Product Manual 26712
(Revision A, 11/2017)
Original Instructions

ProTech® GAP™ Manual

A graphical tool for programming the SX, TPS, and MSM versions of the ProTech® product family

Software Manual

General Precautions

Read this entire manual and all other publications pertaining to the work to be performed before installing, operating, or servicing this equipment.

Practice all plant and safety instructions and precautions.

Failure to follow instructions can cause personal injury and/or property damage.

Revisions

This publication may have been revised or updated since this copy was produced. To verify that you have the latest revision, check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, on the *publications page* of the Woodward website:

www.woodward.com/publications

The latest version of most publications is available on the *publications page*. If your publication is not there, please contact your customer service representative to get the latest copy.

Proper Use

Any unauthorized modifications to or use of this equipment outside its specified mechanical, electrical, or other operating limits may cause personal injury and/or property damage, including damage to the equipment. Any such unauthorized modifications: (i) constitute "misuse" and/or "negligence" within the meaning of the product warranty thereby excluding warranty coverage for any resulting damage, and (ii) invalidate product certifications or listings.

Translated Publications

If the cover of this publication states "Translation of the Original Instructions" please note:

The original source of this publication may have been updated since this translation was made. Be sure to check manual *26455*, *Customer Publication Cross Reference and Revision Status & Distribution Restrictions*, to verify whether this translation is up to date. Out-of-date translations are marked with ⚠. Always compare with the original for technical specifications and for proper and safe installation and operation procedures.

Revisions— A bold, black line alongside the text identifies changes in this publication since the last revision.

Manual 26712

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Important Definitions

This is the safety alert symbol used to alert you to potential personal injury hazards. Obey all safety messages that follow this symbol to avoid possible injury or death.

- **DANGER** - Indicates a hazardous situation, which if not avoided, will result in death or serious injury.
- **WARNING** - Indicates a hazardous situation, which if not avoided, could result in death or serious injury.
- **CAUTION** - Indicates a hazardous situation, which if not avoided, could result in minor or moderate injury.
- **NOTICE** - Indicates a hazard that could result in property damage only (including damage to the control).
- **IMPORTANT** - Designates an operating tip or maintenance suggestion.

⚠WARNING

Overspeed / Overtemperature / Overpressure

The engine, turbine, or other type of prime mover should be equipped with an overspeed shutdown device to protect against runaway or damage to the prime mover with possible personal injury, loss of life, or property damage.

The overspeed shutdown device must be totally independent of the prime mover control system. An overtemperature or overpressure shutdown device may also be needed for safety, as appropriate.

⚠WARNING

Personal Protective Equipment

The products described in this publication may present risks that could lead to personal injury, loss of life, or property damage. Always wear the appropriate personal protective equipment (PPE) for the job at hand. Equipment that should be considered includes but is not limited to:

- **Eye Protection**
- **Hearing Protection**
- **Hard Hat**
- **Gloves**
- **Safety Boots**
- **Respirator**

Always read the proper Material Safety Data Sheet (MSDS) for any working fluid(s) and comply with recommended safety equipment.

⚠WARNING

Start-up

Be prepared to make an emergency shutdown when starting the engine, turbine, or other type of prime mover, to protect against runaway or overspeed with possible personal injury, loss of life, or property damage.

Electrostatic Discharge Awareness

NOTICE

Electrostatic Precautions

Electronic controls contain static-sensitive parts. Observe the following precautions to prevent damage to these parts:

- **Discharge body static before handling the control (with power to the control turned off, contact a grounded surface and maintain contact while handling the control).**
- **Avoid all plastic, vinyl, and Styrofoam (except antistatic versions) around printed circuit boards.**
- **Do not touch the components or conductors on a printed circuit board with your hands or with conductive devices.**

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual *82715*, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Follow these precautions when working with or near the control.

1. Avoid the build-up of static electricity on your body by not wearing clothing made of synthetic materials. Wear cotton or cotton-blend materials as much as possible because these do not store static electric charges as much as synthetics.
2. Do not remove the printed circuit board (PCB) from the control cabinet unless absolutely necessary. If you must remove the PCB from the control cabinet, follow these precautions:
   - Do not touch any part of the PCB except the edges.
   - Do not touch the electrical conductors, the connectors, or the components with conductive devices or with your hands.
   - When replacing a PCB, keep the new PCB in the plastic antistatic protective bag it comes in until you are ready to install it. Immediately after removing the old PCB from the control cabinet, place it in the antistatic protective bag.

Chapter 1.
Overview

Introduction

This manual will provide the following information for the user regarding the use of the ProTech GAP tool which is an enhanced (optional) way to program and configure additional safety logic functions into the ProTech family of Overspeed/Safety Protection products.

- Installation of the additional Woodward software tools required
- Step by step instructions to build custom logic for the ProTech
- Details on how to load & confirm (graphical vs. hardware) the device settings
- How to simulate & test graphical logic on a PC and generate settings files
- Application examples to help users with custom logic designs for safety related functions, or just additional monitoring parameters

General Information

GAP is Woodward's Graphical Application Programmer, (3rd Generation), software tool. It is a Windows based, high-level, block-oriented programming language designed for simple and quick implementation of difficult control strategies. GAP blocks are proven pieces of software, and you don't have to be a computer programmer to program in GAP. GAP is part of the Woodward Integrated Development Environment which includes ToolKit and NetSim, and is the primary programming tool for our high-end electronic control products.

The ProTech family has some products that allow users to add site-specific input/output signals and implement unique software logic related to these signals. This can be done through the Programming and Configuration Tool (PCT), based on Woodward's ToolKit program. There are however, some limitations with this method:

- No graphical view of the application program
- No ability to simulate and test/debug the program
- No error checking prior to loading the program into the ProTech device

As an enhancement to the ProTech family, a tool based on Woodward's GAP application programming environment has been created. This tool provides the following:

- Graphical view of entire application
- Completeness check to ensure the program will be accepted by the device
- Documented feedback of the ProTech CRC codes to ensure program 'fingerprint' verifying laptop GAP program & installed ProTech settings
- GAP Block help clarifying function and input/output fields of each block
- Built-in simulation on the user PC to allow testing/debugging of logic
- Simulation that allows manual entry (control) of Input signals

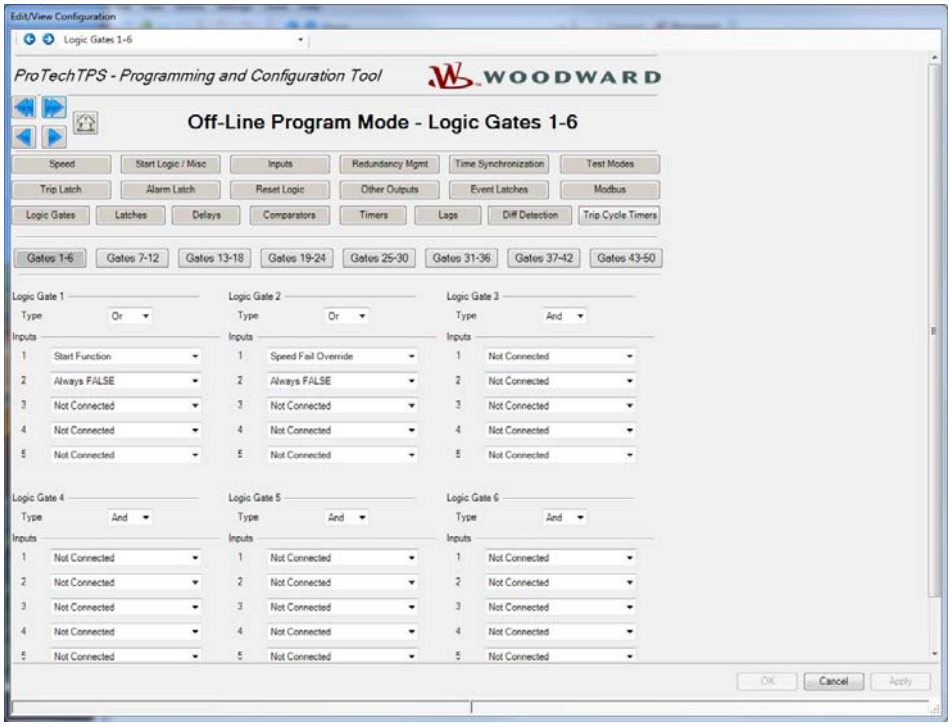


Figure 1-1. Programming & Configuration Tool

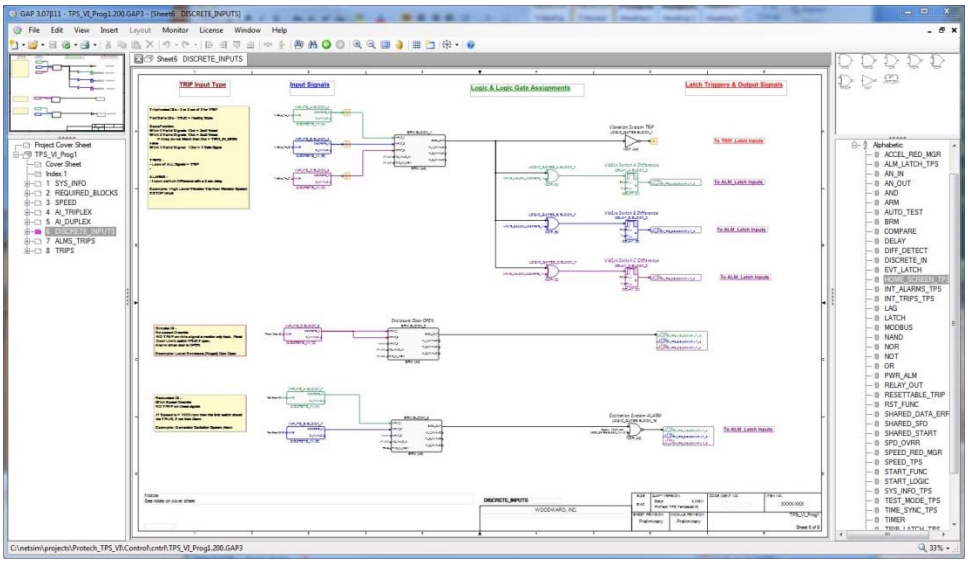


Figure 1-2. GAP Programming & Configuration

Chapter 2.
Installation of Software Tools for ProTech

Tools Required for using GAP for ProTech

The ProTech GAP is a special application of the Woodward GAP tool specifically for ProTech. It is a combination of Woodward's ToolKit software and a special ProTech application program.

To install the GAP Tool, locate/obtain the ProTech GAP Installation CD provided with each ProTech (ProTech-SX, ProTechTPS, or MicroNet Safety Module [MSM]). Alternatively, the ProTech/MicroNetSM Editor and NetSim Coder 1.0, 2.0, and 3.0 can be downloaded from Woodward's Internet website: www.woodward.com/software

In order to use the ProTech GAP tool, the following Woodward programs must first be loaded on the target PC.

- ToolKit version 3.6 (for templates 1.0 & 2.0), version 5.3 (for template 3.00) or later
- ProTech Service Tool for your device
- GAP Editor version 3.13 or later
- ProTech Coder for NetSim 1.0, 2.0 & 3.0
- NetSim 11.1.0.0 Control Executive or later
- Microsoft Visual C++ version 6.00 2010 or 2013 Express compiler

Installing ToolKit Components

It is important to load the ToolKit components first, and establish a connection with your unit. This will insure that the user is able to communicate with the device, and allow them to load the .wset file that the GAP programming tool will create (which is described in detail in the following chapter).

A version of ToolKit install is available on the CD, but the latest version can always be downloaded from the Woodward website. The service tool for your particular device will need to be downloaded from the Woodward website.

- Install ToolKit version listed above or latest version (installed in default directory) with at a minimum an Advanced-Runtime license (Woodward Part# 8447-5002).
  ToolKit Developer license (Woodward Part# 8928-5016) will work as well, but is not required.
  NOTE: This program must be opened at least one time before GAP can use it. The correct ToolKit version is supplied with the installer CD, provided with the product.

- Install the service tool for your particular device (SX, TPS, MSM) again allowing the install program to install in the default directory.
  - SX (Woodward Part# 9927-1837)
  - TPS (Woodward Part# 9927-1684)
  - MSM (Woodward Part# 9927-1838)

Once these tools have been installed, refer to "Using the Programming and Configuration Tool" section in Chapter 10 of the service manual to connect to the device.

- SX service manual 26546V2
- TSP service manual 26501V2
- MSM service manual 26547V2

Installing ProTech/MicroNetSM Editor and NetSim Coder 1.0, 2.0 & 3.0

This section will step the user through the process of installing the ProTech/MicroNetSM Editor and NetSim Coder for Protech. The GAP tool will allow the user to graphically program the ProTech for system trips, alarms, and any custom logic need to configure the ProTech protection device.

- To Install GAP3 - Start the executable program by double clicking SetupGAPxxxxx.exe (or selecting Run, if installing from the Woodward Software page)

- On the Setup screen select Next

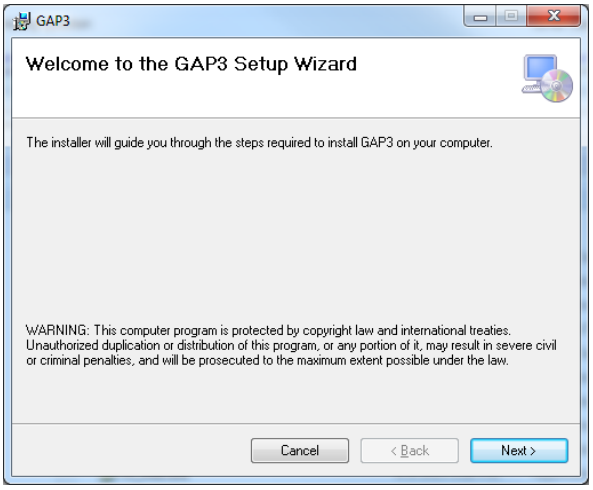


Figure 2-1. GAP Setup Screen

- On the Confirmation screen select Next

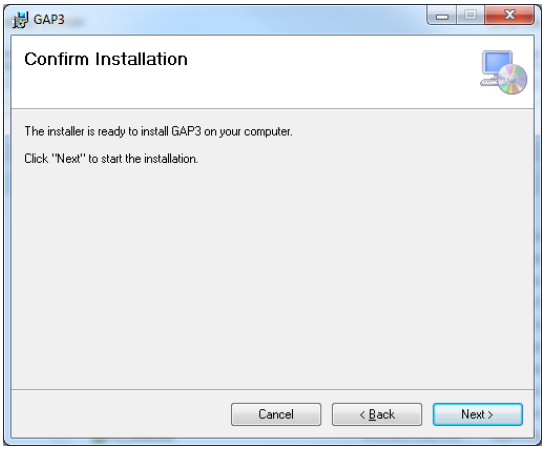


Figure 2-2. GAP Confirmation Screen

- On the License Agreement screen select I Agree, and then next

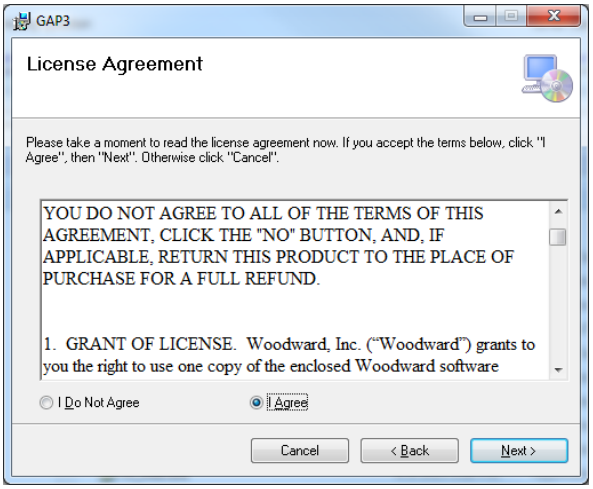


Figure 2-3. GAP License Screen

- The installation will begin

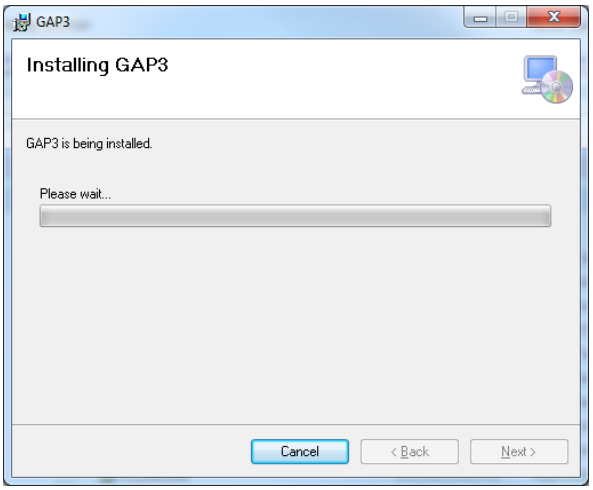


Figure 2-4. GAP Installation Screen

- When Installation is Complete, select Close

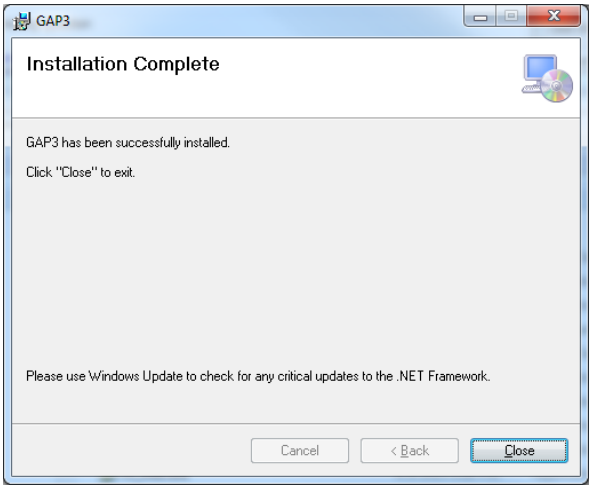
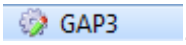


Figure 2-5. GAP Installation Complete Screen

- After the GAP tool has been installed, find it in All Programs – Woodward – GAP3 and click on the GAP3 Icon 

. This will open up the GAP program to verify that it was installed correctly.
- In the GAP3 program select File – New – Project and verify that the ProTech TPS, ProTech SX and MicroNet SM (MSM) are available (versions numbers can advance so there might be more than shown below)
- On the template Pop-Up select the “More” tab and check show all templates.

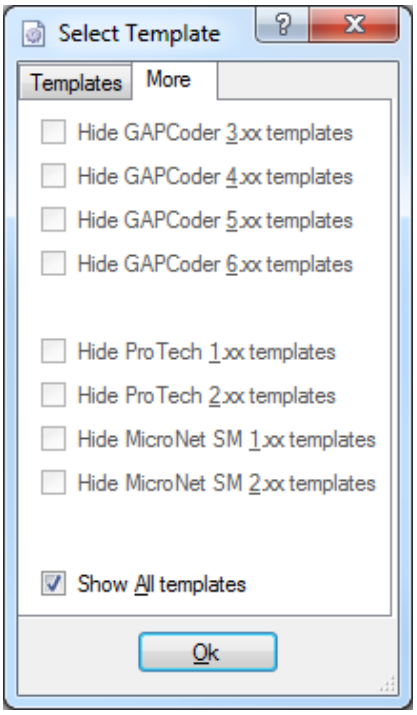


Figure 2-6. GAP Templates Screen

- Now all templates should be visible.

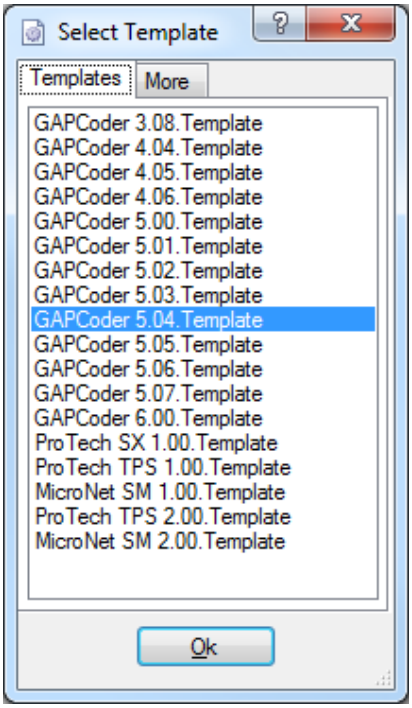


Figure 2-7. GAP Templates Screen

Installing NetSim

This section will step the user through the process of installing NetSim, which can be used to run a simulation, to debug a configuration, prior to loading it into the ProTech.

Installing NetSim Control Executive (11.3 or later)

- Start the executable program by double clicking netsim_x_x_x.exe
  (Or selecting Run, if installing from the Woodward Software page)

- NetSim setup will begin Setup

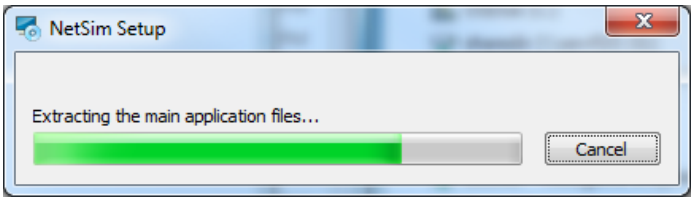


Figure 2-8. NetSim Extracting Screen

- On the Welcome screen select Next

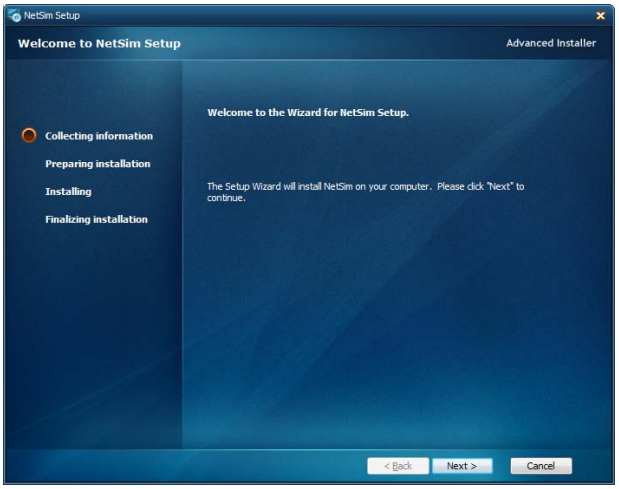


Figure 2-9. NetSim Setup Screen

- On the Configure Shortcuts screen check the box if you want a shortcut installed on your desktop

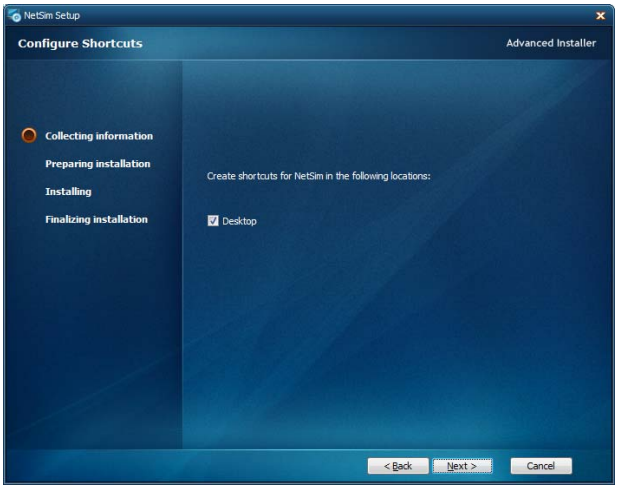


Figure 2-10. NetSim Shortcut Screen

- On the End User License Agreement screen select, I accept the term in the License Agreement

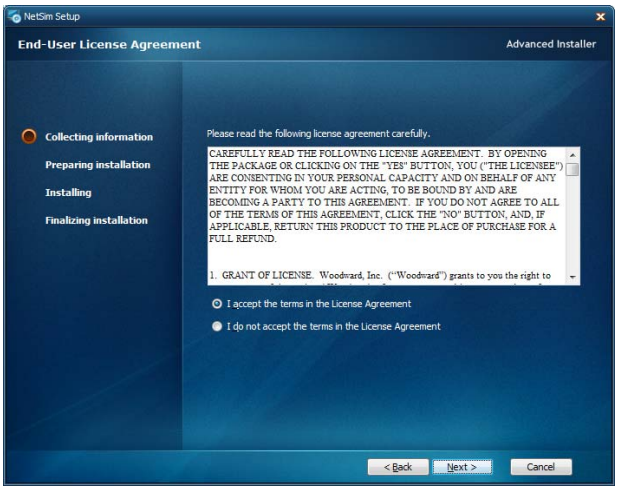


Figure 2-11. NetSim License Screen

- This screen determines where NetSim will be installed. It is recommended to use this default path

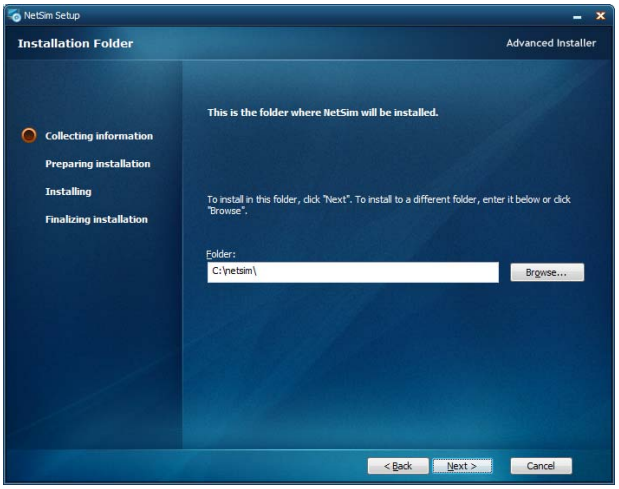


Figure 2-12. NetSim Destination Folder Screen

- NetSim is ready to be installed, select Install

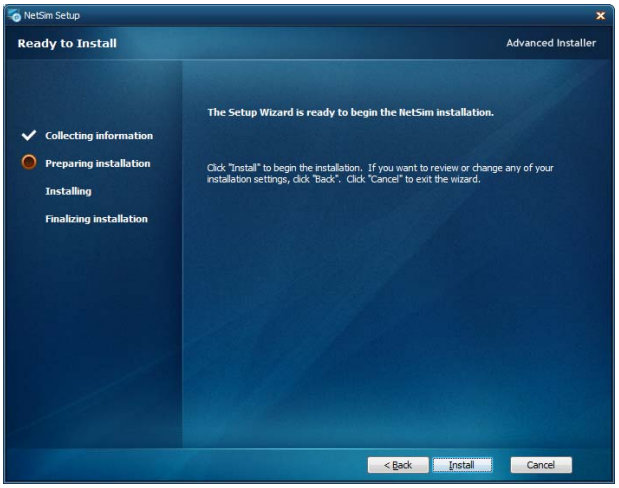


Figure 2-13. NetSim Ready to Install Screen

- NetSim is being installed

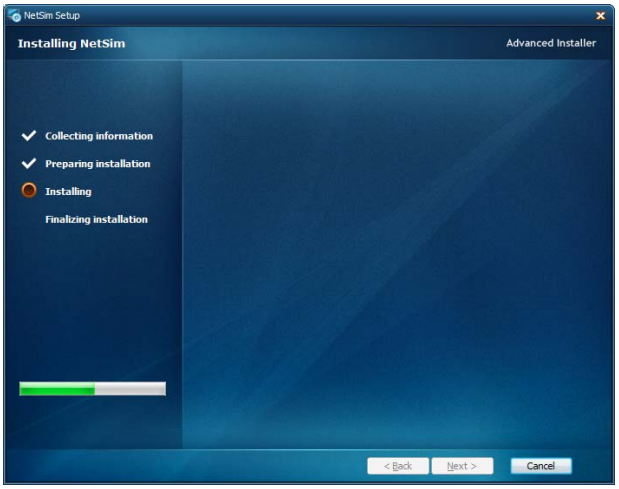


Figure 2-14. NetSim Installing Screen

- Select Finish to complete the installation

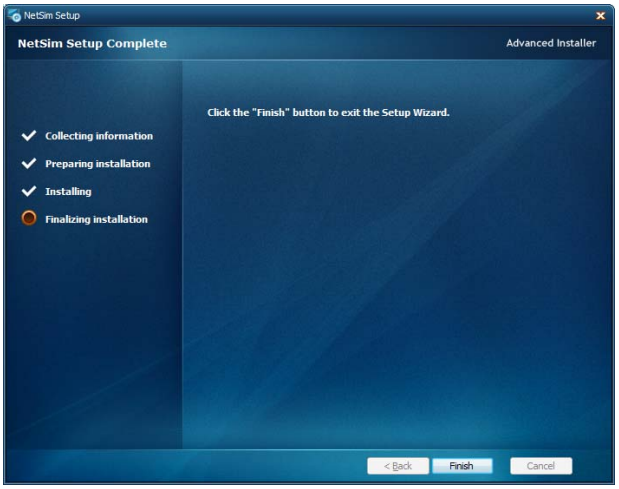


Figure 2-15. NetSim Setup Complete Screen

- After the GAP tool has been installed, find it in All Programs – NetSim – NetSim CE, or on the desktop if that option was selected earlier. Click on the NetSim CE icon to open up NetSim Control Executive to verify that it was installed correctly

.

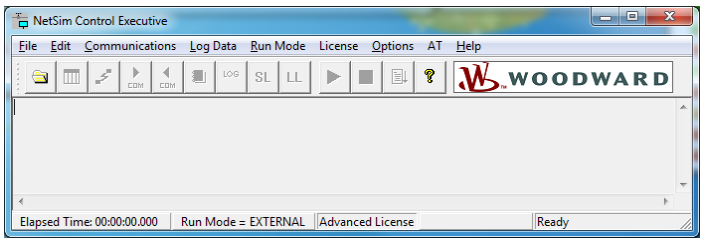


Figure 2-16. NetSim Control Executive

- This competes the installation of NetSim. How to use this tool is explained in detail one of the following chapters.

Installing Visual C++

Installing Microsoft Visual Studio 2008, 2010, 2012 or 2013 Express compiler, free from Microsoft, will install the required version of C++ (version 6.00).

This will allow the user to 'compile' the ProTech GAP application settings program to be executed on their PC by NetSim. Using NetSim the user can perform program debugging on their application, prior to loading the settings into the ProTech.

- Follow the link below to download Visual C++ 2010 Express
  http://www.microsoft.com/visualstudio/eng/products/visual-studio-express-products

- Welcome screen. Uncheck the box to decline setup experiences

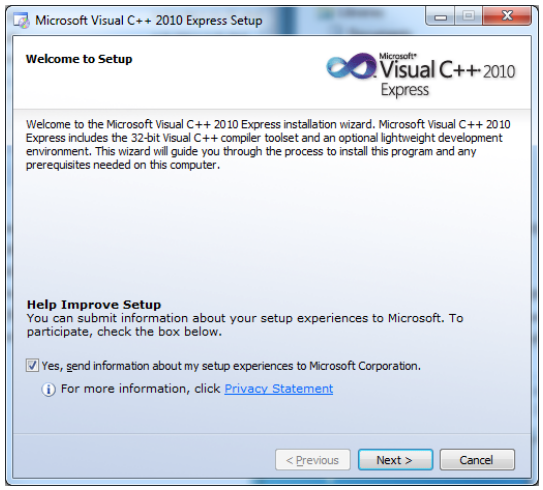


Figure 2-17. Visual C++ Setup Screen

- License Terms, select I have read and accept the license terms

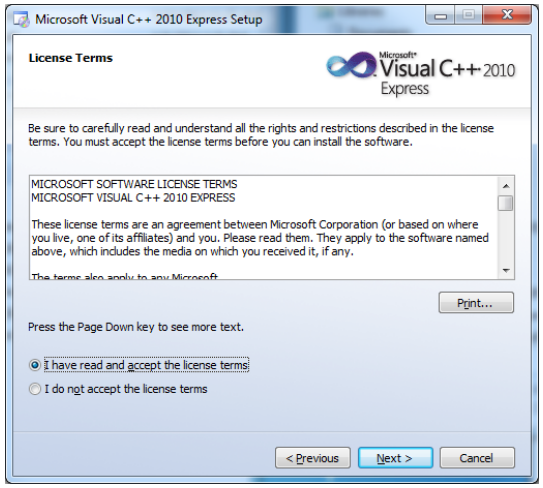


Figure 2-18. Visual C++ License Screen

- Installation Options. Suggest to uncheck SQL server option, it is not needed

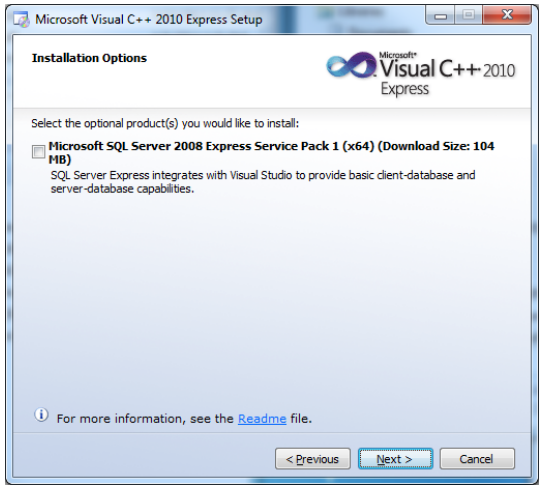


Figure 2-19. Visual C++ Installation Options

- Destination Folder. Suggest to use default location, but it is not necessary

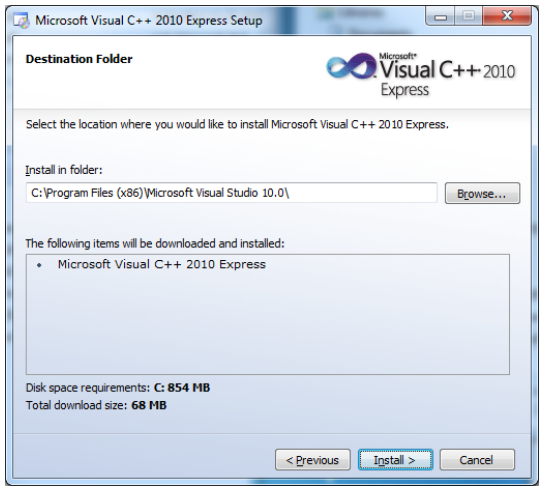


Figure 2-20. Visual C++ Destination Folder Screen

- Download in Progress

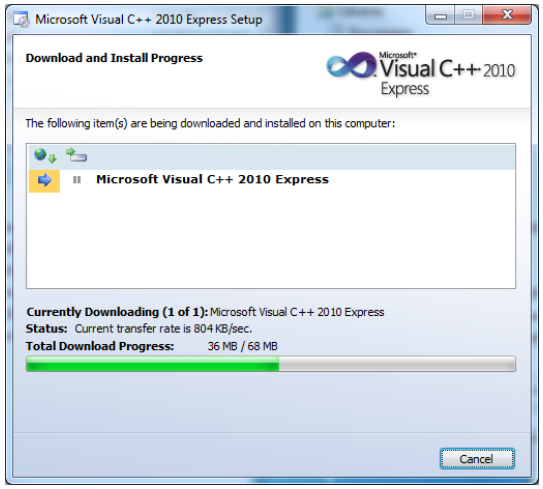


Figure 2-21. Visual C++ Installation Progress Screen

- Setup complete, select exit

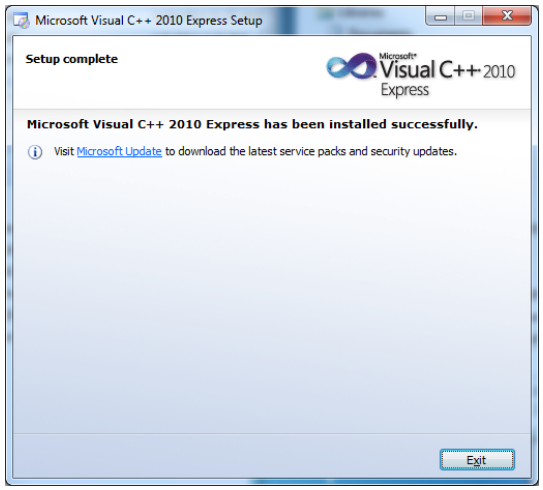


Figure 2-22. Visual C++ Setup Complete Screen

- This competes the installation of Microsoft Visual C++

Chapter 3.
Building an Application

Introduction

The ProTech GAP template allows you to create a custom application program and code it for simulation on your PC. Once you are satisfied with the program, a valid Settings File (.wset) can be created from the application. This file can then be uploaded into the target ProTech device through the ToolKit Service tool. Upon successful completion of the loading of the settings file, the ProTech will return to the GAP application the exact CRC (cyclical redundancy checksum) values related to each program section (in addition to an overall CRC).

Below is a system overview diagram of how the GAP created application interfaces with the current ProTech hardware and service tool.

System Overview Diagram

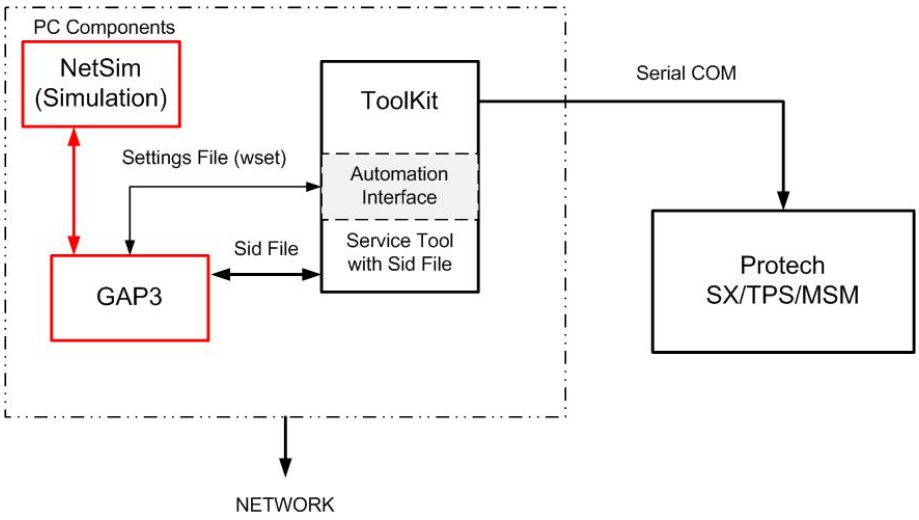


Figure 3-1. Software Functional Interfacing Overview

It is important to note a few key points about this process:

1. Only “settings” files are loaded into the ProTech (unlike other Woodward products using GAP programs where a compiled/executable program is loaded into the device).
2. The GAP template **requires** the Service Tool to send/retrieve information to/from the device.
3. ProTech GAP tool has NO safety related requirements or specifications – all of these requirements are met by the ProTech hardware.
4. The compiling of a ProTech GAP application will be for NetSim only, since there is no compiling for the ProTech hardware.
5. Current templates exist for the SX, TPS, and MicroNet Safety Module.
6. Simulation is intended for users to test the custom programming they plan to run in the hardware, it does not simulate all of the base functions of the Protech.

Choosing a Template

The first step in creating a new project (program) in GAP is to select the desired Template. Templates contain the available program blocks that the user can select to create program logic for a specific target hardware product.

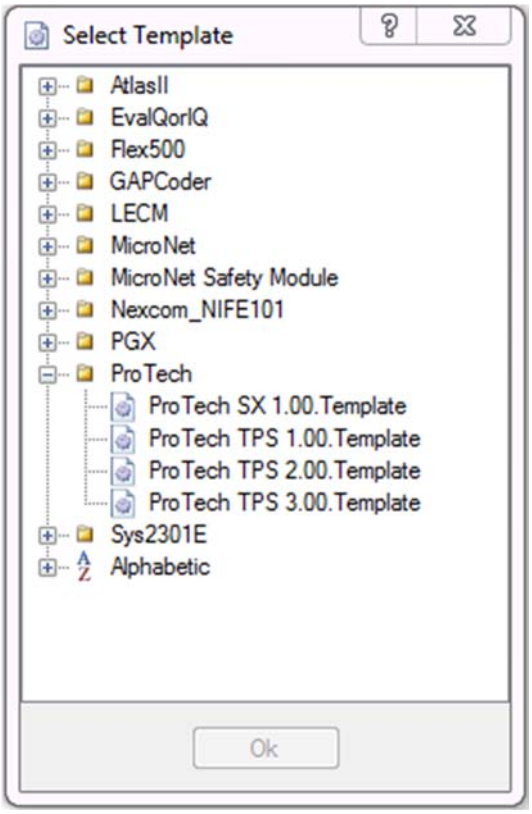


Figure 3-2. Selecting a Template

Note: This Template list likely contains many more template options than you will see.

Version 1.00 Templates

For the ProTech family the version 1.00 templates are for the non-voted input (original released) versions. These templates do not have any Redundancy Manager type blocks available because those products did not have the ability to share input values & status between the kernel modules. For the SX Product line there is only a 1.00 template at this time – if additional block types and functions are added in the future, then a new template version will be released.

The ProTech SX application examples will be in this template.

Version 2.00 Template

For the ProTech family the version 2.00 templates are for the voted input versions (released in 2013) of the Protech TPS and MSM. These products have the ability to share input signal information between the isolated kernel modules (A, B & C) of the TPS and MSM products.

Version 3.00 Template

The version 3.00 template is for the Math Enhanced versions of the Protech TPS and MSM. This template contains additional math calculation blocks (released in 2017). In general, the template required will be determined by the part number and the Protech product that is used.

The ProTech TPS application examples will be in this template.

Note: This manual will proceed with instructions using the Version 3.0 template, but the same steps will work for any template.

In the ProTech templates, categories and block names are automatically created for each block as it is placed on the sheet. This is convenient for a few reasons.

1. For each type of block, there is only a specific number of blocks available (for example there are only 30 total delay blocks).
2. This naming convention is used by the ToolKit service tool programming, therefore it must be followed.
3. Each individual block can be viewed during runtime on the ProTech front panel monitor screen and can be found by this standard naming convention.

It is possible with the GAP tool to add a Description to any block and add comments on the logic sheets, to help clarify and document what the logic does.

Starting a New GAP Project

Differences of ProTech GAP versus other GAP programmable platforms

For those users who have experience using GAP on other Woodward products, there are some major difference in the ProTech GAP tool that make in unique.

ProTech GAP -

- User does not define Block names or Categories – these are pre-defined to match the display screen at runtime. Use block descriptions & comments to describe functions where needed.
- There are NO Rate groups – all blocks execute in each cycle of the minor frame timer. The identifier in parenthesis give the module that block is found in (A, B, or C)
- There are NO tunables, values are changed in configuration mode only via the front panel display or the service tool
- Different block colors reflect which module they are in, not rate group
- Does not link to a compiler for creating executable code to run in the ProTech – it will only produce “setting” files (.wset files) that are identical to the Service Tool settings files and are what is loaded into the hardware
- Does support a compiler for creating a simulation file that is supported by Woodward’s NetSim product.
- Does NOT support monitoring of live values from the ProTech hardware – you must use the front panel display to see live block values on a powered unit, however NetSim will support the monitoring of live values during simulation (via SOS)

Getting Started

When you first Launch the GAP tool, you may see a dialog box as in figure 3.3 below, and will be prompted for a file name and location, this for opening an existing project. If you get this box hit Cancel and you should see the GAP tool open and be ready for a new project/program as shown in Figure 3-3a below.

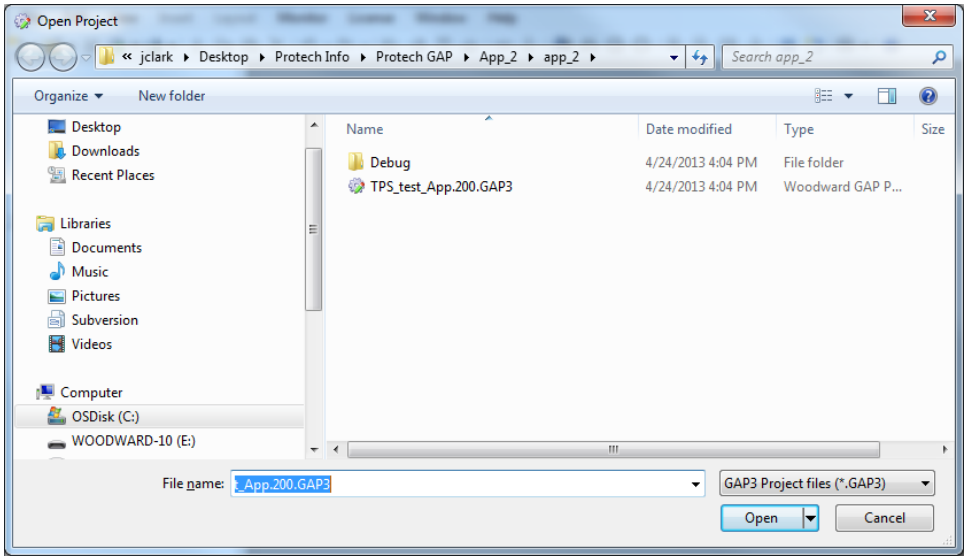


Figure 3-3. New GAP Project

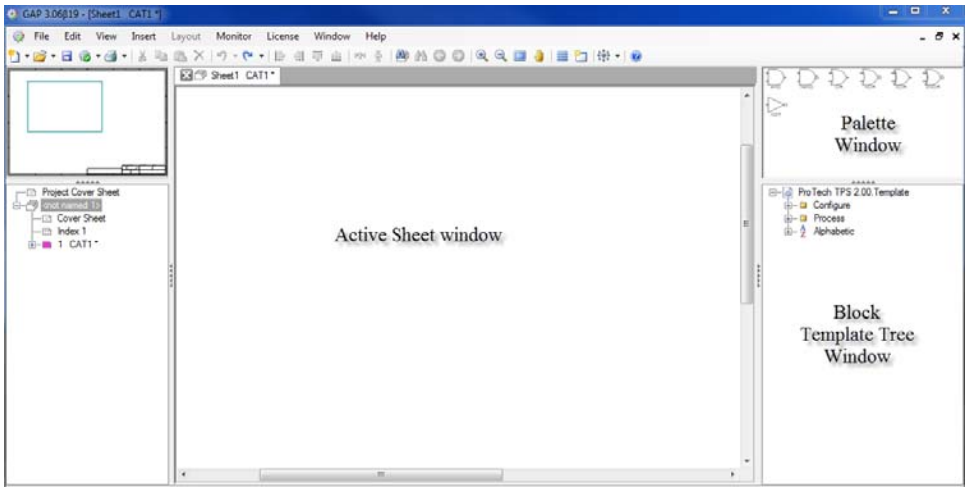


Figure 3-3a. New GAP Project

After reaching this point Select File/New/Project. You should now be prompted for the selection of a template as shown previously in Figure 3-1. For our example we selected ProTech TPS 3.00.

If this is the only Woodward GAP product you have, or just want to have all new programs start with this template you can set this up as the default template by using the “Startup Options/Select Default Startup Template” under the File menu. Note that you need to restart GAP to get the ProTechTPS 3.00 Template to display in the RH window.

Next go to the Block Template Tree window, expand the Configure group and drag the SYS_INFO_TPS block into the Active Sheet window as shown in the Figure below.

Note: More detail about individual GAP blocks can be found in the GAP Help pull-down tab under Block Help.

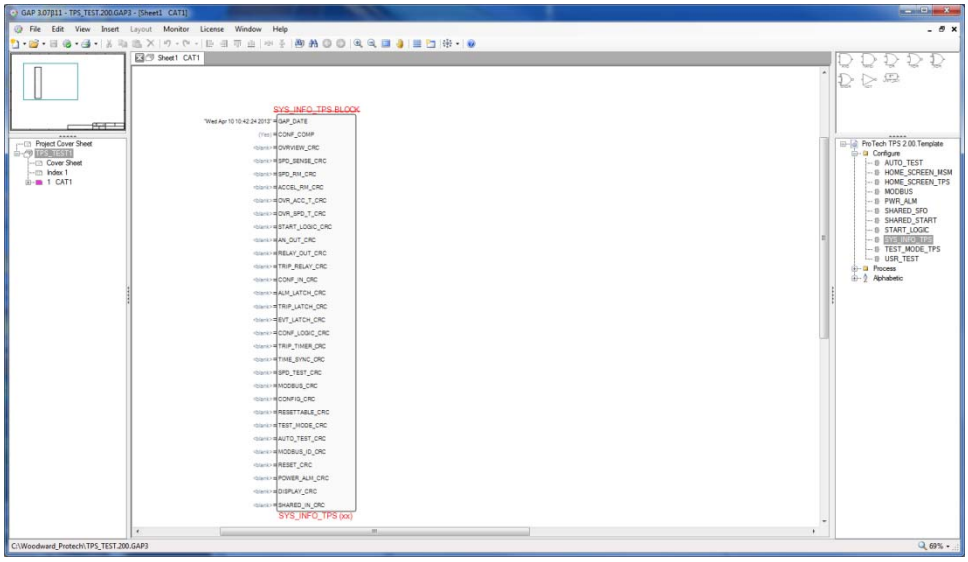


Figure 3-4. SYS_INFO block

You will notice the block name (top) and the block type (bottom) are in RED. This is because you must select which module (A, B, or C) this block is assigned to (shown in red as xx). To do this double click on the block to open it and select A, B or C for the ProTechModule field.

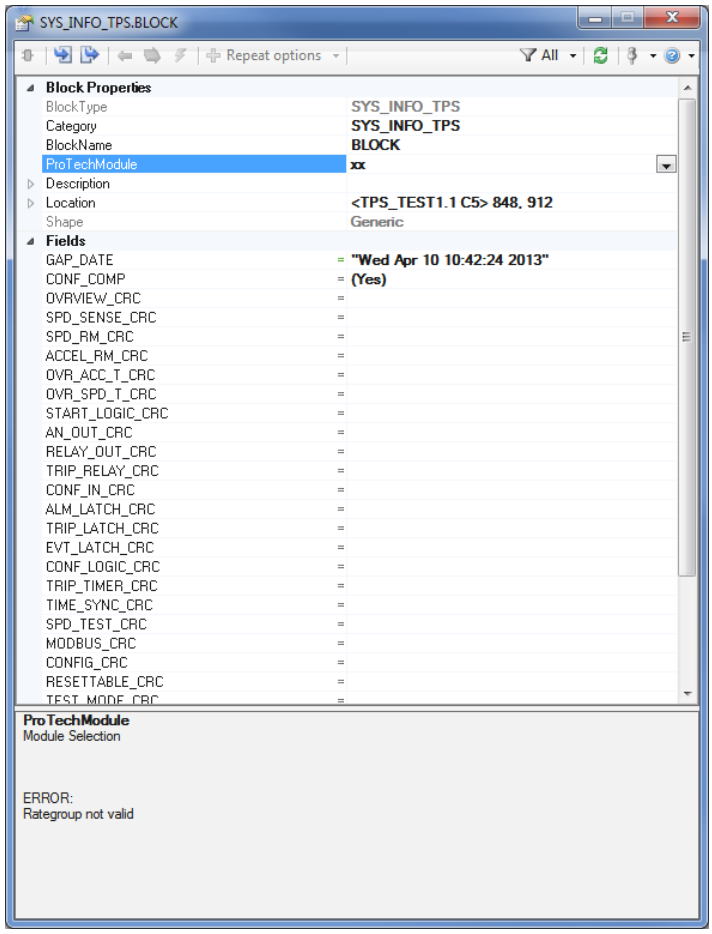


Figure 3-5. SYS_INFO block parameters

Doing this will automatically name the block, convert the color and eliminate the Red errors.

Some blocks are unique and must be assigned to a specific module (such as this one) while others can be declared as (ALL) meaning that they will be duplicated automatically in each of the 3 kernel modules.

The default colors for each module declaration are:

ALL	Black
A	Green
B	Blue
C	Purple

Select this block and Copy/Paste 2 more of these blocks on the page and change them to be assign to modules B and C.

Additional blocks are added in the same way. The input fields will first appear as Red X's (required input fields) or with default values.
These input fields must be programmed with one of the following:

1. Fixed Value
2. Output from another block

There are two ways to program these input fields.

Clicking on the input field, will allow the user to enter a value or select a valid input option. GAP will only show valid inputs for the field type (Boolean or analog), such as Boolean values for logic gates.

The user can also click on the output stem of a block and drag a 'net' line to the input of another block, if it is the correct field type. If it is not the correct data type then GAP will not allow the user to make the connection. A given block can have its stem branch to many other blocks.

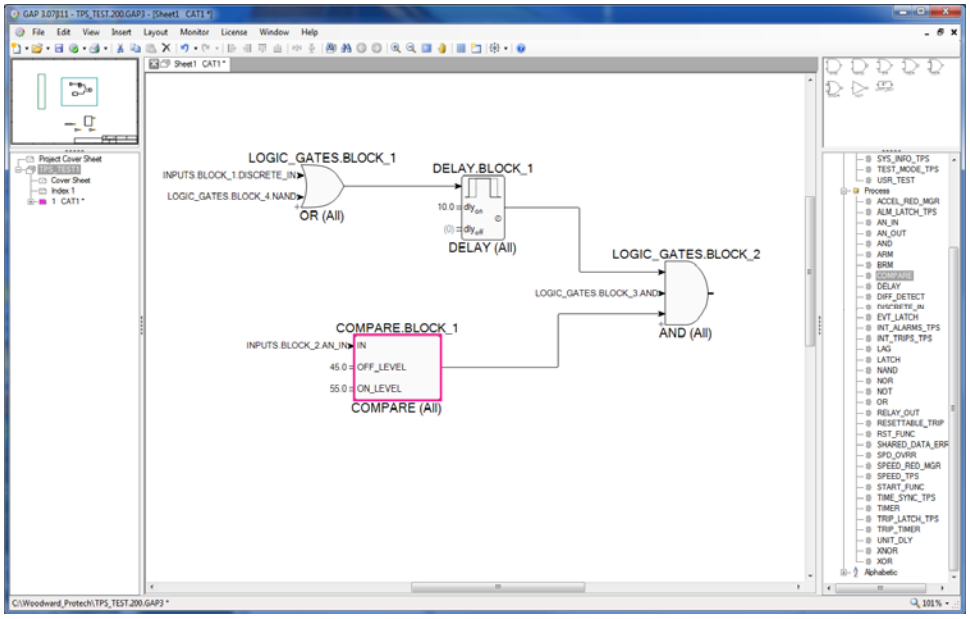


Figure 3-6. Logic blocks

Note: For more detail about how to use the GAP editor, use the Editor Help found under the Help pull-down tab.

Saving a GAP Project

Now Select File/Save Project and you will get a dialog box as shown. In the example below we used TPS_TEST as the file name and Woodward_ProTech as the folder location.

Note: The words program and project both refer to the <filename>.GAP3 file that GAP creates. For simplicity we will use the word program from here forward.

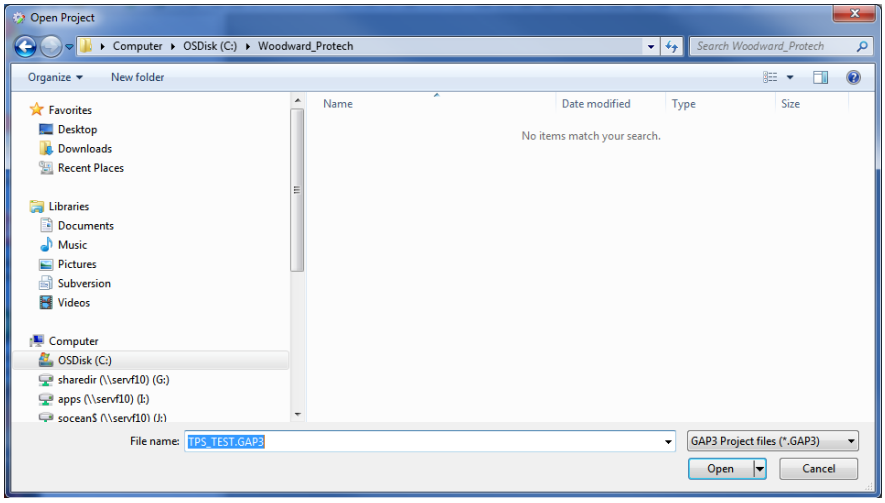


Figure 3-7. Open/Save Project Dialog Box

There will only be one GAP program to maintain that will contain all of the application settings for the ProTech. Once complete, the program will generate three separate settings files, that each get loaded into the ProTech modules A, B & C.

To return to work on this program later, you can simply double click on the GAP3 file and it will automatically be associated with the GAP editor tool.

Quick Steps to Creating & Saving a GAP Program

1. Launch GAP to create a new project, or open an existing project/program
2. In the Palette window (upper right side), there are two groups of blocks, Configure and Process, as well as a full list (alphabetic).
3. Begin building an application by dragging blocks onto the active sheet (Sheet window) and connecting the inputs and outputs. Note: It may be helpful to have the GAP Help window open if you want to check properties of the blocks being placed on the active sheet. You can press the shortcut keys F1 for Block Help or Ctrl+F1 for Editor Help.
4. You can save your project at any time during this process.

Once a GAP program is completed and tested – the “Publications” tool in GAP provides a way to publish the program to enforce documentation and engineering change control revisions. Publishing can be done at a GAP project or module level or both. Below is the basic steps – refer to the GAP help information on further details on using this feature.

Quick Steps to Publishing a GAP Program

1. Be sure all changes and comments are complete, do a final save and perform a completeness check (described later in this chapter)
2. Right-mouse-click on the Project or Module in the GAP explorer window
3. Select Publications and a dialog box will appear where you can enter the Revision/Approval/Description for these revision. After entering this information click on the “Publish” button

4. On the initial publishing of the GAP, you will get a dialog box with the option to save or discard the current change log. (Typically this is discarded at the initial publishing) After initial publishing the GAP will not give this option and will keep all changes in the change log file.
5. On the Cover Sheet (of project or module) there will be 2 identifiers – the upper right corner will show the Revision history log and the lower right corner of each page will show the sheet and module revision

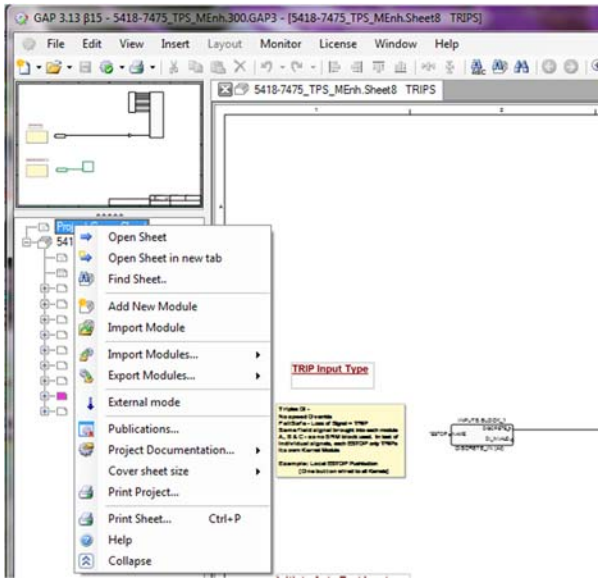


Figure 3-8. Publications (right-click on module)

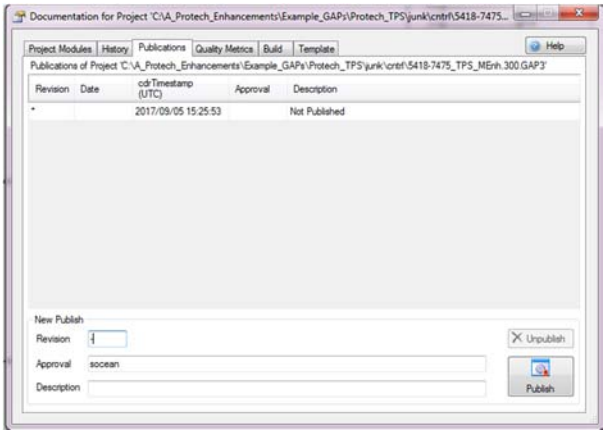


Figure 3-9. Publish Dialog Box

Rev	Date	cdrTimestamp (UTC)	Approved	Description
NEW	2017/09/05	2017/09/05 15:25:53	socean	Site commissioned settings Sept/5/2017

Figure 3-10. Revision History

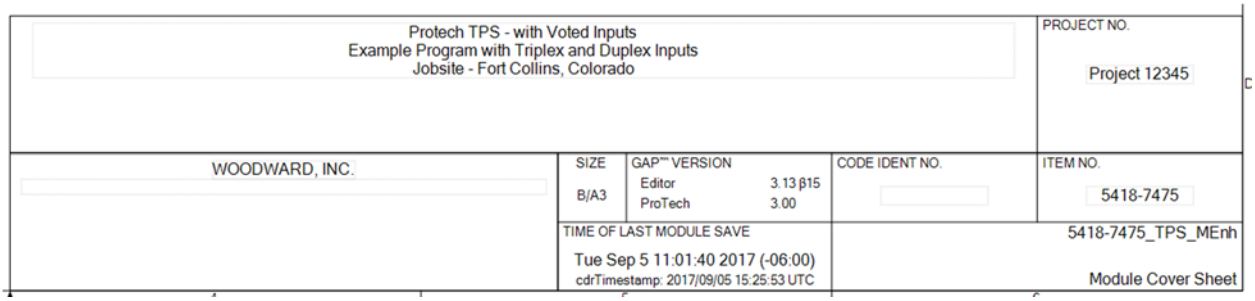


Figure 3-11. Module Date/Timestamp

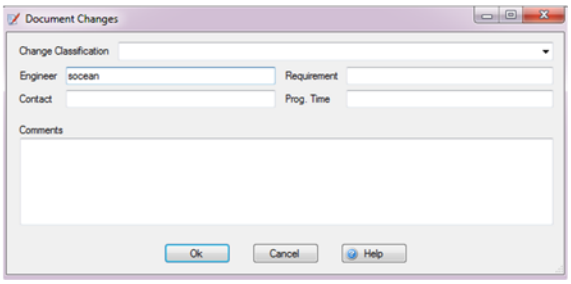


Figure 3-12. Post-Publish Document Change Dialog Box

Structuring Your GAP Program

GAP is primarily used to program the logic section of the ProTech. However, the entire application, which includes logic, speed, test conditions, and Modbus, is available through GAP. In general, if using the GAP tool to maintain the program it is best to follow the structure of the example programs, which include blocks that will contain some of the settings that are done typically through the front display panel keypad (such as start logic, speed inputs and overspeed settings).

Logic Organization

The following is the general construction of the example programs that are provided and shown in this manual. The sheet number refer to the TPS sample program 5418-7475_TPS_MEnh.300.GAP3 (Woodward p/n = 5418-7475)

1. Project Cover sheet – use the title block to identify the project/jobsite/part number – this will also provide revision control for changes
2. System Information blocks (sheet 1) that provide the CRC 'fingerprint' from the target hardware
3. Base Functions (Required/Recommended Blocks) - (sheet 2) good practice to have all of these blocks present in your application so that all critical settings are contained in the GAP program
4. Logic for Safety Instrumented Functions (SIF) – typical Input to Output (left to right) flow of logic on the page – using 'net' connections between block outputs and inputs for ease of readability (sheets 3-6)
5. Alarm and Trip summary Latches and test routines (sheets 7 & 8)
6. Example of some of the newer blocks in the Math Enhancement versions, driving logic to activate an output relay and annunciate some alarms (but not initiate a TRIP) are used in the final sheet of this program (sheet 9)

Programmer Comments

It is good practice to use good notes and programmer comments as much as reasonable when creating a program. In the example programs provided all 3 of the Comment types are utilized –

- Line Text - to outline and highlight a section of code
- Comment Text Box – beige box container for text
- Rich Text – Enhanced format (color/font/size) text editor for

NOTICE

Therefore it is good programming practice to add the blocks shown on the first sheets of each example to the ProTech GAP tool application, so that ALL settings are documented on the GAP sheets and included in the .wset file.

Creating Settings Files for ProTech

Completeness Check

Once the GAP program is complete the first step to making settings files for the ProTech is to run a check that all required input fields have been programmed. The completeness check can be performed after the application is built, or at any time during the build of the application. To run a completeness check, select File/ Compile/Completeness Check Only. A dialog box will open, giving the results of the completeness check. You can also press the shortcut key F5 to run a completeness check.

This check will detect:
Warnings – shown with a yellow caution icon – items to be aware of, they may or may not be a problem with your program, such as a block with no outputs used.
Faults – shown with a red icon – items that must be correct before a settings file or a simulation file can be created.

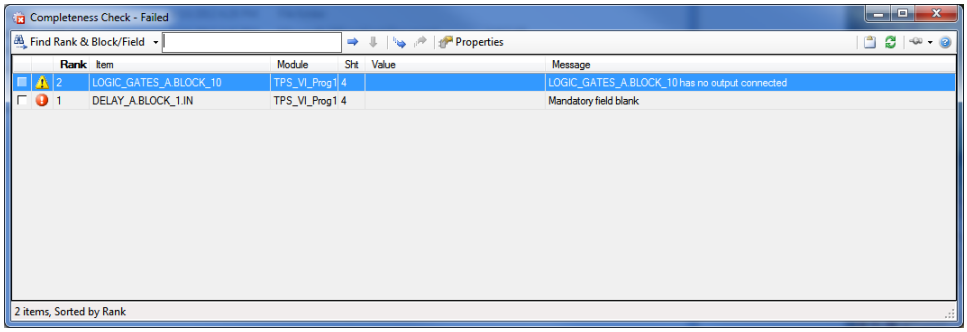


Figure 3-13. Failed completeness check

A program will not compile with Faults, Red icon. A program will compile with warnings, acknowledge screen below

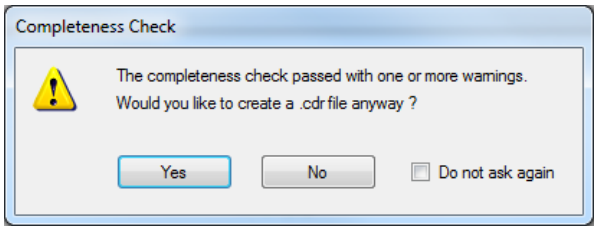


Figure 3-13a. Failed completeness check

A successful completeness check, without warnings is shown below.

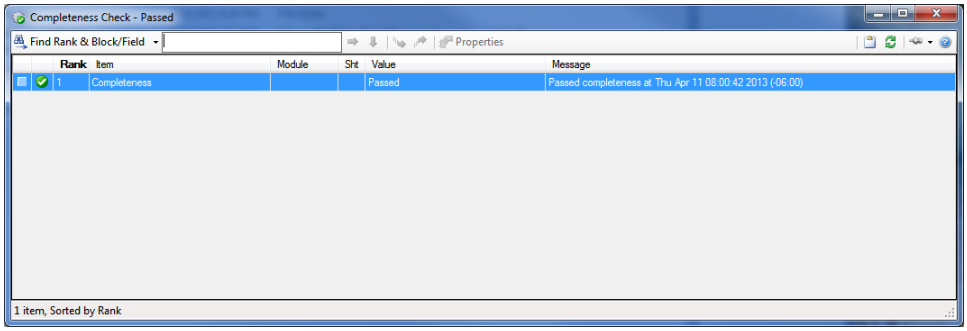


Figure 3-14. Successful completeness check

A successful completeness check, with warnings is shown below.

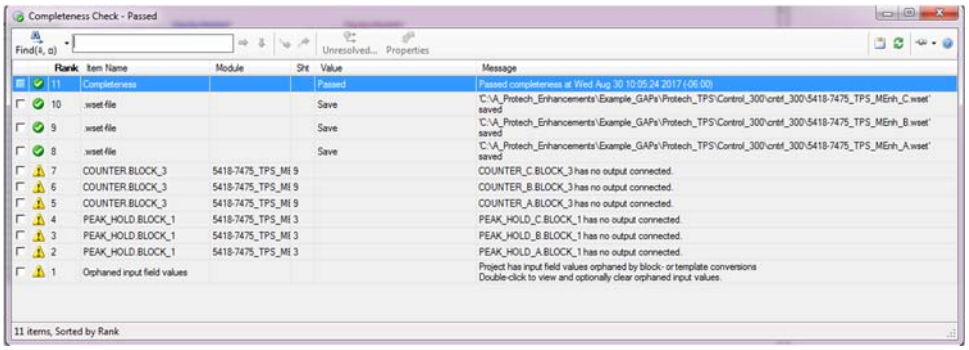


Figure 3-14a. Successful completeness check with warnings

Build a .wset file with GAP

Before a .wset file can be created by GAP, you must have the correct ToolKit service tool (Programming & Configuration Tool) installed on the PC. Refer to the correct chapter in the ProTech manual to install this program and verify that the service tool can correctly communicate to the ProTech.

Method 1 — Only option if you are not connected to the unit.

To create a .wset file, select check File/Compile/Create .wset file. You will be prompted to select the Sid Specification file. Select the correct Sid file for the version of software running on your ProTech. The software version can be found on the front panel display on the ProTech under the Monitor Menu/Module Information. Once selected, a completeness check will be run first and, if passed, a .wset file will be created for each module.

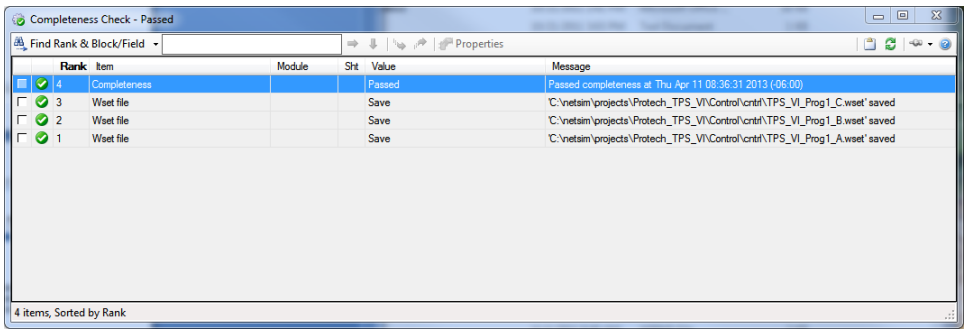


Figure 3-15. Successful completeness check

For the ProTech SX one file will be created, for the TPS and MSM it will create three .wset files. It there were warnings found during the completeness check, then there will be an additional prompt that pops-up to confirm that it is OK to make the .wset files.

These settings files can now be loaded into the ProTech at any time with the use of the ToolKit Programming & Configuration Tool.

Whenever the ProTech GAP tool is used to create the settings file (.wset), it will overwrite all settings that exist in the ProTech device. It will not do a 'partial' load of just the customer-specific logic that was created.

***For Example**: There is no requirement to have the SPEED_SX block in a ProTech GAP tool application for a ProTech SX device. If there is no SPEED_SX block created in the application, then the .wset file that gets created will set all of these input field settings to default, such as the Overspeed setting OVRSPD = 100 rpm. If this setting had been set to 1000 rpm on the device originally, then this setting will be overwritten with 100 when this .wset file is loaded.*

Chapter 4.
Linking the GAP program to the Hardware

Communicating via GAP with the ProTech

As was previously mentioned, refer to the correct chapter in the ProTech manual to install the ToolKit service tool (Programming & Configuration Tool) program and verify that the service tool can correctly communicate to the ProTech.

Figure 4-1. Programming & Configuration Tool

Modules must be in the “Tripped” state in order to download a .wset file to a ProTech module. You will have to enter a password to download the .wset file to the ProTech. **The default password for Config level changes is “AAAAAA”.**

Loading the .wset file from GAP

Method 2—Ideal option if you are connected to the unit.

If you are able to connect with the service tool to the ProTech, the **ideal** method of loading these settings files is to load them directly from GAP. This is done via the **File/Compile/Create and Upload .wset file**.

To do this you must have been able to previously setup an active serial communication link between the ToolKit service tool and the ProTech device. The tool can be open or closed at this point, but it should not have an active communication link to the Protech.

In the GAP menu File/Compile/ProTech/MicroNetSM Port, type in the correct COM port number – this should be the same COM port that the service tool used. Typical laptops today do not have serial ports so usually a USB-to-Serial convertor is used, which may be assigned to a port other than COM1.

Next select File/Compile/Create and Upload .wset file and the GAP will run through the following steps –

1. Prompt for the correct Sid specification (press OK)
2. Perform the completeness check
3. Prompt for the ProTech password (default = AAAAAA then OK)
4. Identify the module (A, B, or C) and Load the correct .wset file
5. Retrieve the CRC Fingerprint from that module and load it into the GAP SYS_INFO block
6. Show completeness check dialog box with 4 completed steps

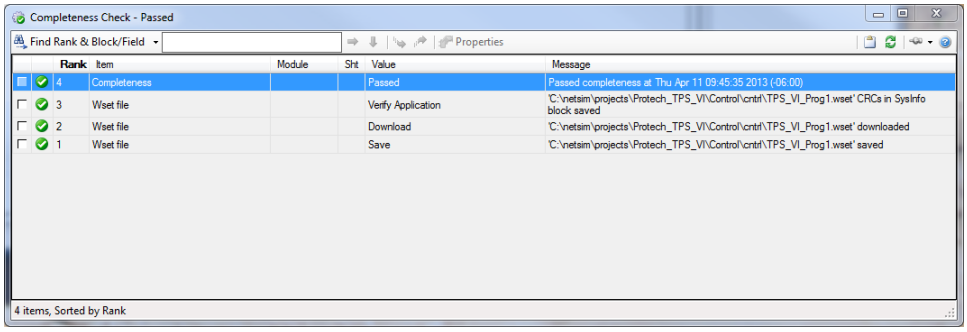


Figure 4-2. Successful GAP upload to ProTech

You will need to do this 1 module at a time on TPS/MSM, however the GAP tool will know which settings file to load and return the “CRC Fingerprint” information of the module that was loaded into the SYS_INFO block in the GAP program.

CRC Fingerprint

It can be extremely critical for a customer, especially an OEM with a unit under warranty, to have absolute confirmation of the settings in a SIL3 safety device protecting their rotating equipment. The ProTech CRC Fingerprint does this by automatically documenting these verification codes in the GAP program.

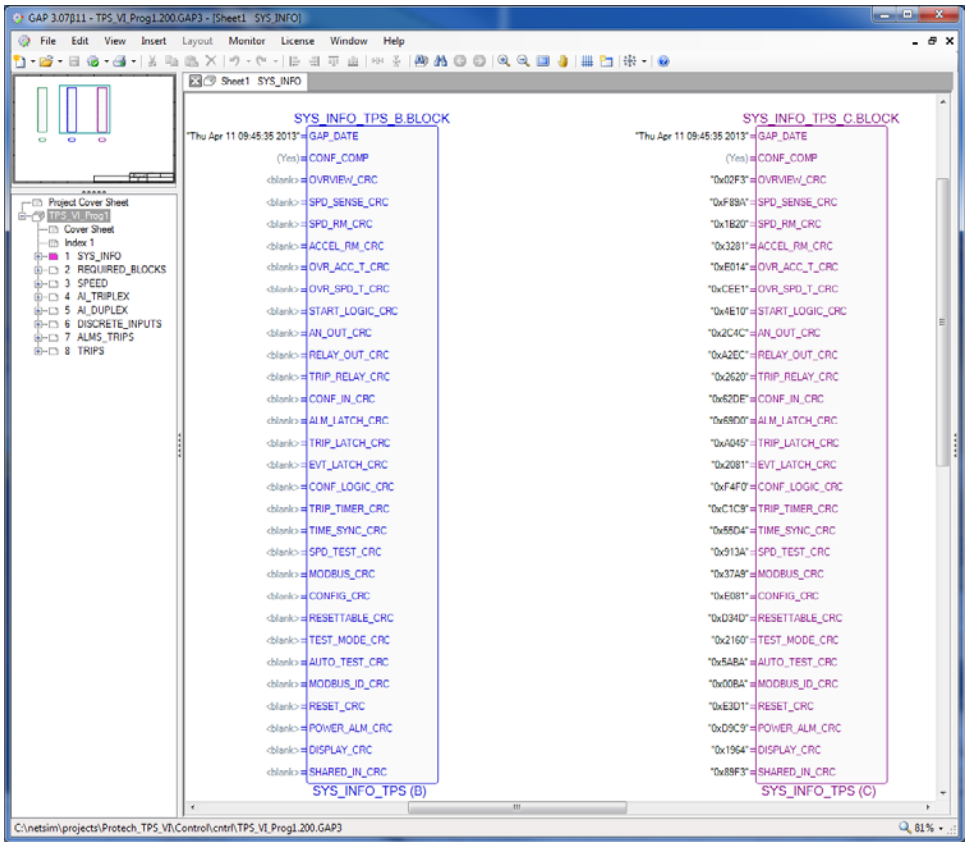


Figure 4-3. CRC Fingerprint Module C (B not loaded)

Once all modules have been loaded and all CRC’s retrieved the GAP will automatically save the file with these secure values in the SYS_INFO blocks.

Note: If any change is made to the GAP after this and the GAP is saved again (even just adding comments), the CRC codes will be blanked out since there is no longer absolute assurance that the GAP is identical to the settings in the ProTech.

CRC Differences

If all of the logic (including input & output signals, Home screen declarations, alarm & trip latches….) is exactly the same, it is possible that the CRC codes between the three modules (TPS/MSM) will be identical.

However, it is most likely that the CRC codes between the modules will be different. This is due to the fact that there will likely be slight logic gate variations between modules to correctly annunciate signal faults in the system and clarify the health status of redundancy manager blocks in all modules. For example, if only two analog input signals are available (instead of 3) for a SIF – then there will be a difference between the settings in the three kernels.

As you can see from the screen shot below, the GAP date and time are identical, but the Overview CRC code is different between the three modules. If you check down the list of program sections, you will see that the only difference between the three is the DISPLAY_CRC code, meaning that the Home Screen block has some different assignments in their input fields.

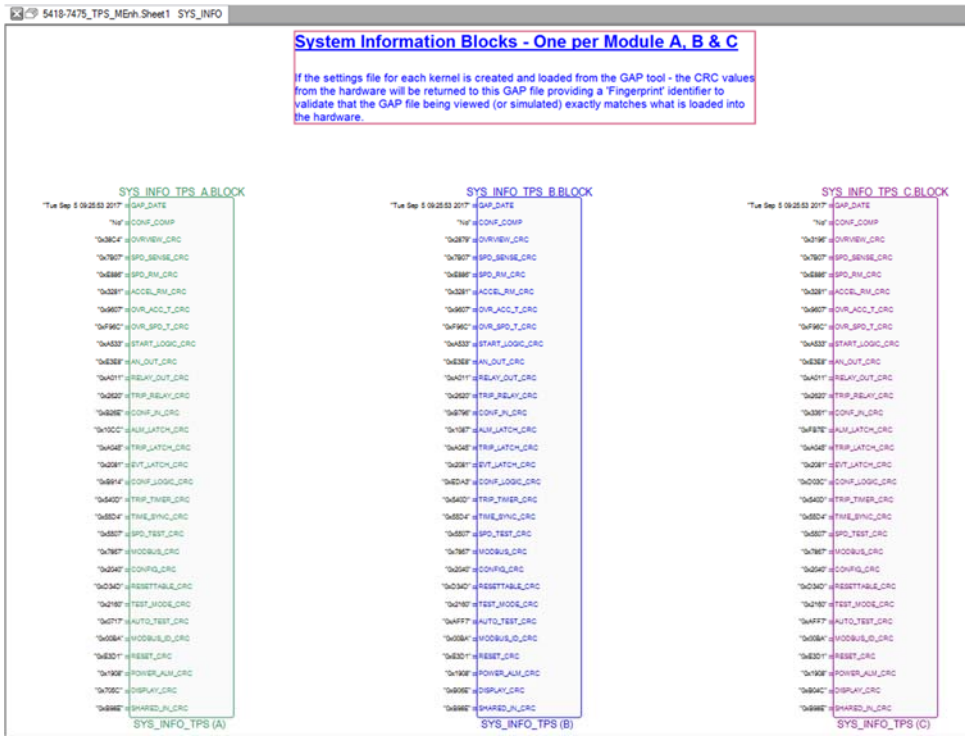


Figure 4-4. CRC Fingerprint on All Modules

There is an input setting on the SYS_INFO block to enable (Yes) or disable (No) the module to module configuration comparison alarm. It should be noted that unique Signal identifiers, like DeviceTag ID's or Input descriptions are NOT considered in the CRC codes. These items are expected to be different between the modules so that field signals can be clearly identified.

Chapter 5.
Logic Simulation Using NetSim

Sequence Steps to Simulate Using NetSim

Compile the GAP

Once you have a complete application that passes the Completeness Check, you are ready to create simulation code that can run on your laptop so you can test the application you have created. This simulation package will give the developer the ability to see live values in the GAP program. Using NetSim the developer can manipulate inputs into the application, and view the results. This is useful in de-bugging the application, before loading and testing it out on the actual hardware. This simulation tool is NOT a substitute for testing all of the functionality on the target device.

NOTICE

This Logic simulation package is intended to help the developer de-bug and test the application. The final application MUST be tested on the actual hardware to ensure that all safety functions operate as intended.

Using the File menu, select Compile/Compile for Simulation/Code with CoderSim.

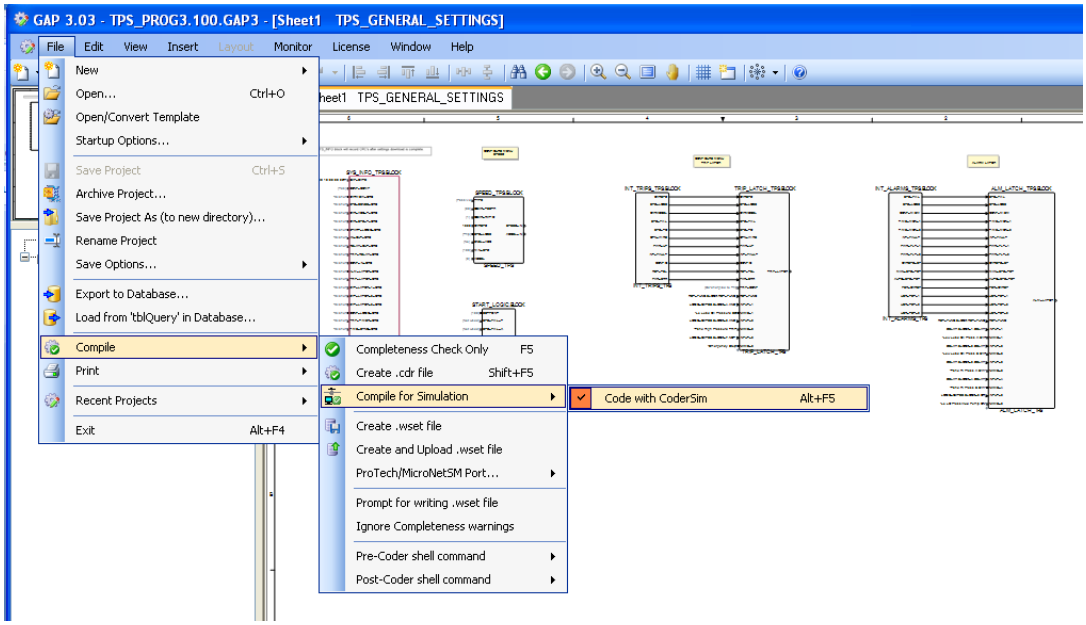


Figure 5-1. GAP Menu Selection to Create NetSim Code

This tool will open a completeness check box and then coder box (like shown below) and create a file that NetSim can use to simulate the GAP program that was created.

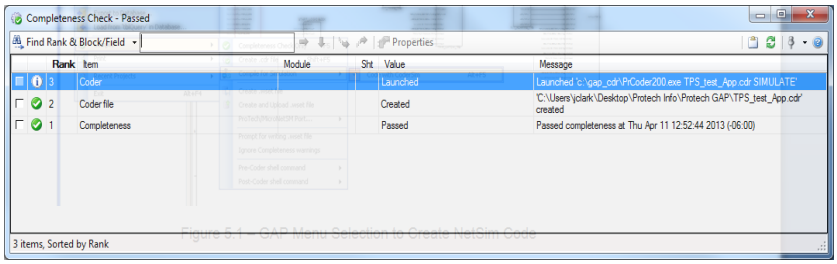


Figure 5-2. GAP Completeness Check and coder Launch

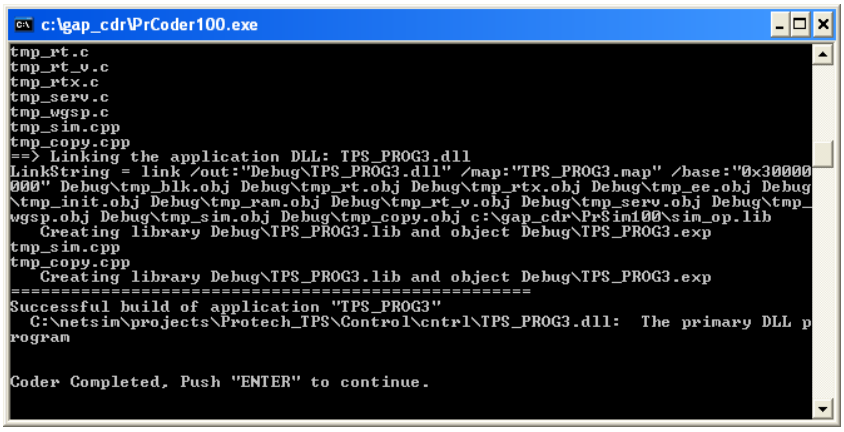


Figure 5-3. GAP Coder Dialog Box

Constructing the Simulation IO Database

These next steps will create a database map for NetSim. This will provide NetSim handles for manipulating inputs and observing outputs in NetSim during simulation.
Launch the Keystone tool from the Start/All Programs/NetSim programs folder and the following dialog box should appear.

Note: This step is only required when Input or Output Signal blocks have been added or deleted. It is not necessary to re-run keystone if only logic block changes have been made to the program.

Click the **Control 1** button (**Location 1** in older versions) and use the browser window to locate the directory/folder where your GAP program file is located. Click OK on the desired folder and it will load that path into the window as shown below.

Note: If the path does not appear in the window to the right of the location button, verify that you have compiled and that the location folder contains the files tmp_itab & tmp_otab.

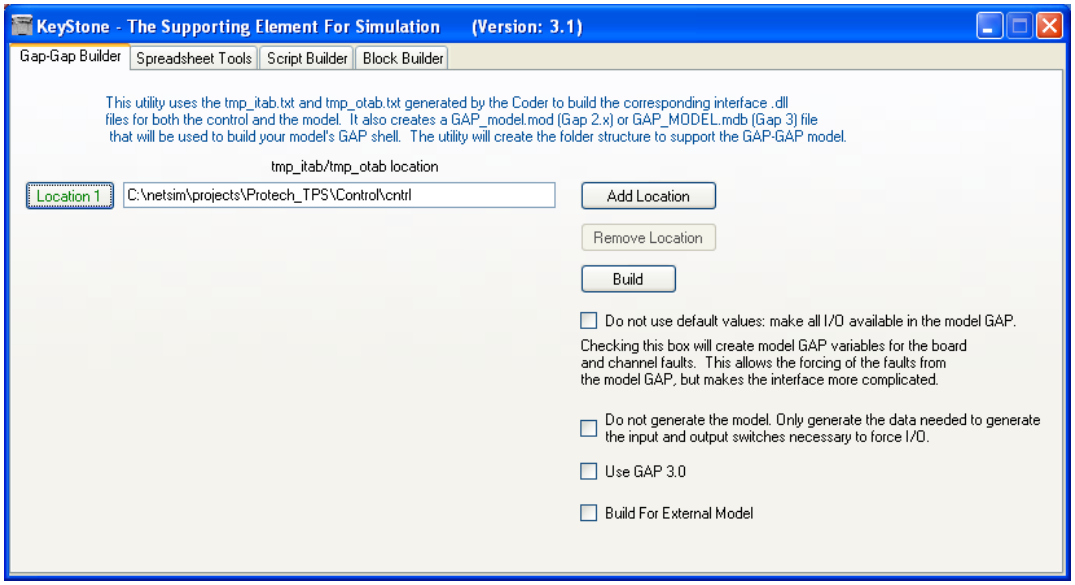


Figure 5-4. NetSim (ver 3.1) Keystone Box

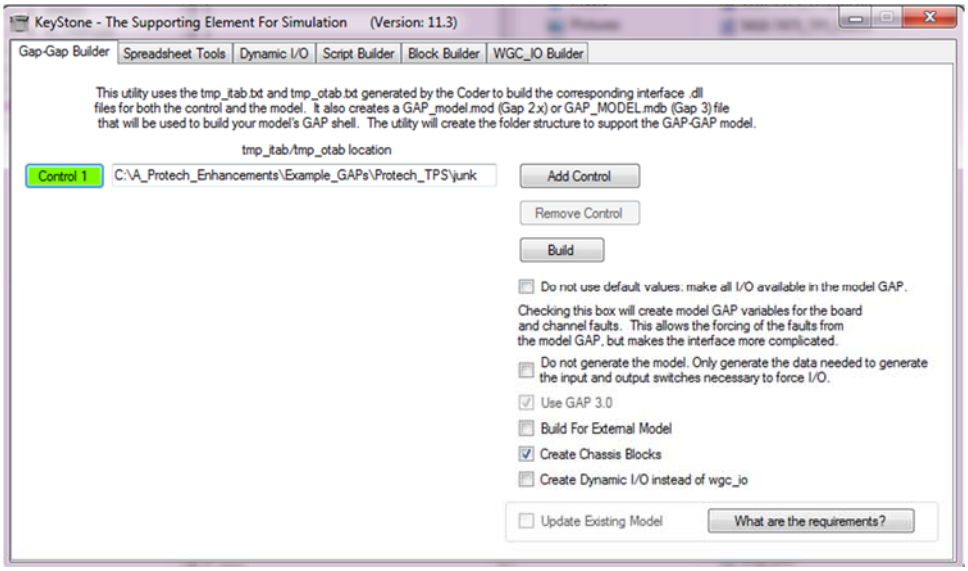


Figure 5-5. NetSim (ver 11.3.0) Keystone Box

Click the Build button and Keystone will create the necessary files to use in the following steps. Keystone builds input and output tabs for NetSim (shown in Figure 5-16 below).

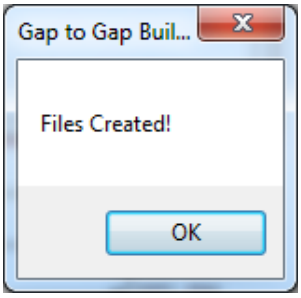


Figure 5-6. NetSim Keystone Build Complete

Note: If you have not programmed any RELAY_OUT block (relay outputs) Keystone will display this error message below. This will not prevent the simulation from working; it is only an indication that there will not be an Output Switches tab in NetSim.

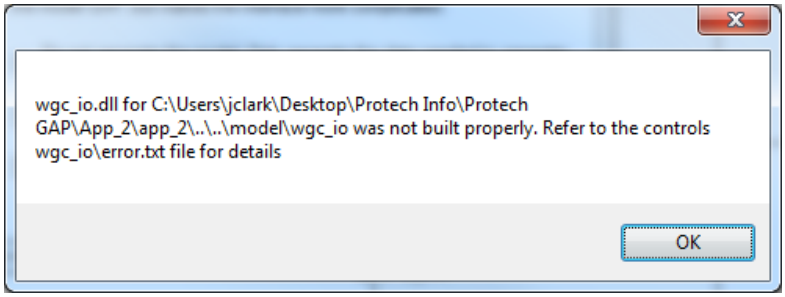


Figure 5-7. Keystone Error Pop-Up

When this is complete, close this dialog box, return to GAP.

Testing via Simulation with Monitor GAP

From the Monitor menu, Select Monitor/Simulate ► Simulate (NetSim).This will open a NetSim Control Executive (NetSimCE) dialog box like one of the figures below, depending on your operating system.

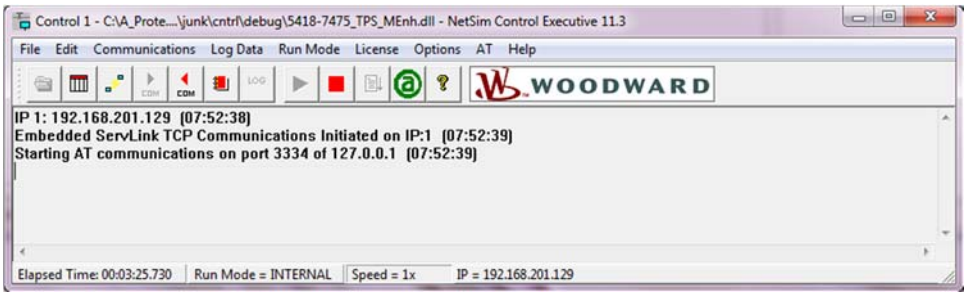


Figure 5-8. NetSimCE Window (Windows XP OS)

To populate live values on your GAP program, follow one of the following procedures, depending on your computer's Operating System.

To Stop communications:
Click the ◄COM arrow if red, to stop communications
(If the ►COM arrow is green, then Communications are already stopped)

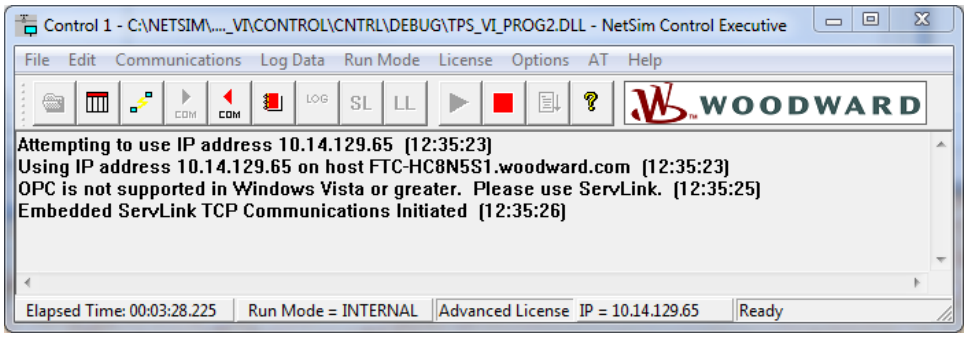


Figure 5-9. NetSimCE Start and Stop Communications

Go to the communications menu and select configure. In the Communication Setup window click on Servlink port, click the Enable box and select TCP as the medium as shown below.

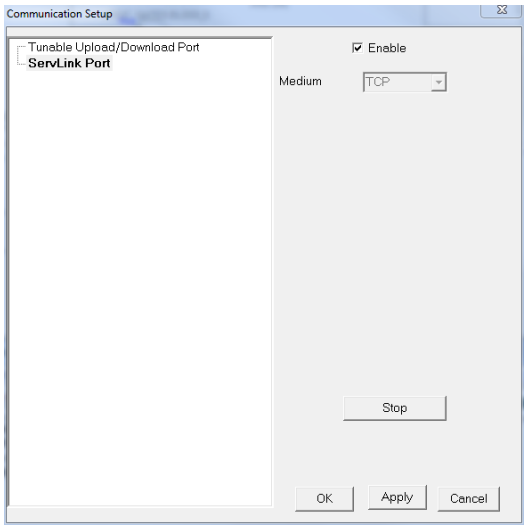


Figure 5-10. NetSimCE Communication Window

Click Apply, then OK. Now start communications (►COM)

For XP –
Nothing else is required, simulated values should appear in GAP.

For Windows 7 –
The Woodward SOS Servlink OPC Server must be used. This tool should launch automatically when Simulate mode was launched above. More explanation of SOS is given later in this chapter

The GAP program should now show live values at the inputs/outputs of each program block, as shown below.

> **Note:** Monitoring of live values is only possible in simulate mode—it is not possible to connect to the ProTech and see live values.

If there are not live values being displayed, follow the steps below.

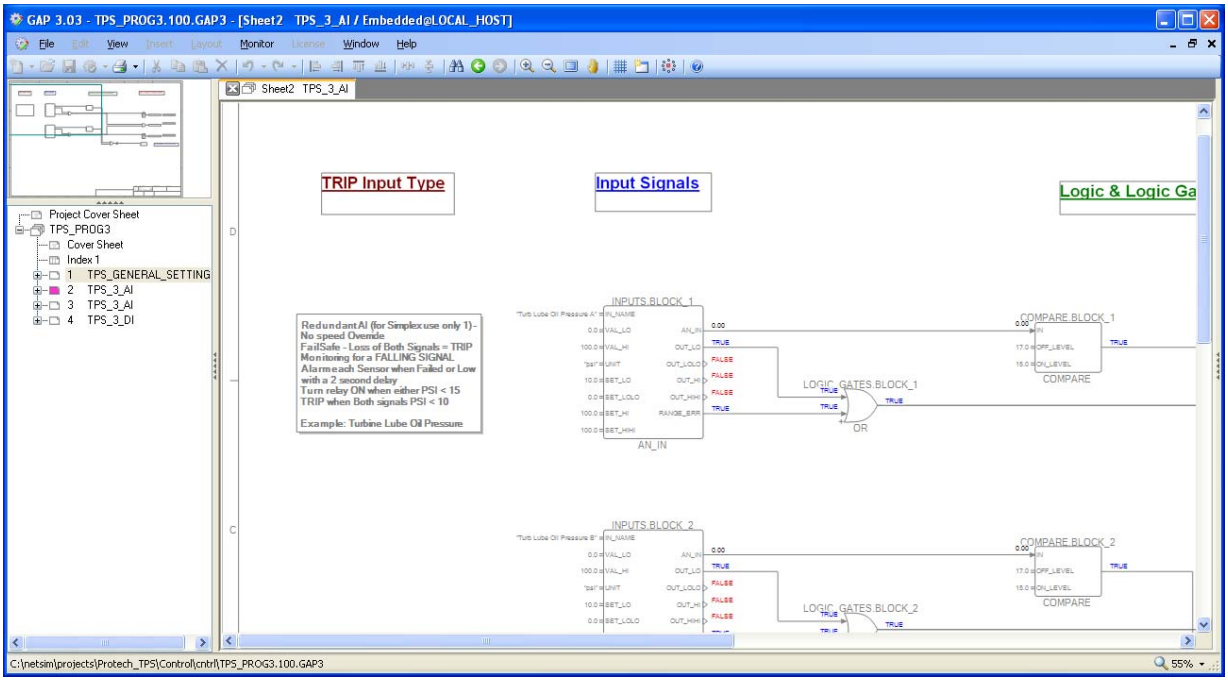


Figure 5-11. GAP in Monitor/Simulate Mode

Manually Starting SOS Servlink OPC Server

First check and see if the SOS Servlink OPC Server is running. This program will run in the icon tray. If the icon is present in the tray, right click and select Show.

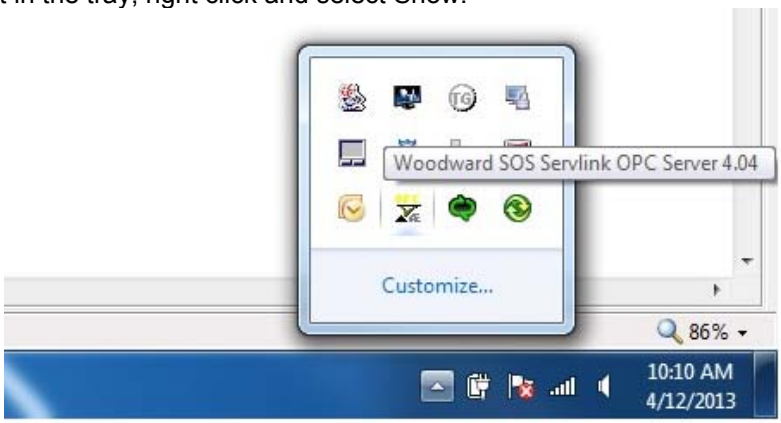


Figure 5-12. GAP in Monitor/Simulate Mode

If the SOS server did not launch, open the server under Start/All Programs/Woodward/SOS Servlink OPC Server and select the Servlink OPC Server icon.

You may get a cyber-security pop-up box (required for connecting to secure controls) that does not apply to the ProTech. Just click OK (no user name or password needed) and ignore the error about finding no secure controls.

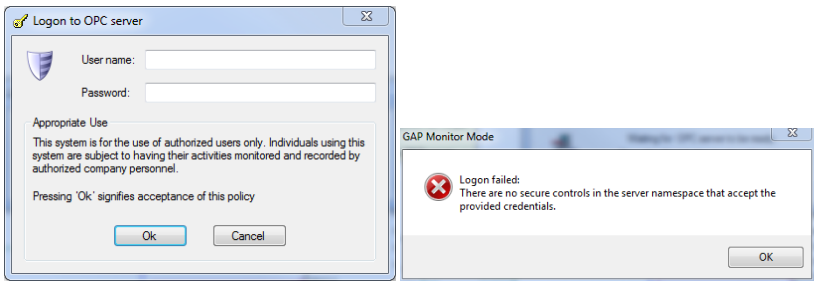


Figure 5-13. Cybersecure Pop-up & Error Box

Note: The SOS should automatically connect to the IP address that appears in NetSimCE window (see Figure 5-8 above).

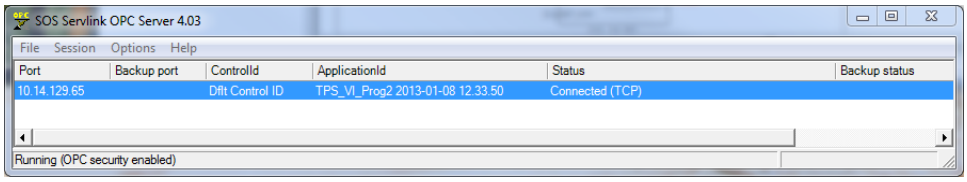


Figure 5-14. SOS Servlink OPC Server Window

If not click on the port and select Session/Modify. This will open a dialog box to enter the IP (as shown in your NetSimCE window). If not automatically connected, select Session/Connect.

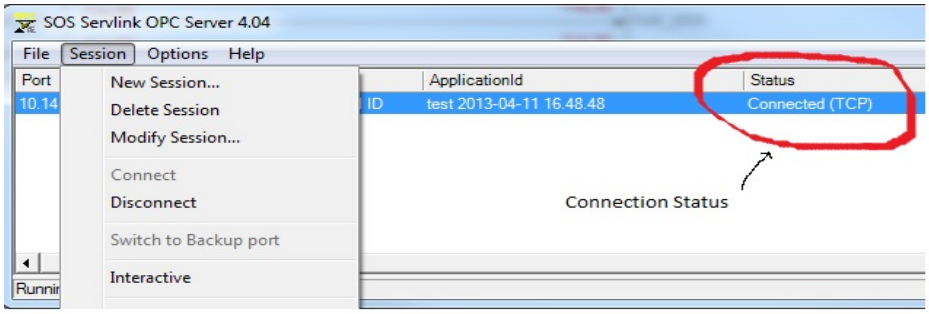


Figure 5-15. SOS Servlink OPC Server Window

To simulate the action of the logic, the input signals can be forced to desired values using the NetSimCE.

Go to the NetSimCE window and Select Variables from the Edit menu. A dialog box with multiple tabs will open. Select the Input Switches tab and you should see a list of the input signals that have been programmed.

Analog example: to set the INPUTS.BLOCK_3 value to 50 (these are scaled units based on the Val_Hi and Val_Lo values, 0-100% in this case), double click on this block in the list and enter a value of 50 as shown below. The buttons at the bottom of this window can be used to clear these manual override values.

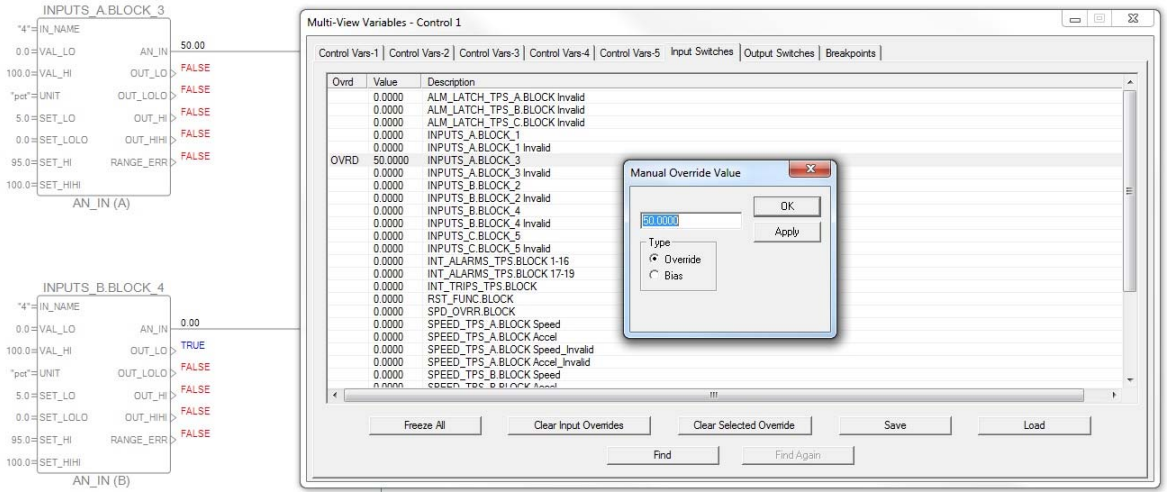


Figure 5-16. NetSim Multi-View Variables Window

Discrete example: to set the INPUTS.BLOCK_1 value to True, double click on this block in the list and enter a value of 1 as shown below (1 = True, 0 = False). The buttons at the bottom of this window can be used to clear these manual override values.

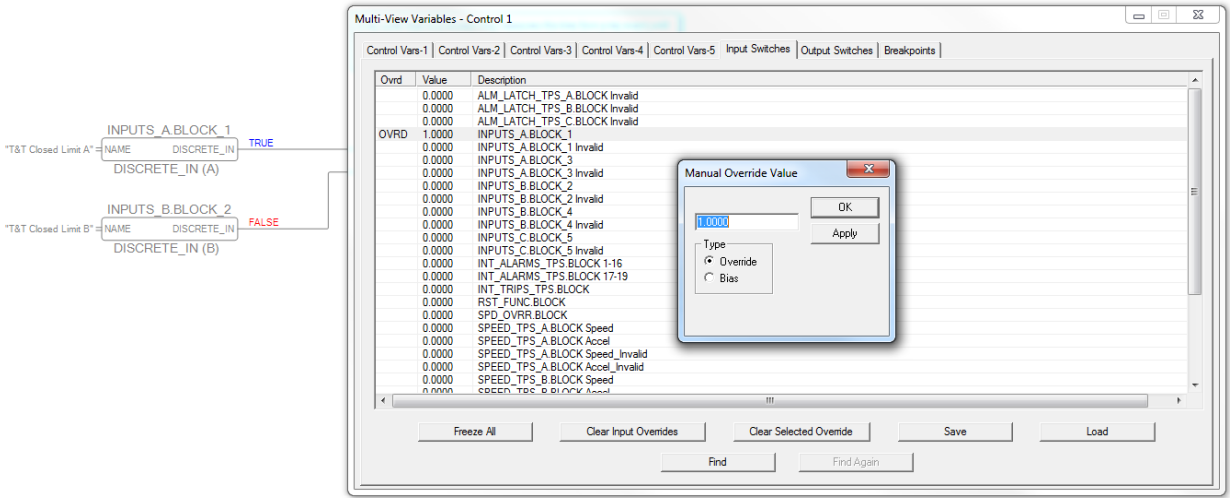


Figure 5-17. NetSim Multi-View Variables Window

Chapter 6.
Application Examples

Overview

The example programs that are provided are intended to help the programmer by showing typical application functions that can be programmed into the ProTech. There are examples using the SX (Simplex Module) and the ProTech TPS (Triplicated Modules) units. The TPS logic can be easily used in an MSM as well.

These example programs are available to be downloaded from Woodward's Internet website: www.woodward.com/software. Search for Protech and you should find a Protech GAP Examples file available for download.

Each program contains multiple examples of Safety Instrumented Functions (SIF) using simplex, redundant and triplicated input signals (both analog and discrete contacts). The input signals are listed with a description of the primary and secondary actions that the logic will trigger, specifically alarms, trips or activation of the customizable relay outputs.

In these GAP examples the first couple of pages of each of these programs contain GAP blocks for the standard/typical Protech settings of:

- Speed Inputs & Settings
- Start Logic Options
- Dedicated Discrete Input Signals (Reset, Start, Speed Signal Override)

While it is not required to include these blocks custom programming, it is a 'best practice' to include these in any GAP program. This is because the settings files generated by the GAP (*filename.wset*) will overwrite all previous settings when loaded into the hardware. Including them in the GAP program will insure that the Protech has all information in the file for standard Protech functions in addition to the custom logic.

Example #1—Application SX_PROG1_DI –
Discrete Input Trips into an SX Unit

Inputs to the Unit

The following table shows the inputs configured for this Program. Under the discrete input channel is the custom tag that was used in this program.

This program includes logic examples for:

- Simplex DI's—Channel 1 and 2
- Redundant DI's—Channels 3 &4 (Loss of both signals results in a TRIP – 2 of 2)
- Triplicated DI's—Channels 5,6 &7 (Loss of any 2 signals results in a TRIP – 2 of 3)

Table 6-1 Inputs Configured for Application SX_PROG1_DI

Channel	Description	Primary Function	Secondary Function
DI #1	Local ESTOP Pushbutton	TRIP on Loss of input	none
DI #2	Low Lube Oil Pressure Switch	TRIP on Loss of input Override when speed OVRD is True	none
DI #3	Vibration Summary Trip Switch A	TRIP on Loss of both A & B (2 of 2) inputs (immediate)	Alarm w/ a 2 sec delay on s/w Diff
DI #4	Vibration Summary Trip Switch B		
DI #5	Pressure Vessel Hi Level Switch A	TRIP on Loss of any 2 out of 3 inputs (immediate)	Alarm w/ a 2 sec delay on any s/w different than other 2
DI #6	Pressure Vessel Hi Level Switch B		
DI #7	Pressure Vessel Hi Level Switch C		

Custom Tags entered for these inputs:

DI #1 ESTOP
DI #2 Lube Oil Pressure
DI #3 VibSys_Trip_A
DI #4 VibSys_Trip_B
DI #5 HP Tank SHH1234_A
DI #6 HP Tank SHH1234_B
DI #7 HP Tank SHH1234_C

Three DI Safety Functions Detailed in This Example Program

ESTOP & Turbine Lube Oil Pressure Example (DI #1 & DI #2) -

Simplex Discrete Input for ESTOP
Simplex DI for Low Lube Oil Pressure

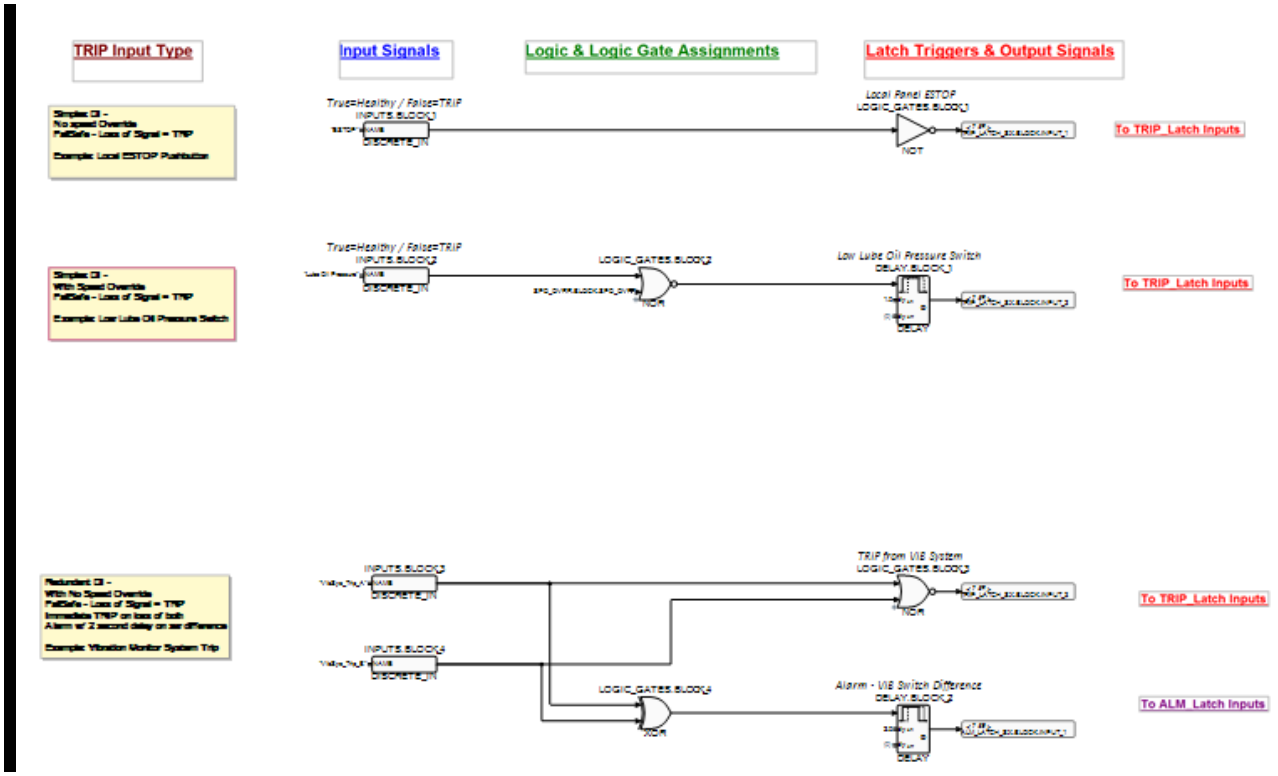


Figure 6-1 DI Safety Function Ilustration

TRIP on the following scenarios:
- ESTOP DI goes Low (FALSE)
- Lube Oil Pressure DI goes Low (FALSE) AND the Speed Failed Override Input is Low (FALSE)

ALARM the following conditions:
NO Alarms related to these Inputs

Annunciations:
When TRIP for DI #1 - annunciate TRIP on **"Local Panel ESTOP"**.
When TRIP for DI #2 - annunciate TRIP on **"Low Lube Oil Pressure SW"**.

Trip from Vibration System Commands Example (DI #3 & DI #4) -
Redundant Discrete Inputs from a Vibration System

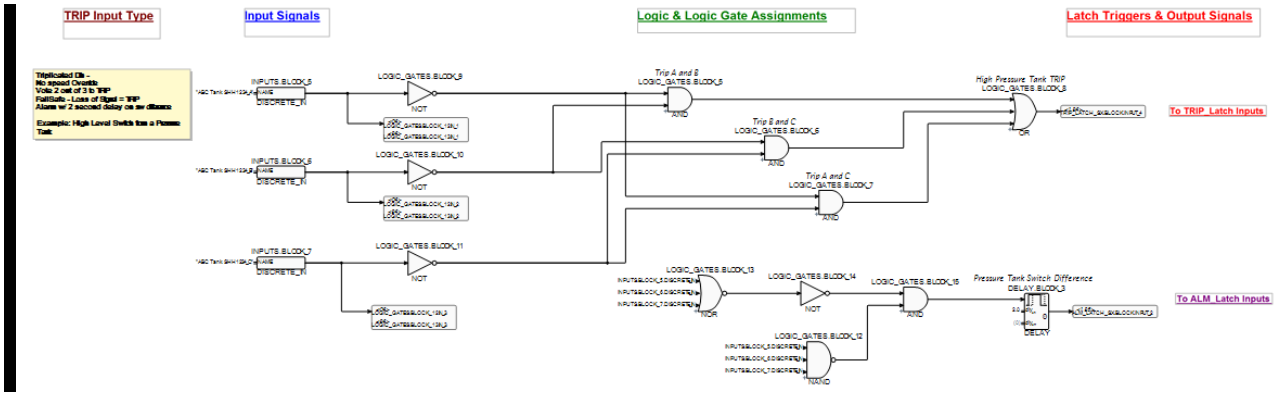


Figure 6-2 Redundant Discrete Inputs from a Vibration System

TRIP on the following scenarios:
BOTH DI go Low (FALSE) AND the Speed Failed Override Input is Low (FALSE) AND the Unit Speed is greater than 500 rpm

ALARM the following conditions:
If the 2 DI's are in different states for more than two seconds

Annunciations:
When TRIPPED - annunciate **"Trip from VIB System"**.
When ALARMING - annunciate **"VIB Switch Difference"**.

Trip from High Pressure Tank Level Switches Example (DI #5, #6 & #7) -
Triplex Discrete Inputs from a Vibration System

TRIP on the following scenarios:
If any two out of the three DI's go Low (FALSE)

ALARM the following conditions:
If any of the three DI's are in a different state than the other two for more than two seconds

Annunciations:
When TRIPPED - annunciate **"High Pressure Tank Trip"**.
When ALARMING - annunciate **"Pressure Tank SW Diff"**.

Outputs from the Unit:

The message indications below are custom messages that have been added to the Trip and Alarm Latch and Log functions in the ProTech.

Custom TRIP indications:

Local Panel ESTOP
Low Lube Oil Pressure SW
TRIP from VIB System
High Pressure Tank TRIP

Custom ALARM indications:

VIB Switch Difference
Pressure Tank SW Diff

Example #2—Application SX_PROG1_AI – Analog Input Trips into an SX Unit

Speed Settings, Start Logic & Dedicated Signals

Inputs to the Unit

The following table shows the inputs configured for this Program. Under the input channel is the custom tag that was used in this program.

This program includes logic examples for:

- Redundant AI's - Channels 1 &2 (TRIP on Loss of both signals)
- Redundant AI's – Channels 3 &4 (TRIP on Loss of both signals)
- Triplicated AI's – Channels 5,6 &7 (TRIP on Loss of any 2 signals / 2 of 3)

Table 6-2 Channel Descriptions, Primary Functions, and Secondary Functions

Channel	Description	Primary Functions	Secondary Functions
AI #1	Turbine Lube Oil Pressure A	TRIP on Loss of both A & B (2 of 2) inputs (immediate) TRIP if both signals fall below Low Limit Setpoint of 8 psia	Alarm w/ a 2 sec delay single sensor fault Alarm w/ a 1 sec delay single sensor below low limit setpoint but not failed Alarm & Energize relay output if either sensor falls below alarm setpoint of pressure < 12 psia
AI #2	Turbine Lube Oil Pressure B		
AI #3	High Pressure Tank Level A	TRIP on Loss of both A & B (2 of 2) inputs (immediate) TRIP if both signals rise above High Limit Setpoint of 90%	Alarm w/ a 2 sec delay single sensor fault Alarm w/ a 5 sec delay single sensor above high limit setpoint Alarm if either sensor rises above alarm setpoint of 80%
AI #4	High Pressure Tank Level B		
AI #5	HP Vessel Pressure Sensor A	TRIP on Loss of any 2 out of 3 inputs (immediate)	Alarm w/ a 1 sec delay single sensor above high limit setpoint Alarm w/ a 2 sec delay single sensor fault Alarm & Energize relay output if any sensor rises above alarm setpoint w/ 1 sec delay
AI #6	HP Vessel Pressure Sensor B		
AI #7	HP Vessel Pressure Sensor C		

Custom Tags entered for these inputs:

AI #1	**Turb Lube Oil Pressure A**
AI #2	**Turb Lube Oil Pressure B**
AI #3	**Hi PressTank Level A**
AI #4	**Hi PressTank Level B**
AI #5	**HP Vessel Press A**
AI #6	**HP Vessel Press B**
AI #7	**HP Vessel Press C**

Three Safety Functions Detailed in This Example Program

Turbine Lube Oil Pressure Example (AI #1 & AI #2) - LUBEOIL

Redundant Analog inputs for this signal
Both analog inputs are ranged for 0–100 psia
Trip Level Setpoint = 8 psia
Alarm Level Setpoint = 12 psia

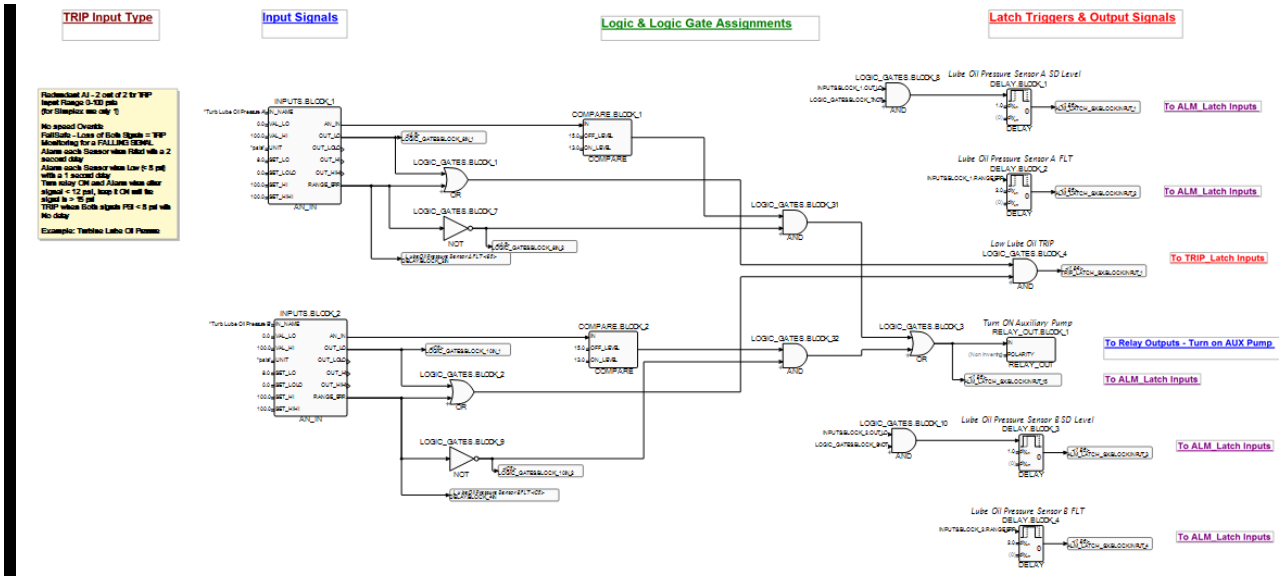


Figure 6-3 Safety Functions Flow Schematic

TRIP on three scenarios:

- Both signals Fail (2 out of 2 Vote to TRIP)
- Both signals fall below 8 psia
- Both signals in 1 of the above conditions

** For the second condition—If the requirement is for the Trip to occur if EITHER signal falls below 8 psia, then the LOGIC_GATES.BLOCK_4.AND block can be changed to an OR block.

ALARM the following conditions:

- Each sensor if out of range (2 ma & 22 ma) for > 2 seconds
- Each sensor if signal is below Trip level setpoint for >1 second

Additional functional requirements are as follows:

- When the Alarm level is reached, energize a Relay Output to turn on an Auxiliary Lube Oil Pump.
- Keep this relay output on until the signal level is above 15 psia.

Annunciations:

When Alarm level is reached annunciate **“Lube Oil Low / Aux Pump On**”.

For Failed Sensors, annunciate **“Lube Oil Press Sensor X (A or B) FLT”.**

For one Sensor at Trip Level annunciate **"Lube Oil Press Sensor X (A or B) SD".**

For Trip annunciate **"Low Lube Oil Press or 2 of 2 Failed TRIP**"

Tank Level Indications (AI #3 & AI #4) - TANKLVL

Redundant Analog inputs for this signal
Both analog inputs are ranged for 0–100 percent
Trip Level Setpoint = 90%
Alarm Level Setpoint = 80%

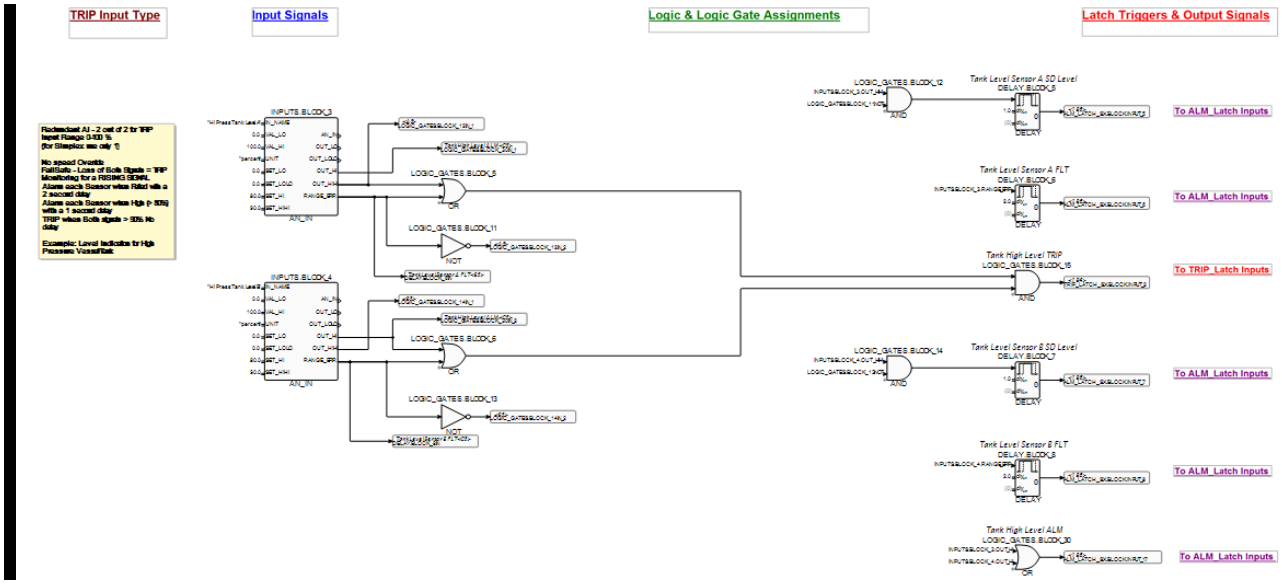


Figure 6-4 Tank Level Indications Schematic

TRIP on three scenarios:

- Both signals Fail (2 out of 2 Vote to TRIP)
- Both signals rise above 90%
- Both signals in 1 of the above conditions

** For the second condition—If the requirement is for the Trip to occur if EITHER signal falls rises above 90%, then the LOGIC_GATES.BLOCK_15.AND block can be changed to an OR block.

ALARM the following conditions:

- Each sensor if out of range (2 ma & 22 ma) for > 2 seconds
- Each sensor if signal is above Trip level setpoint for > 5 second

Annunciations:
When Alarm level is reached annunciate **"Tank High Level ALM**".

For Failed Sensors, annunciate **"Tank Level Sensor X (A or B) FLT".**

For one Sensor at Trip Level annunciate **"Tank Level Sensor X (A or B) SD".**

For Trip annunciate **"Tank Hi Level or 2 of 2 Failed TRIP**"

Pressure Signals from a HP Vessel (AI #5, AI #6 & AI #7)-TANKPR

Triplicated Analog inputs for this signal
All analog inputs are ranged for 0–500 psia
Trip Level Setpoint = 480 psia
Alarm Level Setpoint = 450 psia

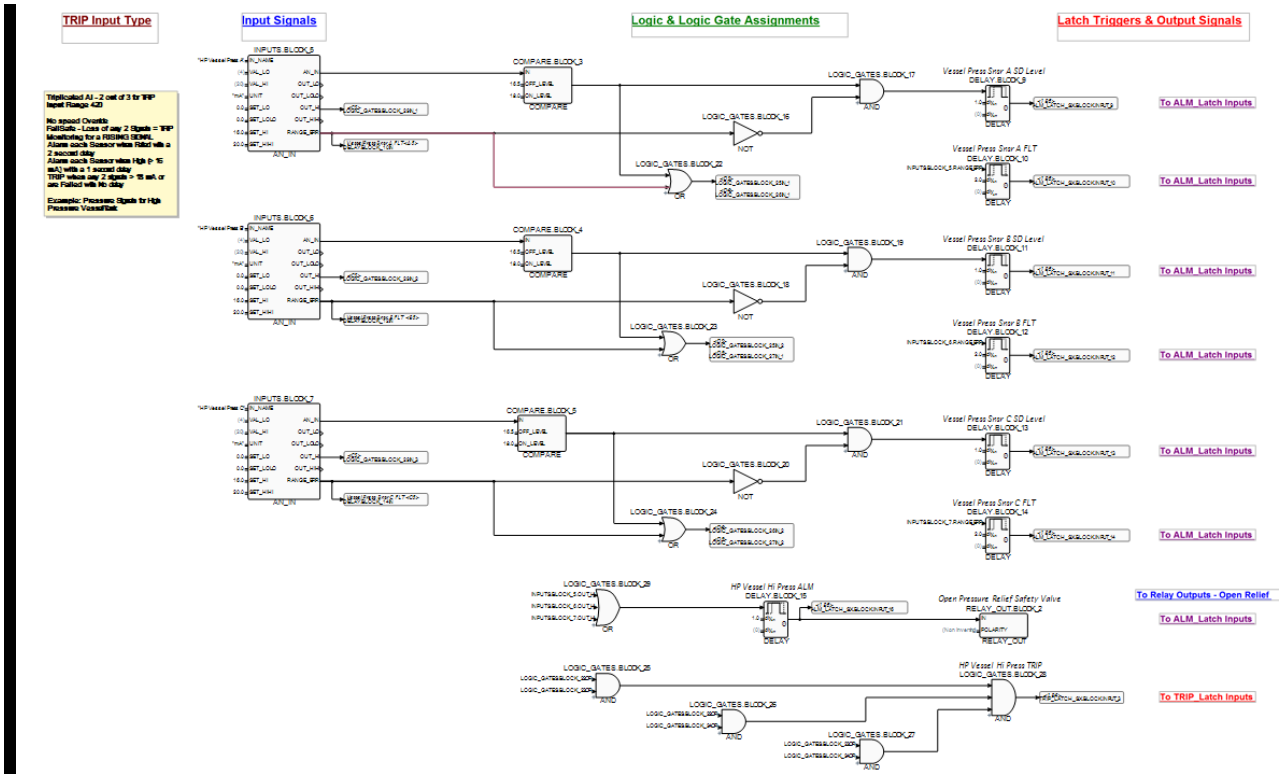


Figure 6-4 HP Vessel Pressure Signals Schematic

TRIP on three scenarios:

- Any 2 out of 3 signals Failed
- Any 2 out of 3 signals above Trip Level setpoint
- Any 2 signals in 1 of the above conditions

ALARM the following conditions:

- Each sensor if out of range (2 ma & 22 ma) for > 2 seconds
- Each sensor if signal is above Trip level setpoint for > 1 second
- Any healthy sensor is > Alarm level setpoint for > 1 second

Additional functional requirements are as follows:
When the Alarm level is reached, energize a Relay Output to turn on an Pressure Relief Safety Valve.

Annunciations:
When Alarm level is reached annunciate **"HP Vessel Hi Press ALM**".

For Failed Sensors, annunciate **"Vessel Press Sensor X (A, B or C) FLT".**

For one Sensor at Trip Level annunciate **"Vessel Hi Press Sensor X (A, B or C) SD".**

For Trip annunciate **"HP Vessel Hi Press or 2 of 3 Failed TRIP**"

Outputs from the Unit

The message indications below are custom messages that have been added to the Trip and Alarm Latch and Log functions in the ProTech.

Custom TRIP indications:

Lo Lube Oil Pressure SD
Tank High Level TRIP
Vessel High Pressure TRIP

Custom ALARM indications:

LubeOil Press Snsr A SD
LubeOil Press Snsr A FLT
LubeOil Press Snsr B SD
LubeOil Press Snsr B FLT
Tank Level Sensor A SD
Tank Level Sensor A FLT
Tank Level Sensor B SD

Tank Level Sensor B FLT
Vessel Press Snsr A SD
Vessel Press Snsr A FLT
Vessel Press Snsr B SD
Vessel Press Snsr B FLT
Vessel Press Snsr C SD
Vessel Press Snsr C FLT
Lo Lube Oil ALM/Aux Pump ON
HP Vessel Hi Press ALM
Tank High Level ALM

Relay Outputs Used

Relay Output #1 Turn ON Auxiliary Pump
Relay Output #2 Open Pressure Relief Safety Valve

Example #3 — 5418-7475_TPS_MEnh.300.GAP3 – Analog & Discrete Input Trips into a TPS Unit

Overview of TPS Program Woodward p/n: 5418-7475

This program was created as an example for a variety of typical safety instrumented (SI) functions. It is available for download from the Woodward.com website and includes the following functional examples:

- Turbine Lube Oil Pressure Monitoring utilizing triplicated AI's – action on falling/low setpoints
- High Pressure Vessel Monitoring utilizing redundant AI's – action on raising/high setpoints
- ESTOP Circuit Trip
- Vibration System Monitoring Trips utilizing triplicated DI's
- Generator Excitation Monitoring utilizing redundant DI's
- Purged Enclosure Pressure Loss (Open Door LS) alarm utilizing a single DI
- Surge Detection Algorithm utilizing redundant AI's – alarming and driving the action of a relay output
- Initiating a Automated Sequence Test of each kernel remotely via a DI
- Monitoring the TRIP valve via Limit Switch DI's that indicate when the Trip valve has closed to capture the 'cycle time' between the de-energizing (or energizing) of the Trip Relay output and the time at which the valve actually closes

This example program can be simulated and tested on a PC using the tools explained in this manual. Customers are welcome to use any parts of this program in their own system, but must modify all settings to match their system and fully validate that the final functionality matches the desired implementation for the specific target machine.

The first few of pages of this example include blocks that are not required for custom programming, but it is best practice to include these in any GAP programming. This will insure that the settings file (5418-7475_TPS_MEnh_A.wset) that is loaded into the Protech has all information in the file for standard Protech functions in addition to the custom logic. For example the configuration of the speed inputs should be included in the GAP so that the final version will contain all settings for the unit.

Inputs to the Unit

The following table shows the inputs configured for this Program. Under the input channel is the custom tag that was used in this program. Triplicated signals are handled with one signal to each kernel module that is programmed on the same channel for each kernel, this is not required, but is a 'best practice' whenever possible.

This program includes logic examples for:

- Triplicated DI's – Channels 1, 2, and 5 on each Module
- Redundant DI's – Channel 3 on Modules A & B
- Simplex DI – Channel 3 on Module C and Channel 4 on Module A
- Triplicated AI's – Channel 6 on each Module
- Redundant AI's – Channel 7 on Modules A and B
- Redundant AI's – Channel 8 on Modules A and B

Custom Tags entered for these inputs:

DI #1 ABC	**ESTOP Circuit**
DI #2 ABC	**Vibration System Trip Signal A, B & C**
DI #3 AB	**Generator Excitation OK Signal A & B**
DI #3 C	**Enclosure Door Panel Limit Switch**
DI #4 A	**Run Periodic Auto Test**
DI #5 ABC	**Limit Switch feedback from Trip Valve A, B & C**
AI #6 ABC	**Lube Oil Pressure Sensor A, B, C**
AI #7 AB	**HP Vessel Level Sensor A & B**
AI #8 AB	**Flow Sensor A & B**

Outputs from the Unit

The message indications below are custom messages that have been added to the Trip and Alarm Latch and Log functions in the ProTech.

Custom TRIP indications:

Lo Lube Oil Pressure TRIP
Lube Oil Sensors Failed TRIP
Tank High Level TRIP
Both Tank Level Sensors Failed TRIP
Vibration System TRIP
ESTOP Circuit TRIP

Custom ALARM indications:

LubeOil Press Sig A Fault
LubeOil Press Sig B Fault
LubeOil Press Sig C Fault
LubeOil Press Snsr Difference
Lo Lube Oil ALM/Aux Pump ON
Tank Level Sensor A Fault
Tank Level Sensor B Fault
Tank Level Sensor Difference
Tank High Level Alarm
Using One Tank Level Sensor
Purged Enclosure Door OPEN
Excitation System Alarm
Vibration System Sig A Diff
Flow Sensor A FLT
Using One Flow Signal

Excessive Surge Alarm

Relay Outputs Used

Relay Output #1 Summary Alarm from Kernel
Relay Output #2 Open Pressure Relief Safety Valve
Relay Output #3 Open Compressor Anti-Surge Valve

NOTICE

When using the Analog Redundancy Manager (ARM) block, the Difference detection logic will only generate an output that can be used for an alarm. It will not remove any signals from the calculation of the output of the block

NOTICE

When a single kernel module is faulted or powered down – the other 2 kernel modules will annunciate an Internal Alarm

Table 6-2 Input Channels, Descriptions, Primary Functions, and Secondary Functions

Channel	Description	Primary Functions	Secondary Functions
DI #1 (ABC)	ESTOP	Emergency Stop Circuit	
DI #2 (ABC)	Vibration System Trips	TRIP on 2 out of 3 inputs lost	Alarm if 1 switch differs from the others for more than 2 seconds
DI #3 (AB)	Generator Excitation OK	Alarm if inputs are NOT True and Speed is > 1000 rpm	No Trips on these
DI #3 (C)	Panel Door Limit Switch	Alarm if Purge Door is Open	Monitor via Modbus
DI #4 (A)	Run Auto/Periodic Test	Operator/DCS initiated auto sequence overspeed test of each kernel, starting with A and document this in TRIP log	
DI #5 (ABC)	Limit Switch from Trip Valve	Monitor Trip Cycle Time (Protech keeps past 20 cycle times in log)	
AI #6 (ABC)	Turbine Lube Oil Pressure (Range 0-100 psia) Validated Output = Median w/ 3 healthy LSS w/ 2 healthy	TRIP on Loss of 2 out of 3 inputs (immediate) TRIP if pressure < 8 psia Alarm each failed sensor with a 2 second delay Alarm individual sensor if highest and lowest sensors differ by more than 10 psia Alarm when Pressure is < 12 psia & clear only when pressure is >15 psia	Energize a relay output (to Turn on Aux Pump) if pressure falls below alarm setpoint of 12 psia
AI #7 (AB)	High Pressure Tank Level (Range 0-100 %) Validated Output = Average w/ 2 healthy Single w/ 1 healthy	TRIP on Loss of both A & B (2 of 2) inputs (immediate) TRIP if average tank level rises above Hi Hi Limit Setpoint of 90% Alarm if average tank level rises above High Limit Setpoint of 85% Alarm each failed sensor with a 2 second delay Alarm if sensors Differ by more than 5% with a 2 second delay,	Energize a relay output (to Open a Vent Valve) if average tank level rises above alarm setpoint of 85%

Channel	Description	Primary Functions	Secondary Functions
AI #8 (AB)	Compressor Flow Sensor (Range 0-20000 scfm) Validated Output = LSS w/ 2 healthy Single w/ 1 healthy	Energize Relay on Loss of both A & B (2 of 2) inputs (immediate) Energize Relay if 3 surge pulses are detected within a period of 20 seconds Alarm each failed sensor with a 2 second delay	Have a counter accumulate all signal pulses detected after the Start signal is received

Making Logic and/or Settings Changes on Units in Operation –

Since the Protech family TPS and MSM models are triplexed systems it is possible to make logic and/or settings changes while the unit is in operation on a running turbine. Typically this is useful for making minor changes such as an alarm or trip level but is also useful when logic is designed to trigger actions based on 'live' values that may be difficult to simulate (such as a flow derivative threshold value).

If 'online' configuration changes are expected to be done, it is recommended to plan for a convenient way to trip individual kernel modules. As shown in the ESTOP example (using Channel #1 DI) above, connect these inputs to individual switches instead of the same pushbutton.

For example: To adjust the High Pressure Tank Trip level in the above program from 90% to 92% while the unit is running, the following procedure would be done.

1. Connect the Toolkit service tool to one of the Kernel Modules (A)
2. Check that all three modules are healthy (not tripped) and check any alarm conditions to insure that tripping a single module will not trip the system.
3. Trip Module A
4. Go to Edit/View configuration
5. Go to page titled 'Math Functions – Constant Blocks' and adjust Block #2 from current value (90) to the desired value (92) and click Apply
6. After new settings are loaded, press the Reset keypad button on this module and check that all 3 modules are again healthy
7. Repeat this process with next 2 modules (B & C)

Chapter 7.
Product Support and Service Options

Product Support Options

If you are experiencing problems with the installation, or unsatisfactory performance of a Woodward product, the following options are available:

- Consult the troubleshooting guide in the manual.
- Contact the manufacturer or packager of your system.
- Contact the Woodward Full Service Distributor serving your area.
- Contact Woodward technical assistance (see “How to Contact Woodward” later in this chapter) and discuss your problem. In many cases, your problem can be resolved over the phone. If not, you can select which course of action to pursue based on the available services listed in this chapter.

OEM or Packager Support: Many Woodward controls and control devices are installed into the equipment system and programmed by an Original Equipment Manufacturer (OEM) or Equipment Packager at their factory. In some cases, the programming is password-protected by the OEM or packager, and they are the best source for product service and support. Warranty service for Woodward products shipped with an equipment system should also be handled through the OEM or Packager. Please review your equipment system documentation for details.

Woodward Business Partner Support: Woodward works with and supports a global network of independent business partners whose mission is to serve the users of Woodward controls, as described here:

- A **Full Service Distributor** has the primary responsibility for sales, service, system integration solutions, technical desk support, and aftermarket marketing of standard Woodward products within a specific geographic area and market segment.
- An **Authorized Independent Service Facility (AISF)** provides authorized service that includes repairs, repair parts, and warranty service on Woodward's behalf. Service (not new unit sales) is an AISF's primary mission.
- A **Recognized Turbine Retrofitter (RTR)** is an independent company that does both steam and gas turbine control retrofits and upgrades globally, and can provide the full line of Woodward systems and components for the retrofits and overhauls, long term service contracts, emergency repairs, etc.

A current list of Woodward Business Partners is available at **www.woodward.com/directory**.

Product Service Options

The following factory options for servicing Woodward products are available through your local Full-Service Distributor or the OEM or Packager of the equipment system, based on the standard Woodward Product and Service Warranty (5-01-1205) that is in effect at the time the product is originally shipped from Woodward or a service is performed:

- Replacement/Exchange (24-hour service)
- Flat Rate Repair
- Flat Rate Remanufacture

Replacement/Exchange: Replacement/Exchange is a premium program designed for the user who is in need of immediate service. It allows you to request and receive a like-new replacement unit in minimum time (usually within 24 hours of the request), providing a suitable unit is available at the time of the request, thereby minimizing costly downtime. This is a flat-rate program and includes the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205).

This option allows you to call your Full-Service Distributor in the event of an unexpected outage, or in advance of a scheduled outage, to request a replacement control unit. If the unit is available at the time of the call, it can usually be shipped out within 24 hours. You replace your field control unit with the like-new replacement and return the field unit to the Full-Service Distributor.

Charges for the Replacement/Exchange service are based on a flat rate plus shipping expenses. You are invoiced the flat rate replacement/exchange charge plus a core charge at the time the replacement unit is shipped. If the core (field unit) is returned within 60 days, a credit for the core charge will be issued.

Flat Rate Repair: Flat Rate Repair is available for the majority of standard products in the field. This program offers you repair service for your products with the advantage of knowing in advance what the cost will be. All repair work carries the standard Woodward service warranty (Woodward Product and Service Warranty 5-01-1205) on replaced parts and labor.

Flat Rate Remanufacture: Flat Rate Remanufacture is very similar to the Flat Rate Repair option with the exception that the unit will be returned to you in “like-new” condition and carry with it the full standard Woodward product warranty (Woodward Product and Service Warranty 5-01-1205). This option is applicable to mechanical products only.

Returning Equipment for Repair

If a control (or any part of an electronic control) is to be returned for repair, please contact your Full-Service Distributor in advance to obtain Return Authorization and shipping instructions.

When shipping the item(s), attach a tag with the following information:
- Return authorization number
- Name and location where the control is installed
- Name and phone number of contact person
- Complete Woodward part number(s) and serial number(s)
- Description of the problem
- Instructions describing the desired type of repair

Packing a Control

Use the following materials when returning a complete control:
- Protective caps on any connectors
- Antistatic protective bags on all electronic modules
- Packing materials that will not damage the surface of the unit
- At least 100 mm (4 inches) of tightly packed, industry-approved packing material
- A packing carton with double walls
- A strong tape around the outside of the carton for increased strength

NOTICE

To prevent damage to electronic components caused by improper handling, read and observe the precautions in Woodward manual 82715, *Guide for Handling and Protection of Electronic Controls, Printed Circuit Boards, and Modules*.

Replacement Parts

When ordering replacement parts for controls, include the following information:

- The part number(s) (XXXX-XXXX) that is on the enclosure nameplate
- The unit serial number, which is also on the nameplate

Engineering Services

Woodward offers various Engineering Services for our products. For these services, you can contact us by telephone, by email, or through the Woodward website.

- Technical Support
- Product Training
- Field Service

Technical Support is available from your equipment system supplier, your local Full-Service Distributor, or from many of Woodward's worldwide locations, depending upon the product and application. This service can assist you with technical questions or problem solving during the normal business hours of the Woodward location you contact. Emergency assistance is also available during non-business hours by phoning Woodward and stating the urgency of your problem.

Product Training is available as standard classes at many of our worldwide locations. We also offer customized classes, which can be tailored to your needs and can be held at one of our locations or at your site. This training, conducted by experienced personnel, will assure that you will be able to maintain system reliability and availability.

Field Service engineering on-site support is available, depending on the product and location, from many of our worldwide locations or from one of our Full-Service Distributors. The field engineers are experienced both on Woodward products as well as on much of the non-Woodward equipment with which our products interface.

For information on these services, please contact us via telephone, email us, or use our website: **www.woodward.com**.

Contacting Woodward's Support Organization

For the name of your nearest Woodward Full-Service Distributor or service facility, please consult our worldwide directory at **www.woodward.com/directory**, which also contains the most current product support and contact information.

You can also contact the Woodward Customer Service Department at one of the following Woodward facilities to obtain the address and phone number of the nearest facility at which you can obtain information and service.

Products Used in Electrical Power Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany:	
Kempen	+49 (0) 21 52 14 51
Stuttgart	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Products Used in Engine Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
Germany	+49 (711) 78954-510
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
United States	+1 (970) 482-5811

Products Used in Industrial Turbomachinery Systems

Facility	Phone Number
Brazil	+55 (19) 3708 4800
China	+86 (512) 6762 6727
India	+91 (124) 4399500
Japan	+81 (43) 213-2191
Korea	+82 (51) 636-7080
The Netherlands	+31 (23) 5661111
Poland	+48 12 295 13 00
United States	+1 (970) 482-5811

Technical Assistance

If you need to contact technical assistance, you will need to provide the following information. Please write it down here before contacting the Engine OEM, the Packager, a Woodward Business Partner, or the Woodward factory:

General

Your Name _____

Site Location _____

Phone Number _____

Fax Number

Prime Mover Information

Manufacturer _____

Turbine Model Number _____

Type of Fuel (gas, steam, etc.) _____

Power Output Rating _____

Application (power generation, marine, etc.)

Control/Governor Information

Control/Governor #1

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #2

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Control/Governor #3

Woodward Part Number & Rev. Letter _____

Control Description or Governor Type _____

Serial Number

Symptoms

Description _____

_____

If you have an electronic or programmable control, please have the adjustment setting positions or the menu settings written down and with you at the time of the call.

Appendix.
ProTech GAP Help Information

In previous versions of this manual this appendix was titled **Protech Template GAP Blocks**. That information is now integrated into the GAP program. Two Help sections are available – Editor Help and Block Help

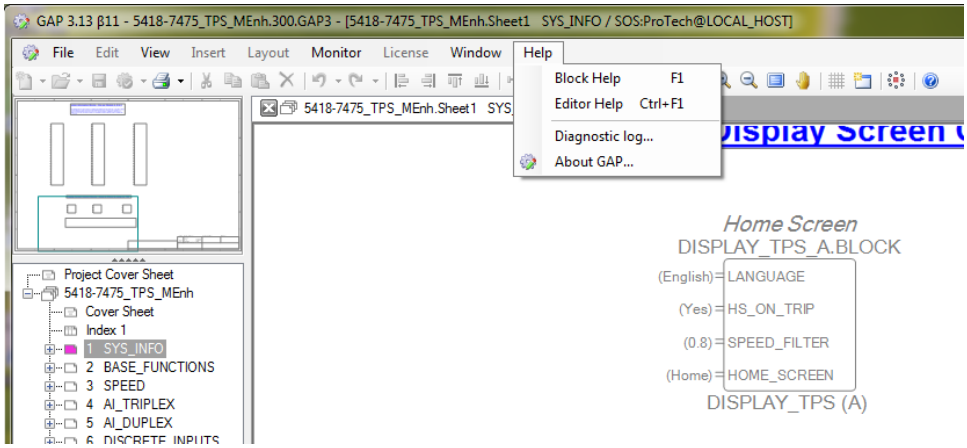


Figure A-1. Menu Selection for GAP Help

Editor Help

The GAP Editor help file contains information about the GAP application development environment. It covers a wide range of topics and hardware. For users unfamiliar with GAP this is a good place to start to learn how to build application programs.

Block Help

Once a block is placed on the page, double click on it to open a properties dialog box what will allow the entering of parameters into each input field. From this pop-up box there is a question mark icon in the upper right (or pressing F1 key) that will access the help information specific to that block.

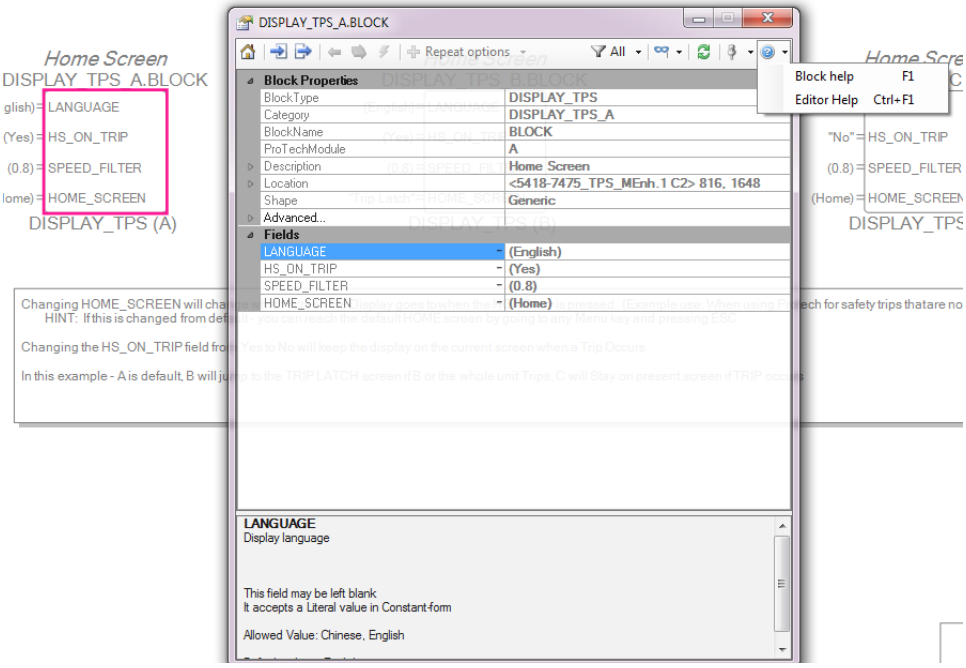


Figure A-2. Accessing GAP Block Help from inside a block

Below is a typical example of the information given:

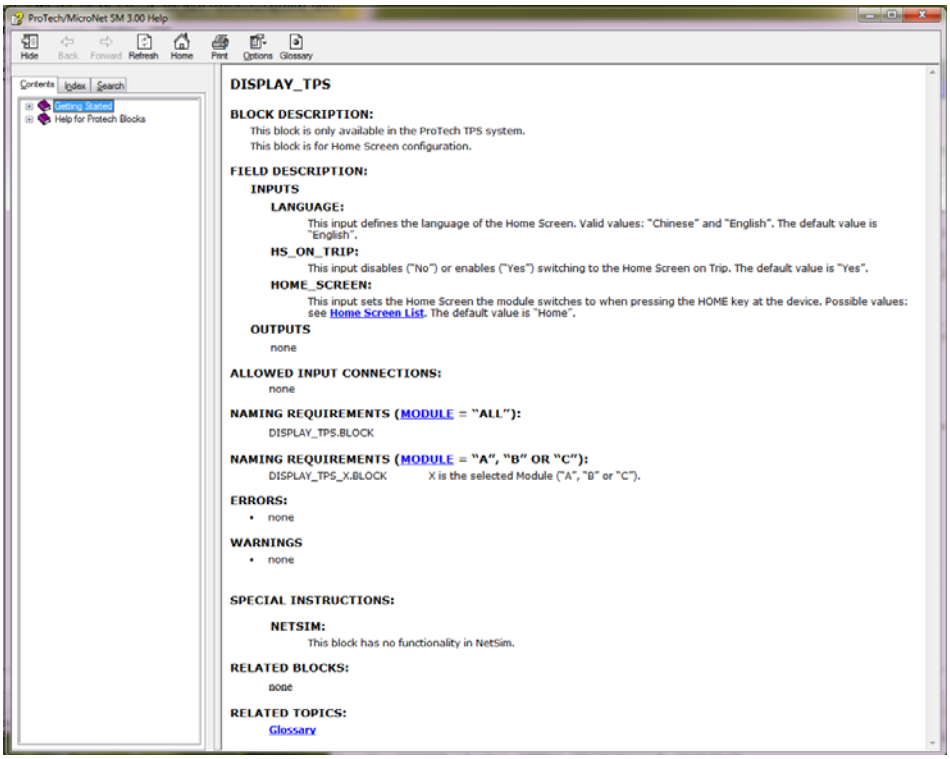


Figure A-3. GAP Block Help Example

Revision History

Changes in Revision A—

- Minor text revisions in Chapter 2
- Many Figures and some content replaced with new in Chapters 3 and 4
- Several Figures in Chapter 5 are new
- Chapter 6, Example 3 and all figures are new
- Replaced Appendix A with completely new content

Released

We appreciate your comments about the content of our publications.

Send comments to: icinfo@woodward.com

Please reference publication 26712.

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Complete address / phone / fax / email information for all locations is available on our website.