

Smart & NeoPAC SoftPLC User's Guide

for SoftPLC and TOPDOC NexGen versions 5.x



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CHAPTER 1 - INTRODUCTION / OVERVIEW

1.1 ABOUT THIS GUIDE

This User Guide is intended to help you quickly begin working with your SoftPLC® controller and the TOPDOC® NexGen (“TOPDOC”) software. It describes TOPDOC software installation and configuration, setting up communications from TOPDOC to SoftPLC, describes the memory structure for SoftPLC, SoftPLC operations, and basic troubleshooting. Detailed information on use of TOPDOC’s editing, documentation, and monitoring functions and the SoftPLC ladder logic instruction set is provided in the TOPDOC help system.

SoftPLC based control systems can be configured to run on a variety of hardware platforms, and connect to an even wider variety of I/O devices. This Guide includes specifications and information on two SoftPLC models, the Smart and the NeoPAC SoftPLCs manufactured by SoftPLC Corp. Detailed and/or specific information on other controllers and I/O devices is beyond the scope of this Guide. You may need to refer to additional SoftPLC Corp. manuals or the documentation provided by your device manufacturers.

If you have purchased your SoftPLC system hardware from SoftPLC Corp, your SoftPLC CPU will already have the runtime software installed and configured to a known default configuration for you. Supplemental hardware system documentation will describe the settings used in detail, and will also describe the procedure you will need to follow to make any changes.

Documentation updates as well as supplementary documentation can be found on SoftPLC’s website at <http://softplc.com>. Our website’s [Support | Resources](#) section also includes some add-on instructions and drivers for SoftPLC. In addition, you can find a list of our [SoftPLC Partners](#), who provide services, hardware and/or software products that work with SoftPLC.

1.1.1 USER GUIDE CONVENTIONS

- Software menu options or buttons appear as **MENU OPTION**
- Text you enter at a command line prompt appears as **command line text**
- Internet links appear as [Hyperlink](#)
- Visited links appear as [Visited Link](#)

1.2 SYSTEM COMPONENTS

1.2.1 SOFTPLC CONTROLLER CPUS

This Guide describes in detail two SoftPLC controller models, the Smart SoftPLC (*ver 4, Cat Nos SMS4-x*) and the NeoPAC SoftPLC (*ver 2, Cat No SN2-x*). Other than the number of communication ports, these models have the same functions and features, and are configured the same way.

Other SoftPLC controller models with version 5 or later firmware are configured and operate the same as the Smart and NeoPAC SoftPLC’s, and the information in this Guide applies. However, for hardware specific information on other models, separate documentation is provided.

1.2.2 SOFTPLC CONTROL SOFTWARE

Every SoftPLC controller includes a SoftPLC control software runtime license. The SoftPLC control software runs your control logic and communicates to I/O, operator interfaces and other devices. SoftPLC also includes an SFTP server, a number of utilities, I/O drivers, loadable instructions, and more. This Guide briefly describes the use of these auxiliary programs or identifies where you can find more information on them.

SOFTPLC LICENSE SIZES

The SoftPLC runtime software is available in 4 license sizes, which determine the amount of I/O that can be supported for various communication networks. Licenses can be field-upgraded upon receipt of payment of the difference in license cost at the time of the upgrade request.

Select the required license size based on the largest value in any applicable category, based on the drivers you will be using. For example, a system using Tealware™ I/O with the SMART driver with 130 discrete inputs and 24 discrete outputs would require a 1K version.

Table 1.1: SoftPLC Runtime License Sizes

| COMM DRIVER (S) | LICENSE FACTOR | LT | 1K | 2K | 8K |
|--|---|-----|------|------|------|
| Local Tealware (SMART.TLM), Modbus serial Master (MODBMAST.TLM) | Discrete Inputs ¹ | 128 | 1024 | 2048 | 8192 |
| | Discrete Outputs ¹ | 128 | 1024 | 2048 | 8192 |
| Allen-Bradley Remote I/O (RIO.TLM, RIOSLAVE.TLM) | A-B RIO Logical Racks | 1 | 8 | 16 | 64 |
| ModbusTCP Master (MBIPMAST.TLM) | ModbusTCP Servers | 2 | 16 | 32 | 128 |
| Ethernet/IP (ETHER_IP.TLM) | Ethernet/IP Connection Bytes ² | 64 | 512 | 1024 | 4096 |

¹ These drivers count discrete I/O as points mapped to the Input and Output image tables.

² Divide by 2 for approximate number of 16 bit tags allowed

FIRMWARE ADD-ONS

Loadable Functions (TLM's):

SoftPLC supports add-ons called Loadable Functions. These can be I/O and communication drivers, ladder instructions, or entire processes. Many TLM's are included with every SoftPLC runtime license, and many others are available at no cost. Some TLM's are purchased options, described below. Our [website](#) lists some of the available free add-on instructions and drivers for SoftPLC, such as data logging, advanced math, read/write text files, and more.

Send Email/Text Messages:

SENDMAIL (Cat No SPZ-EML) is an add-on that can be purchased. It allows a SoftPLC to issue an SMTP message via a ladder instruction. Messages can be sent to multiple recipients, include attachments such as data log files, etc. Use of the SENDMAIL function is detailed in a separate [user manual](#).

Hot Standby/Redundancy Feature:

The SoftPLC Hot Standby System uses both hardware and software components to create a control system with redundant PACs for systems that cannot easily tolerate downtime due to single points of failure. This is a purchased option and is [described](#) in detail in other documentation.

Embedded Web Server:

The SoftPLC Embedded Web Server (Cat No SPZ-WEB) is a purchased add-on software option. It allows SoftPLC to also provide operator interface functionality via web pages. A toolkit is provided with animation widgets that can be used in your web pages to read/write datatable values/states, change graphical elements/features, and more. Use of the Web Server is detailed in a separate user manual.

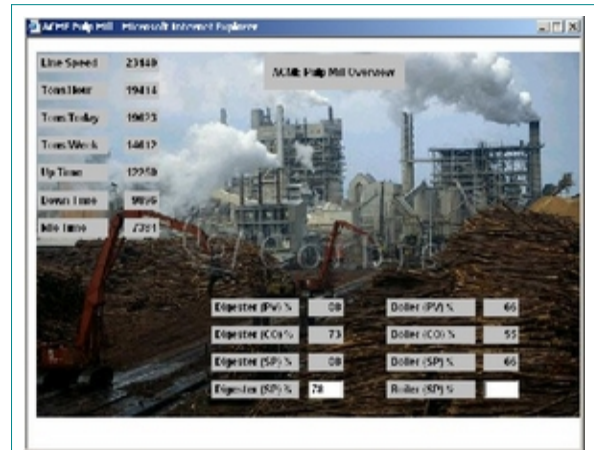


Figure 1.1: Example SoftPLC Web Page

IoTPAC:

An [embedded SoftPLC Web Studio](#) runtime license is a purchased add-on software option. SoftPLC Web Studio is a SCADA/HMI software product that provides object-oriented graphical operator interfaces, alarming, trending, reports, and more. The IoTPAC is a SoftPLC that includes the embedded Web Studio runtime (*called IoTVIEW*) that generates HTML5 web pages, allowing the SoftPLC controller to also be a headless operator interface whose displays can be viewed on any device with a web browser, such as a tablet, smart phone, or PC. Use of Web Studio is detailed in separate documentation.

Firewall/VPN:

SoftPLC can be equipped with an embedded software firewall (Cat No SPZ-FW) which can be used to protect ethernet to ethernet connections such as industrial network to business network, or industrial networks/devices connected to remote sites via the internet. Powerful security features block dangerous and/or unwanted communications from entering your SoftPLC. This is a purchased option. Detailed information is provided in separate documentation.

GATECRAFT LINUX

The SoftPLC controller also includes an embedded Linux operating system specially packaged for industrial control, called Gatecraft™ Linux. Most users do not need to be familiar with Linux to use SoftPLC. SoftPLC setup, programming and maintenance is done through TOPDOC NexGen. However, for certain troubleshooting processes, accessing the Console (*command line interface*) for Gatecraft Linux may be necessary, and information about how to open and use a Console session and the commonly used commands is included in this manual.

1.2.3 TOPDOC NEXGEN

TOPDOC NexGen ("TOPDOC") is used for programming, program documentation, online maintenance, and troubleshooting of your SoftPLC controller. TOPDOC runs on a PC running a Windows 64bit or Ubuntu Linux operating system (*Cat No TDNG-FN for Windows or TDLX-FN for Linux*). With TOPDOC connected to your SoftPLC(s), you can perform functions such as online

programming, data monitoring, I/O forcing, program upload/download, and more. TOPDOC communicates to the SoftPLC only via Ethernet.

TOPDOC installation, basic user interface information, SoftPLC configuration, and communication connections to SoftPLC are in this manual. Detailed information on use of TOPDOC's editing, documentation, and monitoring functions and the SoftPLC ladder logic instruction set is provided in the TOPDOC software's help system.

1.2.4 PROGRAMMER'S TOOLKIT

A Programmer's Toolkit is available for those who want to write C/C++ language custom code (TLM's) to interface and/or work with SoftPLC, or to create custom ladder instructions. The toolkit is available at no cost to customers in warranty or valid support contracts. Technical support for the toolkit is available on an hourly fee basis. Contact SoftPLC Corp for details on accessing/using the [SoftPLC Programmer's Toolkit](#).

CHAPTER 2 - SOFTPLC CONTROLLER HARDWARE

Two controller CPU hardware models are described in this manual, the Smart SoftPLC (ver 4 - Cat Nos SMS4-x) and the NeoPAC SoftPLC (ver 2 - Cat Nos SN2-x). Other CPU models and I/O products are described in separate documentation.

2.1 SMART SOFTPLC

The Smart SoftPLC family of controllers is a versatile system with tremendous connectivity. The base Smart SoftPLC provides Ethernet, an RS-485 serial port, and 2 USB ports for interfacing to I/O and other devices.

The Smart can optionally be factory equipped with one of two local Tealware™ I/O interfaces. [Tealware](#) is SoftPLC Corp's modular I/O system. Tealware I/O and its use with SoftPLC's SMART.TLM driver are described in the [Tealware I/O User's Guide](#) (Cat No TW-MN).

- The LocalPorts interface allows up to 12 racks of Tealware I/O to be connected to the Smart SoftPLC controller.
- The Backplane3 interface allows any 3 Tealware modules to be mounted onto the base Smart SoftPLC.



Figure 2.1: Smart SoftPLC - Base Unit

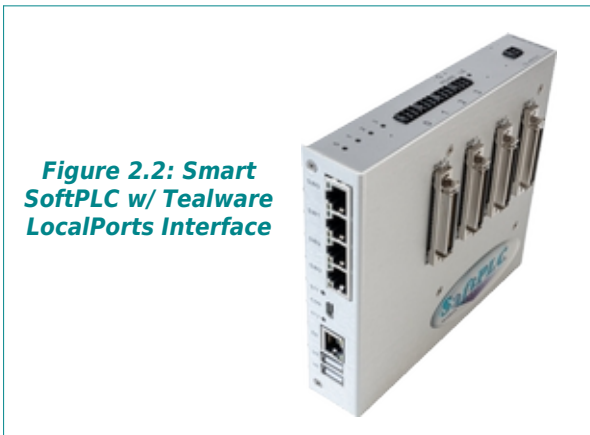


Figure 2.2: Smart SoftPLC w/ Tealware LocalPorts Interface



Figure 2.3: Smart SoftPLC Backplane3 System w/ Tealware Modules

2.1.1 SMART SOFTPLC SPECIFICATIONS

The Smart SoftPLC consists of a base unit, an optional local Tealware interface, optional interfaces on (3) configurable communication ports, and a selected SoftPLC runtime license size. These are assembled at the factory and undergo a system test. Other add-on options are available for field installation. Specifications are in the following table.

Table 2.1: Smart SoftPLC Specifications

| Smart SoftPLC (ver 4) Specifications | | |
|--|---|---|
| User Memory | 512MB RAM, 8GB on-board eMMC flash | |
| Removable Memory | MicroSD (<i>optional - no card included</i>) | |
| Processor | 64-bit, quad-core ARM processor | |
| Operating Temperature | 0 to 60°C, (storage -40~85°C) Extended Temperature option (Cat No SPO-EXTEMP) -20~70°C | |
| Humidity | 0-95%, non-condensing | |
| Input Voltage Range | 6~72 VDC, terminal block connector (<i>alternatively 12-48VAC</i>) | |
| Power Requirements | 2-5W based on options selected | |
| Communication Ports | (1) 4-port GB Ethernet switch plus (1) stand-alone GB Ethernet port (1) RS-485 port, 2-wire non-isolated. 3-wire terminal block connector (2) USB 2.0 host ports (1 w/ OTG capability) (1) Micro-USB serial console port (<i>for troubleshooting only</i>) | |
| | (3) Option Ports, any mix of choices below (<i>must be factory installed</i>): RS-485, isolated 2 wire (Cat No SPO-485) A-B RIO Master, A-B RIO Adapter or Data Hwy Plus (Cat No SPO-BH) | |
| Wireless | 802.11 b/g/h WiFi (<i>requires Cat No SPO-WIFI antenna extension kit</i>) | |
| | Bluetooth 4.0 dual mode | |
| | Cellular modem (<i>requires Cat No SM4-MDM1</i>) | |
| Local I/O Interfaces (Option - <i>only one/system</i>) | Backplane3 - supports any 3 Tealware™ modules LocalPorts - 4 connectors, each supports up to 3 Tealware racks | |
| Remote I/O | Serial and Ethernet connections, (option) A-B RIO w/ SPO-BH | |
| Protocols | Serial | Modbus Master/Slave, DF1, ASCII |
| | Ethernet | Ethernet/IP, ModbusTCP, DF1 Ethernet (PCCC) |
| Real Time Clock | Via Internet or local LAN NTP Server | |
| Dimensions (HxWxD) | 5.75 x 6 x 1.5 in without modules (146.1 x 152.4 x 38.1 mm) 5.75 x 6 x 5.625 in. w Tealware modules (146.1 x 152.4 x 142.88 mm) | |
| Packaging | Fanless/Diskless system, metal enclosure, DIN-rail mount, optional Panel Mount Bracket (Cat No SM-VBKT) | |
| LED's | (2) System Status, (4) Serial/Option Port Status, (1) Cell Modem Status, (10) Ethernet Port Status | |

2.1.2 SMART SOFTPLC COMMUNICATION PORTS & LED'S

The Smart SoftPLC CPU has:

- (1) 4-port GB Ethernet switch with multiple interfaces for routing capability
- (1) stand-alone GB Ethernet port
- (2) USB 2.0 Host ports
- (1) micro-USB port (*for troubleshooting if the Ethernet connectivity is not working*)
- (1) RS-485 port, 2-wire non-isolated
- (3) configurable ports

The configurable ports are factory installed optional interfaces such as Allen-Bradley “blue-hose” for Remote I/O and Data Highway Plus (Cat No SPO-BH), isolated 2-wire RS-485 (Cat No SPO-485), and others. Up to 3 interfaces of any mix are supported.

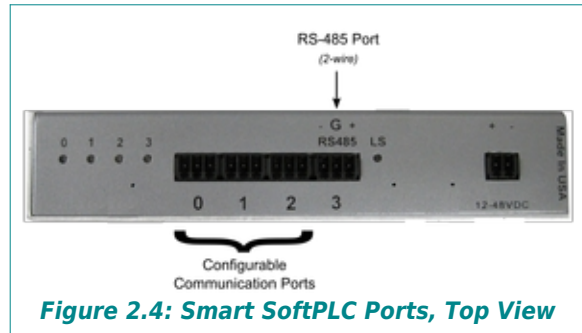


Figure 2.4: Smart SoftPLC Ports, Top View

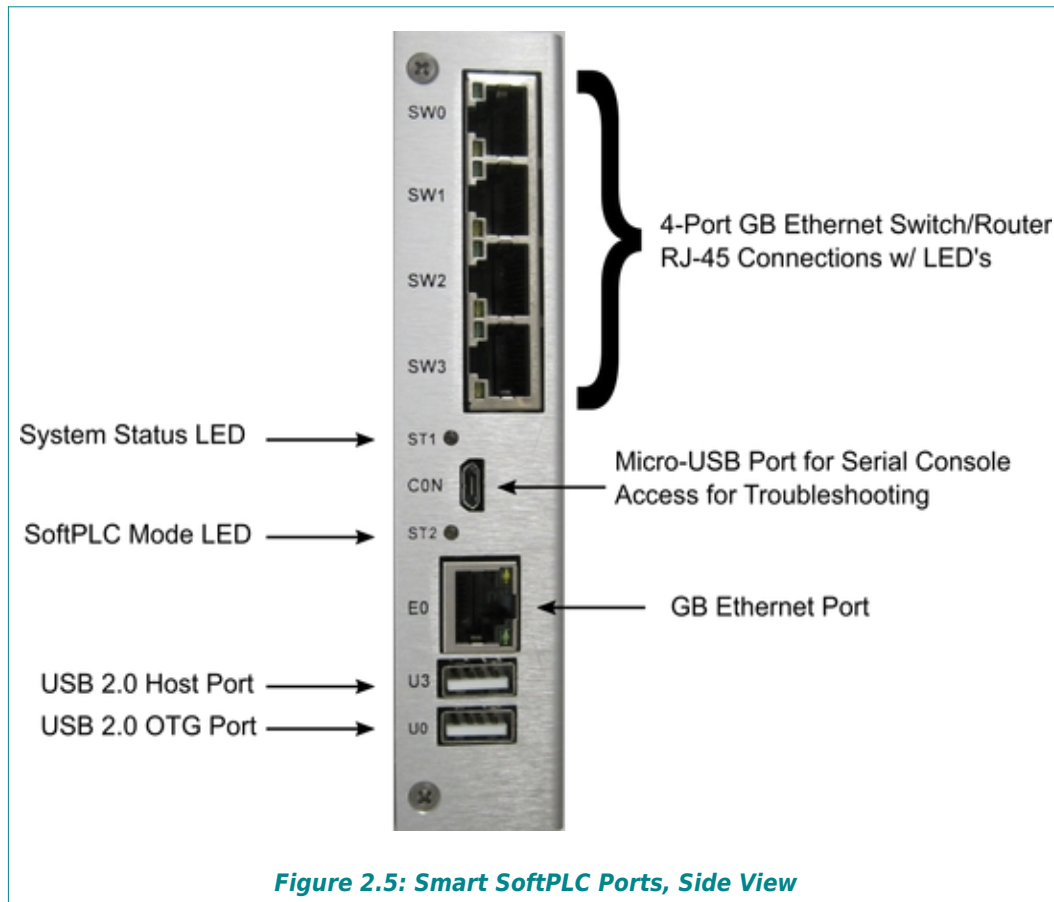


Figure 2.5: Smart SoftPLC Ports, Side View

ETHERNET PORTS

All Smart SoftPLC Ethernet ports are GB (10/100/1000 BaseT) RJ-45 connections. The four SWx ports can be configured as a switch or an Ethernet bridge. They are configured as interface br0 in the network setup. The individual port (E0) is configured as ethernet0 in the network setup.

The factory default is for br0 to be set to 192.168.1.100.

USB PORTS

Smart SoftPLC has (2) USB ports that are 2.0 Host capable. The bottom port, marked U0 is an “on-the-go” (OTG) capable port.

By default, these ports are shipped inactive.

- You can use them as RS-232 serial ports for communication by purchasing the SoftPLC USB to Serial Support Kit (Cat No SPO-USBSERKIT) which includes a compatible USB 2.0 to 9-pin RS-232 serial port cable, null modem cable and the firmware to allow serial communications (eg: DF1, Modbus, ASCII) using SoftPLC drivers.
- You can use them to mount a USB flash drive for purposes of data logging or other functions that read/write files, including TLM’s or SSH console commands. Chapter 10 has details on the procedure to mount a USB flash drive.

To see connected device information, you can use the “lsusb” command in a Console session. If you are using one of these ports, USB0 is Bus 001 and USB3 is Bus 004 in the Linux configuration.

SERIAL CONSOLE PORT

The Micro-USB port labeled CON can be used to access a Linux console for troubleshooting when the Ethernet port(s) are not available, such as a configuration error or if you forget your IP address.



NOTE

SoftPLC Corporation Cat No SPO-UCONCBL is a 10 foot Micro-USB to USB 2.0 cable, that supports data exchange and is compatible with the SoftPLC environment. Other cables are for charging and/or may not be compatible. Use of the SPO-UCONCBL is required if you request technical support.

Use of the CONsole port is described in Chapter 6 on Troubleshooting.

STATUS LED'S

System Status LED (ST1)

The System Status LED is on the side panel and is marked ST1. It lights **GREEN** to indicate that the CPU is receiving power. The LED turns **BLUE** when the firmware is loaded successfully upon startup.

Operating Mode LED (ST2)

The Operating Mode LED is on the side panel and is marked ST2. This is a tri-color LED that is used to indicate the operating mode of SoftPLC:

- **OFF** - SoftPLC is in Remote Program mode, or is not loaded.
- **LIGHT RED** - SoftPLC is in Remote Test mode.
- **GREEN**- SoftPLC is in Remote Run mode.
- **RED** - SoftPLC is in Fault mode.

Communication Port LED's (0-3)

There are 4 LED's on the top panel corresponding to the serial and configurable communication ports, numbered 0 through 3. These LED's are **GREEN** when the port is Receiving (RX) and **BLUE** when the port is Transmitting (TX).

Line Status LED (LS)

The LS LED is used to indicate status of the optional internal cellular modem. The LED is **GREEN** when the modem has communication activity and is **BLUE** when the modem is not connected.

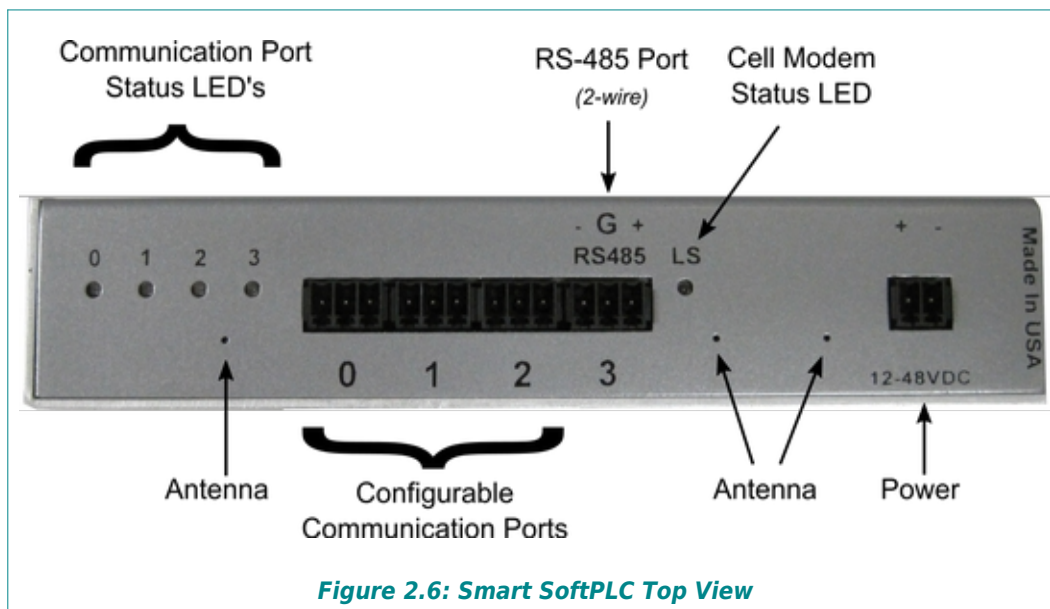


Figure 2.6: Smart SoftPLC Top View

RS-485 PORT

The port marked "3" on the enclosure is a two-wire, non-isolated RS-485 serial port, with a 3-prong terminal block connector. A female connector for this port is included with each Smart SoftPLC. The required wiring for this connection is shown on the Smart SoftPLC metal enclosure, as in the figure above. This port is mapped to COM9.

CONFIGURABLE COMMUNICATION PORTS

Ports 0, 1, and 2 are 3-wire terminal block connectors that can be used with optional factory installed communication interfaces in the Smart SoftPLC. You can order a Smart SoftPLC with up to 3 of any mix of available interfaces. A label on the top panel will indicate the system configuration and required wiring connections. A female connector for each option port ordered with the system will be included.

The interfaces currently available and the required wiring is shown below.

Table 2.2: Smart Configurable Port Wiring by Protocol

| Catalog No | Communication Protocol | Wiring (Left to Right) |
|------------|--------------------------------|-------------------------|
| SPO-BH | Data Highway Plus | Clear - Shield - Blue |
| SPO-BH | Allen-Bradley Remote I/O (RIO) | Blue - Shield - Clear |
| SPO-485 | RS-485, 2 wire, isolated | Neg - Ground - Positive |



HINT

If you lose your female connectors, you can purchase replacements or spares with Cat No SPO-CKIT, which includes (1) 2-prong power connector and (2) 3-prong connectors.

POWER

Smart SoftPLC has a wide acceptable input power range, that connects to a 2 prong terminal block. The female connector for this port is included with each Smart SoftPLC. Although the port is marked 12-48 VDC, the system actually supports a 6-72 VDC input power range, making it suitable for use with solar battery powered systems.



CAUTION

Take care that the polarity of your power wiring is correct, otherwise system damage will result. Ensure power supply is OFF when wiring into the connector on the NeoPAC.

Correct wiring is Positive on the left, Negative on the right, as shown in the previous figure.



HINT

If you lose your female connectors, you can purchase replacements or spares with Cat No SPO-CKIT, which includes 1 power and 2 3 prong connectors.

ANTENNA CONNECTIONS

If you purchased the WiFi option (Cat No SPO-WIFI) or the internal cellular modem option (Cat No SM4-MDM1), the associated antennae will connect through these holes. Details on these options are found in other user guides.

2.2 NEOPAC SOFTPLC

The NeoPAC SoftPLC family of controllers is a powerful system in a small form factor.

2.2.1 NEOPAC SOFTPLC SPECIFICATIONS

The NeoPAC SoftPLC consists of a base unit, 2 configurable communication ports, and a selected SoftPLC runtime license size. These are assembled at the factory and undergo a system test. Other options are available for field installation. System specifications are in the table below.



Table 2.3: NeoPAC SoftPLC Hardware Specifications

| NeoPAC SoftPLC (v2) Hardware Specifications | |
|---|---|
| User Memory | 512MB RAM, 8GB on-board eMMC flash |
| Removable Memory | MicroSD (optional-no card included) |
| Processor | 64-bit, quad-core ARM processor |
| Operating Temperature | 0 to 60°C, (storage -40~85°C) Extended Temp option (Cat No SPO-EXTEMP) -20~70°C |
| Humidity | 0-95%, non-condensing |
| Input Voltage Range | 6~72 VDC, terminal block connector (alternatively 12-48VAC) |
| Power Requirements | 2-5W based on options selected |
| Communication Ports | (1) GB Ethernet port (2) USB 2.0 host ports, (1) w/ OTG (1) Micro-USB serial console port (for troubleshooting only) |
| | (2) Option Ports, any mix of choices below (must be factory installed): RS-485, isolated 2 wire (Cat No SPO-485) A-B RIO Master, A-B RIO Adapter or Data Hwy Plus (Cat No SPO-BH) |
| Wireless | 802.11 b/g/h WiFi, requires Cat No SPO-WIFI antenna extension kit |
| | Bluetooth 4.0 dual mode |
| Remote I/O | Serial and Ethernet connections, A-B RIO w/ SPO-BH option |
| Protocols | Serial Modbus Master/Slave, DF1, ASCII |
| | Ethernet Ethernet/IP, ModbusTCP, DF1 Ethernet (PCCC) |
| Real Time Clock | Via Internet/Local LAN NTP Server |
| Dimensions (HxWxD) | 3.945 x 1.349 x 3.823 in (100.2 x 34.26 x 97.1 mm) |
| Packaging | Fanless/Diskless system, aluminum enclosure, DIN-rail mount |
| LED's | (2) System Status, (2) Option Port Status, (2) Ethernet Port Status |

2.2.2 NEOPAC SOFTPLC COMMUNICATION PORTS & LED'S

The NeoPAC SoftPLC CPU has:

- (1) stand-alone GB Ethernet port,
- (2) USB 2.0 Host ports, one with OTG (On-the-Go) capability
- (1) micro-USB port for troubleshooting if the Ethernet connectivity is not working
- (2) configurable ports

The configurable ports are factory installed optional interfaces such as Allen-Bradley “blue-hose” for Remote I/O and Data Highway Plus (Cat No SPO-BH), isolated RS-485 (Cat No SPO-485), and others. Up to 2 interfaces of any mix are supported.

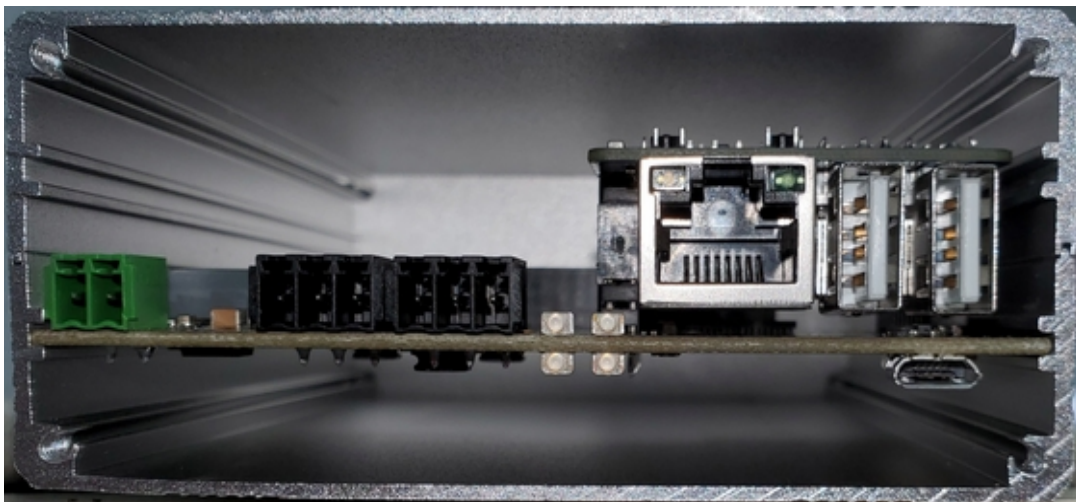


Figure 2.8: NeoPAC SoftPLC

ETHERNET PORT

The NeoPAC Ethernet port is a GB (10/100/1000 BaseT) RJ-45 connection. It is configured as ethernet0 in the network configuration file. The factory default is for ethernet0 to be set to 192.168.1.100.

USB PORTS

NeoPAC SoftPLC has (2) USB ports that are 2.0 Host capable. The bottom port, marked U0 is an “on-the-go” (OTG) capable port.

By default, these ports are shipped inactive.

- You can use them as RS-232 serial ports for communication by purchasing the SoftPLC USB to Serial Support Kit (Cat No SPO-USBSERKIT) which includes a compatible USB 2.0 to 9-pin RS-232 serial cable, null modem cable and the firmware to allow serial communications (eg: DF1, Modbus, ASCII) using SoftPLC drivers.

- You can use them to mount a USB flash drive for purposes of data logging or other functions that read/write files, including TLM's or SSH console commands. Chapter 10 has details on the procedure to mount a USB flash drive.

To see connected device information, you can use the “lsusb” command in a Console session.

SERIAL CONSOLE PORT

The Micro-USB port labeled CONSOLE can be used to access a Linux console for troubleshooting when the Ethernet port is not available, such as a configuration error or if you forget your IP address.



NOTE

SoftPLC Corporation Cat No SPO-UCONCBL is a 10 foot Micro-USB to USB 2.0 cable, that supports data exchange and is compatible with the SoftPLC environment. Other cables are for charging and/or may not be compatible. Use of the SPO-UCONCBL is required if you request technical support.

Use of the CONSOLE port is described in Chapter 6 on Troubleshooting.

STATUS LED'S

There are 4 LED's on the front panel:

System Status LED (STAT)

The System Status LED lights **GREEN** to indicate that the CPU is receiving power. The LED turns **BLUE** when the firmware is loaded successfully.

Operating Mode LED (MODE)

The Operating Mode LED is a tri-color LED that is used to indicate the operating mode of SoftPLC:

- **OFF** - SoftPLC is in Remote Program mode, or is not loaded.
- **LIGHT RED** - SoftPLC is in Remote Test mode.
- **GREEN**- SoftPLC is in Remote Run mode.
- **RED** - SoftPLC is in Fault mode.

Communication Port LED's

There are 2 LED's corresponding to the serial and configurable communication ports, numbered P1 and P2. These LED's are **GREEN** when the port is Receiving (RX) and **BLUE** when the port is Transmitting (TX).

CONFIGURABLE COMMUNICATION PORTS

Ports 1 and 2 are 3-wire terminal block connectors that are used with a factory installed communication interface in the NeoPAC SoftPLC. Users can order a system with up to 2 of any mix of available interfaces. A label will indicate the system configuration when shipped from

the factory and the required wiring connections. A female connector for each ordered option port is included with the SoftPLC.

The interfaces currently available and the required wiring is shown below.

Table 2.4: Smart Configurable Port Wiring by Protocol

| Catalog No | Communication Protocol | Wiring (Left to Right) |
|------------|--------------------------------|-------------------------|
| SPO-BH | Data Highway Plus | Clear - Shield - Blue |
| SPO-BH | Allen-Bradley Remote I/O (RIO) | Blue - Shield - Clear |
| SPO-485 | RS-485, 2 wire, isolated | Neg - Ground - Positive |



HINT

If you lose your female connectors, you can purchase replacements or spares with Cat No SPO-CKIT, which includes (1) 2-prong power connector and (2) 3-prong connectors.

POWER

The NeoPAC SoftPLC has a wide acceptable input power range, that connects to a 2-prong terminal block. The female connector for this port is included with each NeoPAC SoftPLC. Although the port is marked 12-48 VDC, the system supports a 6-72 VDC input power range, making it suitable for use with solar battery powered systems.



CAUTION

Take care that the polarity of your power wiring is correct, otherwise system damage will result. Ensure power supply is OFF when wiring into the connector on the NeoPAC.

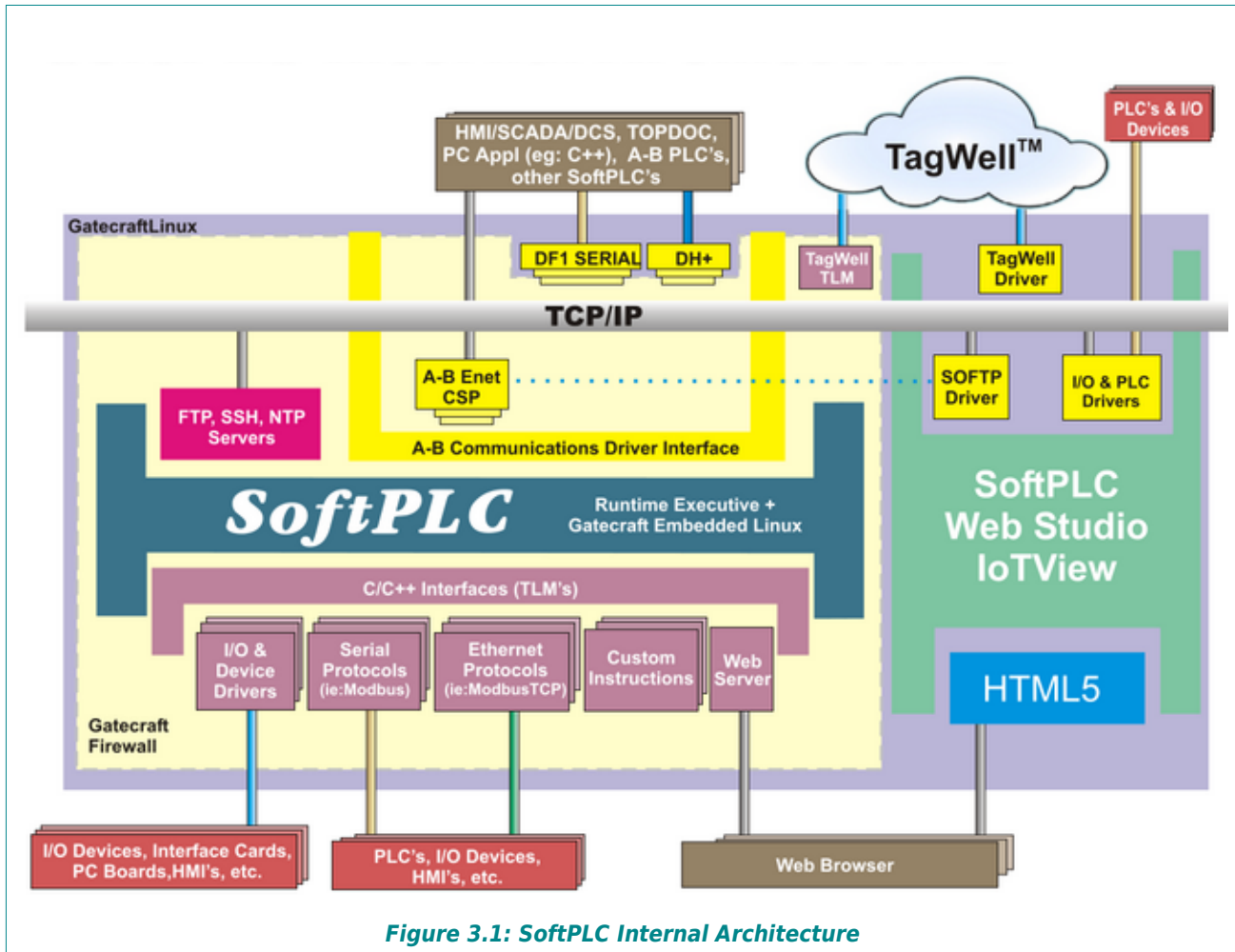
Correct wiring is Positive on the left, Negative on the right, as shown in the Figure.

ANTENNA CONNECTIONS

If you purchase the WiFi option (Cat No SPO-WIFI), the associated antenna will connect through holes not shown in the figure. Details on this option is found in other documentation.

CHAPTER 3 - HOW SOFTPLC OPERATES

A SoftPLC runtime control software license is installed in each Smart or NeoPAC SoftPLC CPU. It is a multi-tasking application program that runs on top of Gatecraft Linux, the operating system in the SoftPLC CPU. The figure below depicts the internal structure of SoftPLC.



Some of the elements in the above figure are optional components, described in other documentation. These include the Web Studio IoTView, TagWell, Web Server, and the Gatecraft Firewall.

3.1 SOFTPLC MODES OF EXECUTION

When SoftPLC is running, it has 4 possible operating modes:

- **PROGRAM** - SoftPLC does not access I/O nor solve ladder logic. Logic and datatable can be changed. datatable size can be modified; new files can be added and/or existing files can be resized.
- **TEST** - SoftPLC reads the inputs, solves the ladder logic, but does NOT write to the outputs. datatable can not be resized/created in TEST mode; however, ladder logic can be changed.

- **RUN** - SoftPLC goes through repetitive, synchronous scan cycles that read inputs, solve the ladder logic, and write outputs. Any requests from O•N•E channels are also serviced. datatable can NOT be resized, but values can be changed; ladder logic can be modified.
- **FAULT** - SoftPLC automatically goes to FAULT mode as a result of a runtime fault. The execution of the ladder program is halted and outputs are shut down. The Status file is updated with the cause of the fault and where in the ladder program the fault occurred.

3.1.1 CHANGING THE SOFTPLC MODE

TOPDOC NexGen can be used to put SoftPLC in either RUN, PROGRAM, or TEST mode.

If the SoftPLC CPU has a hardware keyswitch, the keyswitch sets the mode. If the keyswitch is in the REMOTE position, then TOPDOC NexGen sets the mode.

3.2 SOFTPLC SCAN SEQUENCE

3.2.1 INITIALIZATION

When the controller is powered up, it first boots Gatecraft Linux, and then runs a script which loads the SoftPLC runtime. The loading process is as follows:

- SoftPLC runtime loads and reads the configuration files in \SoftPLC\run
- Checks for SoftPLC copy protection key. If one does not exist, SoftPLC is started in DEMO mode without TLM's
- From MODULE.LST, the selected TLM's are initialized (*I/O drivers and loadable instructions*)
- Loads the APP (*application program file*) specified in STARTUP.LST.
- Creates the necessary datatable in RAM memory.
- Selects operating mode specified in STARTUP.LST or by hardware keyswitch
- Updates time/date in Status file S2 to SoftPLC's hardware clock (*which gets its time via an NTP Server*)
- Opens the specified O•N•E communication channels

3.2.2 SCAN CYCLE

After initialization, SoftPLC enters a SCAN loop and exits only upon user command (*e.g.: changing mode with TOPDOC*), power loss or fault. In the SCAN loop, SoftPLC:

- Reads inputs
- Updates outputs
- Applies forcing as defined by the force table
- Updates the Status file (S2)
- Executes ladder logic

- Responds to O•N•E communication requests

**CAUTION**

The order of events in the SCAN loop will vary based on the loaded TLM's and settings in STARTUP.LST. Some TLM's operate synchronously to the ladder scan and some are asynchronous.

3.2.3 DEINSTALLATION

The SoftPLC task can be stopped using the Console or a keyboard. When this happens, SoftPLC performs the following:

- Frees RAM memory allocated for datatable
- Closes O•N•E Communication channels
- Instructs I/O driver(s) to shutdown (*outputs will be set to 0 or last state depending on I/O driver capabilities and settings*)
- Removes I/O Drivers from memory
- Exits to Gatecraft Linux

3.3 HOW SOFTPLC INTERACTS WITH I/O DRIVERS

Regardless of operating mode, I/O drivers are called from SoftPLC at least once each scan. If SoftPLC is in PROGRAM or FAULT mode, no I/O access takes place. I/O Drivers are also called from SoftPLC whenever a mode change takes place. The Allen-Bradley remote I/O drivers are also called once every 100 rungs of ladder logic execution to service any pending Block Transfer requests.

In addition, each I/O Driver is called once when SoftPLC is being started and once when SoftPLC is being shutdown. This allows I/O Drivers to perform one time initialization tasks such as reading the command line arguments specified in MODULE.LST, loading "smart" cards, allocating memory, or installing interrupt vectors. Being called prior to SoftPLC's shutdown lets the I/O Drivers do clean up such as shutting down outputs, freeing memory or restoring interrupt vectors.

Most SoftPLC Corporation developed I/O Drivers support I/O forcing for all digital points mapped to the SoftPLC I/O image tables. Some drivers have been written as ladder instructions for more time-sensitive control, these might not support forced I/O. The detailed driver documentation describes full capabilities and requirements of each specific driver.

CHAPTER 4 - TOPDOC INSTALLATION & CONFIGURATION

4.1 TOPDOC NEXGEN OVERVIEW

TOPDOC NexGen (“TOPDOC”) is the ladder logic programming, documentation, troubleshooting and configuration software for SoftPLC.

TOPDOC (Cat No TDNG-FN) provides:

- offline application development
- online maintenance/troubleshooting
- application documentation (*e.g.: address labels and rung comments*)
- hard-copy reports
- import/export utilities
- SoftPLC configuration

TOPDOC can run on any computer that runs a Windows 64-bit operating system that also provides the following minimum hardware requirements:

- ~150MB available hard drive space
- 1280 x 1024 minimum screen resolution
- Ethernet port (*for communicating with a SoftPLC*)
- Mouse (*strongly recommended*) or touchpad
- USB 2.0 port (*for installation of software and for software protection key*)



NOTE

There is also a Linux version of TOPDOC NexGen. Installation instructions for that version are included with the software and are not included in this manual.

4.2 INSTALLING TOPDOC NEXGEN

4.2.1 TOPDOC NEXGEN LICENSE KEY DONGLE

TOPDOC uses a USB software protection key (“dongle”) for license protection. You can legally install TOPDOC on multiple computers, then insert the USB key on the system you want to use in order to run TOPDOC.



Figure 4.1:
TOPDOC
NexGen Copy
Protection
Key



CAUTION

The software protection key (dongle) for your TOPDOC NexGen package is very valuable. You should treat it carefully, like a wallet. Lost key replacements cost full package price!

4.2.2 TOPDOC SOFTWARE INSTALLATION

Follow the steps below to install TOPDOC onto your PC.



HINT

Do not attach the USB copy protection dongle until you complete software installation.

1. From the USB drive or downloaded zip file, double-click “topdoc-nexgen-5.0.0-win64.exe” to start the TOPDOC NexGen setup program.



NOTE

You will need administrative rights to perform this installation.

2. If you have administrative rights, answer the Windows UAC prompt affirmatively to begin, which will display the “Welcome to TOPDOC NexGen Setup” window. Per the recommendation, you should close all other applications, then press **Next** to continue.
3. This will display the Binary Software License Agreement. You can use **PageDown** or scroll to see the entire Agreement. If you agree with the terms, select **I Agree** to continue.
4. Next, the Install Options page will appear. We recommend that you select the default to NOT add TOPDOC NexGen to the system PATH. You can also choose here whether to create a Desktop Icon or not. Press **Next**.
5. Now you can choose the Install Location. The default folder is C:\SoftPLC\.



CAUTION

We strongly recommend you select the default folder, changing only the destination drive letter if desired. If you change the folder name, TOPDOC NexGen will **NOT** run properly after installation until you perform the “**Post Installation Steps**” described at the end of this document.

6. After pressing **Next**, select the default or enter the desired name of the Start Menu folder. Then, click **Install** to proceed with extracting and installing the software.
7. A progress bar will be displayed during the installation process. When the installation has finished, the Completing TOPDOC NexGen Setup screen will automatically appear. Press **Finish** to exit the install program.
8. If this is a first-time installation, you will need to install the driver for the USB copy protection dongle “Keylok2”. If you chose to create desktop icons, there will be an icon you can double-click to install the Keylok2 driver on your desktop. Otherwise, the Keylok2 Driver Installer is selectable from the Start Menu folder.

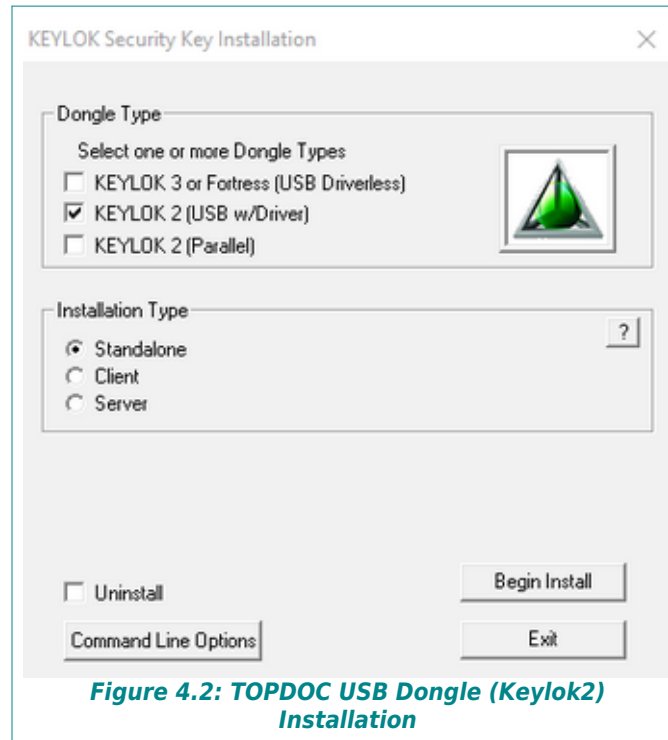


Figure 4.2: TOPDOC USB Dongle (Keylok2) Installation

As shown in the above Figure, select Dongle Type of **KEYLOK2 (USB w/Driver)** and Installation Type **Standalone**, then press **Begin Install**.

After the driver has been installed, you can attach the USB dongle and run TOPDOC NexGen by clicking on the desktop icon or selecting it from the Start Menu folder.

4.2.3 POST INSTALLATION STEPS

If you selected to install TOPDOC NexGen into a different folder than the default \SoftPLC\, you must manually modify a configuration setting before you can successfully run TOPDOC NexGen.

Using Windows Explorer, find your installation folder, go to the lib subfolder and then open the file Topdoc.cfg into a text editor.

Search for "-Dtopdoc.path.data=" and modify the default folder "/SoftPLC" to your selected installation folder. Make sure you enter the folder name with matching upper/lower case text.

For example, if you installed TOPDOC NexGen in \Users\Pluto\SoftPLC, then change:

```
[JavaOptions]
java-options=-Dtopdoc.path.data=/SoftPLC
to:
[JavaOptions]
java-options=-Dtopdoc.path.data=/Users/Pluto/SoftPLC
```


4.3 TOPDOC FOLDERS/FILES

The TOPDOC installation creates a number of sub-folders below the “Program Executables” folder you specified during installation. The table below identifies these and their purpose.

Table 4.1: TOPDOC NexGen Folders (sub-directories)

| FOLDER | DESCRIPTION |
|--|---|
| \SoftPLC | Home folder of the installation |
| \SoftPLC\bin | TOPDOC executables, help files, etc. |
| \SoftPLC\plc | Top level for local PLC_name folders (1 dedicated folder per PLC_name) Also TLM defaults and definition files |
| \SoftPLC\plc\ <plc_name>< td=""> <td>Local SoftPLC configuration files (.LST, .XML, ONE*.CFG) for <PLC_name> (eg: DEFINE.LST, NETWORKS.LST, STARTUP.LST, SMART.XML, etc.)</td> </plc_name><> | Local SoftPLC configuration files (.LST, .XML, ONE*.CFG) for <PLC_name> (eg: DEFINE.LST, NETWORKS.LST, STARTUP.LST, SMART.XML, etc.) |
| \SoftPLC\app | Folder to store sub-folders for <APP_name> (1 dedicated folder per APP) |
| \SoftPLC\app\<>APP_name> | Specific SoftPLC APPs (ladder programs with documentation) and backup files (softplc.app and softplc.bak files) |
| \SoftPLC\clip | Program Clips (library of template APP files, *.XML) |
| \SoftPLC\tlm | TOPDOC Loadable Modules (drivers and custom instructions, *.tlm.so files) |
| \SoftPLC\usr | User specific settings and configurations |

There is not a one-to-one relationship between ladder programs (softplc.app) and a specific controller (plc). One SoftPLC <PLC_name> can have many APPs and one application <APP_name> can be used in multiple SoftPLC’s.



CAUTION

TOPDOC/SoftPLC application and configuration files all have the same filename. It is only their directory folder location that can be used to associate the files to a specific application or PLC name with meaning to the user. It is recommended that you include identifying information in the APP Comment and PLC Definition file (DEFINE.LST) so you do not inadvertently mis-associate files to the wrong PLC or APP_name folders.

4.4 USING TOPDOC NEXGEN

4.4.1 LOADING TOPDOC NEXGEN

Attach your TOPDOC USB protection dongle, and then load TOPDOC using either the desktop icon or load it from the Start Menu folder. Detailed information about how to use TOPDOC can be found in the help system within the program and the tutorial videos at <http://softplc.com>.



Figure 4.3: TOPDOC NexGen Initial/Login Display

Click **OK** to login as **Default** with a blank Password (unless pre-existing Users and/or Passwords have been previously setup).

A “SoftPLC News & Update” window will then display. If you are connected to the internet, the most recent Blog entries from <http://softplc.com> will display. Otherwise, this window will be blank. Press **OK** to close it.

You can now select from the Main Menu options. Select **PLC** for online functions and **APP** for offline editing.

4.5 TOPDOC TO SOFTPLC COMMUNICATIONS

TOPDOC NexGen communicates to SoftPLC only on Ethernet, using standard Ethernet cross-over or patch cables. For Smart and NeoPAC SoftPLC’s, the Ethernet cable should have an RJ45 connector on the SoftPLC end.



NOTE

If your TOPDOC PC is used on your company network, your TCP/IP is probably configured as required by your company. Contact your network administrator before making any changes to your network settings, or if you have questions about the fixed IP address and subnet mask you can use for your SoftPLC applications.

4.5.1 CHECKING ETHERNET COMMUNICATIONS WITH PING

Before you try to connect from TOPDOC to SoftPLC, it is useful to test the Ethernet connection using the “ping” utility.

1. Set up your Windows TCP/IP to a unique address on the subnet used by SoftPLC (default IP address = 192.168.1.100).

Each Windows operating system has a slightly different method for configuring TCP/IP. Refer to your Windows help files for instructions on your particular system.



HINT

Firewalls and active wireless Ethernet channels can sometimes interfere with TOPDOC to SoftPLC communications. If you are experiencing connection issues, try turning these off.

2. Confirm the Ethernet cabling is correct. When both the SoftPLC and Windows computer are powered on there should be a solid ON Link LED near the Ethernet port confirming a correct cable configuration.
3. Test the Ethernet Configuration by using the Windows ping.exe utility. To use the ping utility, type “ping <SoftPLC’s TCP/IP address>” at a command line (eg: from the Run option or a Command Prompt window). For example,

```
ping 192.168.100.1
```

4. Ping.exe will attempt to communicate with the SoftPLC four times. If ping.exe reports a timeout problem, TOPDOC will NOT be able to communicate. If this happens, confirm the SoftPLC and your PC are on the same subnet, check cable connections and/or consult your network administrator for help.

4.5.2 CHECKING COMMUNICATIONS BETWEEN TOPDOC & SOFTPLC

Load TOPDOC and select **PLC** from the main menu. This will open a new **PLC** window. The menu is in the lower left portion of this window.

If the Local PLC Defs list (*upper left*) already displays your SoftPLC’s name, you can select **Edit Remotely**, **Upload** or **Download** to connect and work with that SoftPLC.



HINT

You can use the **Detect on Net** option to check communication before proceeding with other tasks. **Detect on Net** is described in more detail in the next Chapter.

If your SoftPLC’s name is not listed in the Local PLC Defs list, select **Detect On Net**. This opens a new window and TOPDOC will issue a communications broadcast command to display all the SoftPLC’s on the current subnet, also called “discovering” the PLCs.

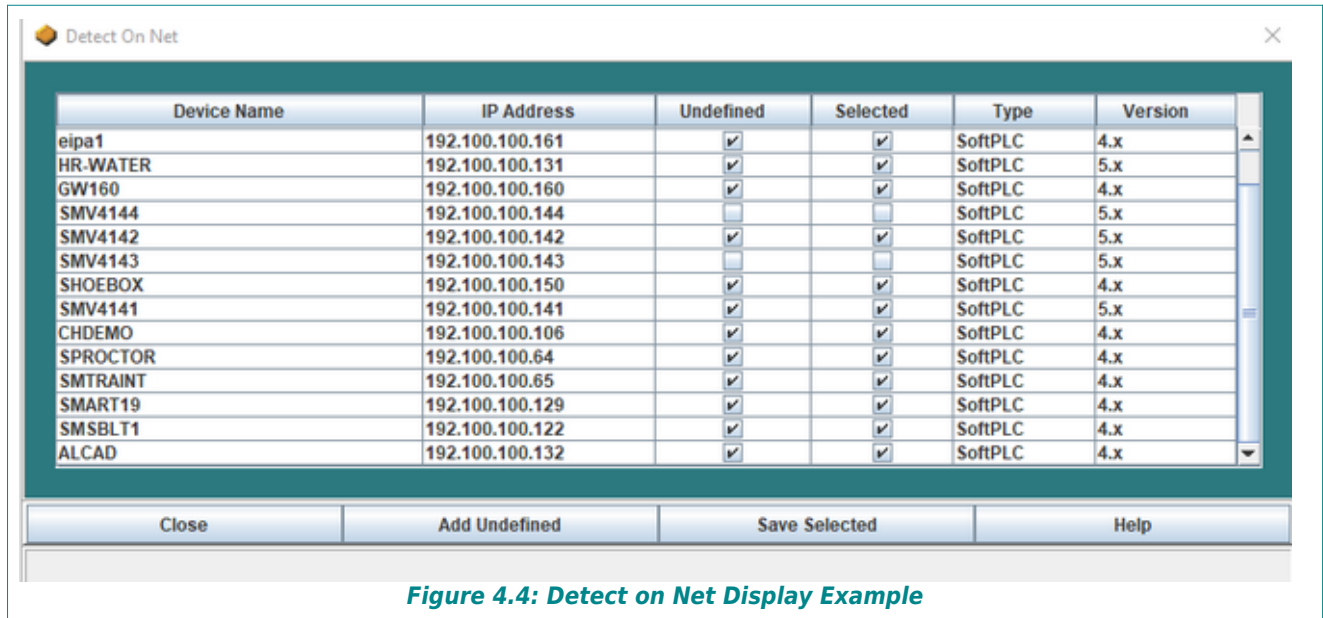


Figure 4.4: Detect on Net Display Example

Successful Detect on Net

If the Detect on Net is successful, you can now either:

- Click on **Add Undefined** to upload and save all new SoftPLC configurations to your PC, or
- Click the check-boxes in the **Selected** column for the SoftPLC's of interest, and then click **Save Selected** to upload and save only those configurations to your PC.

A message will be displayed showing the progress. When the **Close** button becomes available, the upload/save process is complete.

When you **Close** the Detect on Net window, any new PLC Definitions will be added to the Local PLC Def's list in the upper left of the PLC window. You can now connect to a PLC for editing, upload, download, etc.



NOTE

You may need to turn off the Windows Firewall and/or other Ethernet interfaces (such as wireless) to use the Detect-on-Net function.

Unsuccessful Detect on Net

In certain Windows installations, **Detect-On-Net** fails even when firewalls are set off. If this occurs, follow the steps below if you need to create the PLC definition(s) on your PC.

1. "ping" the SoftPLC (as described in the above section "CHECKING ETHERNET COMMUNICATION WITH PING")

- If “ping” is successful, then in TOPDOC’s PLC Configuration Editor, select **ADD**. You will be prompted to enter a new PLC name.

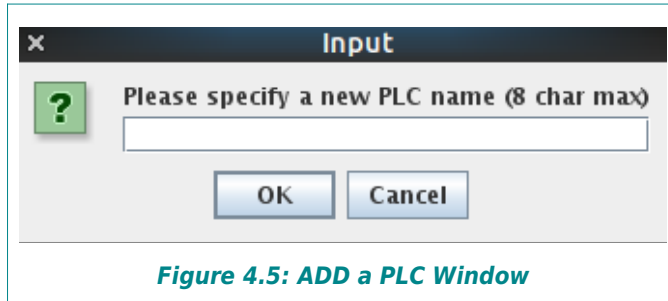


Figure 4.5: ADD a PLC Window

CAUTION

The PLC name you provide **MUST** be a maximum of 8 letter, number or underscore (_) characters. Spaces are **NOT** supported in SoftPLC names!

- Click on the PLC name you added. A menu with 5 options will appear to the right of the list of PLC’s as shown below. You will first need to **Define** the PLC (*detailed information about using the Define Editor is described in the next chapter*).

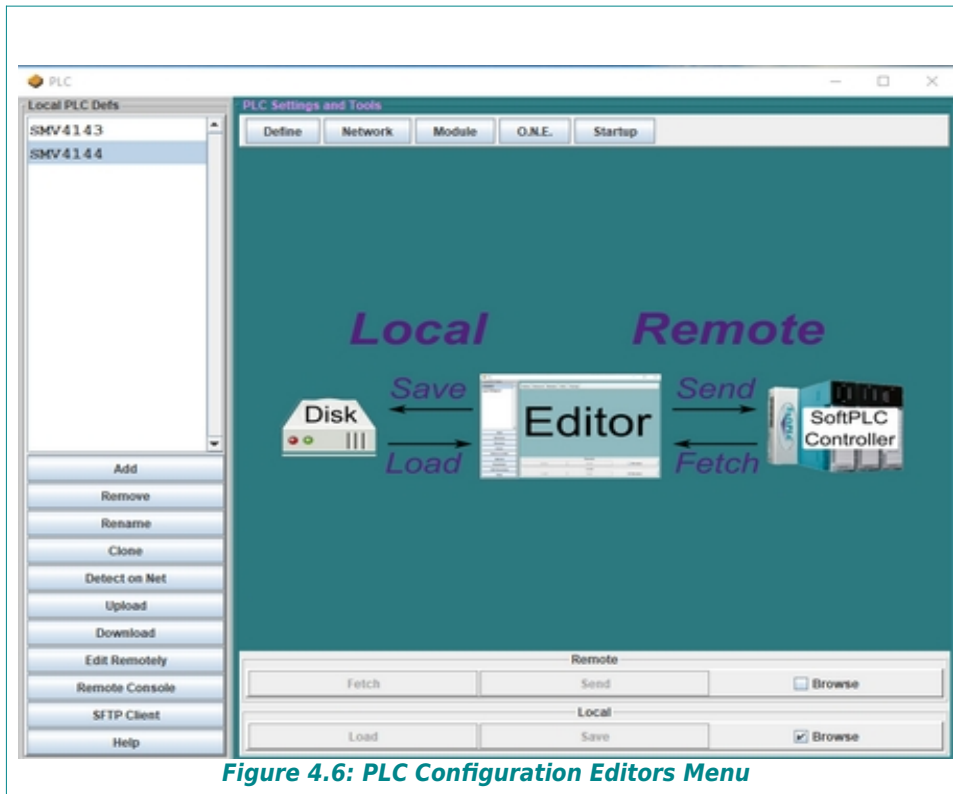


Figure 4.6: PLC Configuration Editors Menu

4. After you **Define** the PLC, select each of the other menu options one at a time. As you select each one, from the menu at the bottom of the window, select **Fetch**, then select **Save**. This will upload and save the various configuration files from the SoftPLC to your PC. You should now be able to connect to the PLC for editing, upload, download, etc. or modify the configurations.

**NOTE**

Details on each of the PLC Configuration Editors and using the **Fetch** & **Save** options are in the next Chapter.

CHAPTER 5 - TOPDOC PLC EDITOR

The PLC Editor provides access to the functions you do when connected to a SoftPLC, sometimes referred to as “Online and SoftPLC Configuration” functions. To access the PLC Editor, load TOPDOC NexGen and select **PLC** from the main menu. The next figure shows an example of the PLC Editor window when you first load it.

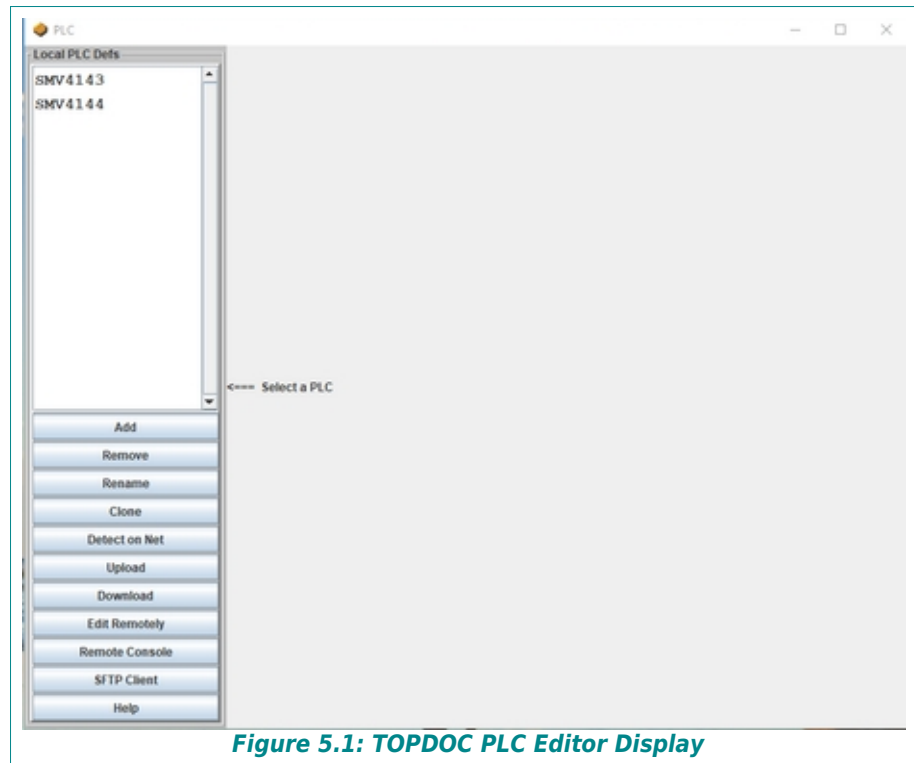


Figure 5.1: TOPDOC PLC Editor Display

5.1 TOPDOC PLC EDITOR MENU OPTIONS

The TOPDOC PLC Editor utilizes a simple interface that makes it easy for you to create and maintain the definition information for all your SoftPLC’s, and also to perform online editing. The first 4 options and **Edit Remotely**, **Upload** and **Download** are documented in the help system and are not included in this manual. The remaining options are described in this manual:

- **Detect on Net** interrogates the TCP/IP subnet to find all the SoftPLC’s on it
- **Remote Console** provides access to the SoftPLC’s Linux console for advanced troubleshooting and configuration functions
- **SFTP Client** provides secure file access, file transfer, and file management to SoftPLC’s flash disk

5.2 PLC EDITOR LOCAL PLC DEFS PANEL

The PLC Editor's upper left panel lists the "Local PLC Defs". These are the SoftPLC's for which you have saved configurations on your TOPDOC PC. Each PLC Definition corresponds to a sub-folder below the \SoftPLC\plc\ folder, and which is used to store the individual configuration files for each PLC. The configuration filenames do not change from one SoftPLC to another, the folder where they are located establishes the relationship between a <PLC_name> and its configuration information.

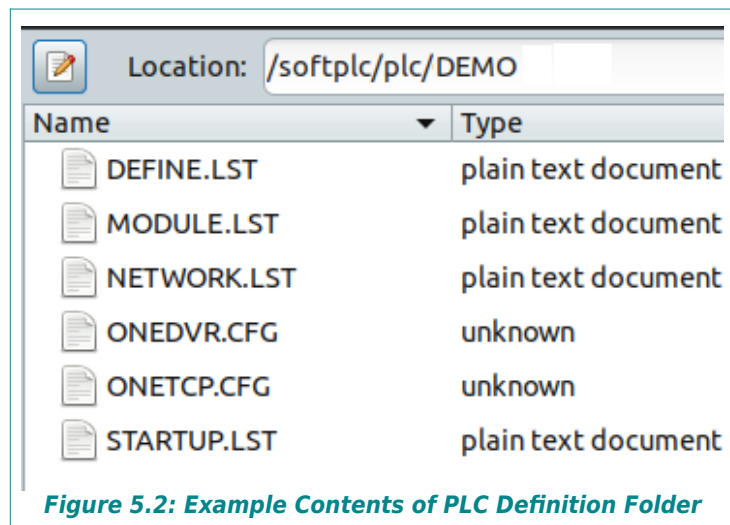


CAUTION

TOPDOC/SoftPLC configuration files all have the same filenames. It is only their directory folder location that can be used to associate the files to a specific application or PLC name with meaning to the user. It is recommended that you include identifying information in the PLC Definition file (DEFINE.LST) so you do not inadvertently mis-associate files to the wrong PLC_name folders.

The figure shows an example of the folder location and the configuration files for a PLC named "DEMO".

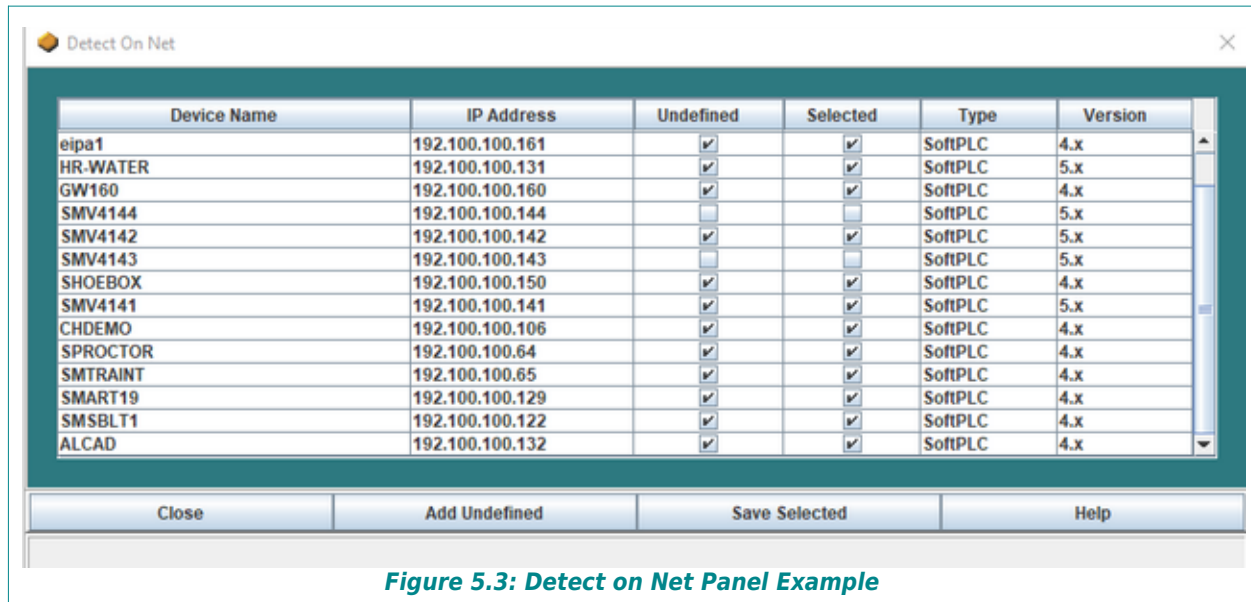
When you select to [Add](#), [Remove](#), [Rename](#) or [Clone](#) a PLC, you are manipulating the folder and/or its contents on your drive, as if you were performing these functions using Windows File Explorer.



5.3 DETECT ON NET (WHO FUNCTION)

The Detect on Net function is quite powerful. It lets a qualified person walk into a new plant and in minutes have a complete local record of all SoftPLCs in the plant, including their names, IP addresses, and configurations. The figure below shows an example of SoftPLC's that were detected on a subnet using [Detect On Net](#).

The Detect On Net panel is called up by selecting the [Detect On Net](#) option found on the main PLC panel.



5.3.1 DETECT ON NET TABLE COLUMNS

- **Device Name** is the name assigned by the Startup editor and should be unique across all your SoftPLCs. This should be the same name shown in the left listbox of the PLC Configuration Manager. If it is not unique, you will need to correct this using the Rename button and the Startup Editor before Adding or Saving that PLC to your PC.
- **IP Address** is the actual TCP/IP Address of the Device. This should agree with the one shown on the Define editor panel for this SoftPLC.
- **Undefined** will be checked by TOPDOC NexGen if either:
 - there is no entry in the PLC Configuration Manager for this Device, or
 - the detected IP Address is in disagreement with the IP address recorded in the Define editor configuration file for this Device
- **Selected** check boxes are user changeable. Individual Devices may be selected in support of the Save Selected button (see below.)
- **Type** is the kind of Device, which can be a SoftPLC (controller and/or Gateway) or an Ethernet I/O Adapter.
- **Version** is the firmware version of the Device, which needs to match the Define editor configuration file for this Device in order for TOPDOC to be able to configure and edit the Device properly.

5.3.2 DETECT ON NET MENU BUTTONS

- **Add Undefined** will create or update definitions for all SoftPLCs checked as Undefined. A folder below \SoftPLC\plc\ will be created if one does not exist already, and the Define data's IP Address will be made current.
- **Save Selected** operates only on the Selected (checked) Devices. If any Selected Devices

are also **Undefined**, TOPDOC will also perform an **Add Undefined** on those SoftPLCs. Next it does a Fetch and a Save for all Selected SoftPLCs for the following editors: Network, Module, O•N•E, and Startup. This is a simple way to get backups of all your PLC configurations for all your SoftPLCs.

- Once you select either of the above options, a message will be displayed showing the progress. When the **Close** button becomes available, the upload/save process is complete.

When you **Close** the Detect on Net window, any new PLC Definitions will be added to the Local PLC Def's list in the upper left of the PLC window. You can now connect to a PLC for editing, upload, download, etc.

5.3.3 TROUBLESHOOTING DETECT ON NET

If the Detect on Net is unsuccessful, something in your PC networking may be interfering with TOPDOC's ability to broadcast to find the SoftPLC's. Below are some common issues and solutions:

- You may need to turn off the Windows Firewall and/or other Ethernet interfaces (*such as wireless*)
- If you are running TOPDOC in a Virtual Machine (VM), the Network Adapter Settings for the Windows "Guest" must be set as a "Bridged Adapter".
- If you are running TOPDOC on a computer that has VM software installed and you are running TOPDOC in the "Host", the VM's Network Interfaces must be disabled.

5.4 CONFIGURING A SOFTPLC CONTROLLER

When you select an existing PLC definition by clicking on its name in the list, the PLC Configuration Editors panel is displayed (see figure below).

Across the top right side of the screen are menu buttons corresponding to the individual editors used to manage your SoftPLC configurations. There are 5 parts to a SoftPLC configuration:

- With the **Define** Editor you identify to TOPDOC NexGen the information to properly configure the SoftPLC
- With the **Network** Editor you configure SoftPLC's TCP/IP settings
- With the **O•N•E** Editor you configure SoftPLC's communications channels to TOPDOC, other SoftPLC's, certain operator interfaces, Allen-Bradley PLC's, etc.
- With the **Module** Editor you choose and configure SoftPLC's I/O and other communication drivers and/or loadable instructions
- With the **Startup** Editor you configure which APP to run and SoftPLC's general operation functions

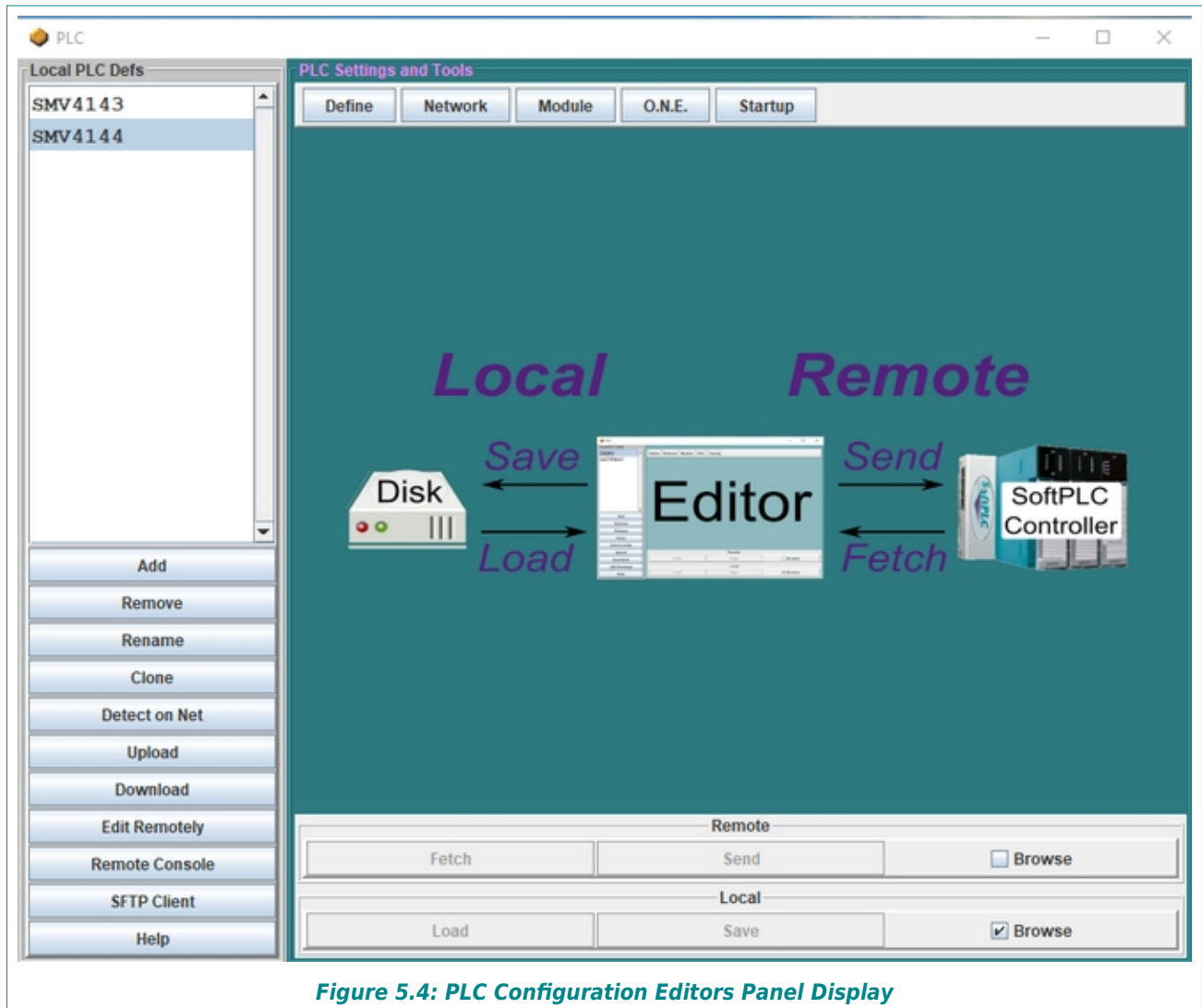


Figure 5.4: PLC Configuration Editors Panel Display

5.4.1 PLC CONFIGURATION EDITORS PANEL USER INTERFACE

The primary key to understanding the use of TOPDOC's PLC Configuration Editors is to first understand its use of the terms **local** and **remote**, and to know which definition you are editing at any point in time.

Refer to the center graphic in the above figure as a guide to understanding the menu buttons below it, and where the configuration files being edited will reside - either on your TOPDOC PC (**Local**) or the SoftPLC flash disk (**Remote**).

LOCAL CONFIGURATION FILES

Local refers to configuration files residing on your TOPDOC computer.

- On your TOPDOC PC, you can **Save** all of the configuration files for each SoftPLC. The files for each SoftPLC will be stored in the <PLC_name> folder. For example, the local configuration files for a PLC named MYPLC would be stored in \SoftPLC\plc\MYPLC.
- To edit a configuration previously stored on disk, use **Load**.

REMOTE CONFIGURATION FILES

Remote refers to data residing in a SoftPLC, and is accessible from TOPDOC only through an Ethernet connection.

- **Send** is used to transfer configuration information from TOPDOC to a SoftPLC. TOPDOC manages all the details regarding where the information needs to be placed on the SoftPLC flash.



NOTE

After doing a **Send** from a PLC Configuration Editor, it is always necessary to restart the SoftPLC for any changes to take effect.

- **Fetch** is used to retrieve existing configuration information from a SoftPLC flash disk into a PLC Configuration Editor.



CAUTION

The displayed data in an editor after a **Fetch** reflects what is on the SoftPLC flash disk. This may **NOT** be the same as the data being used by an operating SoftPLC controller, unless the SoftPLC has been restarted after the last **Send** operation.



HINT

Fetch only loads the information into the PLC Configuration Editor, it does not copy it to your TOPDOC PC drive. You must use **Save** to backup configuration files to your PC.

BROWSE CHECKBOXES

The Browse checkboxes determine whether the data you are editing when you first load a PLC Configuration Editor (*or transition between the various PLC Configuration Editors*) is going to be retrieved from your PC or the attached SoftPLC.

- **Local Browse**, if checked, means that the data will automatically be Loaded from the TOPDOC PC disk into the respective editor. (*This is the default and recommended option.*)
- **Remote Browse** means that the data will automatically be Fetched from the currently selected SoftPLC into the respective editor.



HINT

It is recommended that you use the Local Browse mode. Otherwise, if you are not connected to a SoftPLC, you will get communication errors as you select different PLC Configuration Editor tabs.

If neither Browse mode is enabled, no data is automatically provided for an editor. This is called “Non-Browse Mode”. In Non-Browse Mode, as you transition between PLC’s or Configuration Editors, the data from the previously viewed PLC is displayed in the new PLC’s editor view. You can always select which information to edit by pressing either the [Fetch](#) or [Load](#) button.

 **CAUTION**

If you are not careful, using Non-Browse Mode could be potentially harmful in either your misinterpreting the data or changing the wrong configuration files.

Non-Browse Mode is seldom used, but can be helpful if you want to duplicate some of the configuration files from one PLC to another. (Use [Clone](#) if you want to duplicate an entire configuration.)

 **CAUTION**

Editor data is only on-screen data. It may be different than what is on the local disk or in the remote PLC at any point in time. Displayed editor data reflects your locally saved data only upon a [Load](#), and only reflects what is stored in the SoftPLC upon a [Fetch](#) command.

5.5 [DEFINE EDITOR](#)

Unlike all the other PLC Configuration Editors, the Define Editor configuration file (DEFINE.LST) is only used locally. It is used to describe your SoftPLC, and most importantly to allow TOPDOC to properly interact with the selected PLC.

 **CAUTION**

When you [Add](#) a new PLC, you should first use the Define Editor and [Save](#) the information before attempting any other configuration or to go online with the PLC.

To load the Define Editor, click on a PLC name from the leftmost list box, then press [Define](#).

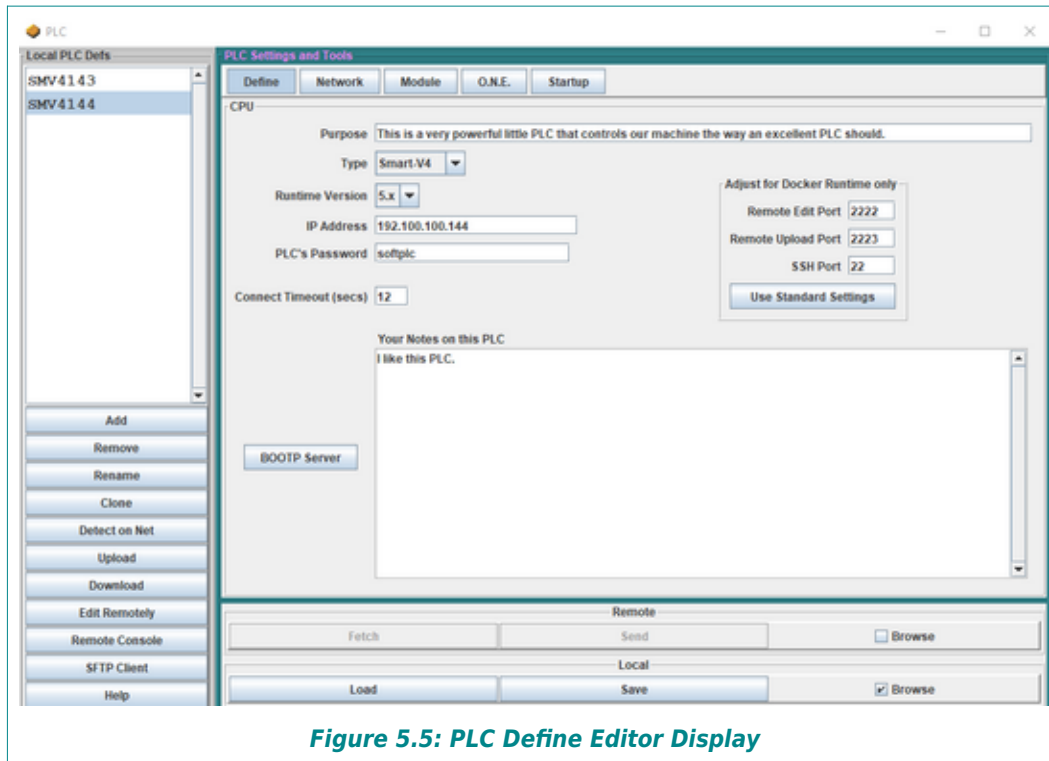


Figure 5.5: PLC Define Editor Display

5.5.1 DEFINE EDITOR CONFIGURATION DATA

The Define Editor manipulates a text file called DEFINE.LST, that when you **Save** it, resides in the \SoftPLC\PLC\

- **Purpose** is a place to describe your PLC with a single line comment.
- **Type** is a combo box that gives you a choice of various SoftPLC controller models. It is important that you select the correct model, as this ensures TOPDOC can create and store the other configuration files properly.
- **Runtime Version** is a combo box that allows you to identify the firmware version of your SoftPLC (4.x or 5.x.) which in turn determines the fields in the other Editors that will be displayed, and the folders and file formats TOPDOC will use when you **Send** configurations to SoftPLC.



CAUTION

The Runtime Version **MUST** be set to the proper version for your controller's runtime system software or your SoftPLC configuration will be invalid. TOPDOC NexGen versions 5 and later support only version 4.x and 5.x SoftPLC firmware, if your SoftPLC is an earlier version, you will need to use an older version of TOPDOC.

**HINT**

Version 5.x and later SoftPLC's firmware version at time of manufacture can be found on the product label. For earlier SoftPLC firmware versions, you can interrogate the SoftPLC or contact support@softplc.com with your serial number and request the last known version information.

- **IP Address** should be set to the valid IP address of the SoftPLC on your TCP/IP network. This must match the configured IP Address in the SoftPLC Ethernet configuration file (NETWORKS.LST).
- **PLC's Password** is the password used for accessing the Console and SFTP functions (*root user password for this SoftPLC's Gatecraft Linux*). The default is "softplc".

**CAUTION**

Do not change the PLC Password unless you understand the consequences!!!! Detailed information on securing your SoftPLC from unintended or malicious use, which includes changing the PLC Password, root user password, and other cyber-security related options are described in the application note "SoftPLC Security", available only to registered users covered under a valid support contract, and upon request to SoftPLC Corporation.

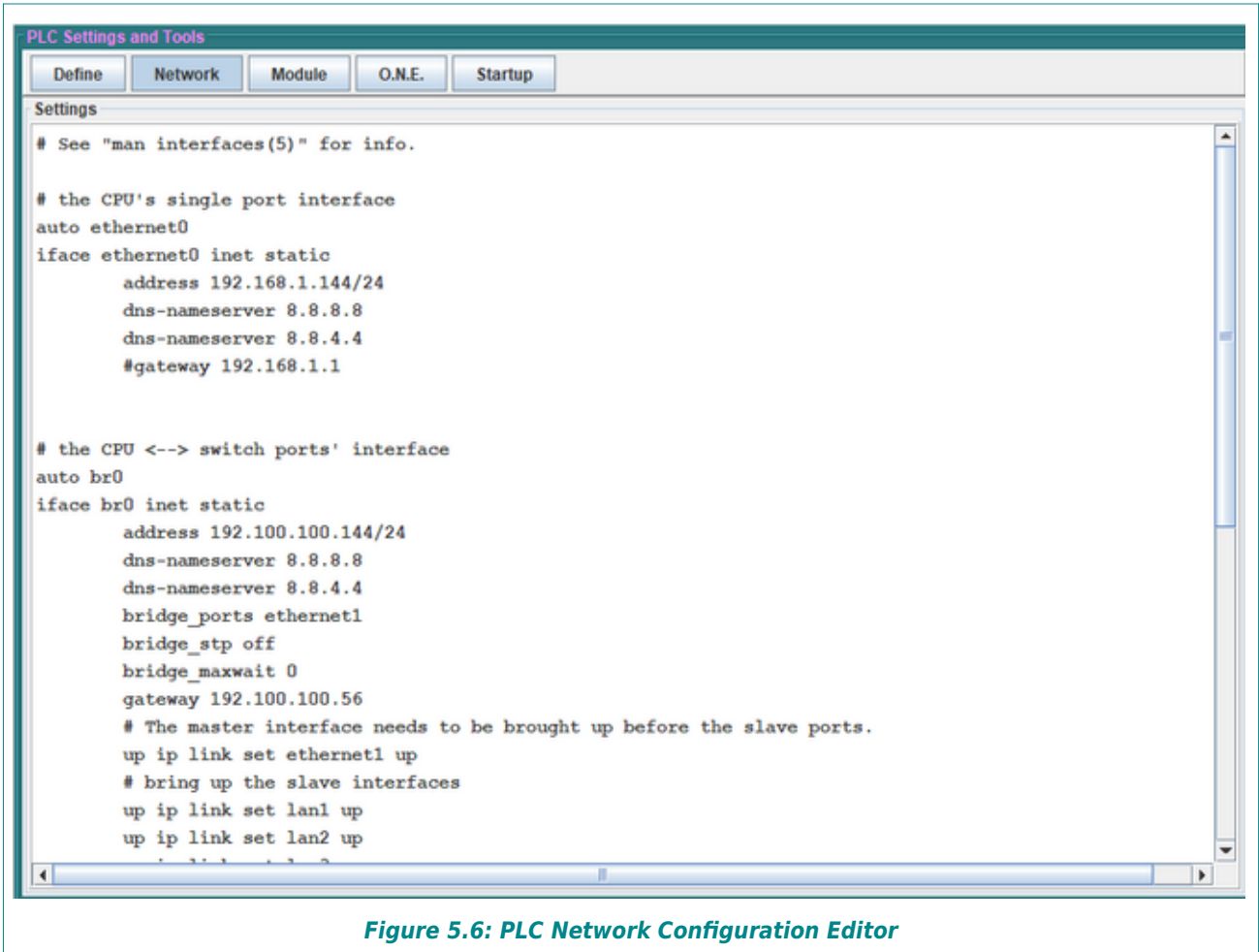
- **Connect Timeout** specifies the amount of time in seconds TOPDOC should wait for a reply to TCP/IP communications requests before reporting a communications problem.
- **Your Notes on this PLC** provides a free format text area where you can put any text you would like: serial numbers, updates, maintenance notes, etc.
- **BOOTP Server** This button enables a BOOTP server in TOPDOC that can be used to configure a SoftPLC's IP Address. This support is primarily for configuring Tealware Ethernet I/O Adapters and legacy SoftPLC systems and is no longer commonly used. Contact support@softplc.com if you want information on the BOOTP Server.
- **Adjust for Docker Runtime Only** is a section with communication settings for TOPDOC to use with SoftPLC runtimes running in a Docker container. Docker based SoftPLC's are described in separate documentation.

5.6 NETWORK EDITOR - TCP/IP CONFIGURATION

You use the Network Configuration Editor panel to view/configure a SoftPLC's TCP/IP support. To load the Network Editor, click on a PLC name from the leftmost list box, then press [Network](#).

The Network Editor configuration data is kept in a text file named NETWORKS.LST. The remote copy on the SoftPLC is in /etc/NETWORKS.LST. The local copy is in \SoftPLC\PLC\`<plc_name>`\NETWORKS.LST.

The following figure shows the Network editor panel default configuration file for the Smart SoftPLC v4. Lines starting with # are comments.



5.6.1 NETWORK EDITOR CONFIGURATION DATA

For both the NeoPAC and Smart SoftPLC, the stand-alone Ethernet port (labeled E0 on the metal enclosure) is "iface ethernet0". If you intend to use this port, change the **address** to the

desired value. If you are using DNS or a gateway, remove the "#" symbol(s) and change the IP addresses to the desired value(s).


```

# the CPU's single port interface
auto ethernet0
iface ethernet0 inet static
    address 192.168.1.144/24
    dns-nameserver 8.8.8.8
    dns-nameserver 8.8.4.4
    #gateway 192.168.1.1

```

Enter desired new values in place of the defaults, adding/removing a # symbol at the beginning of a line to disable/enable that function

Figure 5.7: Configuration of Single Ethernet Port ethernet0



HINT

The host IP **address** is entered as a “netmask”, which is a shorthand for describing a range of IP addresses. The left hand side of a netmask specifies the host IP address. The right hand side specifies the subnet mask in a binary form that indicates how many digits of the host address are significant. /24 is equivalent to a subnet mask of 255.255.255.0, /16 is equivalent to a subnet mask of 255.255.0.0

For a Smart SoftPLC, the br0 section of the NETWORKS.LST file is used to configure the Ethernet switch port (*labeled SW0 through SW3 on the metal enclosure*). Change the **address**, **dns-nameserver** and **gateway** fields to the desired values.

```

iface br0 inet static
    address 192.168.1.100/24
    dns-nameserver 8.8.8.8
    dns-nameserver 8.8.4.4
    bridge_ports ethernet1
    bridge_stp off
    bridge_maxwait 0
    gateway 192.168.1.1

```

Enter desired new values in place of the defaults, adding/removing a # symbol at the beginning of a line to disable/enable that function

Figure 5.8: Configuration of Smart Ethernet Switch (br0)



NOTE

The last two lines of this file link to another setup script that allows advanced switch configurations, including routing support. Editing the bridge scripts is beyond the scope of this manual. Contact support@softplc.com if you have need to modify the bridge script.

5.6.2 CHANGING SOFTPLC'S IP ADDRESS

To change SoftPLC's IP address(es), **Fetch** the current settings and modify the desired entries. **Send** to the SoftPLC and **Save** to your local disk. Change your PC's TCP/IP settings to use a fixed IP address that is on the same subnet as the new IP address of the SoftPLC.

You will need to restart the SoftPLC in order for the changes to take effect. This can be done via the **Startup** editor, by cycling power, or via the **Remote Console**.

5.7 O•N•E CONFIGURATION EDITOR (COMMUNICATIONS)

The O.N.E. Editor is used to configure communication channels that enable a SoftPLC to talk with Allen-Bradley PLC's, HMI's or other devices that use specific Allen-Bradley (A-B) protocols. Example application uses are using ladder logic MSG instructions between SoftPLC's and A-B PLC's, or SoftPLC communications to an HMI.



NOTE

O•N•E is an acronym for SoftPLC's communications software API called Optimum Network Executive. Via O•N•E, SoftPLC's appear as A-B PLC's to other devices on A-B networks.

O•N•E supports up to 32 channels of 3 different network types:

- A-B TCP/IP Ethernet (*also referred to as PCCC, PLC-5 Ethernet or SLC-500 Ethernet*)
- Data Highway Plus (DH+)
- DF1 full/half duplex protocol on RS-232/485/422 serial

SoftPLC using these protocols on these media types appear to other devices and/or applications identical to an Allen-Bradley PLC-5's, making SoftPLC extremely compatible with a wide variety of products from many different vendors. The table below shows O•N•E channel types and the media types that they support.

Table 5.1: O•N•E Channel Media Types/Supported SoftPLC Models

| O.N.E CHANNEL TYPE | MEDIA TYPES | SOFTPLC MODELS |
|--------------------|------------------------|---------------------------------|
| Server | Ethernet | All |
| Client | Ethernet | All |
| Serial DF1 | RS-232, RS-485, RS-422 | All |
| Smart DH+ | Data Highway Plus | Smart & NeoPAC w/ SPO-BH option |
| KTx DH+ | Data Highway Plus | SoftPLC Processor |
| SST DH[+] | Data Highway Plus | SoftPLC Processor |

**NOTE**

SoftPLC's Data Highway Plus support provides peer-to-peer messaging functions, it is not a "pass-through" interface. Therefore, when used as a protocol gateway, it cannot be used to program an A-B PLC or for an HMI to communicate to an A-B PLC, without accompanying MSG programming in the SoftPLC. SoftPLC technical support can provide template MSG programming and/or low-fee based application programming for HMI Gateway applications.

5.7.1 ONE EDITOR CONFIGURATION DATA

The figure below shows the default O.N.E. Configuration Editor display.

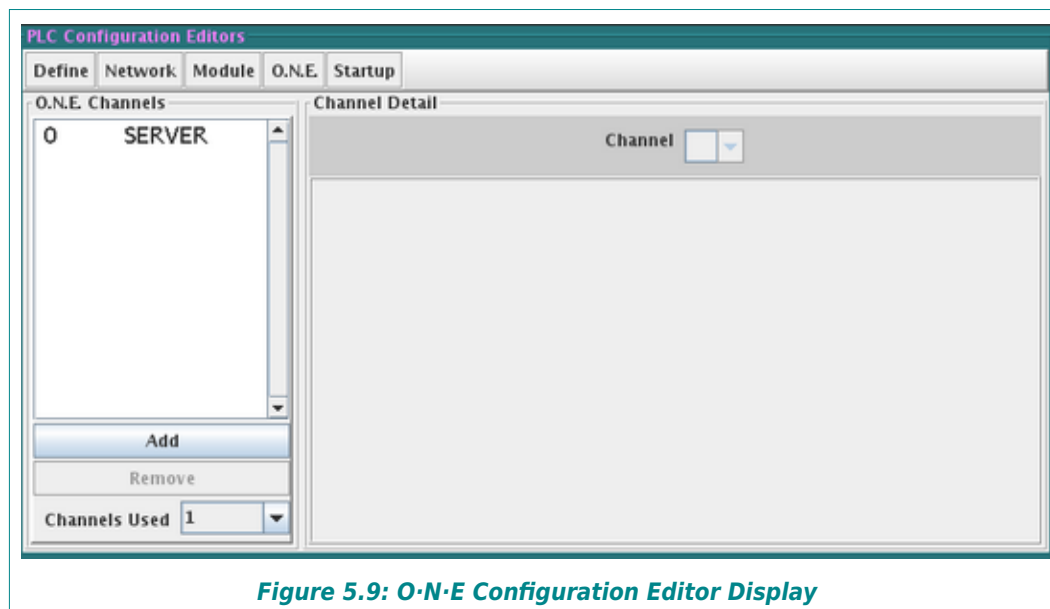


Figure 5.9: O·N·E Configuration Editor Display

In the O.N.E. Channels panel, the configured channels are listed. There are buttons on the lower left that allow you to **Add** and **Remove** O·N·E Channels.

You can define more channels than you may actually use. The **Channels Used** setting determines the number of channels SoftPLC will open when it starts up. This can be less than the number defined. In order for a defined channel to be eligible for use, it must be part of the contiguous block of channels numbered from 0.

The entry order of O·N·E Channels is important as they are loaded in the order listed and only the number of Channels Used (from 0 up) as you specify are active. Additionally, higher priority is given to the lowest number channels.

**CAUTION**

If any of the **used** O·N·E channels are not configured properly or there is an error when SoftPLC tries to open the channel (*ie: disconnected cable*), then SoftPLC will not start up.

ADDING A CHANNEL

To create a new O·N·E channel, press **Add**. A new window allows you to select a channel Type, and after you press OK, you can then customize the parameters for the Channel.

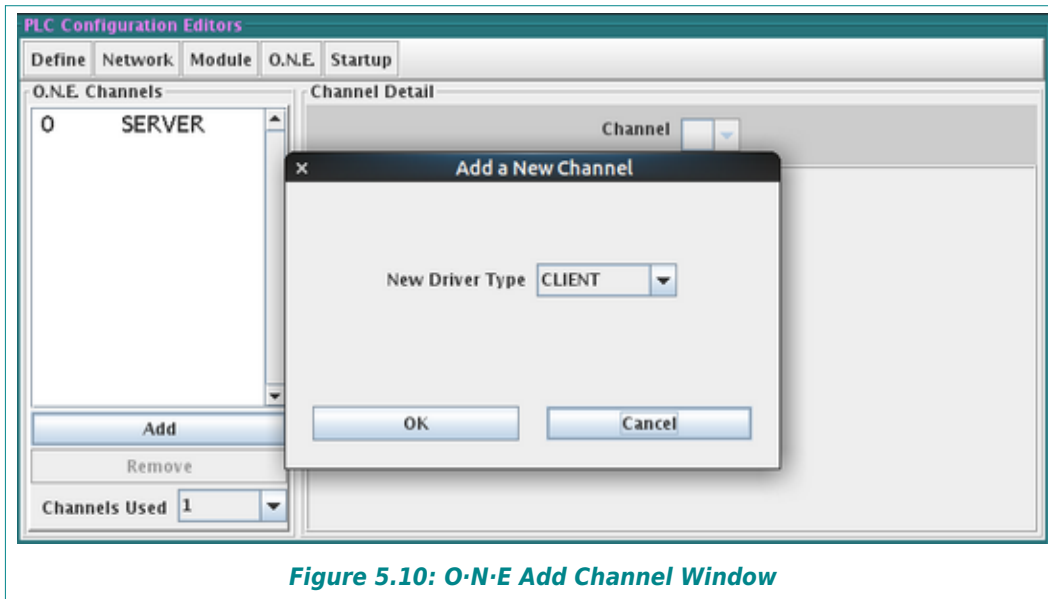


Figure 5.10: O·N·E Add Channel Window

REMOVING A CHANNEL

To delete a channel, press **Remove**, and then select **Yes** at the “Are you sure?” prompt.

5.7.2 O.N.E SERVER TYPE CHANNEL

You always need one O·N·E channel defined as type **Server** in order to support communications with TOPDOC NexGen, SoftPLC’s SFTP Server, and HMI/SCADA products. A **Server** channel is created by default when you **Add** a new PLC.

There are no parameters for the Server type channel.



HINT

It is recommended that the Server channel always be set to ONE Channel 0 for best performance with TOPDOC any and Ethernet connected HMI/SCADA products.



CAUTION

Do not delete the Server channel. TOPDOC will not be able to communicate to the SoftPLC.

5.7.3 O·N·E CLIENT TYPE CHANNELS

O·N·E Client channels are used for peer-to-peer communications on Ethernet:

- SoftPLC to another SoftPLC
- SoftPLC to an Allen-Bradley PLC
- SoftPLC to another device that supports the MSG instruction or other peer-to-peer functions

One (1) client type channel is required for each unique TCP/IP address to which SoftPLC will be communicating. More detail on setting up Client Channels for use with the MSG instruction can be found in the TOPDOC Help File's MSG Instruction information and in Chapter 12.

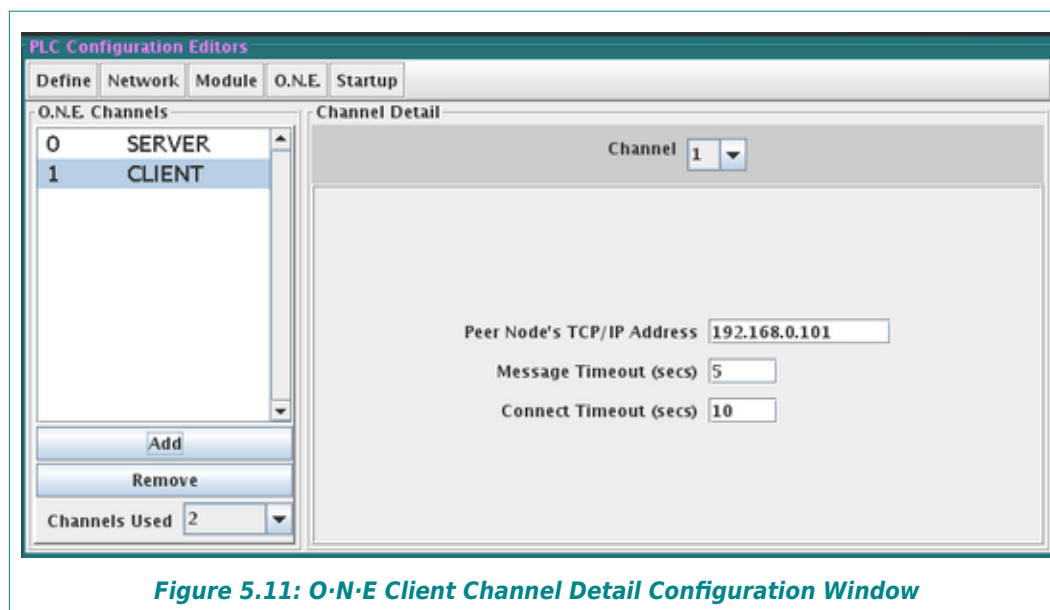


Figure 5.11: O·N·E Client Channel Detail Configuration Window

The figure above shows the window for Client Channel configuration. The parameters to be configured are:

- **Peer Node's TCP/IP Address** - the TCP/IP address or host name of the other station
- **Message Timeout** - the number of seconds from the time the MSG is initiated before setting the MSG instruction error bit
- **Connect Timeout** - the number of seconds to wait before reporting a TCP/IP connection error

5.7.4 SERIAL DF1 TYPE CHANNELS

Serial O·N·E Channels are normally used when SoftPLC is to connect via the DF1 full duplex or half-duplex slave protocols to an operator interface, SCADA package, DCS, or the wide variety of devices that support the DF1 protocol for peer-to-peer communications. Cabling requirements can be found later in this section.

 **NOTE**

Some SoftPLC controller models support add-on serial interface cards for up to 16 ports. If you are planning to use add-on serial ports, you need to ensure the hardware you select is compatible with SoftPLC's extended COM support. SoftPLC Corp. sells compatible serial port add-on cards.

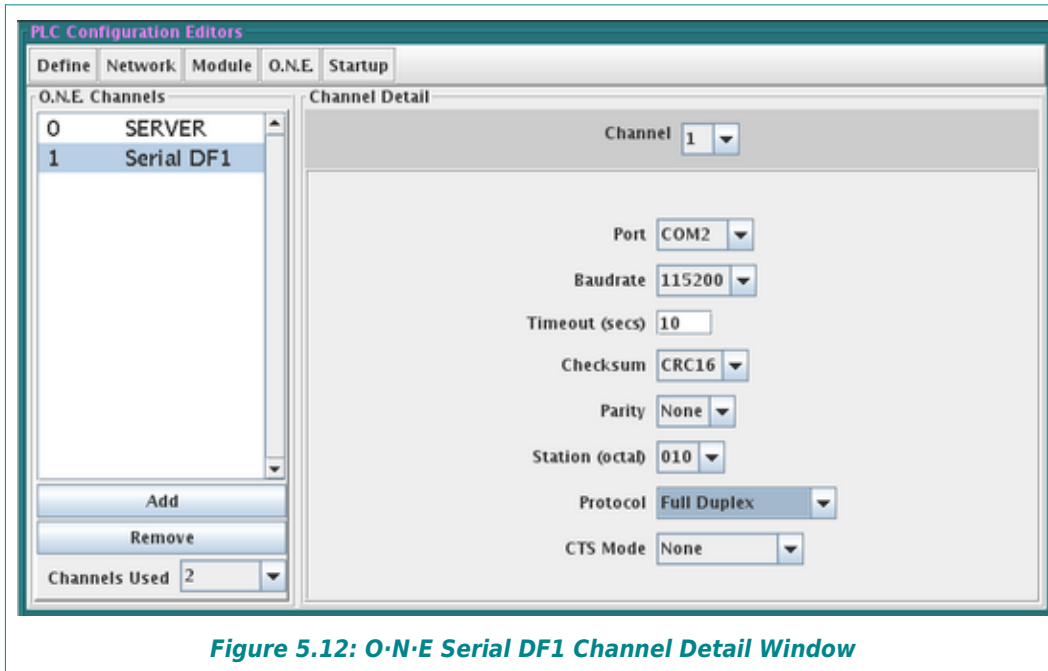


Figure 5.12: O·N·E Serial DF1 Channel Detail Window

DF1 CHANNEL CONFIGURATION

The figure above shows the Serial DF1 configuration window. For the O·N·E Serial DF1 driver you can configure the following parameters:

- **Port** - the number of the SoftPLC serial port, COM1 and up. The O·N·E Serial DF1 driver supports up to 16 COM ports, for numbers COM1 to COM16



CAUTION

Some SoftPLC systems are factory set to use COM1 as a CONSOLE for troubleshooting purposes. We do not recommend you remove the CONSOLE function, without carefully considering the consequences of losing this functionality. Therefore, your first choice for serial O·N·E communications should be COM2, which is the default. *(The Smart and NeoPAC SoftPLC's have a dedicated CONSOLE port, so this does not apply.)*

- **Baudrate** - the speed of the serial communications link, from 300 to 115200 bits/second. This must match the setting of the device at the other end of the link
- **Timeout** - the length of time in seconds SoftPLC should wait before issuing a communications timeout error

- **Checksum** - the type of error checking method to be used. We recommend CRC16. This must match the setting of the device at the other end of the link.
- **Parity** - normally set to None. This must match the setting of the device at the other end of the link.
- **Station** - the octal station number of the SoftPLC on the network. This value is only important if you are connecting via DF1 half-duplex protocol to devices on a Data Highway network, where each station number must be defined and be unique. For point-to-point communications, this value is not relevant.
- **Protocol** - select Full Duplex or Half-Duplex Slave protocol. This must match the setting of the device at the other end of the link.



NOTE

Smart and NeoPAC SoftPLC's do not have RS-232 ports. However, you can use one of the USB ports with a USB to serial cable kit (Cat No SPO-USBSERKIT) for DF1 communications. You can use the Smart or NeoPAC SoftPLC RS-485 port for DF1 Half-Duplex communication only.

- **CTS Mode** - Clear To Send Mode is used for Half-Duplex Slave protocol when used with modems. Choices are None, Millie Modem and Handshaking. If you are using a serial modem with SoftPLC for DF1 communications, contact support@softplc.com for assistance.

SERIAL CONNECTIONS

When communicating to a SoftPLC from another computer or HMI, through one of its serial RS-232 (COM) ports, you use a standard null modem cable. SoftPLC Corp sells these cables as Cat No ICO-CNM. If you are using a USB to Serial connection for RS-232, the SPO-USBSERKIT provides the necessary firmware/cables (see Chapter 10).

5.7.5 KTX (DH+) & SST (DH+) TYPE CHANNELS

Data Highway Plus communications are supported in SoftPLC Processor models with ISA or PCI slots. KTx Type Channels are used with Allen-Bradley 1784-KT, -KTX, -KTXD, -PKTX, or -PKTXD cards and SST Type Channels are used with 5136-SD cards. Up to 8 cards per SoftPLC are supported. These interface cards are all obsolete and beyond the scope of this manual. Contact support@softplc.com if you need information on using these interface cards.

5.7.6 SMART DH+

Smart and NeoPAC SoftPLC's equipped with one or more optional BlueHose interfaces (Cat No SPO-BH) support Data Highway Plus communications.

**CAUTION**

These same SPO-BH ports can be configured for Remote I/O (RIO) communications using TOPDOC's Module Editor. The Module and O.N.E. configuration editors do not check for multiple configurations applied to the same port. SoftPLC will not start-up if the same port is configured for multiple BlueHose protocols.

For the O·N·E Smart DH+ driver you can configure the following parameters:

- **Station** - The octal DH+ station number of the SoftPLC (0-64).
- **Message Timeout** - the length of time in seconds SoftPLC should wait before issuing a communications timeout error
- **Port** - the SoftPLC port number of this BlueHose interface
- **Termination Resistor** - Select **Off** if this station is not on the end of the DH+ network. Select **On** to use the internal software Termination Resistor.
- **Baudrate** - Select the desired DH+ network speed, **57600**, **115200**, or **230400**.

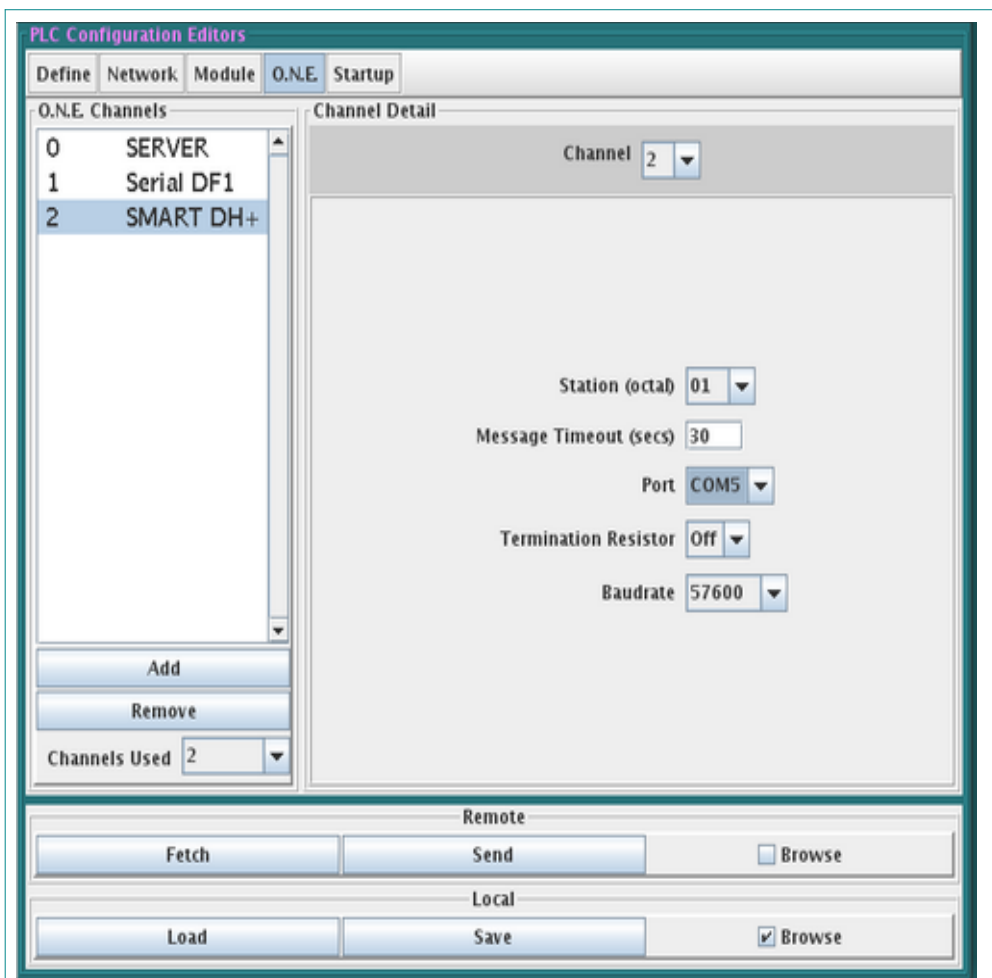


Figure 5.13: Smart/NeoPAC DH+ Configuration Editor Display

5.8 MODULE (TLM) CONFIGURATION

SoftPLC supports loadable software modules that are written in C++ (or C). These loadable software modules are often referred to as TLMs (TOPDOC Loadable Modules.) TLMs can be for communicating to I/O or other devices (Drivers,) or they can be a container for user written ladder instructions (Modules), or both.

TLMs are loaded by SoftPLC at runtime when you select to **Use** a module in the Module Configuration Editor, which adds an entry to a text file called MODULE.LST. Local TLM configuration data is stored in \softplc\plc\\MODULE.LST and the remote TLM configuration data is in the file /SoftPLC/run/MODULE.LST in the SoftPLC. The Module Editor edits these MODULE.LST files.

TOPDOC uses a definition file provided by the developer of the TLM to understand what is required to configure it. For the most commonly used SoftPLC provided TLM's, this file is called DEFAULTS.<x>, where <x> is the SoftPLC version. Other TLM's may use a different text file whose name is hard-coded into the TLM. These files are located in the \SoftPLC\plc folder on your hard drive. More information about these files can be found in the "Available Modules List" section.

5.8.1 TYPES OF TLM'S

DRIVERS

Driver TLMs are used to communicate to I/O or device networks. A DRIVER type TLM can automatically get CPU control on each PLC scan, whereas a MODULE type TLM does not get CPU control unless called by a ladder instruction. Forcing of discrete I/O points can be supported in a DRIVER TLM.

MODULES

Module TLMs are normally a container for ladder instructions, but can also be loaded and can run as a separate task within SoftPLC. Module TLMs can be computations, data manipulators, or device interfaces (*e.g.: motion control cards, serial communications protocols.*) A Module TLM can contain a number of TLIs (TOPDOC Loadable Instructions.) If you load the module you have access to all the TLIs contained within it. TOPDOC NexGen treats TLIs, once loaded, like other ladder instructions.

5.8.2 MODULE CONFIGURATION EDITOR

You use the TOPDOC NexGen Module Editor to install/uninstall and to configure TLMs for your SoftPLCs.

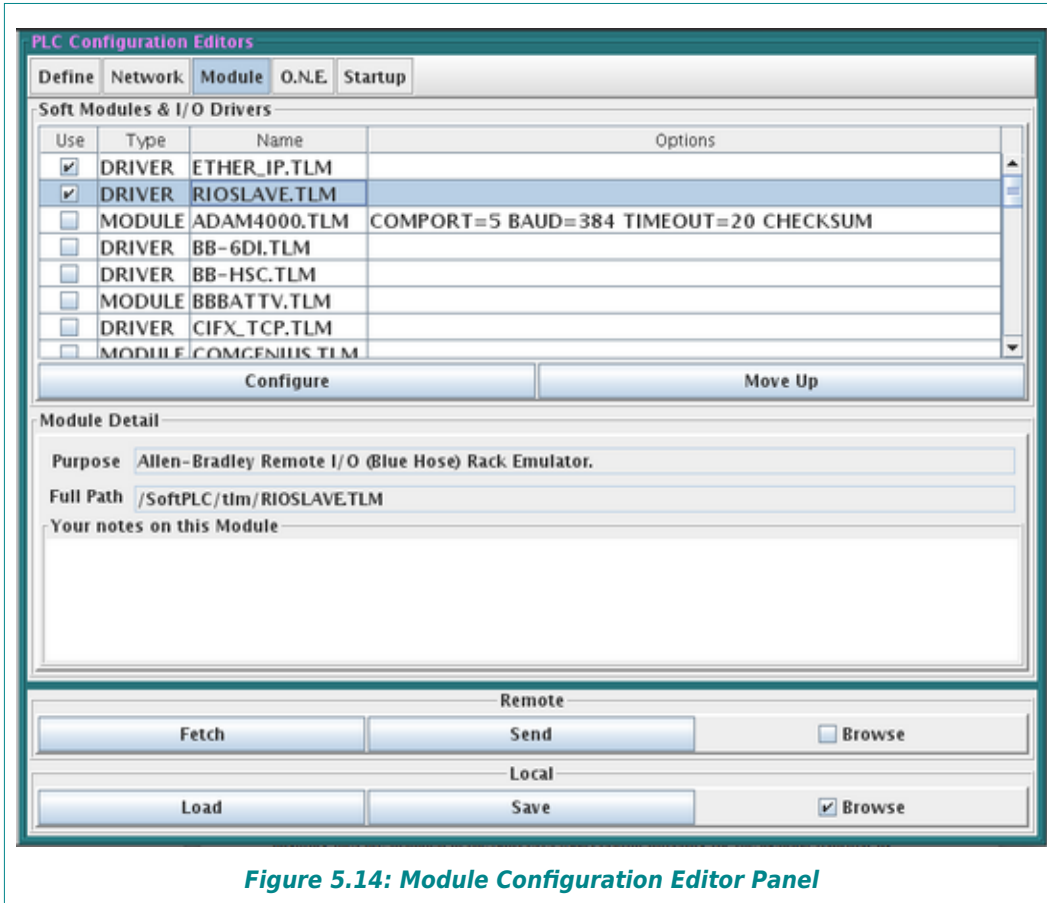


Figure 5.14: Module Configuration Editor Panel

At the top of the Module Editor panel is a table with 4 columns:

- **Use** - If checked, indicates that this TLM is to be loaded at runtime by SoftPLC. TLMs that are listed, but where the **Use** box is not checked, are installed on your PC, but will not be inserted into the MODULE.LST file.



HINT

The most popular SoftPLC developed TLM's are installed with TOPDOC, and will appear in the TLM selection list in the Module Configuration Editor. Refer to the section on "Available Modules List" if the TLM you want to use does not appear in the list.



CAUTION

Some TLM's are SoftPLC runtime version specific. Before selecting to **Use** a TLM, make sure it will operate with your SoftPLC.

- **Type** - established by the TLM developer to be either DRIVER or MODULE for each TLM and is not user definable. TLM developers indicate the Type in a TLM configuration file.

- **Name** - the filename of the TLM without path information.
- **Options** - an unformatted text field that can be used to customize the way the corresponding TLM operates. Each TLM sets its own rules for its command line options, but defaults are supplied when appropriate. When you select to **Use** a TLM for which the developer established Options, you can edit the options by double-clicking in this field and typing the desired information.

Module Detail is displayed below the list of TLM's (center of screen) for the currently selected TLM.

- **Purpose** - provided by the TLM developer and is a brief description of what the TLM does.
- **Full Path** - where the TLM resides in the remote SoftPLC. It is chosen by the TLM developer and displayed here.
- **Your Notes on this Module** - this is an unformatted field that can be used to enter text that might be helpful to you in using this module.

MODULE EDITOR BUTTONS

There are 2 buttons below the list of TLM's:

CONFIGURE BUTTON

Configure will be enabled when a TLM is selected for Use *and* that TLM uses a configuration file. Usually all DRIVER type TLMs need to be configured, and you will need to refer to separate documentation on how to configure them.

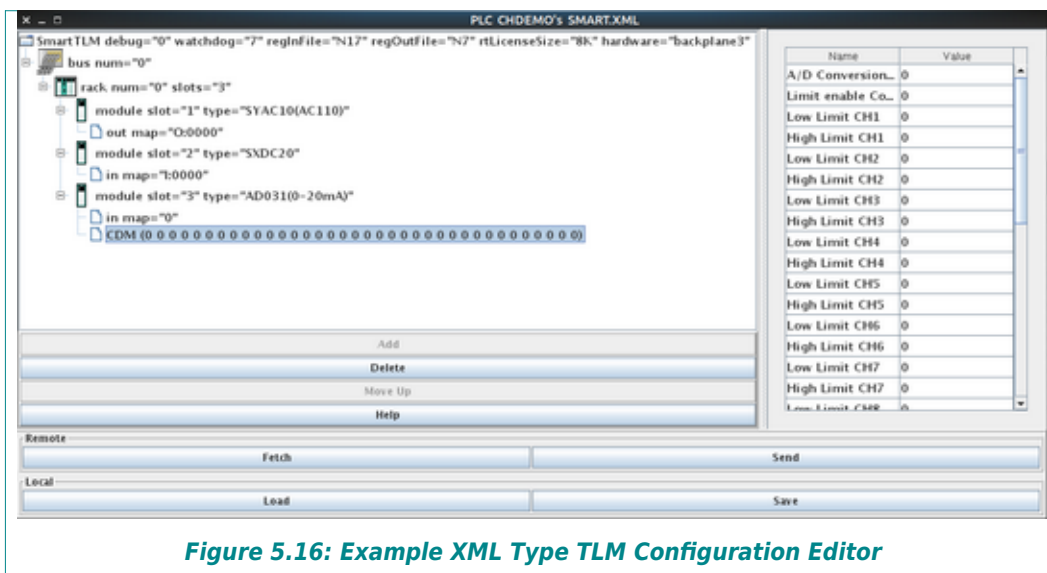
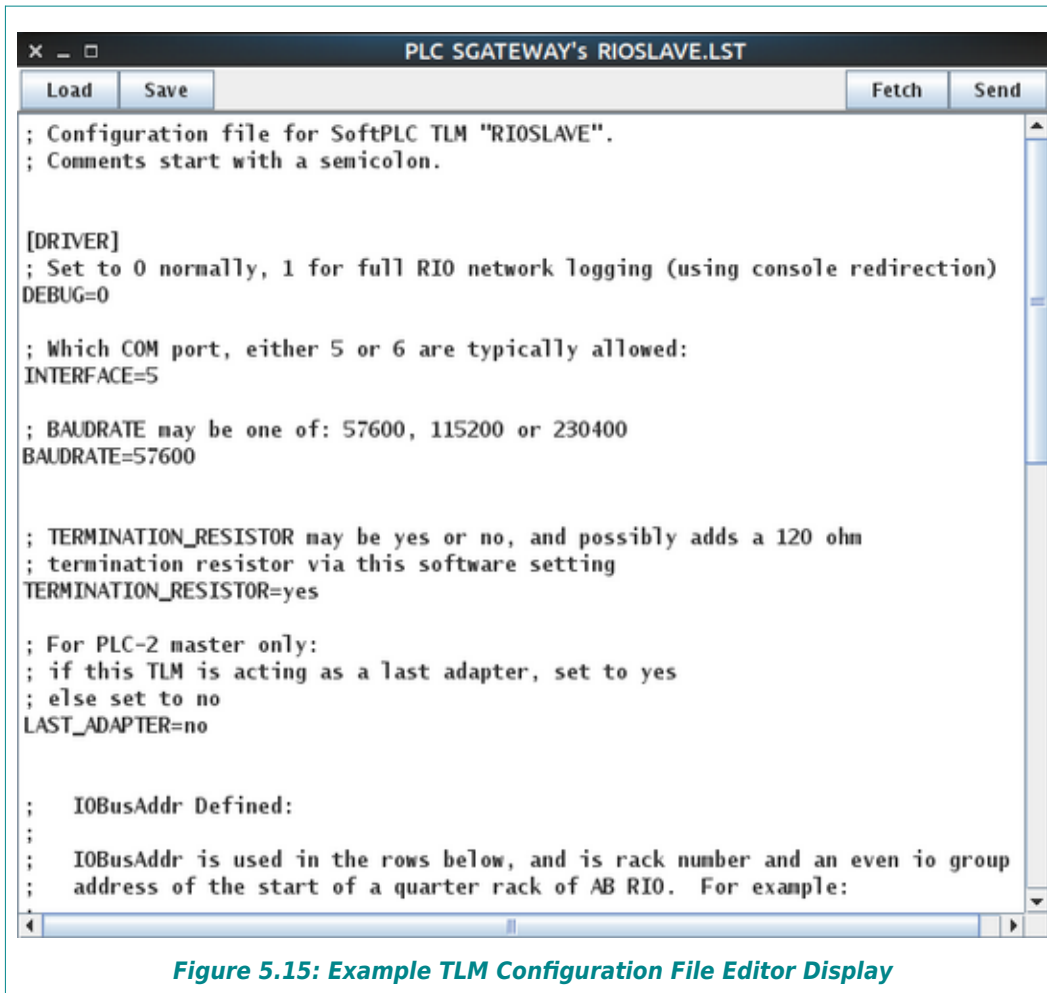
Most TLMs' configuration files are text files. When you press **Configure**, TOPDOC loads a text editor that can be used to **Fetch** and/or **Load** a default template or existing configuration file, and after editing, be used to **Send** and/or **Save** the configuration file. An example is shown in Figure 5.15.



HINT

The name of the configuration file is shown at the top of the editor window (RIOSLAVE.LST in the example figure).

Some TLM's use a customized editor that will be launched when you press **Configure**. These are typically SoftPLC provided I/O drivers that use an XML formatted configuration file, such as the local Tealware I/O driver SMART.TLM, and the Modbus Master drivers, MBIPMAST.TLM and MODBMAST.TLM. An example is shown in Figure 5.16.



MOVE UP BUTTON

Move Up lets you move a particular module up in the list. This lets you establish an order of loading within SoftPLC. Most TLMs have no preference with regard to load order, if they do, this would be noted in the specific TLM documentation.

5.8.3 MODIFYING THE AVAILABLE MODULES LIST

The list of available TLM's in the Module Editor is based on definition files in the local (TOPDOC) PC's \SoftPLC\plc folder. If you want to **Use** a TLM that is not listed, you will need to obtain or create the proper definition file for that TLM and install it in the TOPDOC PC's \SoftPLC\plc folder.

TLM definition files are text format files. An example TLM definition file is shown in the following figure. Lines starting with # are comments, non-commented lines are used by TOPDOC to understand what is needed to configure the TLM.

For SoftPLC provided TLM's not included in the DEFAULTS.<x> definition file, the associated definition file, configuration editor, any other auxiliary files will be included. The proper installation location for each file will be identified in the documentation for the TLM.

```
#This file is a sample MODULE definition file.
#Create a file with an extension of .DEF in the \SoftPLC\plc directory for your TLMs.
#Everything to the left of the first = on each line is a property name.
#The corresponding property value is to the right of the first =.
#For path separator use the / character not \. Case is important, especially for
#version 4.x SoftPLC.

# Do a search and replace, changing "YOURDVR.TLM" to whatever your tlm name is.
# Say your tlm is "mygreatt1m.t1m.so", then search and replace YOURDVR.TLM
# with MYGREATT1M.T1M which is uppercase and no trailing ".so".
# YOURDVR.TLM must be all uppercase, keywords must be lowercase.

# Properties for YOURDVR.TLM
module.purpose.YOURDVR.TLM=DRIVER for C++ Toolkit.

# please put it in /SoftPLC/t1m/
module.path.YOURDVR.TLM=/SoftPLC/t1m/YOURDVR.TLM

# set to either DRIVER or MODULE
module.type.YOURDVR.TLM=DRIVER

# default command line options, if any. set to empty of none, (remove "ioport=380")
module.options.YOURDVR.TLM=ioport=380

# the name of your driver configuration file
module.cfgdata.YOURDVR.TLM=/SoftPLC/t1m/YOURDVR.LST

# which driver configuration file editor, the one shown is a general text editor:
# see the DEFAULTS.LST file for more examples. You can also write your own editor.
module.cfgeditor.YOURDVR.TLM=topdoc.plc.TextConfigurationEditor

#EOF
```

Figure 5.17: Sample TLM Definition File

Some TLM's require configuration or other auxiliary files. The *.TLM and any auxiliary files, editors, etc. must also be installed in the TOPDOC PC's \SoftPLC\tlm folder (or the location referenced in the TLM's definition file) to be able to use the TLM in offline APP editing. Additionally, for offline APP editing, a local PLC definition must also be created that has the *.TLM checked for **Use** in the Module Editor.



CAUTION

When you select to USE a TLM, make sure the *.TLM and any required configuration or other auxiliary files are installed in the SoftPLC's /SoftPLC/tlm directory (or the location required by the TLM.) Otherwise, SoftPLC will not start.

5.9 STARTUP CONFIGURATION EDITOR

TOPDOC NexGen's Startup Editor contains some useful tools and is also used to edit a PLC settings file called STARTUP.LST. STARTUP.LST contains runtime options that are used to specify the the application program file to run, the PLC Name, start-up operating mode and more. The local version is in \SoftPLC\plc\

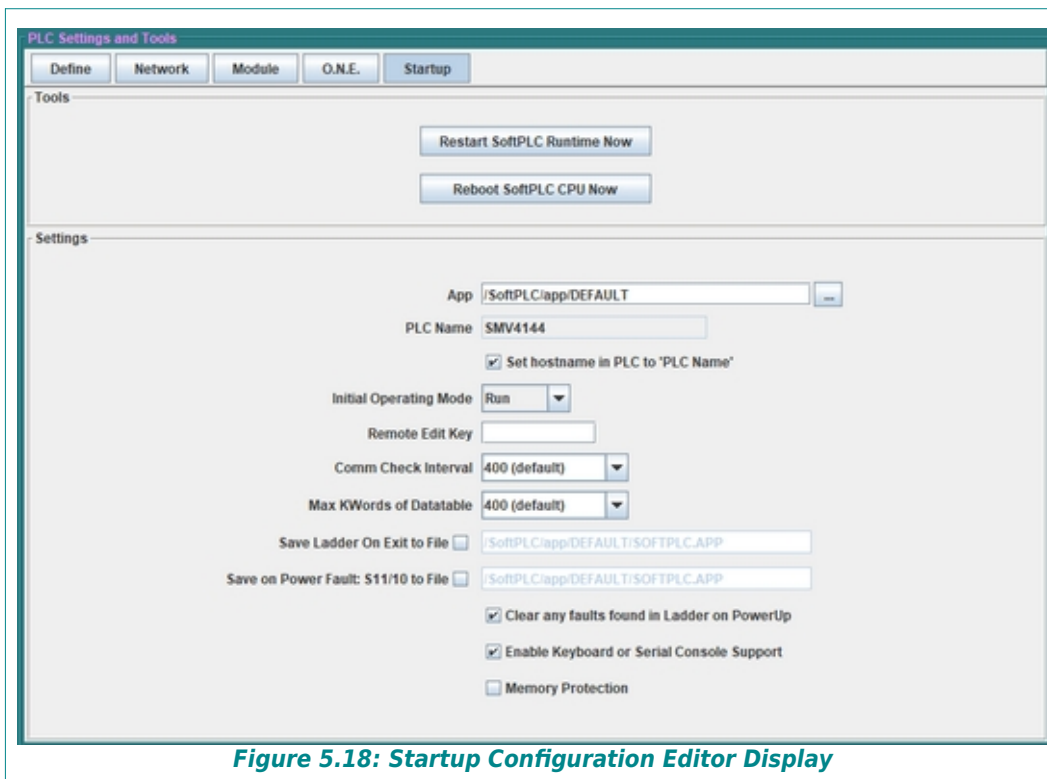


Figure 5.18: Startup Configuration Editor Display

5.9.1 STARTUP EDITOR TOOLS

There are 2 buttons at the top of the Startup Editor:

- **Restart SoftPLC Runtime Now** - Pressing this button will cause the SoftPLC *runtime* task to restart. This is useful if you have changed configuration settings in the Module, O.N.E. or Startup editors (except for the **PLC Name**), or the configuration files of any of the Used Modules. Restarting will load the new configuration settings, without restarting the entire SoftPLC controller.



CAUTION

Restarting or Rebooting the SoftPLC while it is controlling equipment will cause communication to connected devices to end abruptly, which may result in a dangerous situation. Check the possible consequences of a Restart or Reboot before doing so.

- **Reboot SoftPLC CPU Now** - Pressing this button will cause the SoftPLC *controller* to restart (*similar to cycling power*). Rebooting is useful if you have changed the Network settings or the **PLC Name** in the Startup editor.

5.9.2 STARTUP EDITOR SETTINGS

- **App** - the name of the ladder application SoftPLC should load and run at startup. The App file can reside on any drive available to the SoftPLC, the default folder is /SoftPLC/app/. If a file is not specified, SoftPLC will start with a blank application called DEFAULT. If you are connected to a SoftPLC, pressing the [...] button to the right of the text area will open a selection list that shows the names of all the Apps in that SoftPLC.
- **PLC Name** & **Set Hostname to PLC in "PLC Name"** - This should always agree with the local name of the PLC as given in the listbox of PLC's on the left. This is not a text editable field. To change this field, simply **Save** or **Send** the Startup data and then **Load** or **Fetch** the changed data back into the editor. If you **Save**, then **Load**. If you **Send**, then **Fetch**.
- **Set Hostname to PLC in "PLC Name"** - Uncheck this if you want to
- **Initial Operating Mode** - You can select this to be Run, Program, or Test. The default is Run. If you select any other Mode, you will need to use TOPDOC's Remote Editor to change the mode before the SoftPLC will run the logic and communicate to any I/O or other devices.



NOTE

If your SoftPLC has a hardware keyswitch, the keyswitch position will override this setting. However, if the keyswitch is in REMOTE mode, this setting will determine which Remote mode is set at SoftPLC startup.

- **Remote Edit Key** - If you enter a value in this field, anyone attempting to use TOPDOC's **Edit Remotely** or **Upload** options will need to have the correct value of the **Remote Edit**

Key in their local copy of STARTUP.LST. The default is to have this field empty.



CAUTION

Do not change the Remote Edit Key unless you understand the consequences!!!! Detailed information on securing your SoftPLC from unintended or malicious use, which includes changing the Remote Edit Key, PLC Password, root user password, and other cyber-security related options are described in the application note “SoftPLC Security”, available only to registered users covered under a valid support contract, and upon request to SoftPLC Corporation.

- **Comm Check Interval** - This setting adjusts the frequency that a SoftPLC checks its peer-to-peer messaging queues. A smaller number is a faster frequency but may slow down the overall scan time somewhat under a heavy messaging load. Checking a queue means seeing if any HMI application(s) have sent SoftPLC communication commands on any O•N•E channels that are currently in use. Each channel has its own queue. During each check, all active O•N•E channels are serviced, but only one packet is serviced from the front of each queue. This option can be used to tune the amount of CPU time SoftPLC gives to these communications requests. The default is to check after each 400 rungs, plus at the end of program scan. If your program has less than this setting’s number of rungs, then only the end of program check is done and this setting will have no effect.
- **Max KWords of Data Table** - This sets a high limit for your datatable size, where one kword is 1024 sixteen bit words. If you are running out of system RAM you can reduce this value. If you are running out of datatable you can increase this value. The default is 400 kwords. If TOPDOC NexGen tries to expand the datatable beyond this limit, the expansion attempt will fail and TOPDOC will report an error code. Actual APP files must always use less than this limit in order to be loaded into this SoftPLC.



NOTE

Most SoftPLC CPU’s have sufficient RAM for any realistic APP size. This setting only applies to older equipment with limited RAM memory.

- **Save Ladder on Exit to File** - gives the name of an APP file that the current SoftPLC RAM contents will be written to whenever you exit SoftPLC via a Console command or a keyboard attached to the SoftPLC. This setting has no effect if SoftPLC is shut down by a loss of power or by pressing the **Reboot SoftPLC CPU Now** button. This option can be used to achieve retentive memory so that unsaved online program changes or datatable values can be saved to flash (*see section on Retentive Memory on Power Loss*). The APP filename entered here does not need to be the same as the Startup **APP** name.
- **Save on Power Fault** - gives the name of an APP file that will be written to whenever bit S11/10 is turned on. Turning on S11/10 causes SoftPLC to fault, at which time the current SoftPLC RAM contents will be stored to this file (*see section on Retentive Memory on Power Loss*).
- **Clear any Faults in Ladder on Powerup** checkbox should normally be set on (*checked*). If a SoftPLC RAM image was saved by either **Save Ladder on Exit to File** or **Save on**

Power Fault it is possible that datatable fault bits were set into the image before saving. In order to be able to automatically restart after such a faulted saved image, SoftPLC needs to clear all the faults one time at startup. If this is set off, you will need to manually clear any faults with TOPDOC before SoftPLC will start running the APP.

- **Enable Keyboard or Serial Console Support** - This setting is for legacy controllers and has no effect. The default is set on (*checked*).
- **Memory Protection** - if this is set (*checked*), it will disable datatable size changes and ladder program rung changes attempted by TOPDOC, regardless of the PLC operating mode. This is similar to older PLC's RUN mode with a hardware keyswitch.

5.9.3 RETENTIVE MEMORY ON POWER LOSS

Most SoftPLC controllers, including the Smart and NeoPAC's, use internal flash memory to store the APP's and configuration files and do not have battery-backed RAM memory. When SoftPLC starts up, the configured APP is loaded from flash into RAM. Any changes to the APP (*ladder, datatable, documentation, etc.*) that occur during runtime, if not saved to flash, will be lost if SoftPLC is shut down or loses power.

Through the use of an Uninterruptible Power Supply (UPS), you can configure SoftPLC so that online logic and datatable changes not yet saved to flash will be retained in the event of an unexpected loss of power.

SoftPLC needs to monitor the UPS to know if it has gone into ON-BATTERY mode. The method to do this will vary based on the UPS model, for example, a contact that can be tied to an input point or a communication cable. With this ON-BATTERY signal, you can cause SoftPLC to go into fault mode by using the signal to turn on bit S11/10 after a TIMEOUT period long enough for the APP to be saved to flash.

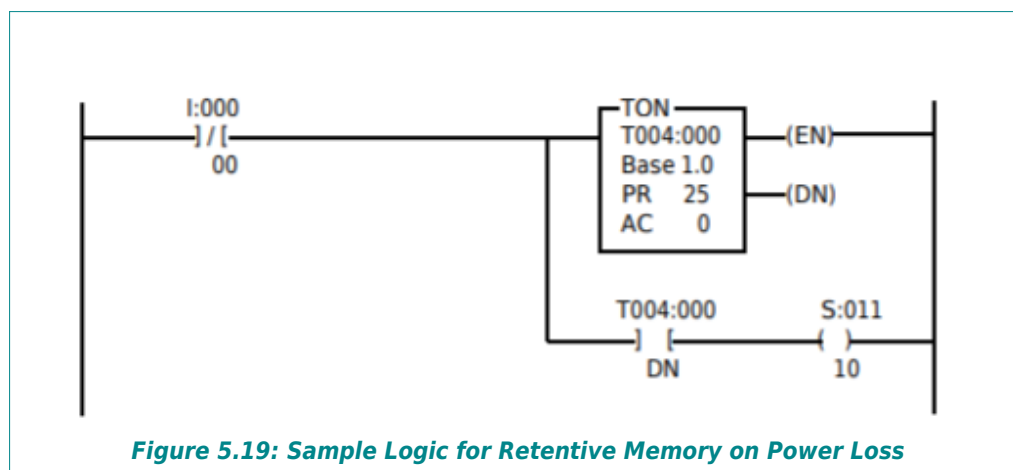


Figure 5.19: Sample Logic for Retentive Memory on Power Loss

In the above example, a digital input (I:0/0) is connected to the power line. In the presence of supply voltage, I:0/0 is ON and the rung is false. When the supply voltage is cut off, I:0/0 goes OFF, which causes the timer (T4:0) to start incrementing. In this example, we are allowing a 25 second delay before generating the fault (S:11/10). When SoftPLC detects that S:11/10 is set, and the STARTUP.LST file has "Save on Power Fault" set ON (Checked), it saves the APP to the disk in the specified location. This back-up operation takes place only once although SoftPLC

may remain in faulted state for a long time as a result of power loss. The purpose of having the 25 second time delay between the time the power loss was detected and SoftPLC was faulted is to prevent false triggering due to momentary glitches in the power line or short periods of power loss which can be handled by the UPS. When power is restored, the rung will be FALSE, T4:0.DN is reset , which resets S:11/10 clearing the fault condition. SoftPLC will be set to PROGRAM mode.

CHAPTER 6 - TROUBLESHOOTING

This chapter will cover how to troubleshoot some of the common issues SoftPLC users encounter. Because SoftPLC systems can be used with so many different types of hardware, networks, etc., detailed troubleshooting is beyond the scope of this manual. If, after trying the suggestions in this section and in the documentation for the TLM's you are using, you still need assistance, contact SoftPLC technical support.

Once a SoftPLC system has been successfully installed, most troubleshooting will be done with TOPDOC NexGen or via standard PLC system hardware troubleshooting techniques. Most problems after installation occur due to component failures in the I/O, cabling, etc. Proper installations should include power protection and noise/surge suppression equipment. Some intermittent problems may be due to improper system protection, particularly when using remote I/O and ethernet communications.

When a new SoftPLC system is in the development/start-up stages, errors in configuration are the most common problems users encounter.

6.1 TROUBLESHOOTING USING TOPDOC


When SoftPLC has been properly configured and successfully loads, TOPDOC can be used to troubleshoot runtime faults and device communication errors. If you can successfully perform a [Detect on Net](#) to the SoftPLC, in most cases you can [Edit Remotely](#) and troubleshoot your system with TOPDOC. If you do not have success with either of these functions, you most likely will need to use the Console function for troubleshooting.

6.1.1 COMMONLY USED TOPDOC TROUBLESHOOTING TOOLS

TOPDOC NexGen has a number of functions to help troubleshoot SoftPLC systems. These include I/O forcing, search/trace functions, watch windows, and more. Additionally, the following functions are very useful:

- [Detect on Net](#) can be used to verify Ethernet communications, the IP address of the SoftPLC and whether or not the SoftPLC is running.
- If a SoftPLC was running, but has unexpectedly stopped, you can use the [Mode](#) button to check the SoftPLC operating mode, to be sure it is not Faulted or in Program mode.
- The PLC Configuration Editors can be used to help determine whether a configuration setting could be the cause of the problem.

6.1.2 DIAGNOSING RUNTIME FAULTS

SoftPLC automatically goes to FAULT mode as a result of a runtime fault. The execution of the ladder program is halted and outputs are shut down (*output behavior will be based on I/O drivers and their configuration*). FAULT mode is indicated with the symbol  on the bottom of the Remote Editor window as shown in the following figure.

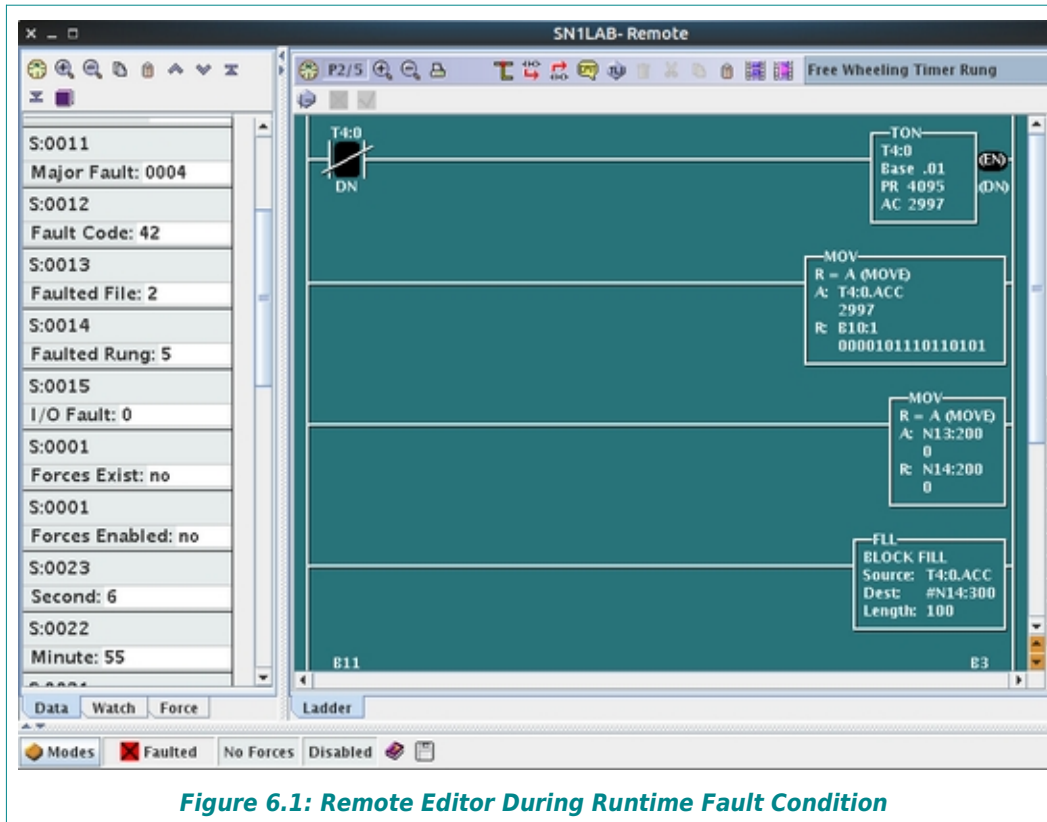


Figure 6.1: Remote Editor During Runtime Fault Condition

Status file words S:11 through S:14 are updated with the cause of the fault and where in the ladder program the fault occurred, if applicable.

- S:11 is the Major Fault word. This is a hex value corresponds to the faulted bits. In the example figure, 0004 means that only bit S:11/3 is ON. Reasons for a fault bit to be ON can be looked up in TOPDOC's help file by searching "fault bits".
- S:12 can contain an integer fault code. In the example figure, the fault code is 42. The meaning of many common runtime faults can be looked up in TOPDOC's help file by searching "fault codes". (See following figure.)
- S:13 and S:14 display the program file and rung number if an instruction caused the fault.

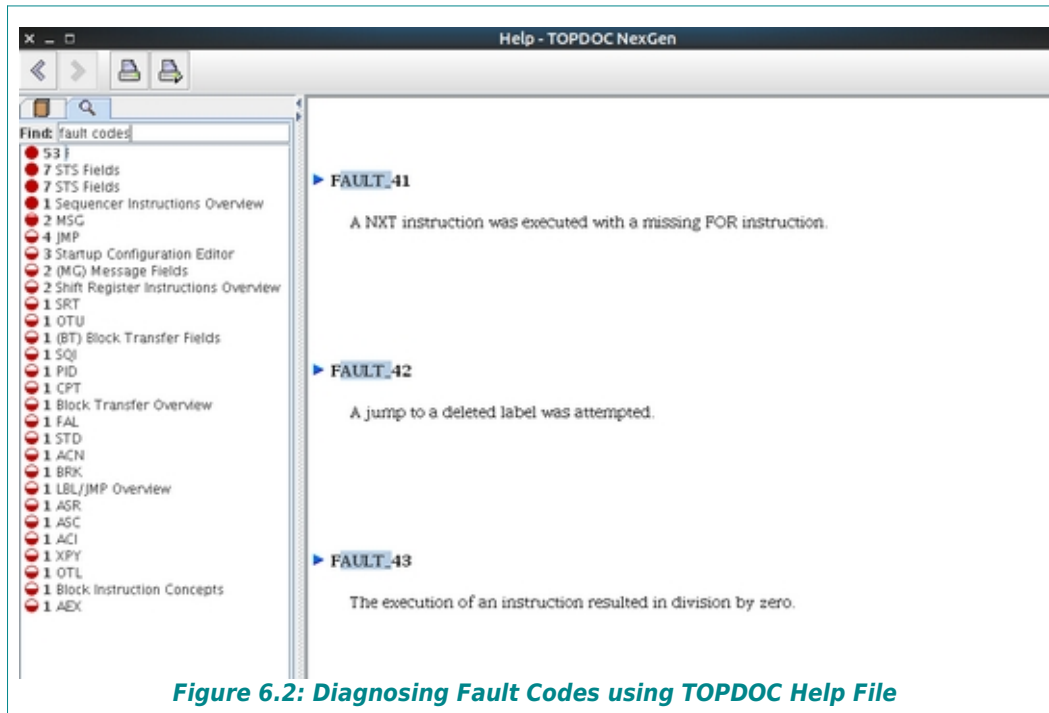


Figure 6.2: Diagnosing Fault Codes using TOPDOC Help File



HINT

If the fault bits or code are not in the help file or the information in the help file does not apply to your situation, you may need to diagnose the problem using the Console as described later in this Chapter.

6.1.3 CLEARING RUNTIME FAULTS

Once you have determined the cause of a runtime fault and taken the necessary steps to correct it, from the TOPDOC **Mode** button select **Clear Faults**. This will zero out words S:11-S:14 and put SoftPLC into PROGRAM mode. You can then go back into RUN mode using the **Mode** button.



HINT

Do not select **Clear Faults** until you have researched the fault codes and/or rung causing the fault, as it will remove that valuable information from the Status file.

6.1.4 DIAGNOSING I/O FAULTS

I/O drivers provide troubleshooting information in different ways, refer to the driver documentation for details. Status file word 15 (S:15) may or may not be utilized by one or more of the drivers you are using. Many SoftPLC provided I/O drivers provide loadable instructions (TLI's) that provide more information than a single status word, and allow the programmer to determine where the I/O status information will reside in the datatable. The figure below shows an example of some TLI's available for the ModbusTCP Master driver.

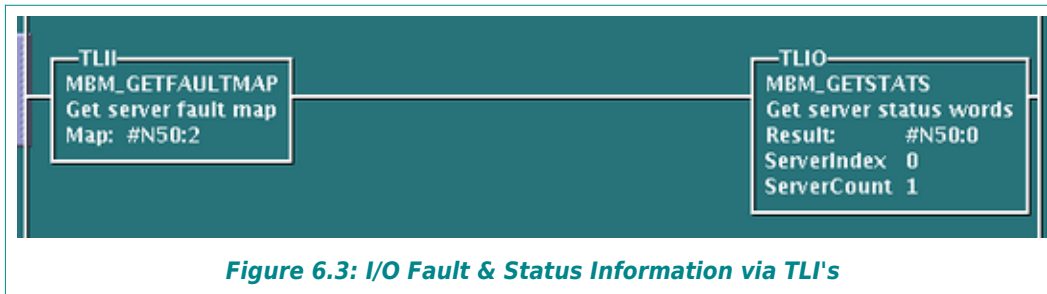


Figure 6.3: I/O Fault & Status Information via TLI's

6.2 TROUBLESHOOTING USING THE PLC CONFIGURATION EDITORS

Runtime issues are often caused by errors in the configuration of the SoftPLC or the TLM's it is configured to **Use** (eg: I/O Drivers). TOPDOC and in some cases, SoftPLC, cannot detect conflicts and other configuration file errors. For example, if you configure the same serial port for both an O·N·E DF1 channel and a Modbus serial I/O driver, this would not be reported as an error.

To verify the configuration SoftPLC is loading, a good practice is to select each Configuration editor (NETWORK, MODULE, O.N.E, STARTUP) one at a time and perform a **Fetch**. Verify that the information retrieved matches what you intended, and that there are no conflicts, typing errors, etc. Also be sure to perform a **Fetch** on the configuration files associated with any of the TLM's you have selected to **Use**.



CAUTION

The displayed data in an editor after a **Fetch** reflects what is on the SoftPLC flash disk. This may **NOT** be the same as the data being used by an operational SoftPLC controller, unless the SoftPLC has been restarted after the last **Send** operation.

If you make any configuration changes, do a **Send** (and a **Save** to backup any changes to your computer). Remember that any Configuration file changes require that SoftPLC be restarted (*except in the case of certain I/O drivers that will reload their configuration files with a PROGRAM to PROGRAM mode transition, eg: the ModbusTCP Master I/O Driver*).



NOTE

After doing a **Send** from a PLC Configuration Editor, it is always necessary to restart the SoftPLC for any changes to take effect.

6.3 TROUBLESHOOTING USING THE SOFTPLC CONSOLE

TOPDOC's editors can only be used for troubleshooting when it can connect to the SoftPLC via **Detect on Net**, to **Fetch** and **Send** configuration files and/or **Edit Remotely**. If you cannot connect, the Console can be used to determine what the fault is, and to correct configuration and other serious issues.

The Console function is SoftPLC's Gatecraft Linux command line interface. This can be compared to the CMD or Powershell function in Windows, but is much more powerful.



CAUTION

SoftPLC's Console can be extremely useful, but can also generate unrecoverable errors if you are not careful. Only authorized individuals should be given the Console login information and password.

This section describes how to connect to the Console, login to the SoftPLC, and general Console usage. The following sections describe specific troubleshooting tools available from the Console.

6.3.1 CONSOLE LOGIN

One default user is defined for SoftPLC's at the factory. That username is "root" (*without the quotes*). User "root" is special to Gatecraft Linux, root is a "superuser" and has full access everywhere in the system. The factory default password for user root is "softplc" (*without the quotes*).



CAUTION

Do not change the PLC Password for user "root" unless you understand the consequences!!!! Detailed information on securing your SoftPLC from unintended or malicious use, which includes changing the PLC Password, root user password, and other cyber-security related options are described in the application note "SoftPLC Security", available only to registered users covered under a valid support contract, and upon request to SoftPLC Corporation.

6.3.2 CONNECTING TO THE SOFTPLC CONSOLE

Connection to SoftPLC's Console can be done using an ethernet or serial connection. Ethernet is always preferred, however the serial option is available when the Ethernet is not working, or you forgot the Ethernet address.

REMOTE CONSOLE MENU OPTION

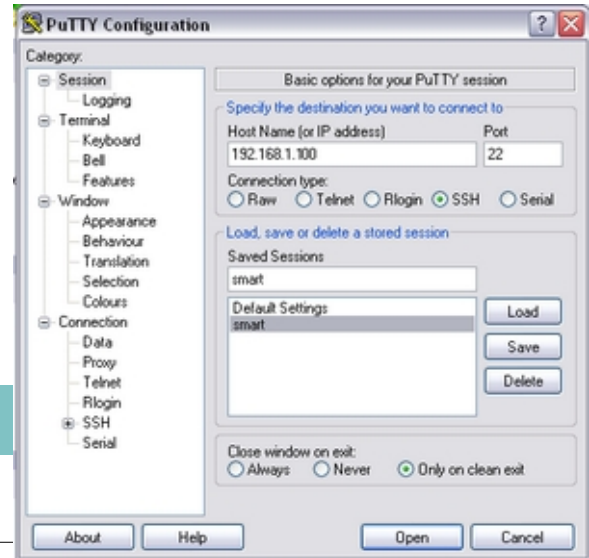
When you select **Remote Console** from the PLC menu in TOPDOC while connected to a configured Ethernet port, TOPDOC will attempt to open a Console and automatically login as user "root" with the PLC password saved in DEFINE.LST. If that password does not match the password for "root" in the SoftPLC, you will not be able to load the Console.

ALTERNATE ETHERNET CONSOLE CONNECTION METHOD

If TOPDOC is not available, you can still connect to the Console in SoftPLC using a third party SSH/telnet client program, such as PuTTY (<https://www.putty.org/>):

1. Connect your PC to the SoftPLC's configured Ethernet port, making sure your PC and the SoftPLC are on the same subnet.
2. Load PuTTY.

3. Select **SSH** as the Connection Type
4. Enter the **IP address** of the SoftPLC as the Host Name (*factory default=192.168.1.100*). Use the default **Port** 22.
5. Press Open.
6. When the Console window appears, login:
 Username = **root**
 Password = **softplc**
7. Now you can use Console commands to view log files, edit files, search, etc.



NOTE

NOTE: Login/Password and all console commands are case sensitive!

SERIAL CONNECTION

Serial connection is via the microUSB port on the Smart or NeoPAC SoftPLC. SoftPLC sells a compatible USB to MicroUSB cable for Serial Console access (*Cat No SPO-UCONCBL*).

NOTE

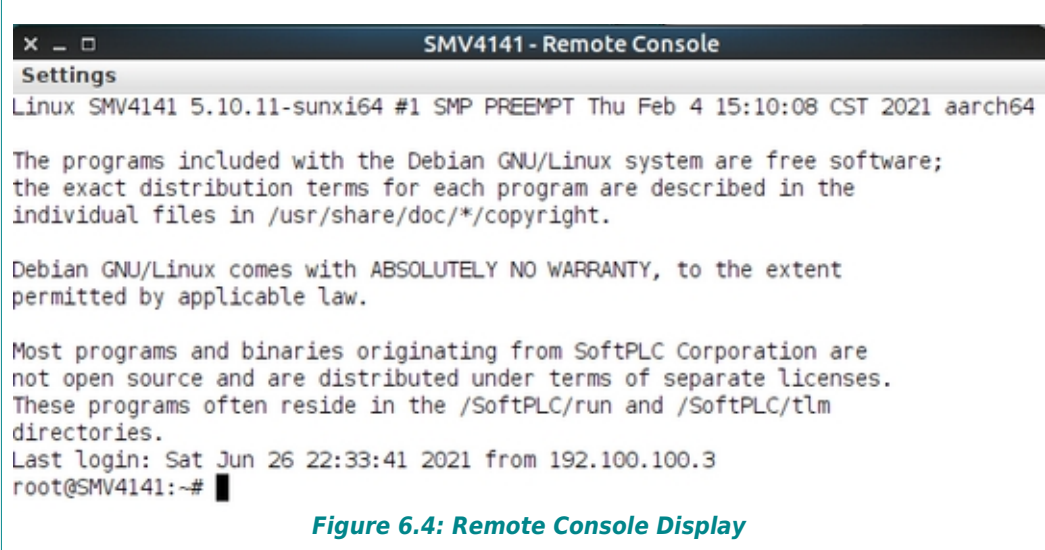
SoftPLC Corporation Cat No SPO-UCONCBL is a 10 foot Micro-USB to USB 2.0 cable, that supports data exchange and is compatible with the SoftPLC environment. Other cables may be designed primarily for charging devices and/or may not be compatible. Use of the SPO-UCONCBL is required if you request technical support for help with serial console issues.

1. Connect from the USB 2.0 port on your PC to the SoftPLC's microUSB Console port using the SPO-UCONCBL cable.
2. Start PuTTY. using a "Direct to COMx" connection, with the communication parameters set to:
 115200 baud
 8 bits
 No Parity
 Stop bit
3. When the console window appears, login:
 Username = **root**
 Password = **softplc**
4. Now you can use Console commands to view log files, edit files, search, etc.

6.3.3 GENERAL CONSOLE USAGE

In most cases, when you access the SoftPLC Console, you will be connecting from your computer to the SoftPLC via SSH. Your computer will essentially be acting as a monitor and keyboard for your SoftPLC system. The following figure shows an example Console display.

Some of the most commonly used SoftPLC Console commands are described in Chapter 7 “Useful Console Utilities And Commands”.



```

SMV4141 - Remote Console
Settings
Linux SMV4141 5.10.11-sunxi64 #1 SMP PREEMPT Thu Feb 4 15:10:08 CST 2021 aarch64

The programs included with the Debian GNU/Linux system are free software;
the exact distribution terms for each program are described in the
individual files in /usr/share/doc/*/copyright.

Debian GNU/Linux comes with ABSOLUTELY NO WARRANTY, to the extent
permitted by applicable law.

Most programs and binaries originating from SoftPLC Corporation are
not open source and are distributed under terms of separate licenses.
These programs often reside in the /SoftPLC/run and /SoftPLC/tlm
directories.
Last login: Sat Jun 26 22:33:41 2021 from 192.100.100.3
root@SMV4141:~#

```

Figure 6.4: Remote Console Display

CONSOLE USER INTERFACE

The Console is a text based interface. You typically enter a command at a prompt, and the system will respond with results, error messages, or at times just another prompt.



NOTE

The user interface in a Console window will vary based on how you are accessing it. The built-in TOPDOC viewer accessed via [Remote Console](#) is described in this manual.

The last line in figure 6.4 `root@SMV4141:~#` shows a prompt, ready for entry of a command.

| | |
|----------------------|--|
| <code>root</code> | is the logged in username |
| <code>@</code> | is a delimiter |
| <code>SMV4141</code> | is the hostname, in this case the name of the SoftPLC |
| <code>:</code> | is a delimiter |
| <code>~</code> | indicates the home directory of current logged in user |
| <code>#</code> | is the prompt symbol |

```

root@SMV4142:~# cd /SoftPLC
root@SMV4142:/SoftPLC#

```

Figure 6.5: Console Prompt Example

Figure 6.5 shows a command entered into the Console from the home directory, and the prompt when you are positioned in the SoftPLC directory.

A **Settings** menu option at the top is available to change the display color and font.



HINT

When using the Console, the directory separator is a forward slash (/), rather than the backslash (\) used in Windows.

All commands, command line options, and filenames are case sensitive.



CAUTION

Be extra careful with case when typing in the command line. Typing the incorrect case may produce an error, but sometimes using the wrong case can result in a command affecting the wrong file, running a different command than intended, or a command appearing to run, but not doing what you expected.

If you use a command that responds with a large amount of text (as shown in the following figure), you can use the arrow keys **[↑]**, **[↓]**, **[←]**, **[→]**, **[PageUp]** and **[PageDown]** to see text out of view. Press **[q]** or **[Q]** to exit and receive a new prompt.

The bottom line of the window will display the line numbers you are viewing for the current response.

```

SMV4142 - Remote Console
Settings
-- Journal begins at Mon 2021-04-12 13:21:25 CDT, ends at Wed 2021-06-30 10>
Jun 28 15:48:49 SMV4142 systemd[1]: Starting SoftPLC Runtime...
Jun 28 15:48:49 SMV4142 [551]: SoftPLC : version 5.0.210514
Jun 28 15:48:49 SMV4142 [551]: Copyright(C) 1993-2019 SoftPLC Corporation
Jun 28 15:48:49 SMV4142 [551]: ALL RIGHTS RESERVED.
Jun 28 15:48:49 SMV4142 [551]: SoftPLC : serial no. 2000-20000, &LOADLOC=0x>
Jun 28 15:48:49 SMV4142 [551]: SoftPLC : loaded "/SoftPLC/app/DEFAULT/SOFTPLC>
Jun 28 15:48:49 SMV4142 [561]: LEDS : Jan 4 2021 initializing...
Jun 28 15:48:49 SMV4142 [561]: RIOSLAVE: version Feb 2 2021 initializing...
Jun 28 15:48:49 SMV4142 [561]: fpga_personality:0x07 fpga_version:0x03
Jun 28 15:48:49 SMV4142 [561]: INTERFACE:0 BAUDRATE:230400 TERMINATION RES>
Jun 28 15:48:49 SMV4142 [561]: RIOSLAVE.LST uses 872 digital io connection>
Jun 28 15:48:49 SMV4142 [561]: RIOSLAVE: slave thread started.
Jun 28 15:48:49 SMV4142 systemd[1]: Started SoftPLC Runtime.
Jun 28 15:48:49 SMV4142 [561]: ONE : version 5.0.210514
Jun 28 15:48:49 SMV4142 [561]: ONETCP : version 5.0.210514
Jun 28 15:48:49 SMV4142 [561]: LEDS : SetMode(old=REM_PROG, new=REM_RUN)
Jun 28 15:48:49 SMV4142 [561]: RIOSLAVE: SetMode(old=REM_PROG, new=REM_RUN)
Jun 28 15:48:49 SMV4142 [561]: RIOSLAVE: RIOMASTER[0] mode: FAULTED
lines 1-19
  
```

Figure 6.6: Example Console Response with Multiple Pages of Text

CONSOLE TEXT EDITOR “NANO”

An editor is provided so you can modify text files (eg: many of the SoftPLC configuration files). To access the text editor, type **nano** at the prompt. To edit a specific file, at the prompt, type **nano <name of file>**.

The figure below shows a nano editor session of a MODULE.LST file. Some of the available commands in the nano editor are listed at the bottom of the window.



HINT

The **^** symbol indicates the **[Ctrl]** key should be pressed along with the following key. For example **[Ctrl] [G]** provides detailed help information.

```

x _ □ SMV4144 - Remote Console
Settings
GNU nano 5.4 MODULE.LST *
1 MODULE=/SoftPLC/tlm/LEDS.TLM
2 DRIVER=/SoftPLC/tlm/RIOSLAVE.TLM
3 DRIVER=/SoftPLC/tlm/ETHER_IP.TLM
4

[ line 3/4 (75%), col 33/33 (100%), char 94/95 (98%) ]
^G Help      ^O Write Out ^w Where Is  ^K Cut      ^T Execute   ^C Location
^X Exit      ^R Read File ^_ Replace   ^U Paste     ^J Justify   ^_ Go To Line

```

Figure 6.7: Console Text Editor - nano

6.4 CONSOLE TROUBLESHOOTING FUNCTIONS

This section describes some of the most commonly used troubleshooting techniques while connected to the SoftPLC Console. Appendix A provides a list of additional useful commands. Details on these commands, and other available commands, can be found on the internet.

6.4.1 SYSTEM LOG

SoftPLC maintains a system log of activities relating to SoftPLC startup, shutdown, communication accesses, and certain runtime errors. By reviewing this log, many SoftPLC problems can be quickly detected, particularly configuration and certain hardware errors.

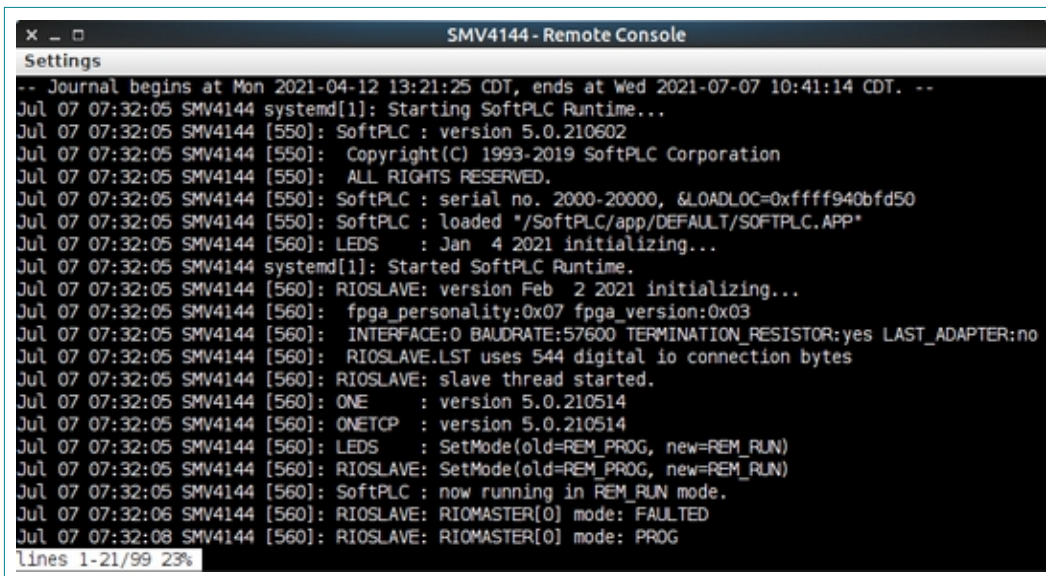
The default is for the system log to reside in RAM memory. You can redirect the system log output to a file or another drive, if you want to be able to email it or examine it in depth. Other settings are possible, such as maximum size. The system log clears and restarts upon boot-up.

To view the system log, you need to use the Console. The command to view the SoftPLC system log is:

```
journalctl -u softplc
```

You can re-direct the system log output to a text file (*eg: in the example below, "syslog.txt"*) on the SoftPLC. You can then use the [SFTP Client](#) to transfer the file to your PC, or you can edit it with [nano](#).

```
journalctl -u softplc >syslog.txt
```



```

x _ □ SMV4144 - Remote Console
Settings
-- Journal begins at Mon 2021-04-12 13:21:25 CDT, ends at Wed 2021-07-07 10:41:14 CDT. --
Jul 07 07:32:05 SMV4144 systemd[1]: Starting SoftPLC Runtime...
Jul 07 07:32:05 SMV4144 [550]: SoftPLC : version 5.0.210602
Jul 07 07:32:05 SMV4144 [550]: Copyright(C) 1993-2019 SoftPLC Corporation
Jul 07 07:32:05 SMV4144 [550]: ALL RIGHTS RESERVED.
Jul 07 07:32:05 SMV4144 [550]: SoftPLC : serial no. 2000-20000, &LOADLOC=0xffff940bfd50
Jul 07 07:32:05 SMV4144 [550]: SoftPLC : loaded "/SoftPLC/app/DEFAULT/SOFTPLC.APP"
Jul 07 07:32:05 SMV4144 [560]: LEDES : Jan 4 2021 initializing...
Jul 07 07:32:05 SMV4144 systemd[1]: Started SoftPLC Runtime.
Jul 07 07:32:05 SMV4144 [560]: RIOSLAVE: version Feb 2 2021 initializing...
Jul 07 07:32:05 SMV4144 [560]: fpga_personality:0x07 fpga_version:0x03
Jul 07 07:32:05 SMV4144 [560]: INTERFACE:0 BAUDRATE:57600 TERMINATION_RESISTOR:yes LAST_ADAPTER:no
Jul 07 07:32:05 SMV4144 [560]: RIOSLAVE.LST uses 544 digital io connection bytes
Jul 07 07:32:05 SMV4144 [560]: RIOSLAVE: slave thread started.
Jul 07 07:32:05 SMV4144 [560]: ONE : version 5.0.210514
Jul 07 07:32:05 SMV4144 [560]: ONETCP : version 5.0.210514
Jul 07 07:32:05 SMV4144 [560]: LEDES : SetMode(old=REM_PROG, new=REM_RUN)
Jul 07 07:32:05 SMV4144 [560]: RIOSLAVE: SetMode(old=REM_PROG, new=REM_RUN)
Jul 07 07:32:05 SMV4144 [560]: SoftPLC : now running in REM_RUN mode.
Jul 07 07:32:06 SMV4144 [560]: RIOSLAVE: RIOMASTER[0] mode: FAULTED
Jul 07 07:32:08 SMV4144 [560]: RIOSLAVE: RIOMASTER[0] mode: PROG
lines 1-21/99 23%

```

Figure 6.8: Example System Log (journalctl -u softplc)

Information of note in the system log includes the SoftPLC runtime version and the fpga firmware version. You can also see the loading progress of each TLM and ONE channel, the SoftPLC operation mode. If there are any faults, you can see specifically which TLM or function generated the fault condition, and a description of the cause of the fault.

NOTE

The serial number in the system log is not unique. When contacting SoftPLC technical support, your unique serial number is on the product label.

6.4.2 RE-STARTING SOFTPLC VIA THE CONSOLE

There may be times you will want to restart or shutdown a SoftPLC without cycling power. For example, any time you change the SoftPLC's configuration or other system files you need to restart SoftPLC before the change can take effect. You may not be physically close to the SoftPLC, or cycling SoftPLC power may have effects on other equipment.

In the TOPDOC [Startup](#) editor you can [Restart](#) or [Reboot](#) SoftPLC (as described in Section 5.9.1 STARTUP EDITOR TOOLS).

If TOPDOC is not available, you can also use the Console to stop and/or restart SoftPLC or other processes, using the **systemctl** command as follows:

| | |
|-------------------------------------|--------------------|
| systemctl restart networking | Restart networking |
| systemctl restart softplc | Restart SoftPLC |

CHAPTER 7 - USEFUL CONSOLE UTILITIES AND COMMANDS

At the SoftPLC Linux console, the following are only some of the utilities and shell commands that may be executed.



HINT

For more information about Linux shell commands, the Internet is a great source for free material and tutorials.



NOTE

All commands, command line options, and filenames are case sensitive.



NOTE

When entering directory names, Linux uses the "/" rather than the "\" used in Windows.

Table 7.1: Linux Console User Interface Tips

| FUNCTION | USE | EXAMPLE |
|------------------------------|---|--|
| -help | List & explanation of command options | ls -help tar - help |
| Clear terminal | Cleans up terminal, if it is getting cluttered with too many past commands | clear |
| Autofill "Tab Completion" | Appends matching information to what has been entered to save typing and help prevent typing errors | For a command with the option "Documents", type cd Docu then hit the TAB key the terminal will fill in the rest, showing you cd Documents |
| Stop & Terminate Command | Stop and terminate any command that is currently working | Ctrl+C |
| Pause Command | Pause any command that is currently working | Ctrl+Z |
| Start of line | Moves cursor to the beginning of the command line | Ctrl+A |
| End of line | Moves cursor to the end of the command line | Ctrl+E |

Table 7.2: Console Commands Useful for SoftPLC Maintenance

| COMMAND | DESCRIPTION |
|---|--|
| journalctl -u softplc | Dump contents of SoftPLC syslog to console. View syslog using less: journalctl -u softplc less Press q to exit. |
| ifconfig | List network interfaces |
| date MMDDCCYhhmm.ss | Set system date and time (24 hour clock) ex: 062513462021.00 for 13:46 on June 25, 2021 |
| nano "file" | Edit text file name "file" Save: CTRL-o Exit: CTRL-x |
| tar [mode] [format] [file options] "file" | Lists, creates or extracts an archive file extract bzip2: tar -xjvf filename.tar.bz2 extract gzip: tar -xzvf filename.tar.gz |
| apt [options] [subcommand] ["package"] | SoftPLC Package Manager. (Requires Gateway & DNS IP's defined.) Update package list: apt update Upgrade packages: apt upgrade Install package: apt install "packagename" |
| systemctl restart networking | Restart networking |
| systemctl restart softplc | Restart SoftPLC |

Table 7.3: Console Commands for Navigation/File Functions

| COMMAND | DESCRIPTION |
|---------------------|---|
| cd "path" | Change to directory (ie. cd /SoftPLC/run) |
| ls [options] | List files in current directory. Long format: ls -l Complete list of "ls" options: ls -help |
| rm "file" | Remove file with name "file" |
| Rmdir "directory" | Remove empty "directory" |
| mv "file1" "file2" | Rename "file1" to "file2" |
| mkdir "path" | Make new directory with name "path" |
| which "file" | Locate executable files. Example: which ifconfig |
| find -name "file" | Search for a file in current directory and subdirectories. Example: find -name "NETWORK.LST" |
| which "command" | Locates "command" in path |
| cp "file1" "file2 " | Copy "file1" to "file2" |
| less "file" | Shows contents of "file". Use Up/Down to transverse file and 'q' to exit. |
| cat file | Print contents of file to screen |
| df | report file system disk space usage |
| free | Display amount of free and used memory in the system |

CHAPTER 8 - SOFTWARE MAINTENANCE & BACKUPS

This chapter briefly describes how to transfer files to/from the flash memory in SoftPLC to another system, how to ensure your SoftPLC files are backed up in the event of problems, restoring from backup files, and how to update the firmware in your SoftPLC.

8.1 TRANSFERRING FILES USING SFTP

Since most SoftPLC's have no keyboard/monitor, the easiest way to transfer files to/from the SoftPLC flash is using SoftPLC's embedded SFTP (Secure File Transfer Protocol) server.



NOTE

TOPDOC provides a text based [SFTP Client](#) (described in this manual), or alternatively you could use a third party SFTP client like [WinSCP](#) or [FileZilla](#) that has a more robust interface.

8.1.1 TOPDOC'S SFTP CLIENT

To load TOPDOC's SFTP Client, connect to the SoftPLC via Ethernet and select [SFTP Client](#) from TOPDOC's PLC menu.

When you select [SFTP Client](#) from the PLC menu in TOPDOC while connected to a configured Ethernet port, the SFTP Client will attempt to load and automatically login as user "root" with the PLC password saved in DEFINE.LST. If that password does not match the password for "root" in the SoftPLC, you will not be able to load the SFTP Client.



CAUTION

Do not change the PLC Password for user "root" unless you understand the consequences!!!! Detailed information on securing your SoftPLC from unintended or malicious use, which includes changing the PLC Password, root user password, and other cyber-security related options are described in the application note "SoftPLC Security", available only to registered users covered under a valid support contract, and upon request to SoftPLC Corporation.



Figure 8.1: TOPDOC SFTP Client Window

There is a **Settings** menu option at the top of the window that allows you to change the display color and font.

The prompt is the > symbol.

8.1.2 LOCAL VS REMOTE MACHINES

Before you use SFTP to transfer files, it is important to understand the difference between a “local” and a “remote” machine.

- **Local** - The local machine is the one you started from, the machine you were on when you typed the "sftp" command. In most cases it would be your TOPDOC PC. *(However, this might also be a machine you are logged into remotely through SSH.)*
- **Remote** - The remote machine is the one you just logged into, in this case, the SoftPLC.

8.1.3 SFTP COMMANDS

The following table lists the most commonly used SFTP commands for file transfers.

Table 8.1: Commonly Used SFTP Commands

| COMMAND | DESCRIPTION |
|-------------------------------|--|
| GENERAL COMMANDS | |
| ? or help | List of all commands or explain a particular command For example: ? get |
| exit or quit | Close the connection and leave SFTP |
| put | Copy a file from the local computer to the remote host |
| get | Copy a file from the remote host to the local computer |
| LOCAL SYSTEM COMMANDS | |
| lcd | Change the active directory on the local system |
| lls | List the contents of the current directory on the local computer |
| mkdir | Create a directory on the local computer |
| lls | get a directory listing on the local machine |
| lpwd | Show the present working directory on the local computer |
| REMOTE SYSTEM COMMANDS | |
| cd | Change the active directory on the remote host |
| dir or ls | List the contents of the current directory on the remote host |
| mkdir | Create a directory on the remote host |
| pwd | Show the present working directory on the remote host |
| rename | Rename a file on the remote host |
| rm | Delete a file on the remote host |

**HINT**

You can press **?** or enter **help** at the prompt for a summary list of available commands and syntax. You can also use the [Remote Console](#) to see a full list of commands by entering **man sftp** at a prompt.

PUT AND GET COMMANDS – FILE TRANSFERS**CAUTION**

Use the directory and navigation commands to be sure you are in the desired directories for both the local and remote machines before initiating file transfers.

- **Get** - The **get** command is used to copy files from the remote to the local machine (*from SoftPLC to your TOPDOC PC*).
- **Put** - The **put** command is used to copy files from your local to the remote machine (*from your TOPDOC PC to SoftPLC*).

The formats of these commands are simple, and you may use wildcards. The second parameter is optional, it allows you to specify a different name or destination directory for the transferred file.

```
get remote_path [local-path]
put local_path [remote-path]
```

Table 8.2: SFTP PUT and GET Command Examples

| COMMAND | DESCRIPTION |
|---------------------------------------|--|
| <code>get MBIPMAST.XML</code> | Copies the file MBIPMAST.XML from the SoftPLC to the TOPDOC PC |
| <code>put mycode.tlm.so</code> | Copies the file mycode.tlm.so from the TOPDOC PC to the SoftPLC |
| <code>get log.txt capture1.txt</code> | Copies the file log.txt from the SoftPLC, and save it as capture1.txt on the TOPDOC PC |
| <code>put *.LST</code> | Copies all files ending in .LST in the current directory on the TOPDOC PC to the SoftPLC |

8.2 BACKING UP/RESTORING A SOFTPLC APPLICATION

Each SoftPLC application consists of a number of user specific files that make up a particular machine control or gateway application. This section describes one way to create/restore a SoftPLC unit.

8.2.1 CREATING A BACKUP

Using TOPDOC's PLC Editor you can create a full backup of your application and configuration files by following these steps:

- **Clone** the PLC - This will create local copies of all the configuration files in the specified PLC folder on your PC (eg: NETWORKS.LST, MODULE.LST, ONE.*, STARTUP.LST and any TLM configuration files).
- **Upload** the APP - This will transfer the contents of the SoftPLC RAM to a specified APP folder on your PC.



HINT

In the PLC Editor, use the Define option's Purpose and Your Notes on this PLC fields to document your backup files to relate them to the original PLC, date of backup, or other information. You could also note the name of the APP that you uploaded for your backup procedure. Additionally, in the APP Editor, you can use the APP Comment field to note similar information.

8.2.2 RESTORING FROM BACKUP

To move a SoftPLC application from one SoftPLC to another, or to copy a set of backup files to a new SoftPLC, follow these steps using TOPDOC NexGen's PLC Editor:

- **Clone** the backup PLC - This will create local copies of all the configuration files in the specified PLC folder on your PC (eg: NETWORKS.LST, MODULE.LST, ONE.*, STARTUP.LST and any TLM configuration files).
- Connect your Ethernet cable to the new PLC, changing the IP Address if applicable.
- **Load** and **Send** the configuration files from each editor (**Network**, **Module**, **O.N.E.**, **Startup**) to the SoftPLC
- **Load** and **Send** the configuration files for any **Used** Modules TLM).
- **Download** the APP - This will transfer the contents of the backed up APP to the flash in the new SoftPLC.



NOTE

If the name of the APP is not the same as the STARTUP.LST **App**, you can either **Clone** it from the Download menu or change the STARTUP.LST **App** to the new name after the Download.

If you are simply restoring files into a SoftPLC with the same name as the backup files, you can use the last 3 steps above.

8.3 UPDATING SOFTPLC FIRMWARE

SoftPLC Corporation provides a package management system that allows you to update your SoftPLC firmware (Gatecraft Linux and SoftPLC runtime files) automatically over the internet (similar to a Windows update process).



NOTE

To update your SoftPLC, your SoftPLC must be in warranty or your TOPDOC license must be covered under a software support extension contract. If not, you must purchase the firmware update. Contact support@softplc.com for support or update purchases.



NOTE

The SoftPLC Package Manager can only update firmware within the same Version (the number before the decimal point in the revision number). If you have an older version, contact support@softplc.com for upgrade options/procedures.

8.3.1 CONNECTING YOUR SOFTPLC TO THE INTERNET

(Requires Gateway & DNS IP's defined.)

8.3.2 RUNNING THE SOFTPLC PACKAGE MANAGER

Once the SoftPLC is connected to the Internet, connect locally to the Console.

The command to run the package manager is:

```
apt [options] [subcommand] ["package"]
```

The most common options/subcommands are:

- **apt update** - Update Package List. This will update the list of available packages and their versions, but does not install or upgrade any packages.
- **apt upgrade** - Upgrade Packages. This will install newer versions of the packages you have as well as any packages that are dependencies of them. It will not remove packages.
- **apt install "packagename"** - Install a Specific Package. This allows you to add a function/feature that has been released as a package, or update just a specific package.

After an upgrade, you will need to reboot the SoftPLC.

CHAPTER 9 - SOFTPLC DATE/TIME

The Smart and NeoPAC SoftPLC's do not have a battery backed hardware Real Time Clock. If it is important to your application for the SoftPLC date and/or time to be accurate, this Chapter describes available options.

9.1 SET DATE/TIME AUTOMATICALLY VIA NTP

By default, the SoftPLC date/time are obtained from the internet via an NTP (Network Time Protocol) Server. If your SoftPLC does not have access to the internet, you can configure it to use a local NTP server on your company network. The procedure is below:

1. You will need to modify a configuration file on your SoftPLC using nano. Connect to the Console and enter:
`nano /etc/systemd/timesyncd.conf`
2. In this file, below the line containing **[Time]**, remove the leading **#** from the line reading **#NTP=**. Add your NTP server IP or domain name after the **=** as shown in the example figure below. You can also remove the **#** and enter a different Fallback NTP in the next line, if applicable.

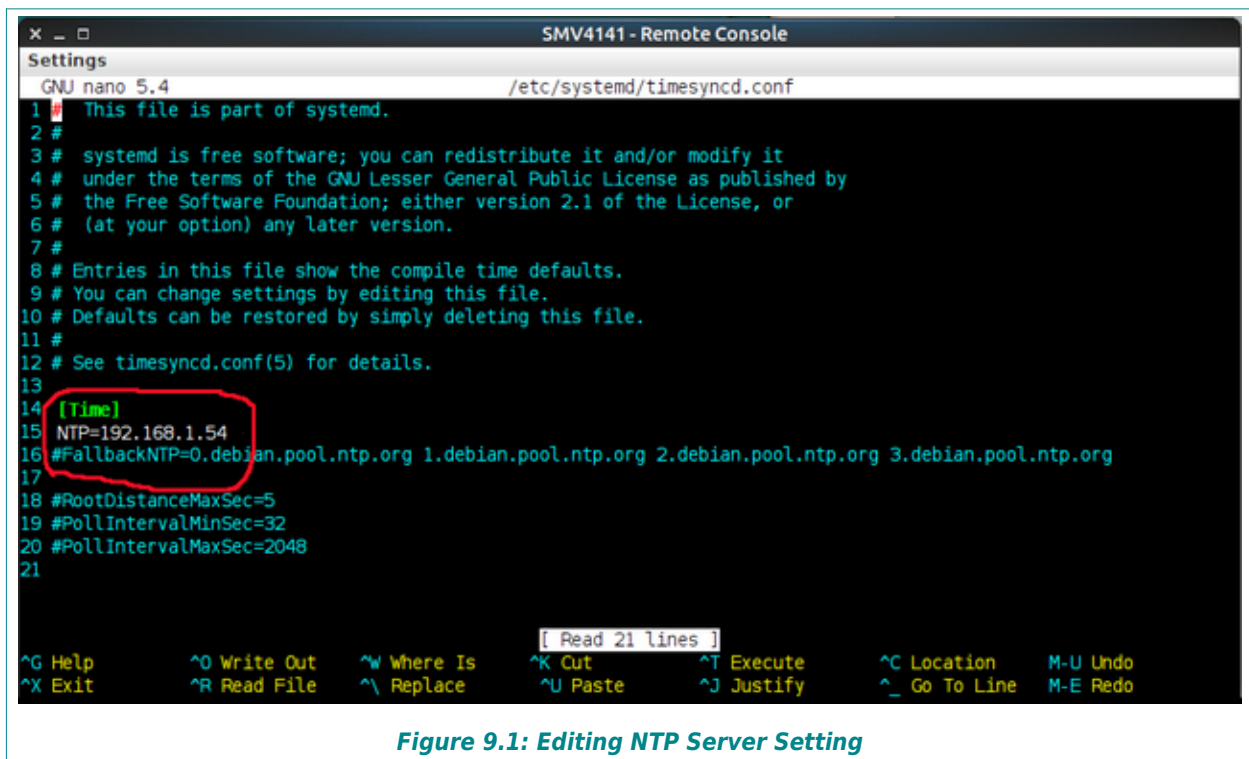


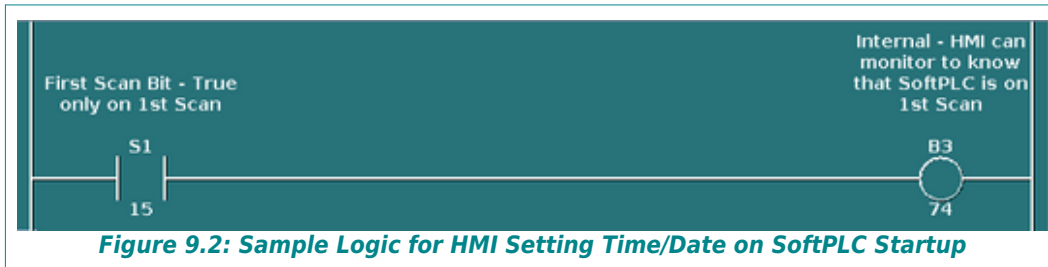
Figure 9.1: Editing NTP Server Setting

3. To save your edits, press **[CTRL] [o]** then **[Enter]**. To exit nano **[CTRL] [x]**.
4. Then restart the "systemd-timesyncd" service.

```
systemctl restart systemd-timesyncd
```

9.2 SET TIME/DATE AUTOMATICALLY VIA STATUS FILE

If a SCADA, operator interface or other intelligent system (“HMI”) is connected to the SoftPLC, you can have it set the date and time by writing values into SoftPLC’s status file words. For example, whenever SoftPLC starts up, you can trigger a write from the HMI by turning on a bit as shown in the sample logic below.



The HMI would, upon seeing the trigger bit TRUE (in this case B3/74), write the current date and time values as integers to the SoftPLC Status File words.

Table 9.1: SoftPLC Date/Time Status File Words

| DATE WORDS | | TIME WORDS | |
|--------------------------------|------|-----------------|------|
| Month (1 - 12) | S:19 | Hour (0 - 23) | S:21 |
| Day (1 - 31) | S:20 | Minute (0 - 59) | S:22 |
| Year (2002 - 2037) | S:18 | Second (0 - 59) | S:23 |
| Day of Week (1 - 7, Monday= 1) | S:3 | | |

9.3 SET TIME/DATE MANUALLY

You can also set the date and time via the Console using the “date” utility. The "date" utility in SoftPLC uses the following command format, where **MM** is month, **DD** is day, **hh** is hour, **mm** is minutes, **CC** is century, **YY** is year and **ss** is seconds.

date [MMDDhhmmCCYY.ss]

So, for example, to set the date & time as June 29, 2021 3:50 pm, enter the following:

date 062915502021.00

CHAPTER 10 - ENABLING USB PORT FUNCTIONS

If your SoftPLC was not factory configured with the USB ports enabled, this chapter describes the steps required to configure for two common uses of SoftPLC's USB ports - logging to a flash drive and serial communication.

10.1 AUTO MOUNTING A USB FLASH DRIVE

SoftPLC Corp has prepared a package with the necessary scripts to add support so that if you connect a USB flash drive to one of the USB 2.0 ports, the drive will mount and become available to the SoftPLC for uses such as backing up/restoring application files and configurations, logging data, reports, loading recipes, etc.

10.1.1 CHECK IF SUPPORT IS ALREADY ENABLED

You can check whether the SoftPLC already supports auto-mounting the USB drive by:

1. Attaching a USB drive to one of the USB 2.0 ports
2. In TOPDOC, select your [PLC](#), then select [Remote Console](#)
3. Type `df -h [Enter]`
4. Look for an entry in the response similar to the line below that will show the device was mounted to "media/sdxx". If you don't see the entry, you will need to perform the steps in the next section.

```
dev/sdxx    xG    xG    xG    x% media/sdxx
```

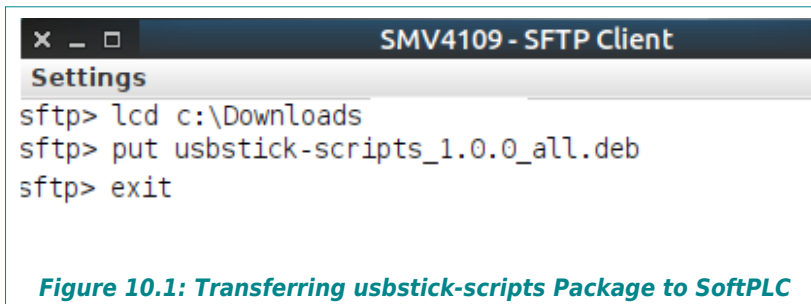
10.1.2 ADDING SUPPORT FOR USB DRIVE AUTO-MOUNTING

1. Obtain the deb package named "usbstick-scripts" from support@softplc.com.
2. Transfer the usbstick-scripts deb package to your SoftPLC:
 - a) In TOPDOC NexGen's PLC Editor, select your [Local PLC](#), then select [SFTP Client](#).
 - b) Enter the following commands into the SFTP Client window.



NOTE

The first command changes the local path to the location of usb2com deb file on your PC. Enter the appropriate location for your system.



```
SMV4109 - SFTP Client
Settings
sftp> lcd c:\Downloads
sftp> put usbstick-scripts_1.0.0_all.deb
sftp> exit
```

Figure 10.1: Transferring usbstick-scripts Package to SoftPLC

3. Install the `usbstick-scripts` deb package:

- a) Select [Remote Console](#)
- b) Ensure the package exists in the current directory by using the `ls` command.
- c) Install the package by typing:

```
apt install ./usbstick-scripts_1.0.0_all.deb
```

- d) At the prompt, restart the “udev” service from the command line:

```
systemctl restart udev
```

4. Plug in a USB flash drive to the port. Check that it was automatically mounted using the `df -h` command. In the example below, the device was detected as “/dev/sda1” was automatically mounted to “/media/sda1”.

```
df -h
```

| Filesystem | Size | Used | Avail | Use% | Mounted on |
|------------|------|------|-------|------|-------------|
| /dev/root | 7.2G | 1.2G | 5.6G | 17% | / |
| devtmpfs | 479M | 0 | 479M | 0% | /dev |
| tmpfs | 495M | 0 | 495M | 0% | /dev/shm |
| tmpfs | 198M | 5.7M | 193M | 3% | /run |
| tmpfs | 5.0M | 0 | 5.0M | 0% | /run/lock |
| tmpfs | 495M | 0 | 495M | 0% | /tmp |
| /dev/sda1 | 7.4G | 2.7G | 4.8G | 36% | /media/sda1 |

10.2 ADDING SUPPORT FOR SERIAL COMMUNICATIONS

SoftPLC Corp has a cable set and firmware package with the necessary scripts to add support for serial communications via the USB 2.0 ports to connect an RS-232 device and communicate to it using drivers such as DF1, Modbus, and COMGENIUS.



NOTE

This section applies only if you are using the SoftPLC USB to Serial Support Kit (Cat No SPO-USBSEKIT). Support for other cables or scripts are not provided by SoftPLC technical support.

10.2.1 CHECK IF SUPPORT IS ALREADY ENABLED

You can check whether the SoftPLC already maps the USB port to a serial port via the SPO-USBSEKIT cable as follows:

1. Attach the USB to serial cable SPO-USBSEKIT to one of the SoftPLC’s USB 2.0 ports.
2. In TOPDOC, select your [PLC](#), then select [Remote Console](#)
3. Type `ll dev/ttyS9 [Enter]` (for U0)

```
ll dev/ttyS10 [Enter] (for U3)
```

4. Look for an entry in the response similar to the line below that will show the device was linked to a COM port (/dev/ttyS9 for COM10) or (/dev/ttyS10 for COM11).

```
llwxrwxrwx 1 root root 7 June 23 11:30 /dev/ttyS9 → ttyUSB0
```

5. If you don't see the entry, you will need to perform the steps in the next section.

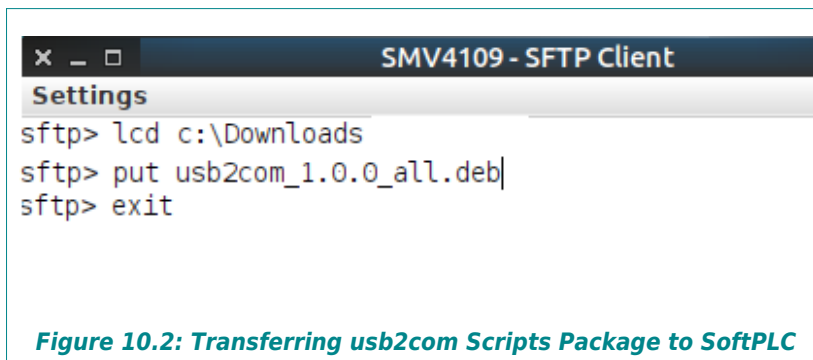
10.2.2 ADDING SERIAL COMMUNICATIONS SUPPORT VIA USB PORTS

1. Obtain the deb package named "usb2com" from support@softplc.com.
2. Transfer the usb2com deb package to your SoftPLC:
 - a) In TOPDOC NexGen's PLC Editor, select your **Local PLC**, then select **SFTP Client**.
 - b) Enter the following commands into the SFTP Client window.



NOTE

The first command changes the local path to the location of usb2com deb file on your PC. Enter the correct location for your system.



3. Install the usbstick-scripts deb package:
 - a) Select **Remote Console**
 - b) Ensure the package exists in the current directory with the "ls" command.
 - c) Install the package by typing:


```
apt install ./usb2com_1.0.0_all.deb
```
 - d) Restart the "udev" service from the command line:


```
# systemctl restart udev
```
4. Plug in the SPO-USBSER cable into one of the USB ports and then check that it was automatically linked to /dev/ttyS9 (COM10) or /dev/ttyS10 (COM11):


```
ll /dev/ttyS9
lrwxrwxrwx 1 root root 7 Jun 23 11:30 /dev/ttyS9 -> ttyUSB0
ll /dev/ttyS10
ls: cannot access '/dev/ttyS10': No such file or directory
```

CHAPTER 11 - SOFTPLC USER MEMORY LAYOUT

Your application program consists of four main parts - the ladder logic program, the datatable where the real I/O values and other parameter data is stored, the property files, and the application documentation.

TOPDOC and SoftPLC maintain all this information in a single file called “softplc.app”, which is uploaded from or downloaded to SoftPLC with TOPDOC. The folder where each softplc.app is located determines its name in the APP list. In addition, online RUN mode changes are limited to the information in these parts of memory.

All other SoftPLC files need to be maintained through TOPDOC’s PLC Configuration Editors or via SSH and the Gatecraft Linux Console.

NOTE

After doing a [Send](#) from a PLC Configuration Editor or performing a [Download](#), it is always necessary to restart the SoftPLC for any changes to take effect.

11.1 PROGRAM MEMORY ORGANIZATION

The application program ladder logic can be divided into a main program and many subroutines. Each of these is referred to as a program file. Program files are numbered starting at P2 (program files 0 and 1 are reserved by SoftPLC and are not accessible to users.) SoftPLC’s can have subroutines numbered P3 through P9999.

Table 11.1: SoftPLC Program Area Memory

| PURPOSE | PROGRAMS | RUNGS | CONTENTS |
|---------------------|----------|-------------------|----------|
| Reserved by SoftPLC | P0 | N/A | |
| | P1 | | |
| Main Program | P2 | P2/0 | Rungs |
| | | P2/1 | |
| | | ... | |
| | | P2/x | |
| Subroutines | P3 | P3/0 - P3/x | Rungs |
| | P4 | P4/0 - P4/x | |
| | ... | ... | |
| | P9999 | P9999/0 - P9999/x | |

Each program file can include up to 10,000 rungs, numbered 0 to 9999. The naming convention is *<program file number>/<rung number>*. For example, P4/65 is the 66th rung of Program File 4.

11.2 UNDERSTANDING THE DATATABLE

SoftPLC stores data values (*real I/O status, stored constants, and instruction parameters*) in an area of memory referred to as the **datatable**. The datatable can be divided into different areas to accommodate different types and formats of data values.

The datatable can be thought of as a big array made up of **bits**, which are the smallest division of the data. A bit can have a value of zero (0) or one (1). You can access any bit in the datatable with a formatted address.

The datatable is organized as an array in groups of 16 bits, with each row of 16 bits making up a datatable **word**. Every datatable word can be accessed with a formatted address. The values can be viewed in TOPDOC in a number of different formats based on how you need to use it (*signed integer, hexadecimal, binary, etc.*)

More complex **structures** are simply combinations of these bits and words, organized to make their meaning easier for you, or for use in ladder instructions requiring more than a single word of data.

Table 11.2: SoftPLC Datatable Components

| COMPONENT TYPE | 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
|---|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|---|
| Bit | | | | | | | | | | | | | | | | |
| Word (16 bits) | | | | | | | | | | | | | | | | |
| Structure (Multiple Words) Individual words/bits are Members | | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | |

The SoftPLC datatable includes many **datatable files** of a number of different available **data types**. A datatable file is a group of logically related data of the same type. SoftPLC’s can have datatable files numbered 0 through 9999.

Each datatable file is made up of a group of elements. SoftPLC’s can have up to 9999 elements per datatable file.

For some data types, the individual elements are single words. Some data types consist of elements that are multiple words. Finally, some data types are composed of a group of elements, referred to as a structure. A structure is subdivided into **members** at the bit or word level. From the ladder logic you can access structures and their individual members with a formatted address, based on the instruction parameters.

In addition to SoftPLC’s actual datatable file organization, you should organize the data within the various datatable files into data blocks (arrays) that help you group and organize related program data. You can address these data blocks in ladder instructions with a leading # sign, the starting address of the data block, and a length. These are called **instruction files** and are used in File, Shift Register, and Sequencer type instructions.

DATA ORGANIZATION TIPS

- Group data by similar use, such as batch recipes or data to be transmitted to another SoftPLC, other PLC or HMI/PC application.
- Leave gaps to allow for online programming changes because the datatable configuration (*number of files and file sizes*) cannot be changed in RUN mode.
- (*A-B Remote I/O only*) Group block transfer data for smart modules.

11.3 DATATABLE FILE TYPES/SIZES

The table below lists the SoftPLC data types available, as well as other information about each type. There are 3 reserved datatable file numbers 0, 1, 2. For file 0 (*Output Image Table*) and 1 (*Input Image Table*), the SoftPLC license determines the maximum size of these files. File 2 (*Status File*) is fixed length and not changeable. All other file types, file number assignments and sizes are user configurable.

Table 11.3: Datatable File Types

| FILE TYPE | LEADING CHARACTER | FILE NUMBER(S) (X) = DEFAULT FILE | MAXIMUM ELEMENTS/FILE | WORDS/ELEMENT |
|----------------|-------------------|--------------------------------------|---|--------------------------------|
| Output Image | O | 0 | 8 (-LT) 64 (-1K) 128 (-2K) 512 (-8K) | 1 |
| Input Image | I | 1 | 8 (-LT) 64 (-1K) 128 (-2K) 512 (-8K) | 1 |
| Status | S | 2 | 32 fixed | 1 |
| Bit (binary) | B | 3-9999 (3) | 10000 | 1 |
| Timer | T | 3-9999 (4) | 10000 | 3 |
| Counter | C | 3-9999 (5) | 10000 | 3 |
| Control | R | 3-9999 (6) | 10000 | 3 |
| Integer | N | 3-9999 (7) | 10000 | 1 |
| Floating Point | F | 3-9999 (8) | 10000 | 32 bits (2 words of memory) |
| BCD/Hex | D | 3-9999 | 10000 | 1 |
| Message | MG | 3-9999 | 10000 | 56 |
| PID | PD | 3-9999 | 10000 | 54 |
| String | ST | 3-9990 | 10000 | 82 |
| Block Transfer | BT | 3-9999 | 10000 | 56 |



NOTE

In addition to the datatable file types in the previous table, you can sometimes use integer program constants which are not stored in the datatable, but in the instruction. TOPDOC NexGen will prompt when constants are allowed during instruction entry.

The table below shows the valid data value range for each data type.

Table 11.4: Data Range Allowed by Data Type

| DATA TYPE | VALID DATA RANGE |
|--|--|
| Integer (includes N, O, I, D, T, C, R) | -32768 to 32767 |
| Floating Point | $\pm 1.1754944e^{-38}$ to $\pm 3.4028237e^{+38}$ |
| Constant | -32768 to 32767 |

11.4 DATATABLE ADDRESSING

Each datatable location can be referenced by its address. You can directly address any file (or group of elements within a file), any structure, any member, any word, or any bit in the datatable. In addition, a feature called indirect addressing can be used to allow value substitution at run time (described later in this chapter).

The figure below shows how addresses are built, and the following tables provide explanations of each term, when they are used, additional details and examples. Not all addresses will include all of the components in the figure below.

Figure 11.1: Logical Address Components

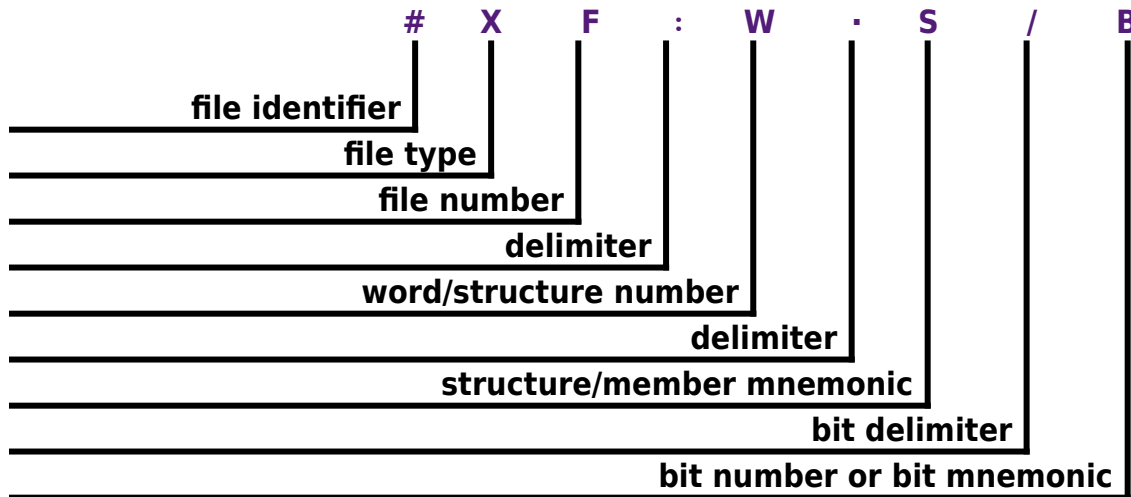


Table 11.5: Logical Address Detailed Descriptions

| COMPONENT CODE | DESCRIPTION | | |
|----------------|--|--|--|
| # | Indicates a starting address within an array within a datatable or instruction file addressed as an entity. Omit for bit, word, and structure addresses. Instructions using this type address will include a parameter for the array length. | | |
| X | File Type | B = Binary BT = Block Transfer C = Counter D = bcD (hex) F = Floating Point I = Input | MG = MessaGe N = iNteger O = Output PD = PID R = contRol T = Timer ST = STring |
| F | File Number | 0=output 1=input | 2=status 3 ~ 9999=all other types, varies by user program |
| : | Colon delimiter separates file and word/structure numbers. | | |
| W | Word/Structure Number | 0 ~ 777 octal for input/output files 0 ~ 31 decimal for status file 0 ~ 9999 decimal for all other file types | |
| . | Period delimiter is used between structure-member mnemonics (e.g.: timer, counter, control, PD, MG, and BT addresses.) | | |
| S | Structure/Member Mnemonic | Refer to specific structure definitions in the TOPDOC Help File | |
| | | E.g.: Timer/Counter | Word 0 = .CTL Word 1 = .PRE Word 2 = .ACC |
| / | Bit delimiter separates bit number or bit mnemonic. | | |
| B | Bit Number or Bit Mnemonic | 00 ~ 07, 10~17 octal for input/output (I/O) files 00 ~ 159999 decimal for binary files (B types) when using direct bit address 00 ~ 15 decimal for all other file types or bit mnemonics for status bits within structures (e.g.: EN for enable bit of Timer/Counter) | |

11.4.1 I/O ADDRESSING

Addresses in the Output and Input image tables (files 0 and 1) are normally used to address discrete input or output bits corresponding to real world devices and are always numbered in octal, not decimal. Therefore, I/O addresses are treated differently than all other datatable addresses. Examples are shown in the table below.

For I/O addresses, in TOPDOC you do not need specify the file number (*since it is always 0 or 1*). Simply use I or O, then the word number and/or bit address (e.g. I07/17).

NOTE

I/O word and bit addresses are number in octal, not decimal.

Table 11.6: I/O Addressing Examples

| LEVEL | EXAMPLE |
|--------|--|
| I1/14 | Bit number 14 (octal) of Input word 01. <i>(The file number, colon delimiter and leading zero are implied and do not need to be entered.)</i> |
| O12/17 | Highest bit, number 17 (octal), in Output word 12 |
| I2 | Input word 2, the 3rd element in the Input File |

NOTE

SoftPLC I/O drivers for different hardware I/O systems map the physical I/O addresses to the SoftPLC datatable in different ways. Some analog or special I/O maps to the I/O files, others to other data file types (e.g.: N files.) Refer to the individual I/O driver documentation for your system for details on the relationship between a physical device and the logical I/O datatable address. Only I/O mapped to the I/O files can be candidates for the forcing function of TOPDOC.

11.4.2 BINARY FILE (BIT) ADDRESSING

B type files can be thought of as storage bits organized in 16 bit words OR as a giant continuous bit stream. Two addressing methods are used for B data. In TOPDOC, the ladder and descriptor editors use the bit format, the datatable editor uses the word format.

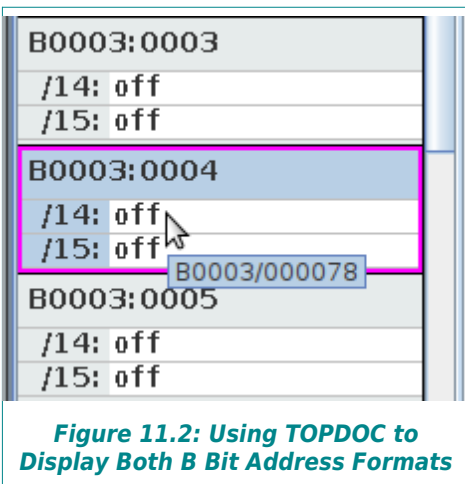


Figure 11.2: Using TOPDOC to Display Both B Bit Address Formats

Holding your mouse cursor over the bit address in the datatable editor provides a tool tip that shows the equivalent alternative address format.

The figure to the left illustrates an example where B3:4/14 is equivalent to B3/78.

The datatable editor uses the File:Word/Bit style formatting. In the ladder and descriptor editors, the B3/78 format is used. HMI/SCADA products vary as to which format they use.

11.4.3 ADDRESS AND BIT MNEMONICS

Within structure type elements, mnemonics let you address individual members of a structure at the word or bit level by an abbreviated name instead of a number. The applicable mnemonics vary based on the type of structure and the instruction with which you are using the address. The tables below list some, but not all, mnemonics and examples of addressing data at different levels within a structure.



HINT

The ladder instruction information in the TOPDOC NexGen Help indicates which mnemonics apply to each address when used in different instructions.

Table 11.7: Example Mnemonics for Structures/Bits

| INSTRUCTION/DATA LEVEL | | WORD LEVEL | | BIT LEVEL | |
|------------------------|-------------|-------------|------|---------------|------|
| TON | Timer (T) | Preset | .PRE | Done | /DN |
| CTU | Counter (C) | Accumulated | .ACC | Overflow | /OV |
| FIFO | Control (R) | Length | .LEN | Enable Unload | /EU |
| PID | PID (PD) | Setpoint | .SP | PV Tracking | /PVT |

11.4.4 EXAMPLE ADDRESSING

Table 11.8: Examples - Addressing Data at Different Levels

| LEVEL | EXAMPLE | DESCRIPTION |
|--------------------------------------|-----------|--|
| File | #N12 | iNteger file, number 12 (# is used to indicate level=file). Used in instructions to indicate the start of an array and where the length is an additional parameter |
| Word (single word data types) | N23:4 | iNteger file, number 23, : (colon) file delimiter, word four (5th element) |
| Element (float data type) | F8:6 | Floating point file, number 8, word 6 (7th element) <i>[Two 16 bit words are used to store the value]</i> |
| Word Member (structure data type) | T14:5.ACC | Timer file, number 14, : (colon) file delimiter, element number 5, . (period) element delimiter, ACC word mnemonic |
| Bit (single word data types) | N17:34/9 | iNteger file, number 17, : (colon) file delimiter, word number 34, / (forward slash) bit delimiter, bit number 9 (10th bit) |
| Bit (binary files) | B3/275 | Binary file number 3, / (forward slash) bit delimiter, 276th element |
| Bit (structure data type) | C5:2/DN | Counter file number 5, : (colon) file delimiter, element number 2, / (forward slash) bit delimiter, DN bit mnemonic |

11.4.5 INDIRECT ADDRESSING

In addition to directly addressing datatable elements, you can indirectly address the file number, element number, and/or bit number part of an address. SoftPLC will use the value stored in the indirect part of the address to resolve the address at runtime.

Therefore, you can use ladder logic to change the value stored at the substitute address. This is a valuable tool for applications such as indexing sequential batch recipe files. For example, changing from one batch to another could be done with an address such as #N[C5:2.ACC], where as the counter accumulates, you would reference #N10, #N11, #N12...

Rules:

- The substitute address must be a word address of type N, T, C, R, B, I, or O. If you use a T, C, or R address, you must use a word-length member such as R6:0.POS or T4:0.ACC.
- The indirect address component is entered in square brackets [].
- You cannot use indirect addresses for I/O addresses.

Table 11.9: Example Indirect Addresses

| INDIRECT ADDRESS | VARIABLE |
|------------------|--|
| N7:[T4:0.ACC] | The accumulated value of T4:0 determines which word in file N7 is referenced by the instruction. |
| N[C5:2.ACC]:0 | Word 0 of the file being referenced is determined by the accumulated value of C5:2. |
| B3/[N7:0] | The value in N7:0 determines which bit is referenced by the instruction. |

CHAPTER 12 - O•N•E SETUP FOR THE MSG INSTRUCTION

If you are using peer-to-peer messaging (MSG instructions) to communicate between SoftPLCs, A-B PLC's or other equipment that uses this function, O•N•E channels must be defined in each SoftPLC.

Table 12.1: O•N•E Setup Definitions

| TERM | DESCRIPTION |
|-------------|---|
| Command Set | Application layer packet format carried by some wrapper protocol and media type. SoftPLC uses the DH+ command set. |
| Transaction | All transactions consist of a COMMAND packet sent out by an initiator and a REPLY packet send out in response by a responder. |
| Command | First part of a transaction. |
| Reply | Response to a Command. |
| Initiator | Node that initiates the transaction, whether it is a read, write, change mode, or other type of command. |
| Responder | Node that replies to a command as part of a transaction |

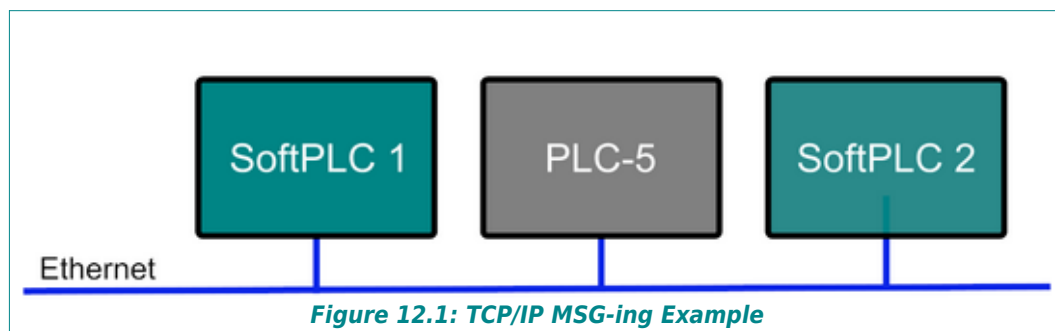
12.1 O•N•E SETTINGS FOR ETHERNET MESSAGING

Unlike other O•N•E channel types, the TCP/IP media type has some special requirements:

- Each SoftPLC node must have at most one server channel.
- Each O•N•E channel definition is either a client or a server.
- SoftPLC can only act as a responder on the server channel, it may not act as an initiator on that channel.
- SoftPLC can only act as an initiator on a client channel, it may not act as a responder on that channel.
- Each peer node that you wish to talk to must be defined in a separate O•N•E client channel.

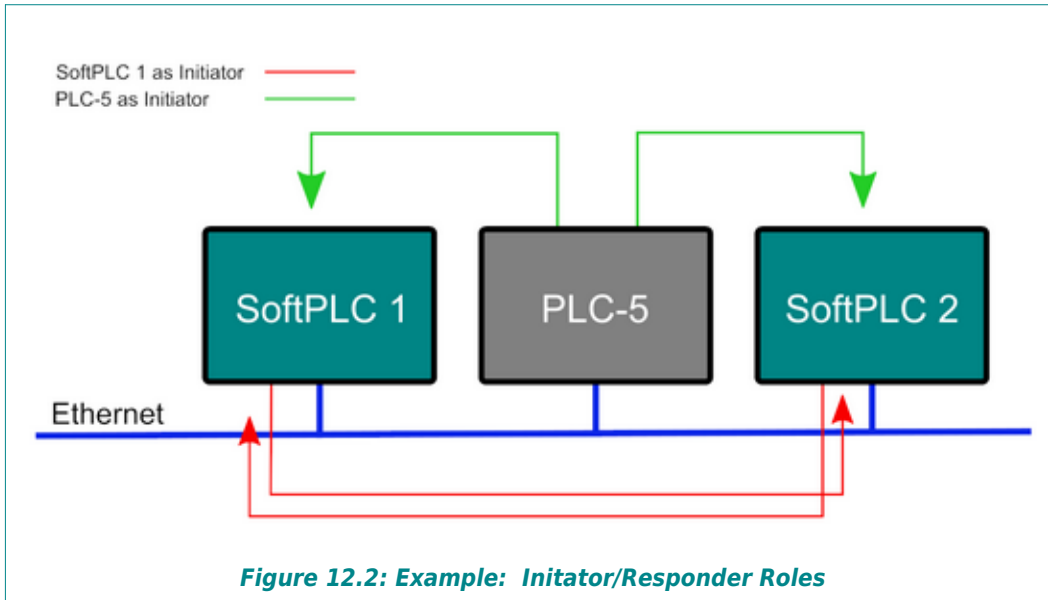
12.2 EXAMPLE USING ETHERNET MESSAGING

Example: Ethernet with 2 SoftPLC's and a PLC-5 that will use peer-to-peer messaging



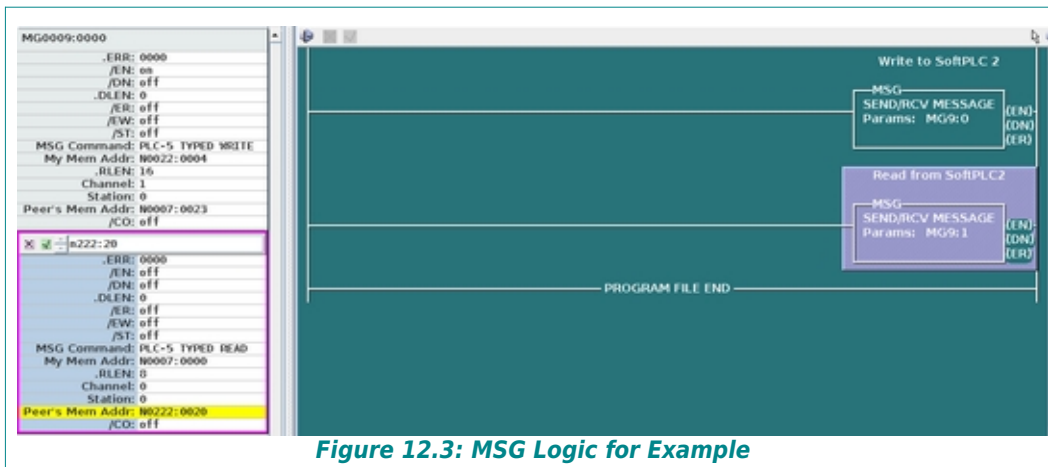
In this example application:

- SoftPLC 1 must read from and/or write to SoftPLC 2 using MSG Instructions (*SoftPLC 1 is the initiator and SoftPLC 2 is the responder*)
- SoftPLC 1 and SoftPLC 2 must be a responder to the PLC-5.
- SoftPLC 2 is never an initiator.



Here are the O•N•E channel definitions that you would need to support this setup:

| O•N•E CHANNEL | SoftPLC 1 | SoftPLC 2 |
|---------------|---|--|
| 0 | Server (responds to PLC-5) | Server (responds to SoftPLC 1 and PLC-5) |
| 1 | Client - Mapped to SoftPLC-2 IP address (Initiator to SoftPLC 2, MSG instructions use this channel) | |



END OF USER GUIDE