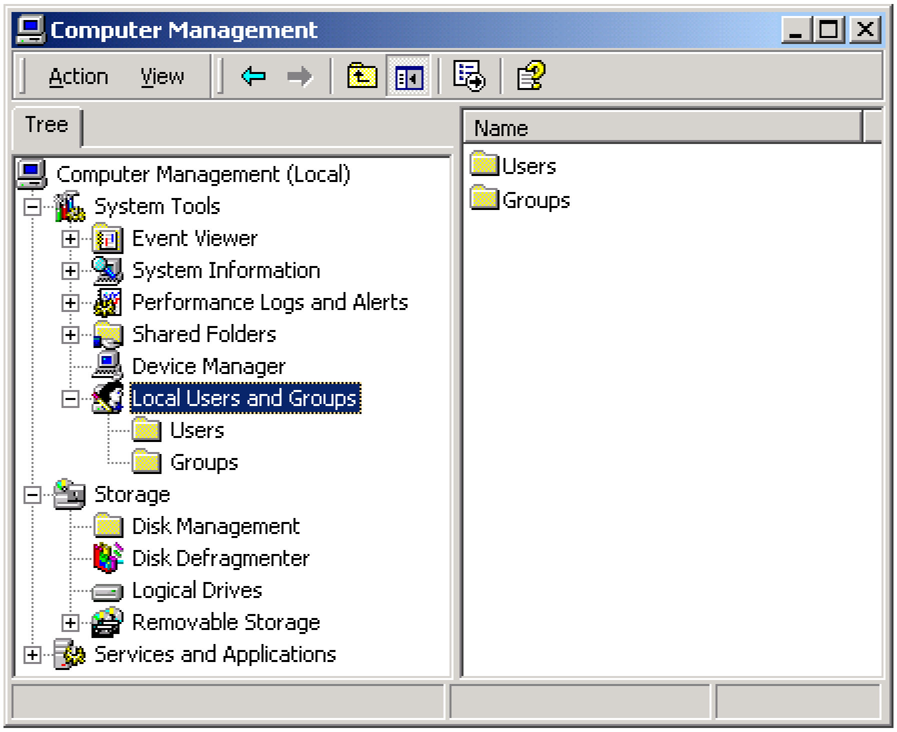
Configuring users and groups differ depending on the operating system your on. Configure users and groups using the instructions for the operating systems listed below.

Adding Users for Windows 95, 98, and ME

In Windows 9x and Me, users may logon to the system to get their unique user profile, but they do not have any rights since the OS is unprotected and they do not belong to any groups. A user can be created simply by entering a unique user name and password when logging on to the OS. A user may skip the login procedure altogether, in which case they become the "Guest" user.

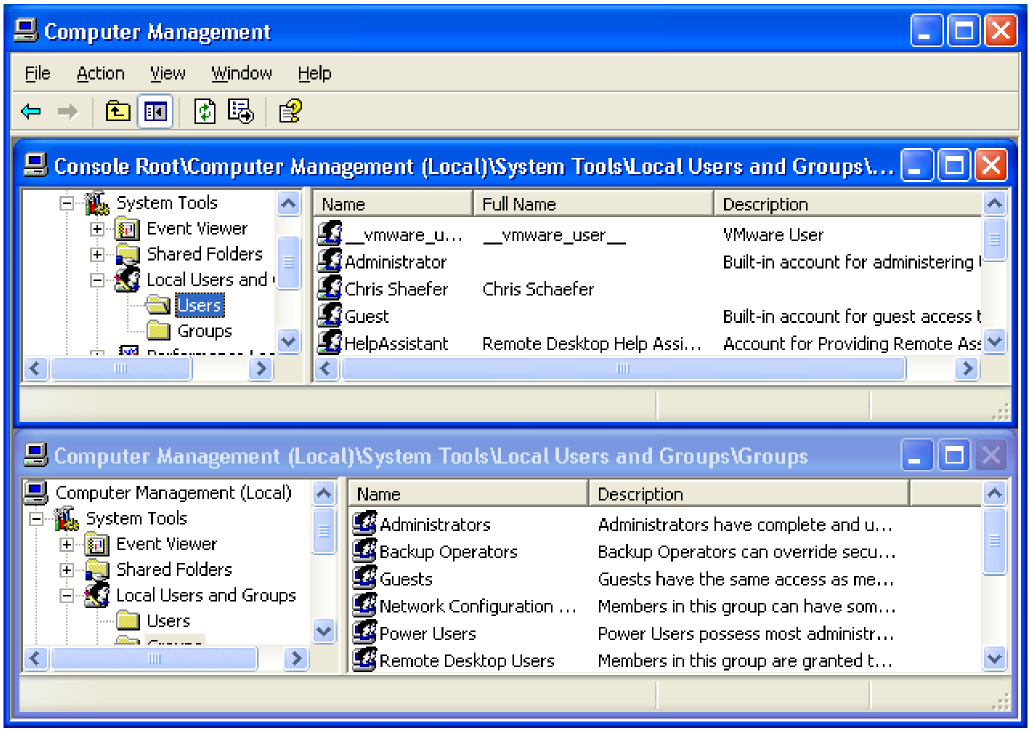
Adding Users for Windows NT

In Windows NT users and groups can be created by entering **Administrative Tools** from **Control Panel** and selecting **User Manager**. This is shown in the figure below.



Adding Users for Windows 2000 and XP

In Windows 2000 and XP users and groups can be created by entering **Administrative Tools** from **Control Panel** and selecting **Computer Management**. Within the Computer Management utility, users and groups can be created by right clicking on the corresponding folders under the **Local Users and Groups** tree item. This is shown in the figure below.


Computer Management
File Action View Window Help
Console Root\Computer Management (Local)\System Tools\Local Users and Groups\...
System Tools
Event Viewer
Shared Folders
Local Users and
Users
Groups
Computer Management (Local)\System Tools\Local Users and Groups\Groups
Computer Management (Local)
System Tools
Event Viewer
Shared Folders
Local Users and Groups
Users

Name	Full Name	Description
__vmware_u...	__vmware_user__	VMware User
Administrator		Built-in account for administering t
Chris Shaefer	Chris Schaefer	
Guest		Built-in account for guest access t
HelpAssistant	Remote Desktop Help Assi...	Account for Providing Remote As:

Name	Description
Administrators	Administrators have complete and u...
Backup Operators	Backup Operators can override secu...
Guests	Guests have the same access as me...
Network Configuration ...	Members in this group can have som...
Power Users	Power Users possess most administr...
Remote Desktop Users	Members in this group are granted t...

Adding Users and Groups on a Domain Controller

If on a domain controller, select **Active Directory Users and Computers** from the **Administrative Tools** menu. From the tree control, right-click the **Users** folder to add users and/or groups.

Configuring User Rights and Audit Policy

Correctly configuring specific user rights and audit policy on the server machine is essential for proper security and for the server to operate correctly. The following user rights need to be configured:

Access this computer from the network - Enter all users/groups that will need to access this computer from the network. These users will represent the server's clients that need to request security clearance.

- Deny access to this computer from the network - Make sure that any user/groups that are listed in the above right are not listed here.
- Generate security audits - A user with administrative rights should be added here. This should be the same user that the server is launched under. See DCOM in the Centralized Security Server- Server Configuration of this manual. This right should

be configured even if security audits are not used. This Administrator will be referenced later in this manual, in the section dealing with DCOM.

- Manage auditing and security log - A user with administrative rights should be added here. This should be the same user that the server is launched under. See DCOM in the Centralized Security Server- Server Configuration portion of this manual. This right should be configured even if the logs are not used.

NOTE: This is the same Administrator described earlier.

Configuration location differs depending on the operating system your on. In Windows NT enter the User Manager and choose User Rights from the Policies menu. If interested in generating security audits, select the Audit option from the Policies drop-down menu in the User Manager. From this dialog, check the Success and Failure buttons next to "File and Object Access".

In Windows 2000 and XP, users rights can be modified under Administrative Tools under Local Security Policy. While on a domain controller, users rights may be modified under Administrative Tools which is under Domain Controller Security Policy. From either application, right-click on the User Rights Assignment to list all user rights.

To enable security audits, click on Audit Policy from within Local Security Policy under Local Policies. Double click on the Audit Object Access policy and check both Success and Failure boxes. The computer's operating system must have the latest service pack installed as this fixes auditing problems with earlier releases.

The following table may assist a user in determining what rights must be given to a user on the machines involved in FasTrak's NT Authentication Security.

Remote Server Machine	Local Server Machine	Client Machine
Access this computer from the network	Generate Security Audits	N/A
Generate Security Audits	Manage auditing and security log	
Manage auditing and security log		

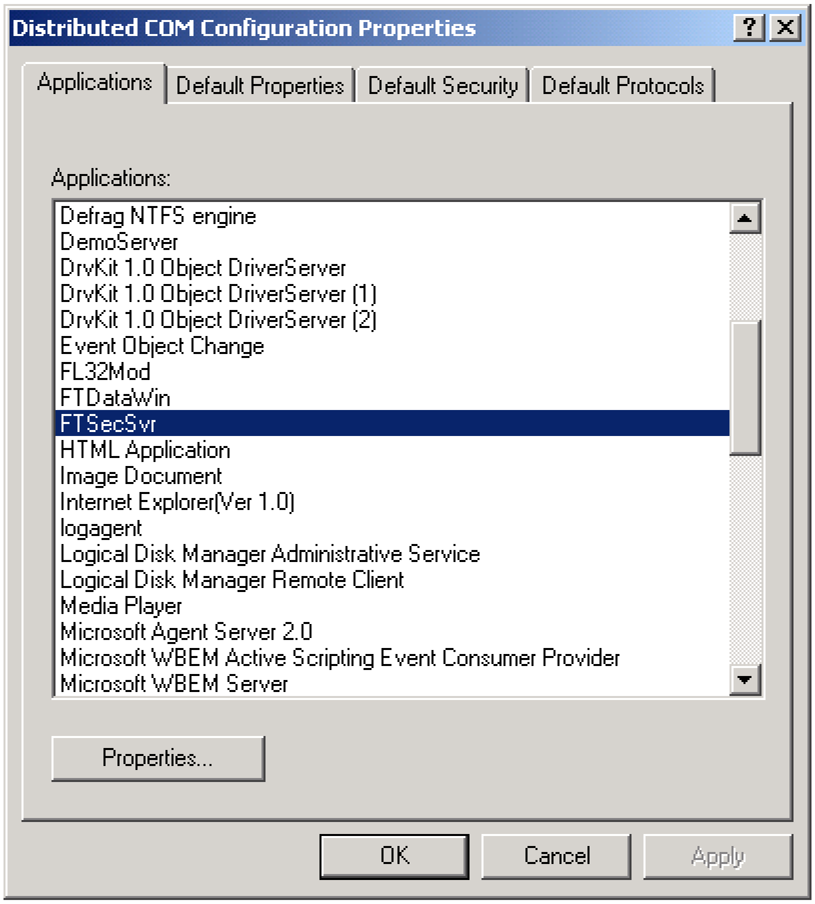
NOTE: It is mandatory that you reboot the machine for the new user rights to take effect.

Configuring DCOM for NT Authentication Security

The machine that the user wishes to run FTSecSvr (FasTrak Security Server) on must be configured for proper server/client communication. Below are the needed steps for configuring the server.

Configuring DCOM on Windows 9x, 2000, and NT

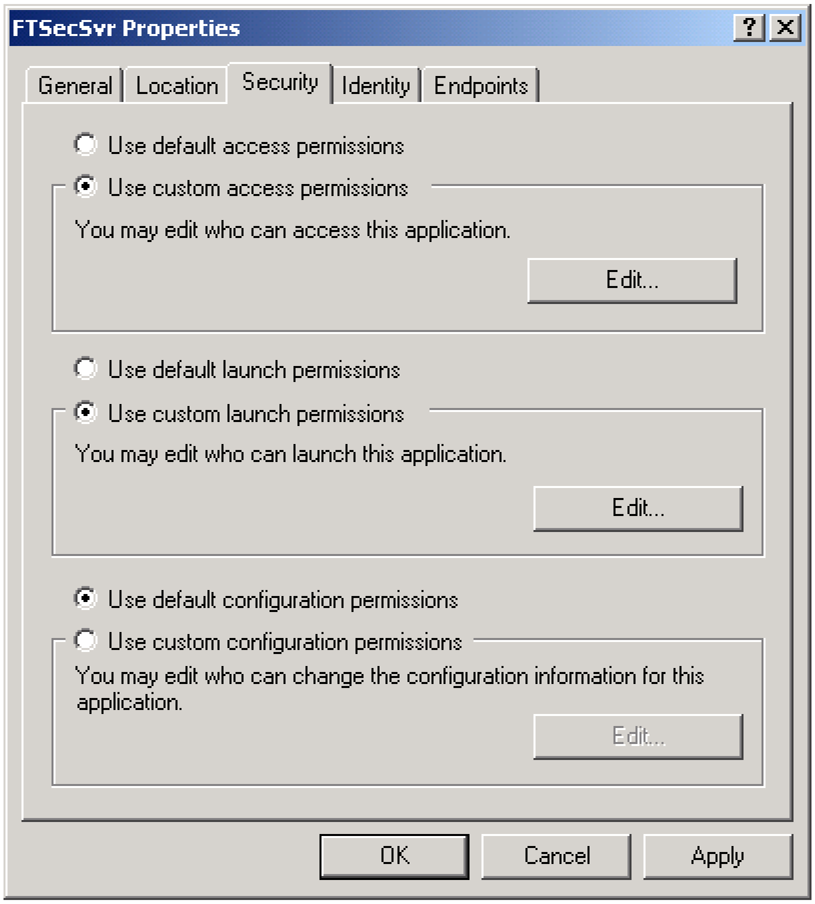
DCOM enables FasTrak clients such as PLC WorkShop to communicate with remote security servers. The dialog window, shown below, is launched by running **dcomcnfg.exe** from a DOS prompt or by clicking on the **Windows Start** button, clicking **Run**, and then typing **dcomcnfg.exe** in the text box. Changes made in DCOM are applied immediately and there is no need to reboot the PC.



Defrag NTFS engine
DemoServer
DrvKit 1.0 Object DriverServer
DrvKit 1.0 Object DriverServer (1)
DrvKit 1.0 Object DriverServer (2)
Event Object Change
FL32Mod
FTDataWin
FTSecSvr
HTML Application
Image Document
Internet Explorer(Ver 1.0)
logagent
Logical Disk Manager Administrative Service
Logical Disk Manager Remote Client
Media Player
Microsoft Agent Server 2.0
Microsoft WBEM Active Scripting Event Consumer Provider
Microsoft WBEM Server

Instructions for Configuration

1. In the **Applications** list box, scroll down and select **FTSecSvr**. If this item is missing, it was not properly installed; refer to earlier sections in this manual.
2. Click the **Properties** button.
3. The **Properties** dialog window opens. Click the **Security** tab.

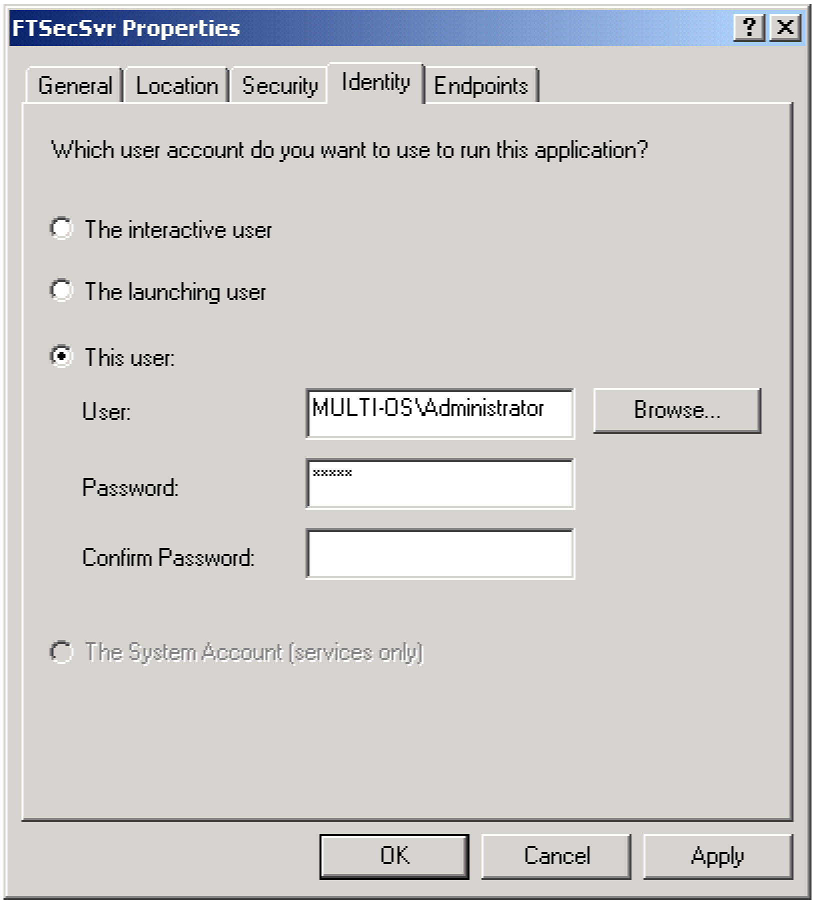


○ Use default access permissions
● Use custom access permissions
You may edit who can access this application.

○ Use default launch permissions
● Use custom launch permissions
You may edit who can launch this application.

● Use default configuration permissions
○ Use custom configuration permissions
You may edit who can change the configuration information for this application.

4. Under the **Security** tab, choose the Administrator (selected when **Configuring User Rights** and **Audit Policy**) who will have access permission. The following affects both the areas of **Access** and **Launch**. For **Custom** security for Launch and Access Permissions, follow these steps.
   - While in the **Properties** dialog, with the **Security** tab being active, click on **Edit**.
   - Click **Add** and choose the **Administrator**.
5. Choose the **Identity** tab and click the **This user** radio button.



FTSecSvr Properties

Which user account do you want to use to run this application?

○ The interactive user

○ The launching user

● This user:

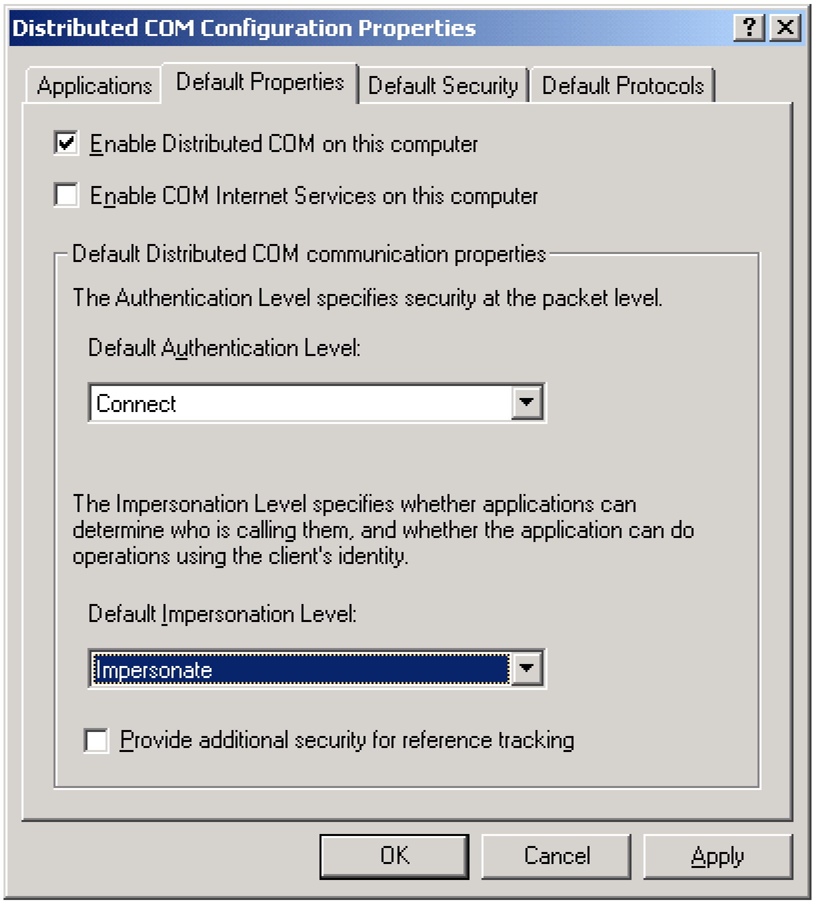
User: MULTI-OS\Administrator

Password: *****

Confirm Password:

○ The System Account (services only)

6. **Browse** and select the **Administrator**. Click **OK** to return to the main dialog.
7. Finally, click the **Default Properties** tab and choose **Connect** for Default Authentication and **Impersonate** for Default Impersonation.



☑ Enable Distributed COM on this computer

□ Enable COM Internet Services on this computer

Default Distributed COM communication properties

The Authentication Level specifies security at the packet level.

Default Authentication Level: Connect

The Impersonation Level specifies whether applications can determine who is calling them, and whether the application can do operations using the client's identity.

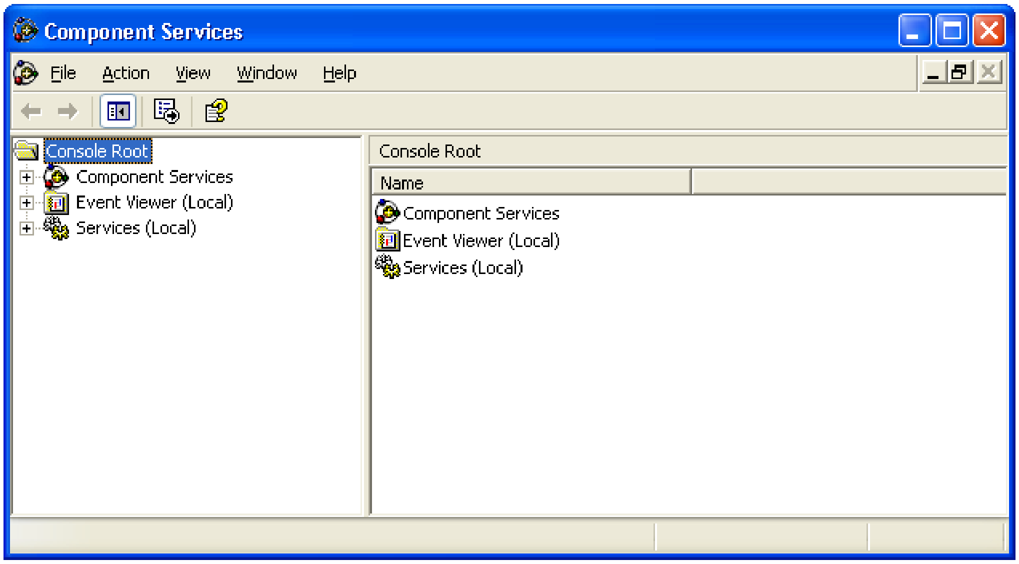
Default Impersonation Level: Impersonate

□ Provide additional security for reference tracking

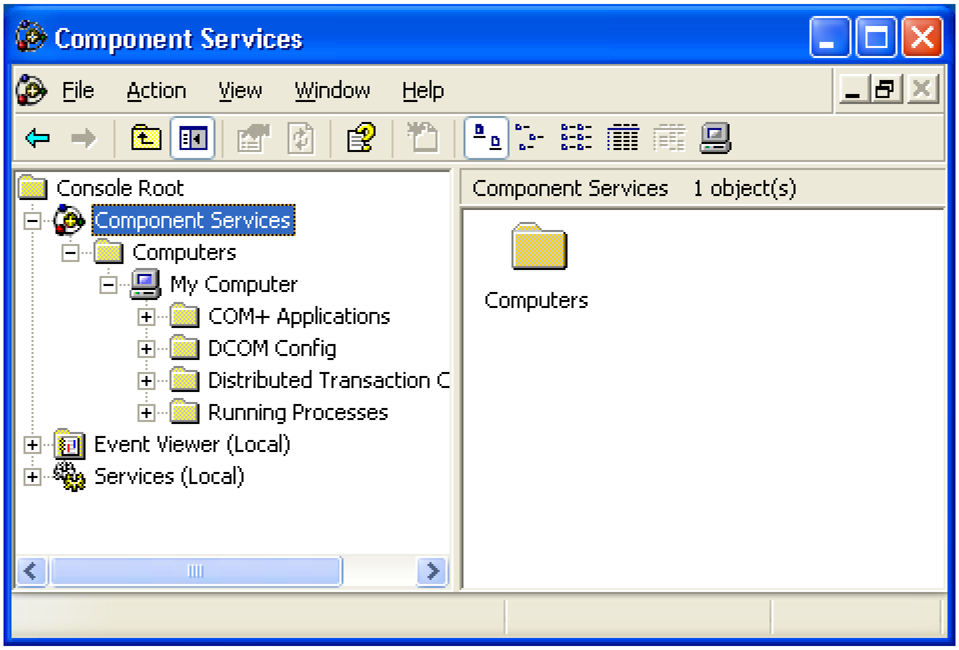
8. If the server is on a remote machine, then for the client, step 7 from above needs only be repeated.

Configuring DCOM for Windows XP

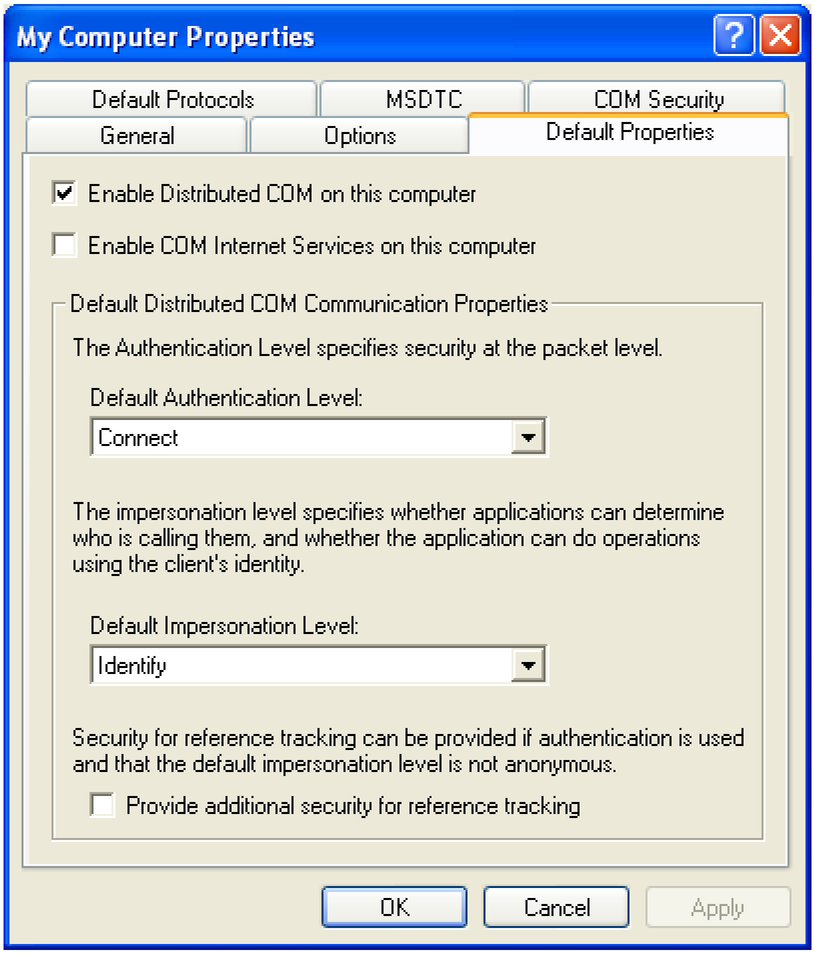
Configuring DCOM under Windows XP begins with launching the application, dcomcnfg.exe, from a DOS prompt or the Run dialog, just as in the previous instructions. The following dialog launches.



Using the tree structure in the left-most pane, expand **Component Services** to **Computer** and then to **My Computer**, as shown in the dialog window below.



Right-click **My Computer** and select **Properties**. The **My Computer Properties** dialog appears. In the **Default Properties** tab, select the default authentication and impersonation levels.



☑ Enable Distributed COM on this computer

□ Enable COM Internet Services on this computer

Default Distributed COM Communication Properties

The Authentication Level specifies security at the packet level.

Default Authentication Level: Connect

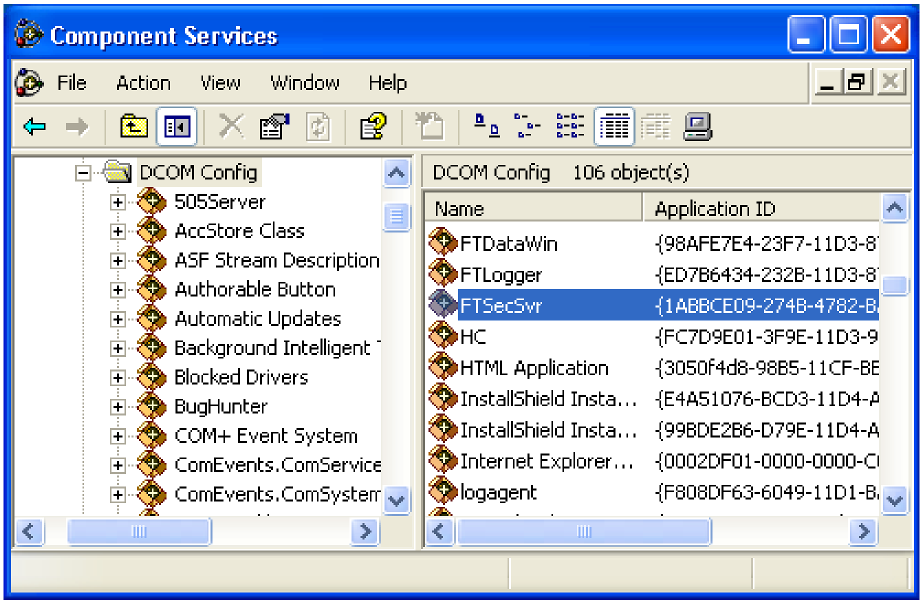
The impersonation level specifies whether applications can determine who is calling them, and whether the application can do operations using the client's identity.

Default Impersonation Level: Identify

Security for reference tracking can be provided if authentication is used and that the default impersonation level is not anonymous.

□ Provide additional security for reference tracking

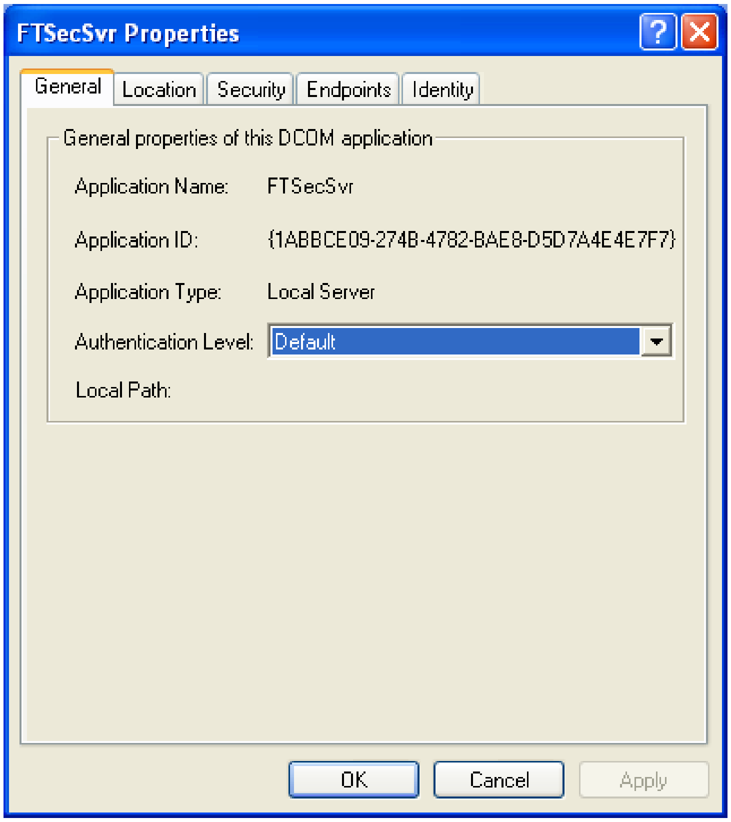
To set the security and identity properties for FTSecSvr, select **DCOM Config** under **My Computer** in the **Component Services** dialog. The available registered COM applications will be displayed. Scroll and select **FTSecSvr**.



DCOM Config 106 object(s)

Name	Application ID
FTDataWin	{98AFE7E4-23F7-11D3-8
FTLogger	{ED7B6434-232B-11D3-8
FTSecSvr	{1ABBCE09-274B-4782-B
HC	{FC7D9E01-3F9E-11D3-9
HTML Application	{3050f4d8-98B5-11CF-BE
InstallShield Insta...	{E4A51076-BCD3-11D4-A
InstallShield Insta...	{99BDE2B6-D79E-11D4-A
Internet Explorer...	{0002DF01-0000-0000-C
logagent	{F808DF63-6049-11D1-B

Open its properties by right-clicking on it. The dialog is shown below.



General properties of this DCOM application

Application Name: FTSecSvr

Application ID: {1ABBCE09-274B-4782-BAE8-D5D7A4E4E7F7}

Application Type: Local Server

Authentication Level: Default

Local Path:

Security Configurator

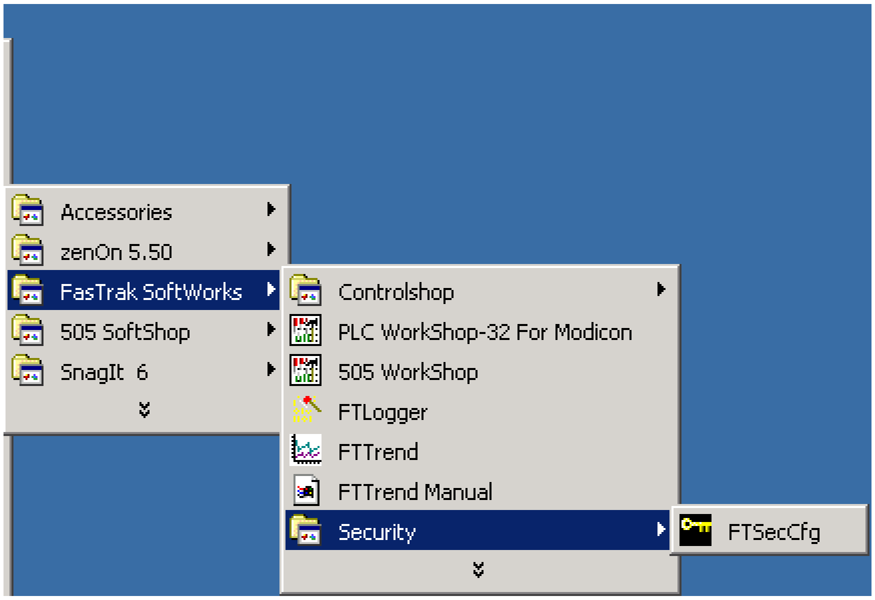
Introduction to Security Configurator

The **Security Configuration Application** (FTSecCfg.EXE) allows users with administrator rights to configure their centralized server based security. This .EXE will reside on the same machine and directory as the server. Users will also be able to install FTSecCfg on client machines running Windows NT (3.1 or later), 2000, XP, or Vista so that they can configure their security server remotely. The following features are supported:

- Ability to configure which users and or groups have access to various FasTrak features. This includes users and groups from the machine running the server. Separate secure features will exist for individual FasTrak applications including programming packages as well as ControlShop applications.
- Security Auditing can be configured for each specific feature on an individual or group basis. Audit information will be logged to the **Event Viewer** in the **Security Log** section.
- A link to the **Event Viewer** will be provided allowing quick access to the **Security Log**. The event viewer can also be accessed under **Administrative Tools** in Control Panel.

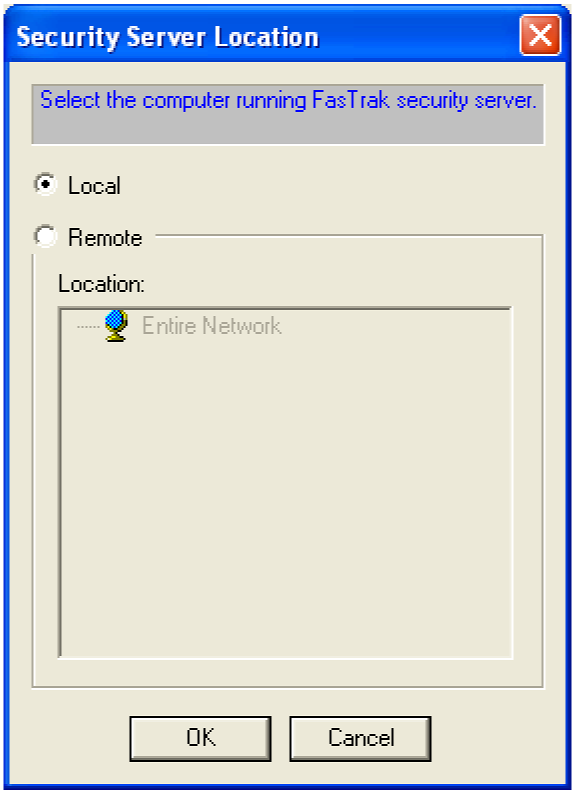
Launching the Security Configurator

The configuration application may be launched from either the Start menu in Windows or from within the WorkShop client.



The Security Configurator application will launch and (if the user is not in the client), at the same time, the **Security Server Location** dialog may open. Both are shown below.

When launched from the Start menu, the **Security Server Location** dialog will prompt the user to select the machine that the server will run on.



Security Server Location

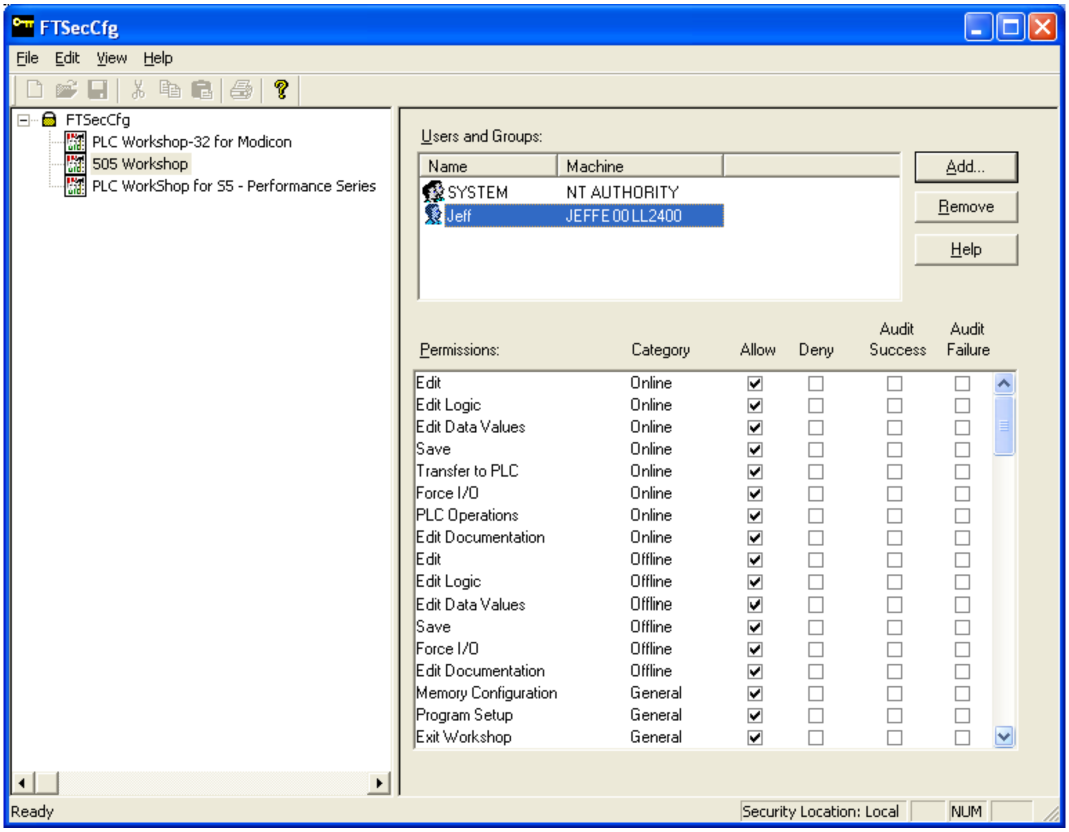
Select the computer running FasTrak security server.

● Local

○ Remote

Location:

Entire Network



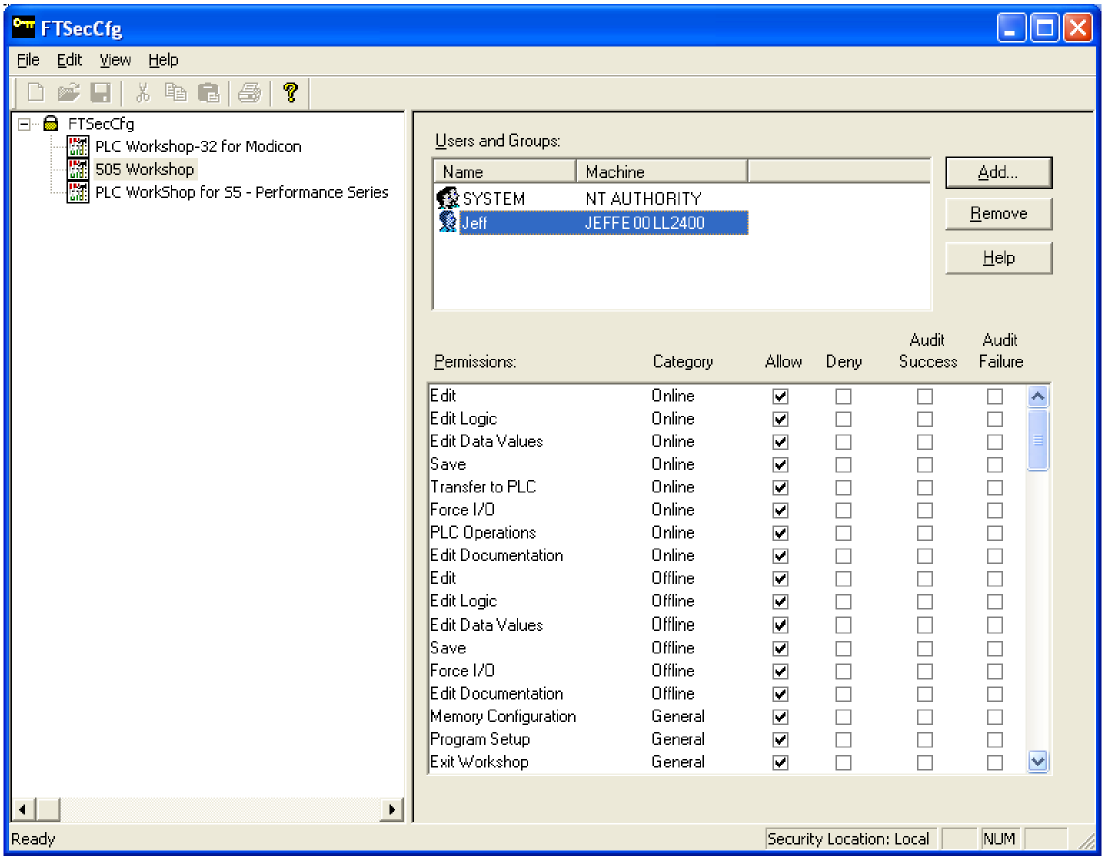
Users and Groups:

Name	Machine
SYSTEM	NT AUTHORITY
Jeff	JEFFE00LL2400

Permissions:	Category	Allow	Deny	Audit Success	Audit Failure
Edit	Online	☑	□	□	□
Edit Logic	Online	☑	□	□	□
Edit Data Values	Online	☑	□	□	□
Save	Online	☑	□	□	□
Transfer to PLC	Online	☑	□	□	□
Force I/O	Online	☑	□	□	□
PLC Operations	Online	☑	□	□	□
Edit Documentation	Online	☑	□	□	□
Edit	Offline	☑	□	□	□
Edit Logic	Offline	☑	□	□	□
Edit Data Values	Offline	☑	□	□	□
Save	Offline	☑	□	□	□
Force I/O	Offline	☑	□	□	□
Edit Documentation	Offline	☑	□	□	□
Memory Configuration	General	☑	□	□	□
Program Setup	General	☑	□	□	□
Exit Workshop	General	☑	□	□	□

Configuring Users, Groups, and Security Audit

After having configured security and chosen a server location, individual Users, Groups of Users, and permissions may be set from within the FTSecCfg utility. The dialog below will be referenced in this manual with regards to these features.



Name	Machine
SYSTEM	NT AUTHORITY
Jeff	JEFFE00LL2400

Permissions:	Category	Allow	Deny	Audit Success	Audit Failure
Edit	Online	☑	□	□	□
Edit Logic	Online	☑	□	□	□
Edit Data Values	Online	☑	□	□	□
Save	Online	☑	□	□	□
Transfer to PLC	Online	☑	□	□	□
Force I/O	Online	☑	□	□	□
PLC Operations	Online	☑	□	□	□
Edit Documentation	Online	☑	□	□	□
Edit	Offline	☑	□	□	□
Edit Logic	Offline	☑	□	□	□
Edit Data Values	Offline	☑	□	□	□
Save	Offline	☑	□	□	□
Force I/O	Offline	☑	□	□	□
Edit Documentation	Offline	☑	□	□	□
Memory Configuration	General	☑	□	□	□
Program Setup	General	☑	□	□	□
Exit Workshop	General	☑	□	□	□

The selected server machine appears in the status bar in the lower right portion of the application window.

In the tree control on the left-most pane, pick **PLC WorkShop**. In the **Users and Groups** list box, two names (System and either the administrators group or the current user) will exist by default with access to all features.

ADDING AND REMOVING USERS AND GROUPS

To add or remove individual users or groups, use the buttons on the far right of this dialog.

Add additional users and/or groups by selecting the **Add** button. Remove users or groups by highlighting the name and selecting the **Remove** button.

Users and groups that are not displayed in the list box are automatically denied access to all features.

The list box is sorted with groups listed first followed by users. A group is identified with the two person icon to the left while the user is identified with the one person icon. A combination of around 16 users and groups can be configured for an application.

SETTING PERMISSIONS

The lower list box in the right pane reflects the access rights and audits for individual permissions based on the highlighted name in the **Users and Groups** list box. When the **Allow** box is checked the user or group will be given access by the server when requested from the client. When the **Deny** box is checked the user or group will be denied access by the server when requested from the client.

In cases where a user has conflicting rights on a permission, the denied permission will always take precedence and the user will not be able to access the feature. one such example would be a user is allowed access to a specific permission but a group they belong to is denied access to the same permission. If neither box is checked, the user will not be granted access to the feature unless one of the groups they belong to has access to the feature

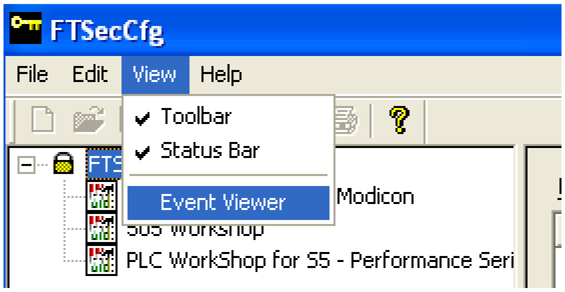
SECURITY AUDITS

Security audits for individual features can be performed on user and groups by selecting the **Audit Success** and/or **Audit Failure** boxes. These audits will appear in the security log on the server machine and can be accessed using Microsoft's Event Viewer. See the topic entitled **Event Viewer** or click **here** for more details on the Event Viewer. A **Success** audit will appear in the security log when a user is given access to a secure feature and the **Audit Success** box is checked for that feature. A **Failure** audit will appear in the security log when a user is denied access to a secure feature and the **Audit Failure** box is checked for that feature.

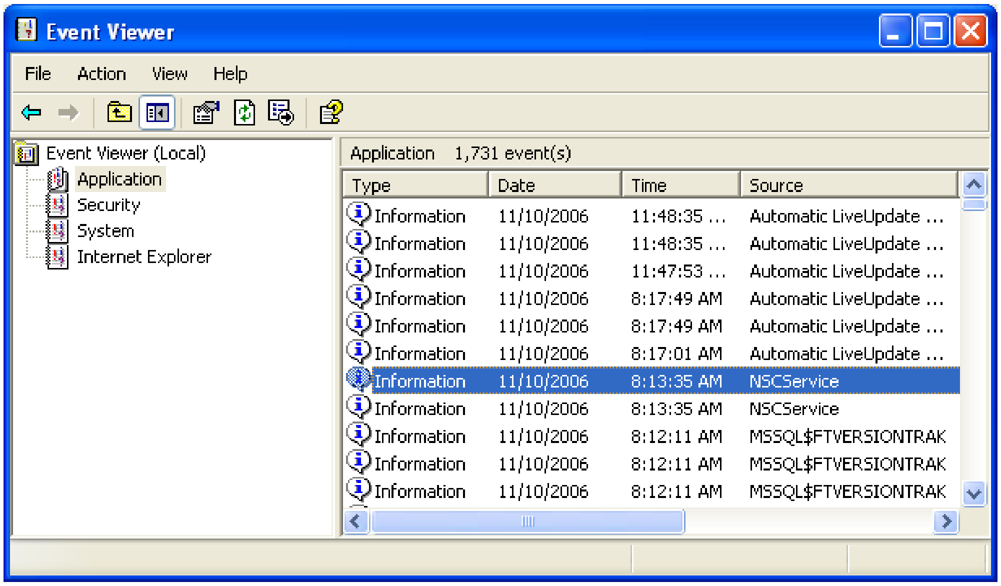
All security changes in FTSecCfg are accumulated and do not get committed to the server until confirmation upon exit of FTSecCfg.

Event Viewer

The Event viewer is a Windows application for displaying application, security, and system logs. FasTrak uses and writes to this log to hold audits. It is launched from within the **Security Configurator**. To launch the Event Viewer, select the **View \ Event Viewer** menu item as shown in the figure below. The Event Viewer is also accessible from the Windows Control Panel under **Administrative Tools**.

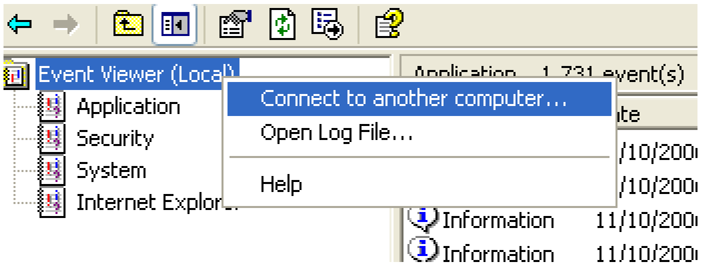


The following window opens. Double-clicking an entry in the right-most pane above will display more information for the item.

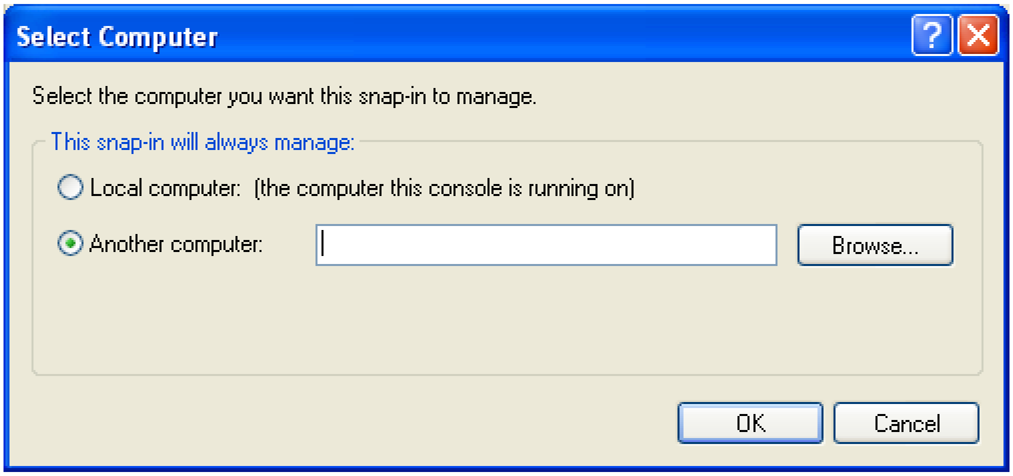


Type	Date	Time	Source
Information	11/10/2006	11:48:35 ...	Automatic LiveUpdate ...
Information	11/10/2006	11:48:35 ...	Automatic LiveUpdate ...
Information	11/10/2006	11:47:53 ...	Automatic LiveUpdate ...
Information	11/10/2006	8:17:49 AM	Automatic LiveUpdate ...
Information	11/10/2006	8:17:49 AM	Automatic LiveUpdate ...
Information	11/10/2006	8:17:01 AM	Automatic LiveUpdate ...
Information	11/10/2006	8:13:35 AM	NSCService
Information	11/10/2006	8:13:35 AM	NSCService
Information	11/10/2006	8:12:11 AM	MSSQL$FTVERSIONTRAK
Information	11/10/2006	8:12:11 AM	MSSQL$FTVERSIONTRAK
Information	11/10/2006	8:12:11 AM	MSSQL$FTVERSIONTRAK

From this application, the user may view the security log. If running the Security Configurator from a different machine than the security server (FTSecSvr), then the security server's machine name must be specified in the event viewer to view the security log entries referring to FasTrak security. This can be accomplished by highlighting the **Event Viewer** in the tree control and then picking the **Action** menu. This is in the figure below.



Selecting **Connect to another computer** launches the following window.


Select Computer

Select the computer you want this snap-in to manage.

This snap-in will always manage:

○ Local computer: (the computer this console is running on)

● Another computer:

Use the **Browse** button for searching for and selecting another computer. Once chosen, click **OK** to accept the selection.

Chapter 14 – Index