# PLC Training Manual

## G-Series Basic PLC Training

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# G-Series PLC Range

IMO's G-series PLC range covers the complete scope of automation potential. Within the IMO PLC range there are three levels. What determines these levels generally is the users requirements for the application such amount of I/O required. The IMO range begins with the expandable brick type PLC, the G7 series. To the compact, slot and rack in the mid-range, the G6 series, through to the high-end G4 series. From the 10 I/O brick style G7 to the 1024 I/O Multi-rack and slot G4 PLC, IMO have got it covered!

The complete G-Series range is programmed through the IEC61131-3 compliant software. This is a windows based program allowing the user to program in Ladder diagram (LD), Sequential Function Chart (SFC) and Instruction List (IL).

## *Range Overview*

| | G7 | G6 | G4 |
|---|---|---|---|
| Power Supply | **110/230Vac or 24Vdc** (E-marked for vehicle low voltage (12V) operation) | **110/230Vac or 24Vdc** (E-marked for vehicle low voltage (12V) operation) | **110 Vac or 230Vac or 24Vdc** |
| I/O | **Up to 80** | **Up to 384** | **Up to 1024** |
| Analogues | Two analogue modules: 2 in, 1 out. Or 4 in. Voltage or Current selectable. | G6F-AD2A 4 analogue inputs. Selectable, 4-20mA, 0-20mA or 0-10V G6F-DA2V voltage input G6FDA2I current input | G4F-AD2A 4 analogue inputs. Selectable, 4-20mA, 0-20mA or 0-10V G4F-DA2V voltage input G4FDA2I current input |
| Comm. options | 2 inbuilt RS232 user configurable ports. RS232 and RS485 options. Modbus, Profibus (slave), DeviceNet (slave) FNet, RNet (IMO comms). User defined comms. | RS232 and RS485 options. Modbus, Profibus, DeviceNet, FNet, RNet (IMO comms). Ethernet. User defined comms. | RS232 and RS485 options. Modbus, Profibus, DeviceNet, FNet, RNet (IMO comms). Ethernet, User defined comms. |
| Expansion | Up to 3 maximum but only 2 of the 1 kind. I.e. 2 analogue modules + 1 relay module. | Maximum rack size of 12 slots. Non-expandable. | Maximum rack size of 8. 3 expansion racks of 8. Totalling 32 slots. |
| Additional features | HSC, RTC module, 7k steps, addition memory module & built in PID. | 17k steps. Dedicated MPU 0.5µs. 3-axis open loop position control module. 3 options of CPU. | 32k steps. Dedicated MPU 0.2µs. Floating-point maths & USB programming port option. PID module with 8 separate PID loops. |
| Programming Software | GMWin. IEC61131-3 (LD/IL/SFC) | GMWin. IEC61131-3 (LD/IL/SFC) | GMWin. IEC61131-3 (LD/IL/SFC) |

- All of the IMO G-series range uses the same programming software, the IEC61131-3 compliant: **GMWin**.
- All the PLC's can be interlinked and share data within their own dedicated network.
- The slot and rack PLC's are modular and very variable. They can be specified to meet the application more precisely.
- The I/O count doesn't include the remote I/O units. A maximum network size of 64 stations, with each possibly having 32 points. (**I/O = 2048**)

# IMO G7

The IMO G7 is a very compact block style programmable controller offering extremely high performance. It is ideal for all applications from process control to machine control

- Up to 80 I/O
- High speed processing 0.5µsec per step
- Memory capacity 68K bytes
- Conforms to elements of the IEC61131-3 (IL/LD/SFC)
- Built in PID, interrupt, pulse count and input filters
- High speed counter input 16kHz, 8kHz two phase
- RTC option and memory module options
- Fieldbus options FNet (master/slave), DeviceNet (slave) and Profibus (slave)
- Two built in RS232 serial ports one dedicated the other user configurable
- Two analogue modules: 2 / 1 analogue i/o or 4 analogue inputs
- Analogue potentiometer module
- 10 I/O expansion module
- RS232 and RS485 option modules
- Uses the same programming software as G6 & G4 (GM-WIN)
- Conforms to CE and UL

# IMO G6

The IMO G6 is a compact modular programmable controller offering extremely high performance. It is ideal for all applications from process control to machine control

- Up to 384 I/O
- High speed processing with dedicated MPU 0.5µsec per step
- Memory capacity 17Ksteps
- Conforms to elements of the IEC1131-3 standard (IL/LD/SFC)
- PID control, computer link, high speed counter and RTC CPU options are available
- Fieldbus option 1Mbps (FNet), DeviceNet, and Profibus options
- Computer link module for linking up to 32 PLCs to a computer, or to other devices by easily configuring user protocols
- Wide range of digital and analogue I/O
- High speed counter module
- Conforms to CE requirements

# IMO G4

The IMO G4 is a modular programmable controller offering extremely high performance. It is ideal for all applications from process control to machine control.

- Up to 1024 I/O
- Very high speed processing with custom gate array 0.2µsec per step
- Memory capacity 32K steps
- Conforms to elements of the IEC1131-3 standard (IL/LD/SFC)
- Many special function modules – PID, Analogue timer, High Speed
- Counter, Positioning, Interrupt and A/D and D/A modules
- Wide range of communication options – ENet (Ethernet), FNet Fieldbus),
- Cnet (Computer Link), DNet (DeviceNet) and remote I/O
- Conforms to CE requirements

## *Part Numbering*

At IMO we use an understandable part number where each element has a meaning and is reused through out the part numbering system, thus making it easy to put together product requirements

G7 Base models: G M 7 – D _ _ _ A (/ DC – E)

- R – Relay o/p
- T – **Transistor o/p**
- I/O: 10, 20, 30, 40, 60
- DC – 24V DC power
- DC power supply. E marked for vehicle applications

G7 Expansion modules: G 7 _ – _ _ _ _ (– E)

- E – Expansion digital I/O
- F- Special function units
- L- Communication units
- DR -Relay
- DT - Transistor
- AD - Analogue
- AT - Ana pot
- CU – Comm. link
- RT - RTC
- DB - DeviceNet
- PB - Profibus
- RU - RNet
- 10A - I/O
- 2A - 4 A/D
- HA - 2 A/D, 1 D/A
- EB - RS232
- EC - RS485
- EA - Comms

G4/G6 CPU, Base and Power models: G M _ – _ _ _ _

- 4 – G4
- 6 – G6
- CPU - CPU
- PAF - Power AC
- PDF - Power DC
- B - Base
- *CPU* A – Standard
  - B – A + RS485 port, PID, RTC
  - C – A + HSC, PID
  - G4 C – Floating-point maths
- *Power* A – For use with Standard I/O
  - B – For use with analogue I/O
  - C – For use with 12-slot rack
- *Base* 04, 06, 08, 12 M

G4/G6 I/O modules: G _ _ – _ _ _ _

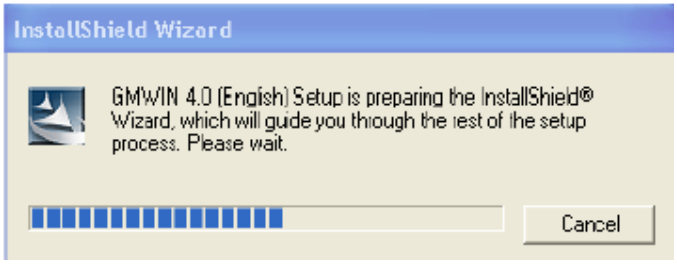
- 4 – G4
- 6 – G6
- I - Digital Input
- Q - Digital Output
- F - Special function units
- L - Communication units
- **RY2A** –16 Relay o/p
- **D22A** – 16 DC i/p
- **D24A** – 32 DC i/p
- **A21A** –230 AC i/p
- **A11A** - 110 AC input
- **AD2A** – 4 Analogue i/p
- **TR2A** – 16 Trans o/p
- **TR4A** – 32 Trans o/p
- **HSCA** – HSC
- **POPA** – Position control
- **FUEA** – FNet
- **PUEB** – Profibus
- **EUTB** – Ethernet
- **CUEC** – RS485 Comm.
- **CUEB** – RS232 Comm.

*Plus many more options*

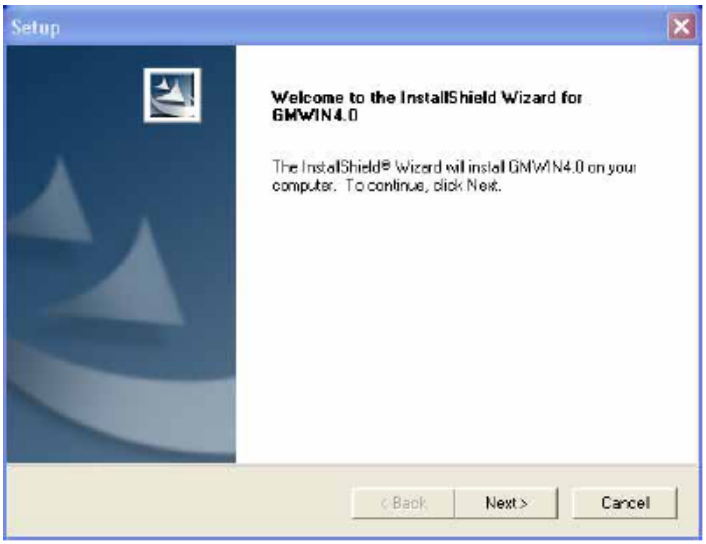
# Installation of IMO GMWin

GMWin can be obtained on the IMO PLC Software CD or can be downloaded from the website: www.imopc.com free of charge.

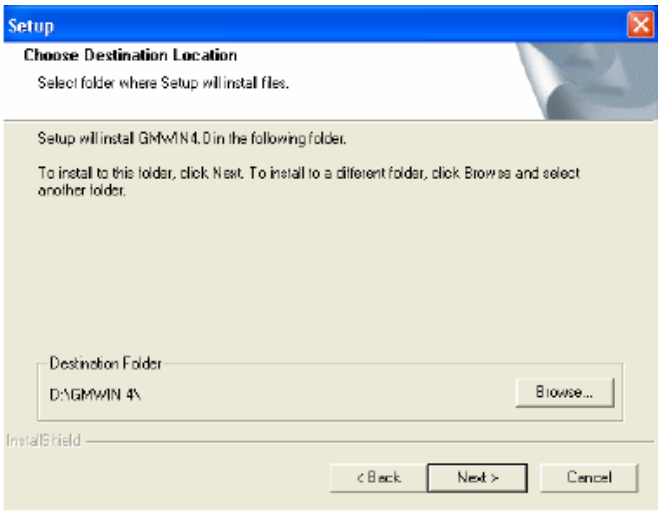
To install double click on the icon GMWIN4.exe and follow the instructions.

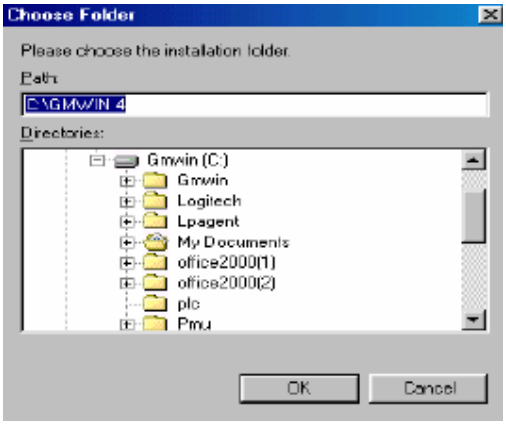

A dialogue box showing the welcome message appears. It is required to exit any other windows application programs that may be running during the installation of GMWIN.



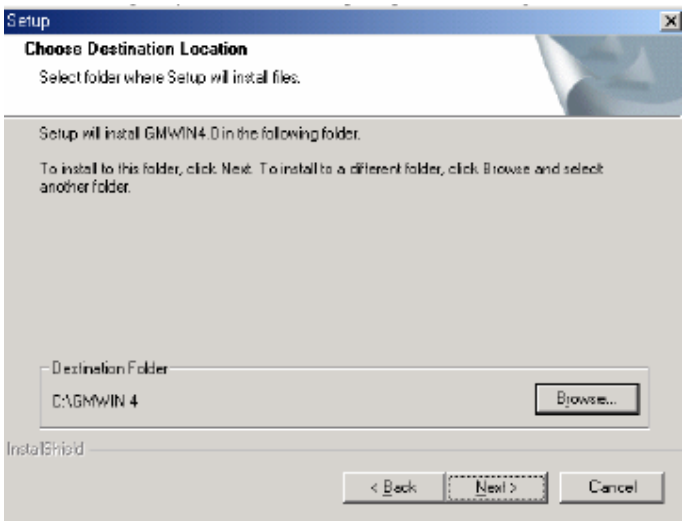

Click Next to move to the next screen.




Select the destination folder for GMWin to be installed into. If **[Browse]** is clicked then a dialogue box will appear for the path to be inputted. Select the path to install to or manually write the path in the box and click **[OK]**.

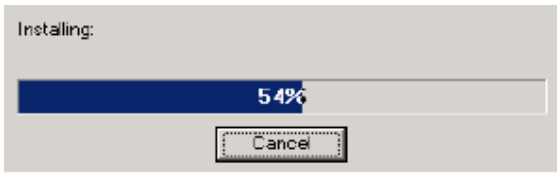



After selecting the path to install, click **[Next]**.

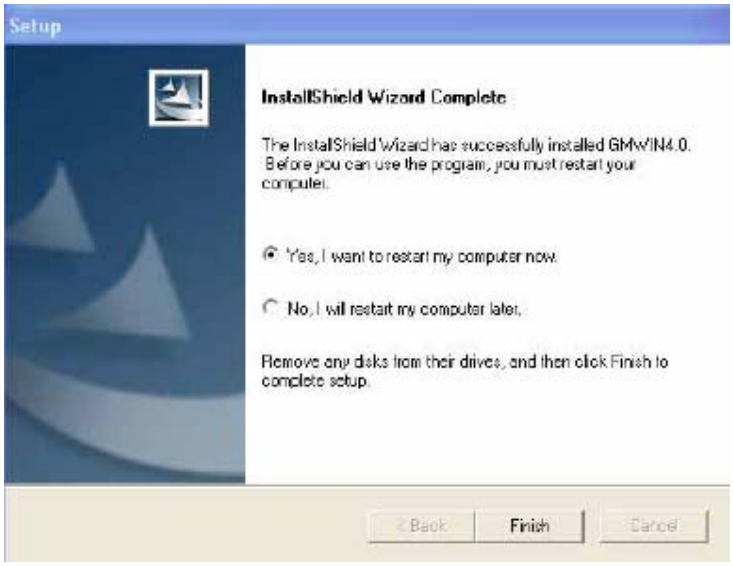



After confirming the path to install into, click **[Next]** to continue.

GMWin will then begin to install on your computer, in the directory specified.



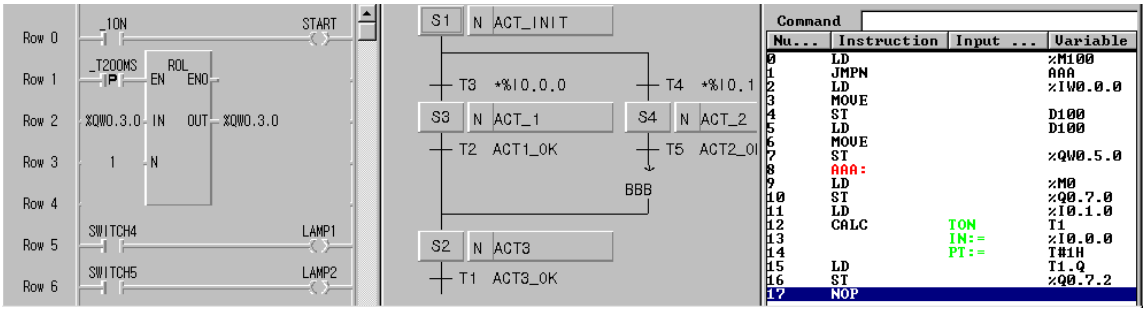

When the install is completed, it is required to restart your computer. You have the option to restart your computer now or later from the following screen.




Now that the installation is complete and after you have restarted your computer, click on the GMWin icon to start programming.

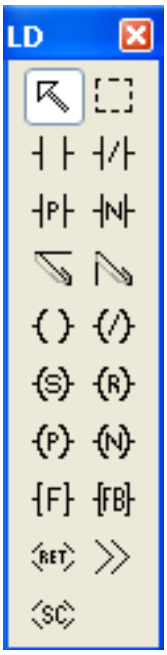
# Introduction to GMWin

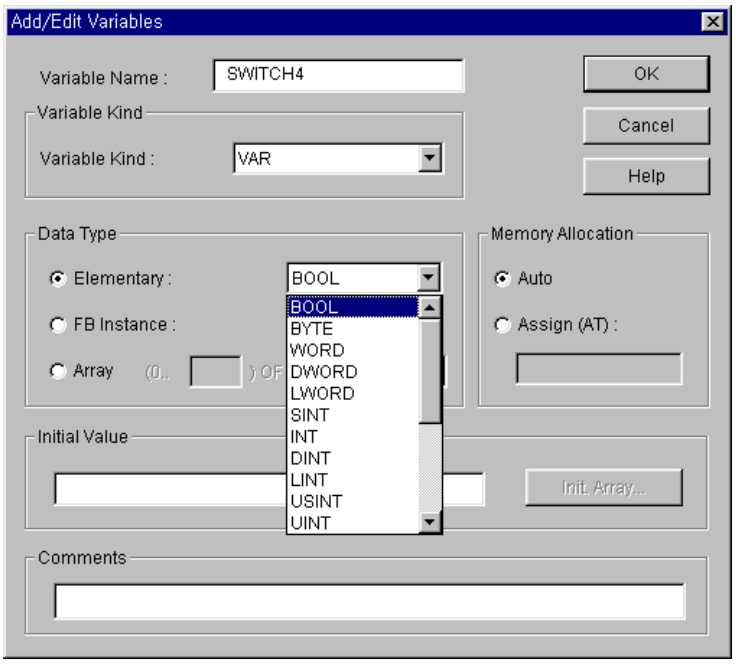
GMWIN is a programming and debugging tool for the full range of G-Series PLC's (G7, G6 and G4). It is an IEC61131-3 programming compliant environment and with three different programming languages, IL, SFC and Ladder.




Ladder SFC IL

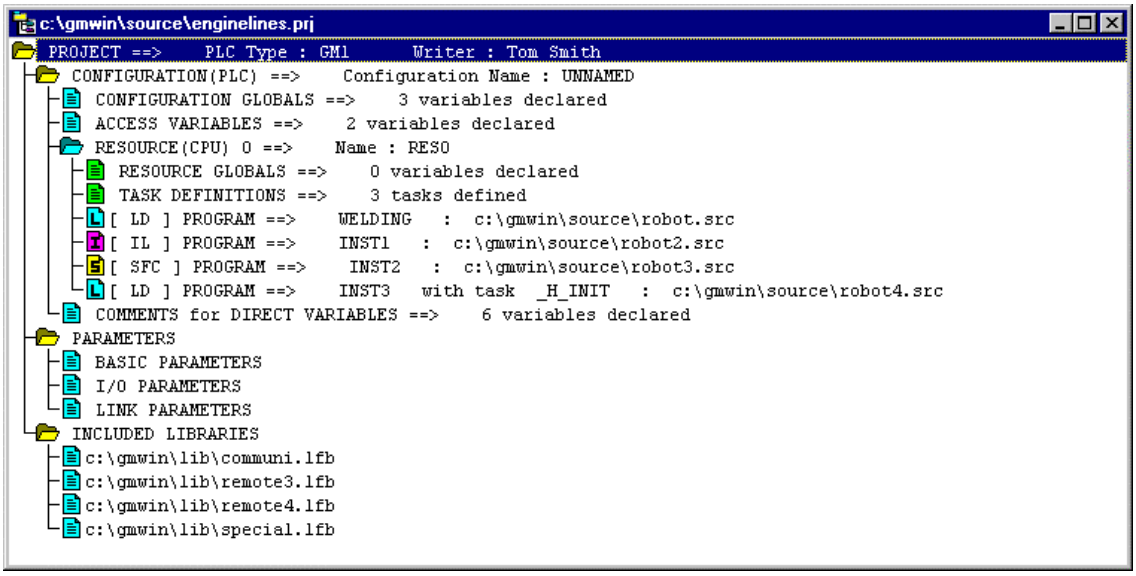
Programs can be created with clear symbols for easy understanding and easy to follow menus to create functions and variables alike.




GMWin complies with the standardising of expressing direct variables by I, Q, M (Input, Output, Memory). The allocation of program variable memory is carried out automatically or by the user designation. Various data type and kinds can be selected to match the variables requirements. It is also possible to set the initial value, and add documentation to every function, function block, constant and variable.

The IMO G-Series is a Project based PLC system. In GMWin it is possible to create several different dedicated programs in different languages to perform specific routines and have them all related in a Project. As well as Programs there is the option of Tasks, which can be time or event driven.



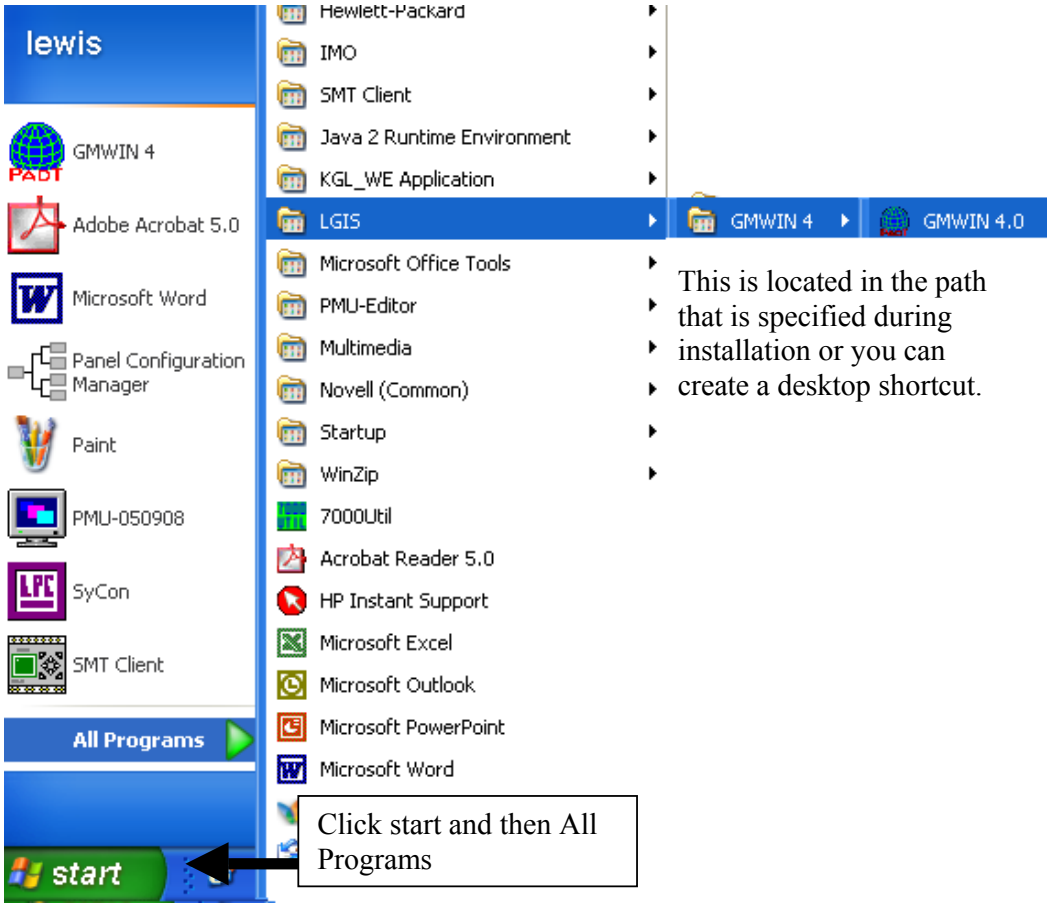

A project tree is shown above that details all libraries, tasks and programs included in a project. Project based programs make duplication and re-use of programs quick and easy.

It is possible to not only download and monitor programs directly connected to a PC but also for PLC's connected in a network. When connected with a PLC it is possible to monitor the operation, change the mode and edit online. Online editing, allows the PLC to remain running and the program can be changed. The full PLC mode, error state and parameters can also be read when connected.

It is also possible to create User-Defined Functions and Function Blocks. This allows for frequently used bits of code being made into an easy to use and re-useable graphical function block. There is also the utility to create User-Defined Communication Protocols, thus allowing obscure and bespoke devices to be communicated with.

# Starting a new GMWin Project

To start a new program click on the GMWin icon.

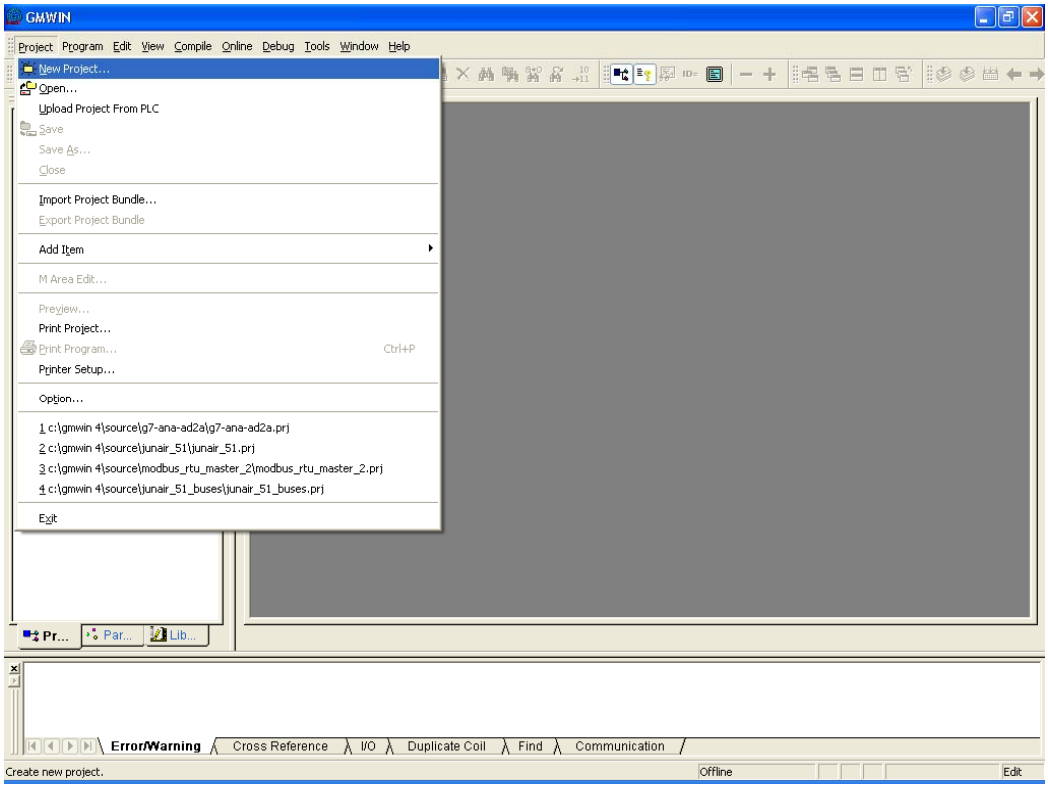



This is located in the path that is specified during installation or you can create a desktop shortcut.

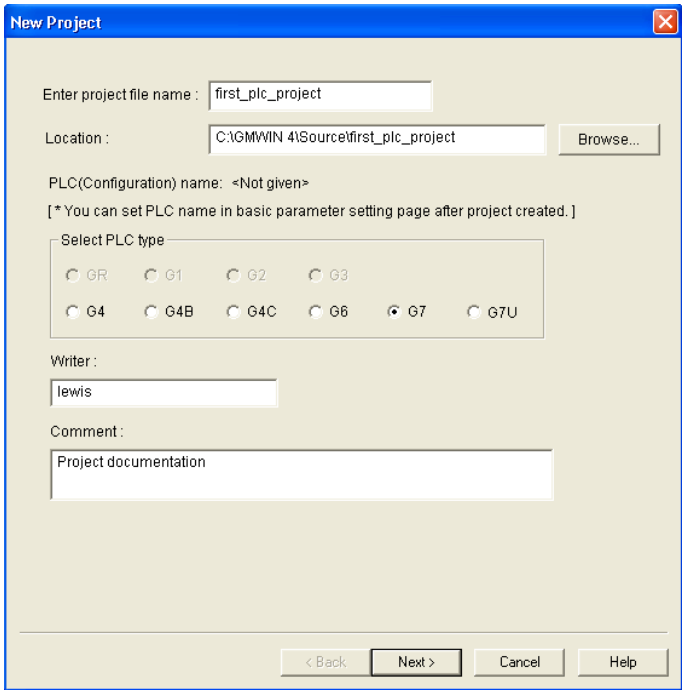

This box pops up whilst the GMWin program is initialising.

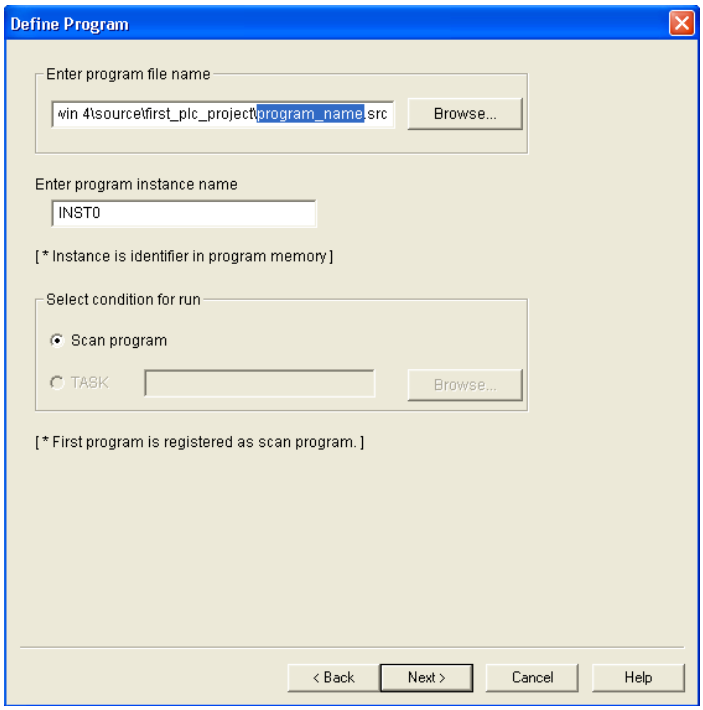
GMWin will appear, with the last project that you were working on, if you did not close the program down. At the moment GMWin will have no project and look rather empty, as this is the first run of the software on your computer.

To begin a New Project, either click the New Project icon or select the option from the drop down Project menu.



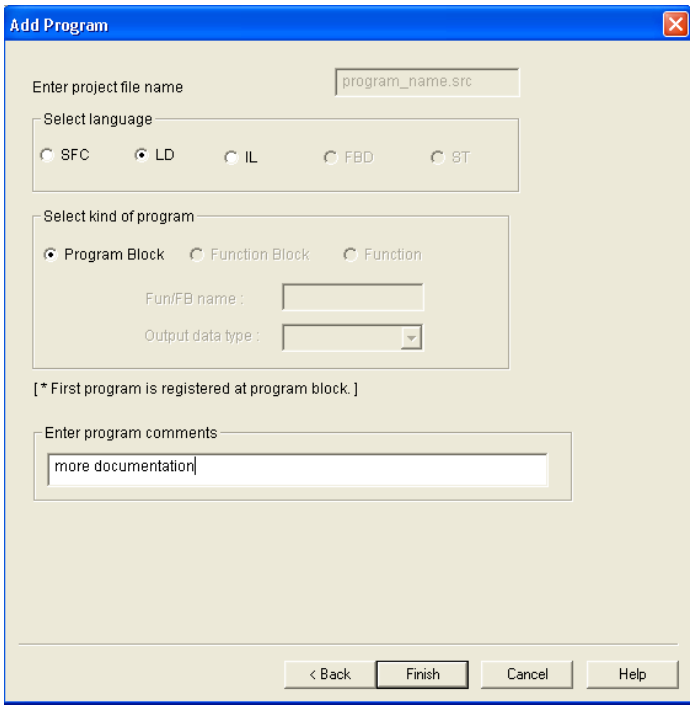

In this first menu we can enter the project details and where the project folder is going to be created. We must select the PLC we are going to use and we have some documentation options.






The next stage is to define the first program. This can be edited later and even removed but initially this must be set up.

The program will initially be called noname.src, but to modify this, simply highlight the area shown and enter a name that has more meaning to your application.




Next we have to select what language we are going to write the program in. The default is ladder.

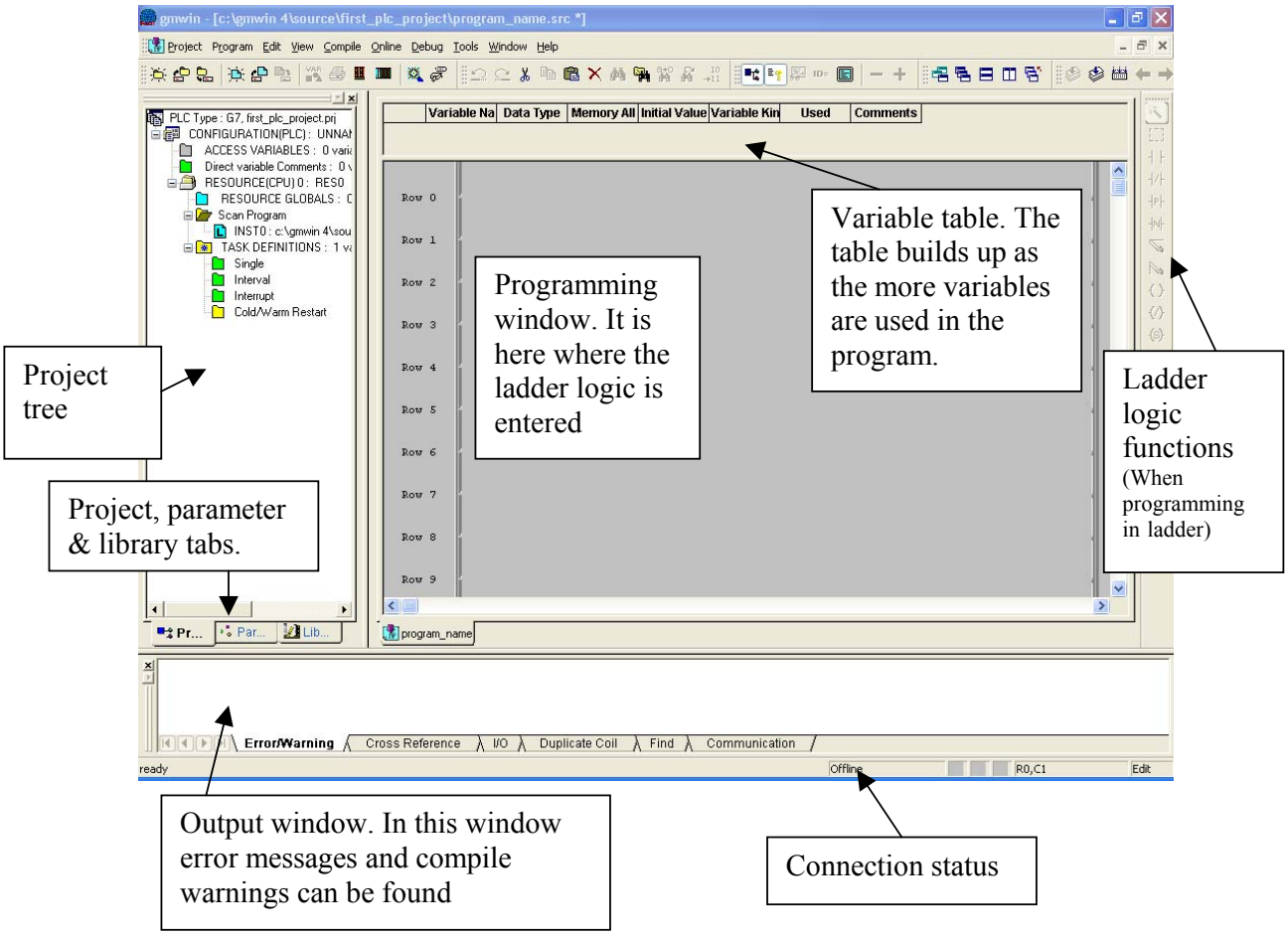
SFC, LD and IL will be discussed in more detail later.

There is also an opportunity to add further documentation notes.

Clicking **[Finish]** will complete the set up process and return you to the main Window with a fuller Project to begin programming.

# Navigating GMWin

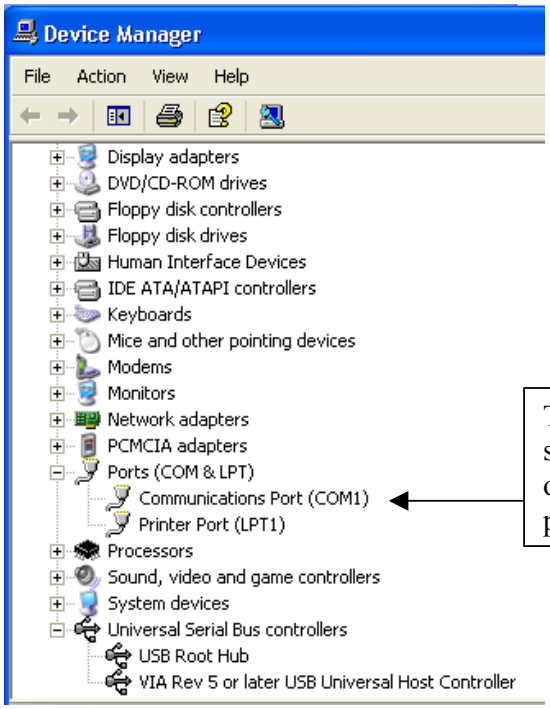
GMWin is a “windows” based programming environment and it can be daunting at first with the amount of information on offer. The programming environment can be customised to your personal preference, with windows an optional buttons being selectable.



## *Setting up the PC connection for programming*

The most important thing to do first is to ensure that the correct communication port is selected in GMWin to connect with a PLC. This is particularly important if you are using a USB to Serial converter.

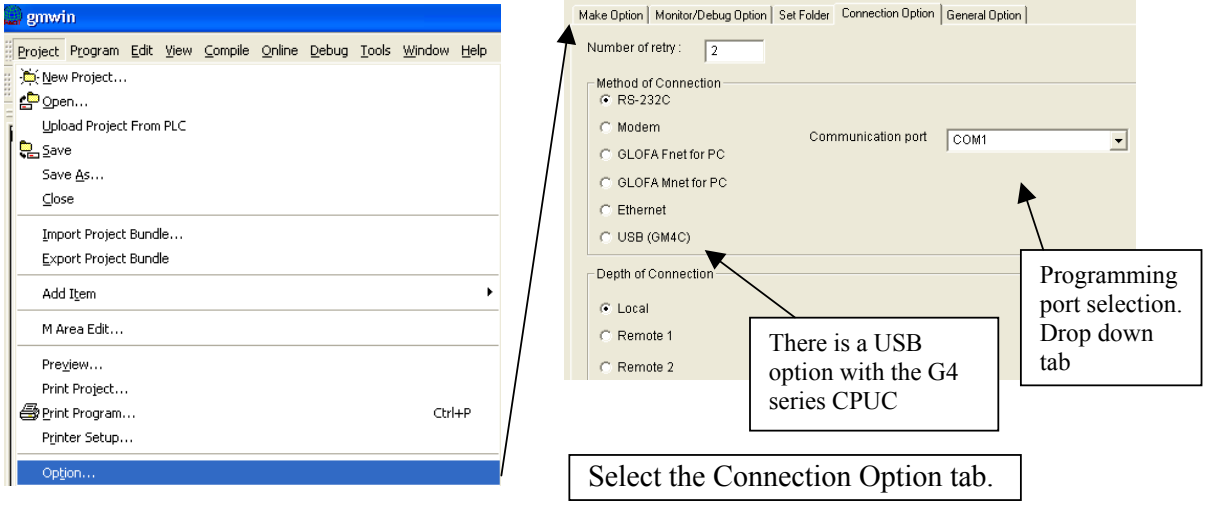
It is possible to locate your computers communication ports using the Device Manager in Windows Control panel. (Control Panel: System, Hardware; Device Manager).



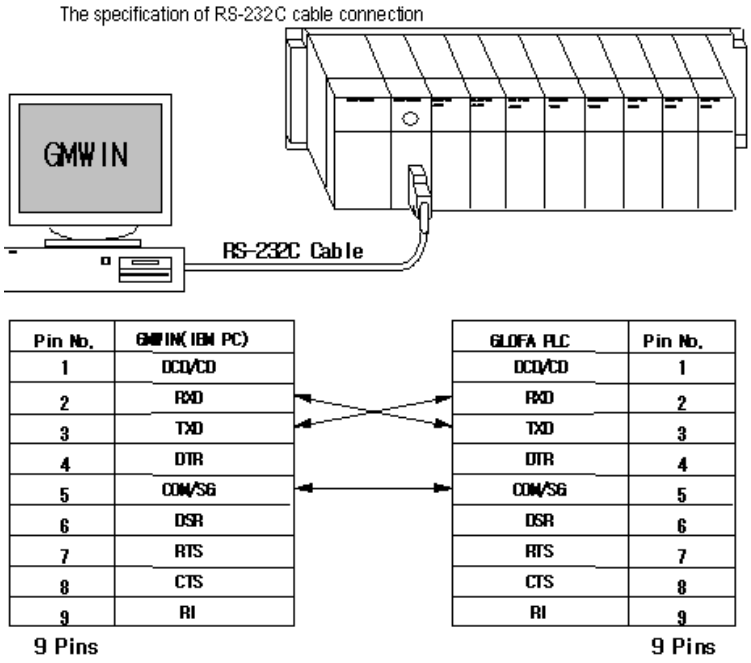

*The Device Manager can be found in the Control Panel, System, Hardware. Your IT manager should be consulted before altering System configurations.*

This computer has a serial port addressed on communication port COM1.

To ensure that the correct port is selected in GMWin go to the option menu in the Project drop down list.



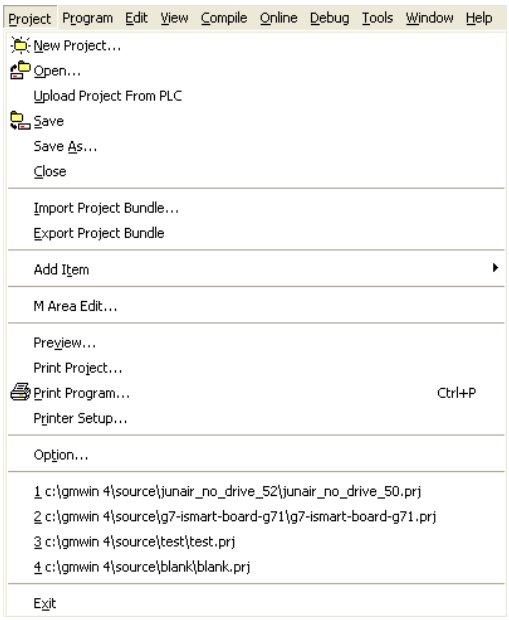
The standard method of connection is RS-232C; this is a standard 3 wire, 9 pin D-type connector crossover cable (KIC-50A). Select the communication port that you are going to use from the drop down list.



# *GMWin Menu's*

## Project Menu

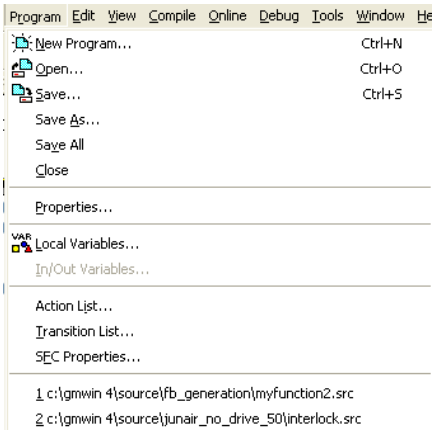
The project menu has the options required to manage the complete project.




| |
|---|
| Starting a new project, opening an existing project, saving and uploading from a PLC (to be discussed latter). |
| Project bundles are the best method for transporting GMWin PLC projects. It collates all the files into one easy to transfer .MUK file. |
| Print options |
| GMWin options |
| Previous projects created. |

## Program Menu

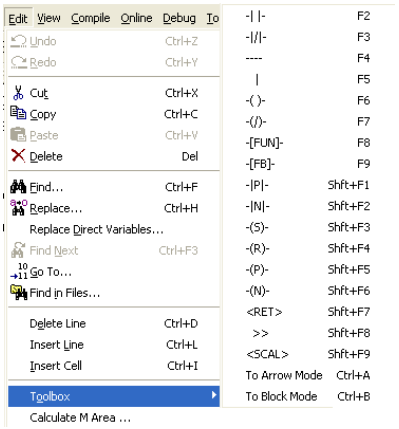
This menu operates the options required for the programs in a project.




A GMWin project is made up of two types of files. A .prj file that contains the project information and at least one .src source file that contains the program information.

## Edit Menu

In this menu there are the options to edit the programs.

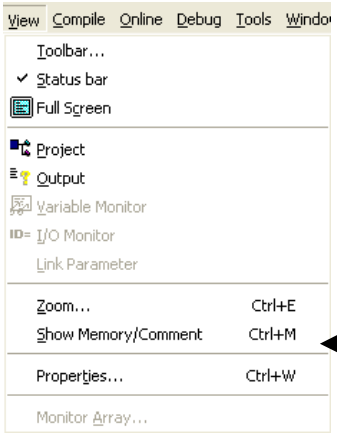



In this menu the options can be found to edit programs.

Ladder logic programming tools (discussed later)

## View Menu

Using the options in this menu you can customise what windows you want to view.

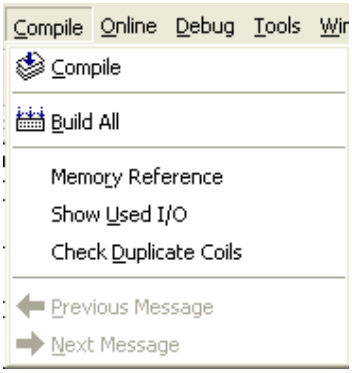



Select or deselect to view the Project and output window

View the documentation added with the memory address

## Compile Menu

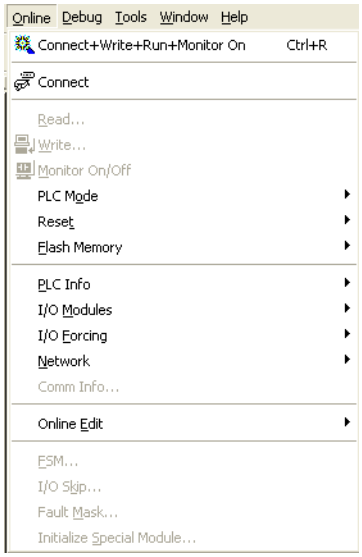
This menu is used to build and compile the program written, ready for downloading it into the PLC.




There is also the option to check the program for duplicated coils, memory and I/O locations used.

## Online Menu

This menu has the options for connection with the PLC. In this menu we can read and write programs to the PLC. Check the status of the PLC, enable communications and reset errors.




Connecting and writing to the PLC

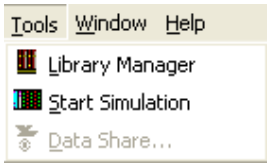
Checking the PLC mode. Can relate to the PLC dipswitch position

PLC information. I/O cards used, communication protocols engaged.

Online editing facility, allows editing of the PLC program in the PLC whilst still running.

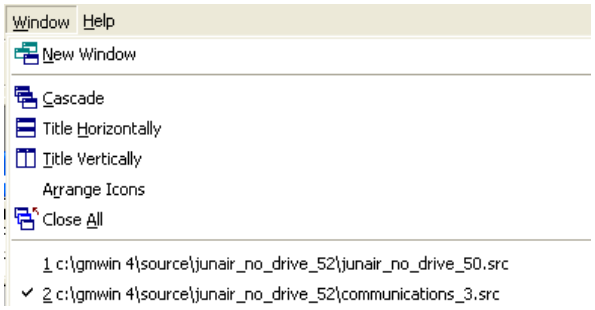
## Tools Menu

The simulation tool can be found in this menu. This is a useful tool to test the project without connecting a PLC.



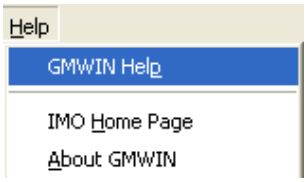

## Window Menu

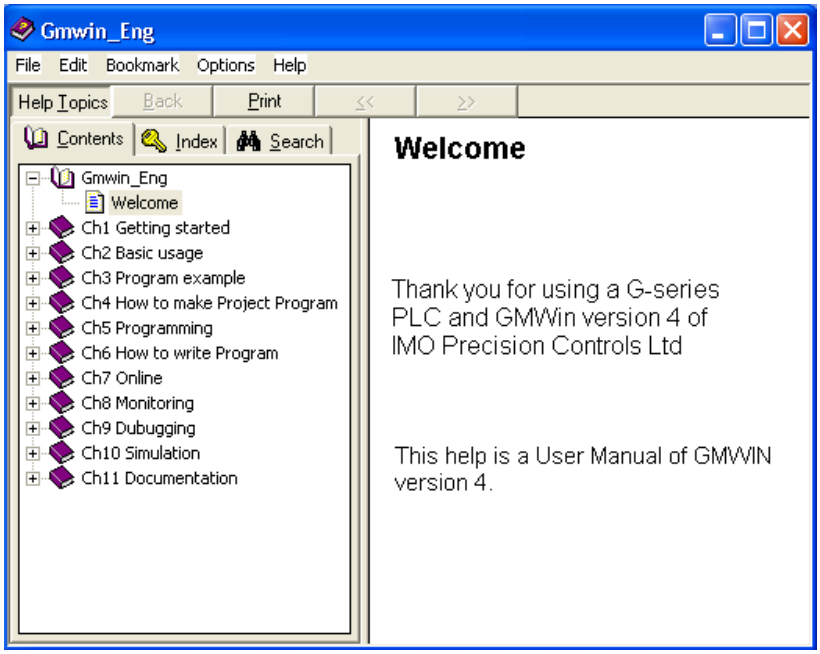
This window allows you to view the different programming windows in different ways.



## Help Menu

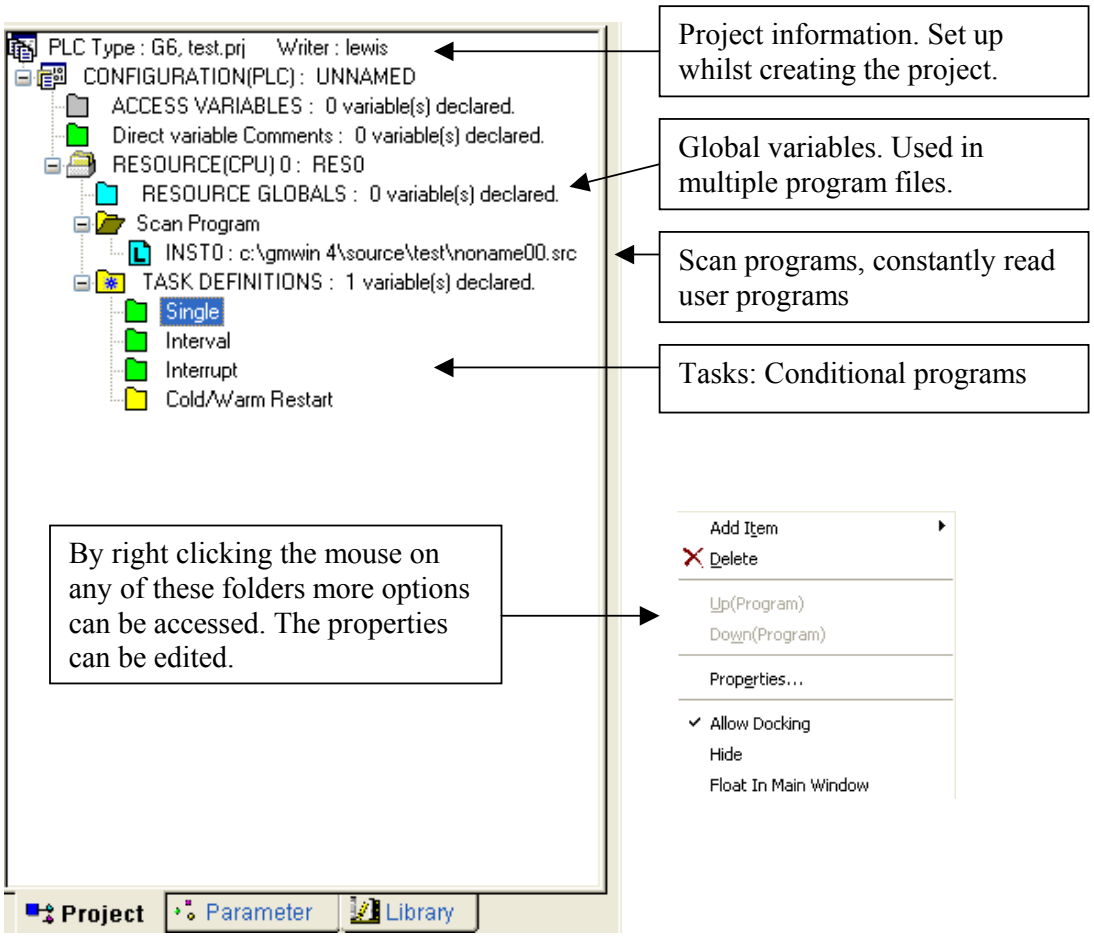
In the help menu you can access the help function and IMO website. Please note that the language settings require windows to have the Far East and Asian files installed. (Control Panel: Regional and Language Settings; Languages; Supplemental Language Support).



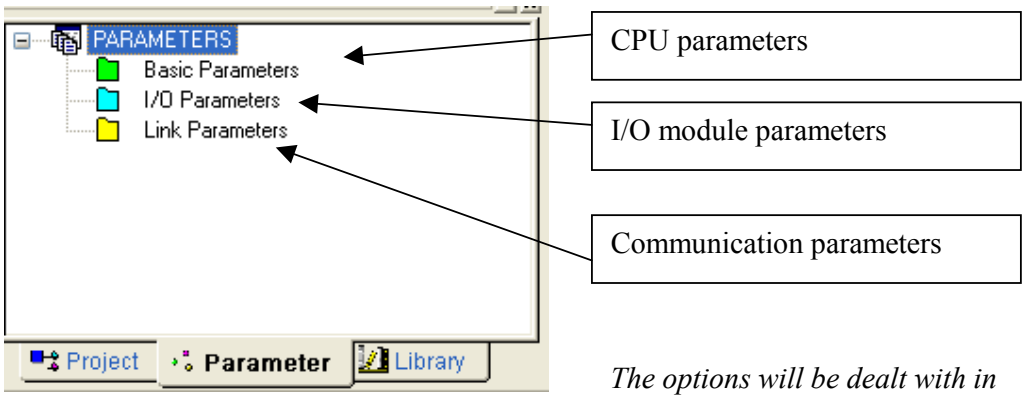
## *Project Tree*

The project tree contains the complete detail of the project. In this menu you can view the variables used, Programs included and task definitions.




## *Parameter list*

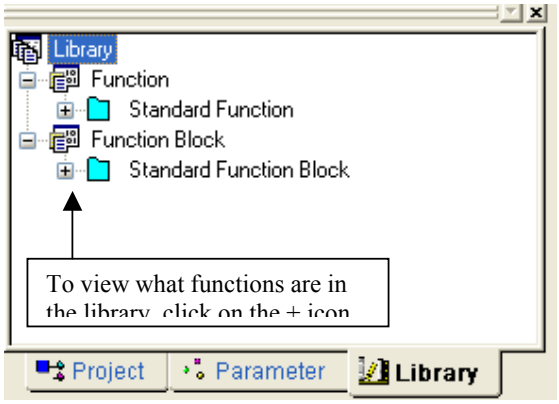
Access the PLC's basic parameters, I/O parameters (the different I/O cards in the slot and rack PLC's) and Link parameters (set up the communication protocols).

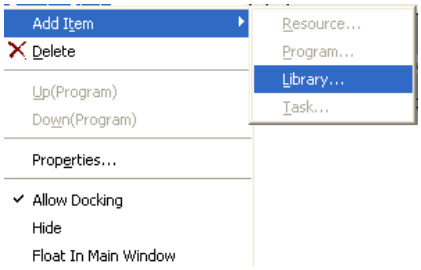



*The options will be dealt with in more detail later.*

## *Library Menu*

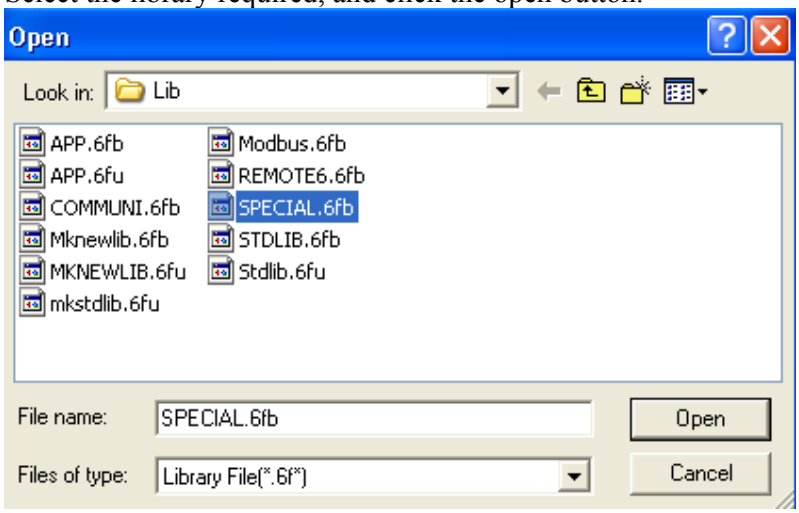
In this menu you can view, add and delete the libraries that contain the functions and function blocks used in programming.



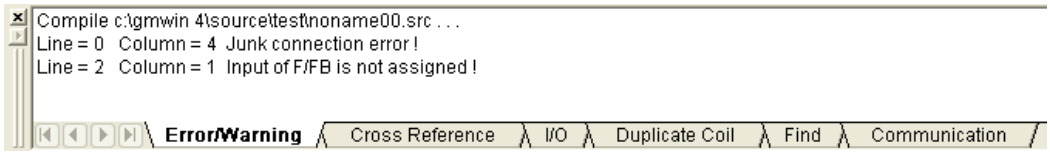

To add a library right click on a folder and select: Add item, Library.

Select the library required, and click the open button.




## *Output Window*

The output window displays messages. In it you can find connection information, error messages and other details.



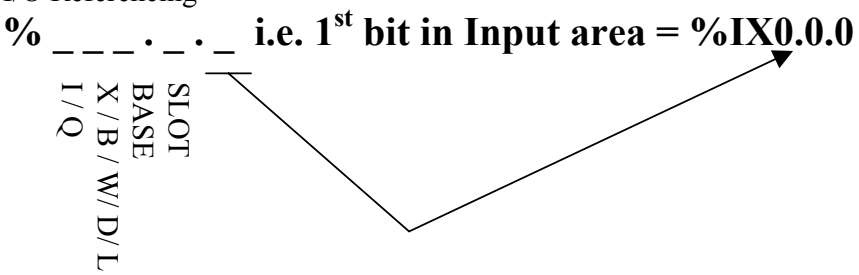

The error messages direct you to where the issue lies within the program.

# Addressing in a G-Series PLC

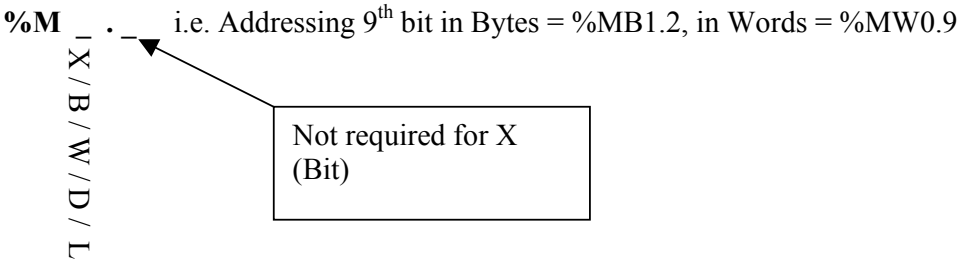
The addressing format adheres to the IEC61131-3 standard for the complete range on G-series PLC, from the G7 through to the G4.

In the IEC61131-3 the addressing is standardised for all PLC manufacturers. It states that to address an input the prefix I must be used. Likewise for an Output, prefix Q and Memory, prefix M.

I/O Referencing

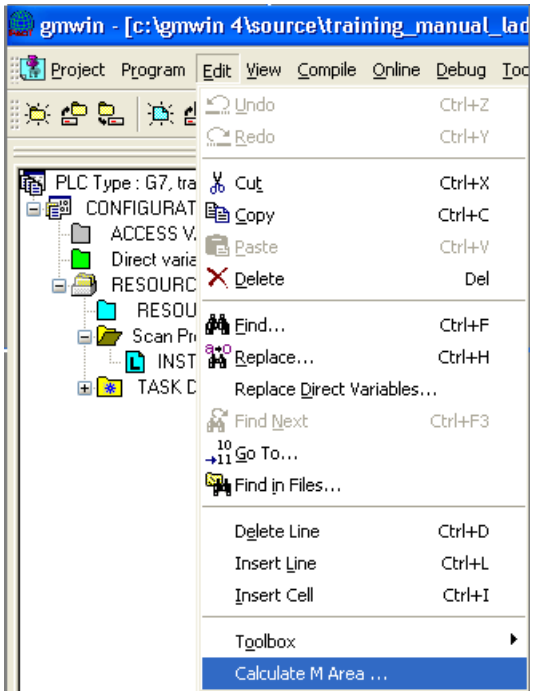


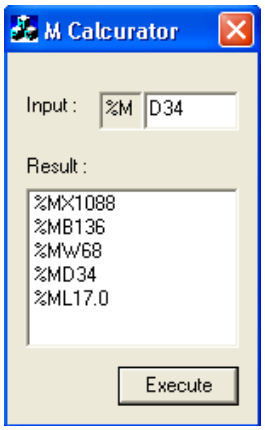

Memory Referencing




In the G-series PLC we can address individual bits, bytes, words and double words and this is done in the structure of the address. When directly addressing I/O or memory a percent symbol must be put before the address structure "%", this signifies that you intend to directly address an input, output or memory location and not a variable. The next symbol is to signify whether it is an input, output or memory location and then the second symbol indicates whether it is a bit, byte, word or double word. Finally it is the location address and this format can differ, depending on if it is an input / output or a memory location.

In the Edit Menu there is a drop down option that will aid in calculating memory locations.




Simply enter the address and click Execute. The M Calculator will then break down the memory address and how it can be addressed differently.

# Memory Allocation in G-series PLC

For a better understanding of addressing and programming in GMWin it is important to know how the memory in the PLC is organised.

The memory is split into two main areas:

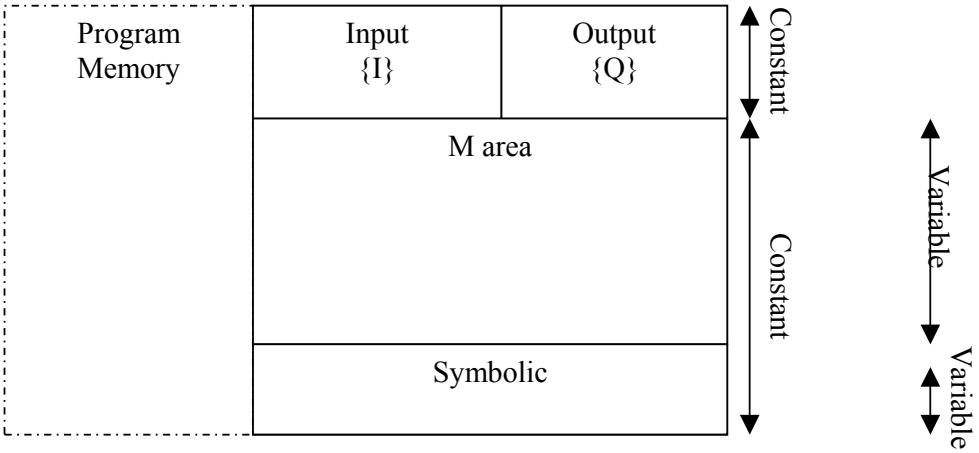
1. The Program Memory

This is where the user created program is stored.

2. The I/O, internal memory and Symbolic memory.

In this part of the memory the I/O reference particular to the type of PLC is stored, along with the internal memory used to store variable data. Lastly the symbolic area is used to store the Functions and Function Blocks used in the Program.

When you enter a Function Block, you are asked to give it an instance name. This is required for storage in the symbolic region of the PLC and it can be referenced again and again but use of its Instance Name.

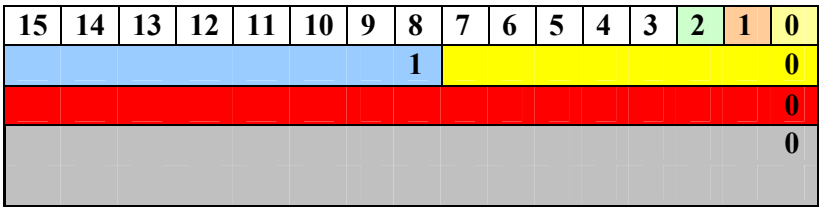



As previously mention in the addressing section, it is possible to address the memory in several different chunks: Bits, Bytes, Words, etc. The M area of memory should be considered as a blank sheet of paper and by using coordinates you locate the memory area required. However the same location can be easily addressed in different ways by using a different coordinate system.

i.e. %MB1.0 = %MX8 = %MW0.8

Therefore it is a good idea to use (where possible) the one consistent addressing structure. This means that if you are most likely t be mostly addressing words then use the structure: %MW_ (and the ._ if you require to address a bit in a word.)

M area (exploded view)




<- Bits
<- 1 byte = 8 bits
<- 1 word = 2 bytes
<- 1 double word = 2 words

{…and 2 double words = 1 long word}

To address in G-Series:
X = bit
B = byte
W = word
D= Double word
L = long word

M = Memory area
I = Input
Q = Output

## Bits and Bytes

Different types of variable information require a different amount of bits to store it. Below is a guide to what is used for different types of variable information.

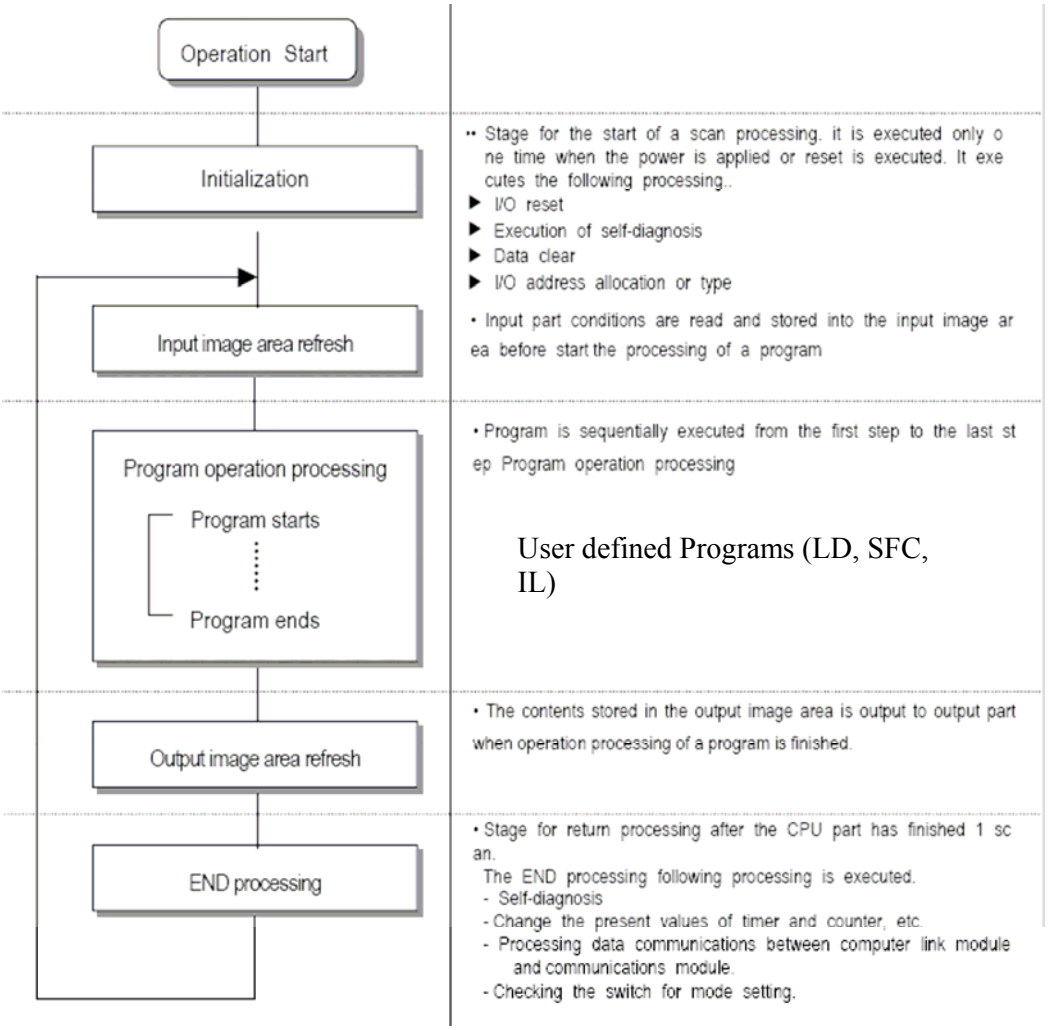
| ***Type*** | ***Name*** | # of bits | ***Comment*** |
|---|---|---|---|
| BOOL | Bit | 1 | Used for I/O addressing |
| BYTE | Byte | 8 | Used for memory allocation |
| WORD | Word | 16 | Used for memory allocations |
| DWORD | Double word | 32 | Used for memory allocations |
| LWORD | Long word | 64 | Used for memory allocations |
| INT | Integer | 16 | Used in calculations |
| SINT | Small integer | 8 | MSB signals the polarity (0 =+ve) |
| USINT | Unsigned Small integer | 8 | Used in calculations |
| UINT | Unsigned integer | 16 | Used in calculations |
| ULINT | Unsigned long integer | 64 | Used in calculations |
| DINT | Double integer | 32 | Used in calculations |
| UDINT | Unsigned Double integer | 32 | Used in calculations |
| REAL | Real | 8 | Floating-point maths |
| LREAL | Long real | 64 | Floating-point maths |

# Ladder Programming Rules

Before programming it is important to know a few basic rules of the ladder diagram structure. In this section we will discuss the basic programming rules of ladder logic.

It is important to be aware of a PLC's scan cycle. This is the order of processing that the PLC performs. The Scan cycle of a GMWin project is as follows:

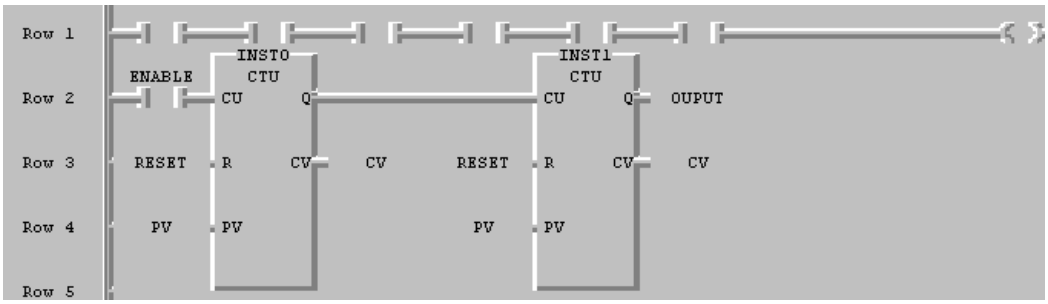
1. On operation start the variables are initialised, and a self-diagnosis is performed.
2. The input conditions are then read in and stored
3. The user program is then sequentially executed.
4. Communications with modules is checked and data shared, variables are up dated and a self diagnoses is performed again
5. Return to read the input conditions and refresh stored memory.



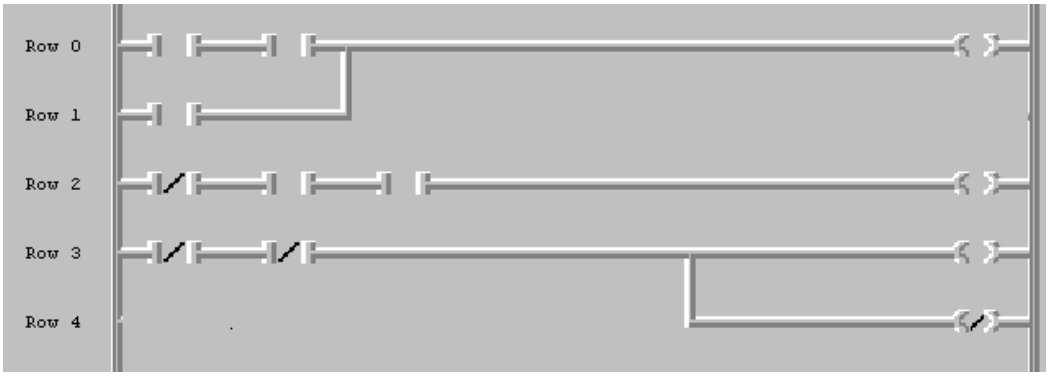

This process is known as the scan cycle and various factors can effect how quick it is. I.e. Larger and more complex programs have bigger scan cycle times.

The flow of a GMWin program is sequential from the first row to the last; this means that Code in Row 1 will be operated on before Row 2. The time difference will be fractional however it is important to note when using latching circuits and sub routines.

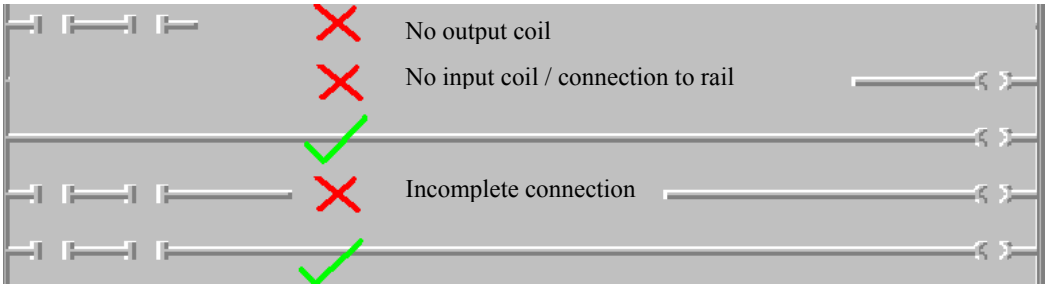
Up to 30 contacts can be placed on one run, but only one coil per line. Function Blocks and Functions use 3 contact spaces on a line and can be put anywhere on a run apart from the first space in a line.




In the GMWin programming environment contacts and coils can be inputted without naming them. This means that the program structure can be drawn out in full before assigning variables.

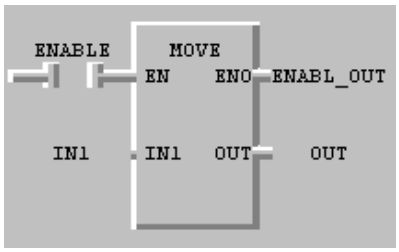


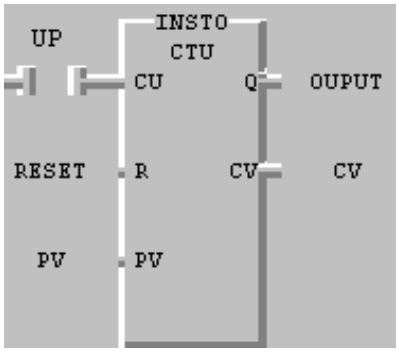

All Rows that have been started must be completed, this means that there must be a complete horizontal connection between the vertical power-rails otherwise the program will not compile.



A Function only has one output and requires an enable signal whereas a Function Block doesn't require an enable and can have several outputs and internal data. When entering a Function Block the user must define an instance name.

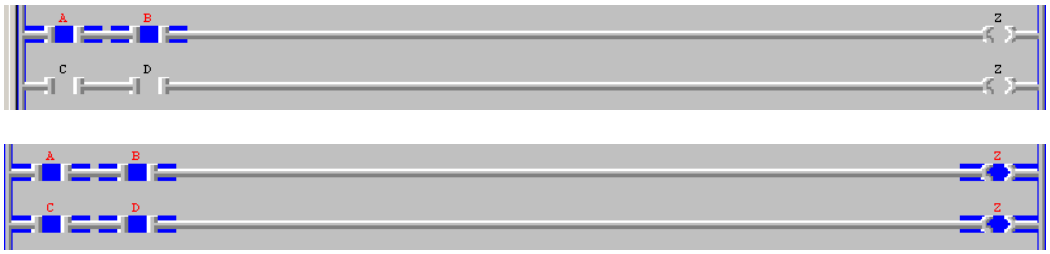
Each Function / Function Block requires a Contact in the first input that a named Variable or constant at the other inputs. It is possible to create user defined Functions and Function Blocks.




It is possible to duplicate coils and this will not bring up an error. This could have been intended however it is an easy mistake to make. With a duplicated coil it will never be active until all conditions are met.

For example in the ladder logic below, A and B on would usually switch Z on. However Z has been duplicated and so required all conditions (A, B, C and D) to be on before being switch positive.

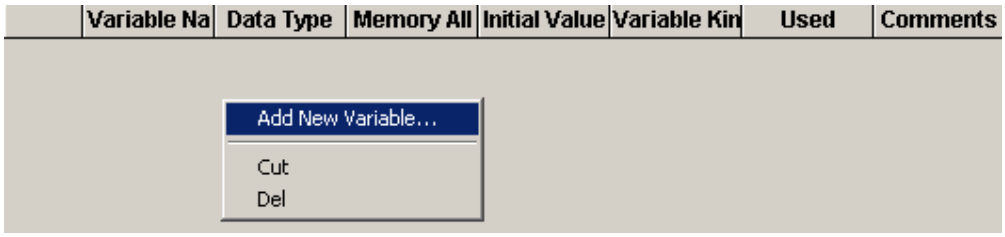


# Variable Declaration

Variables can be expressed in one of two ways. The first is to give a Name to a data element using an identifier and the second is to directly assign a memory address / input or output address to a data element.

Variables can either be entered as contacts/coils/functions or function blocks are entered or in the variable table.

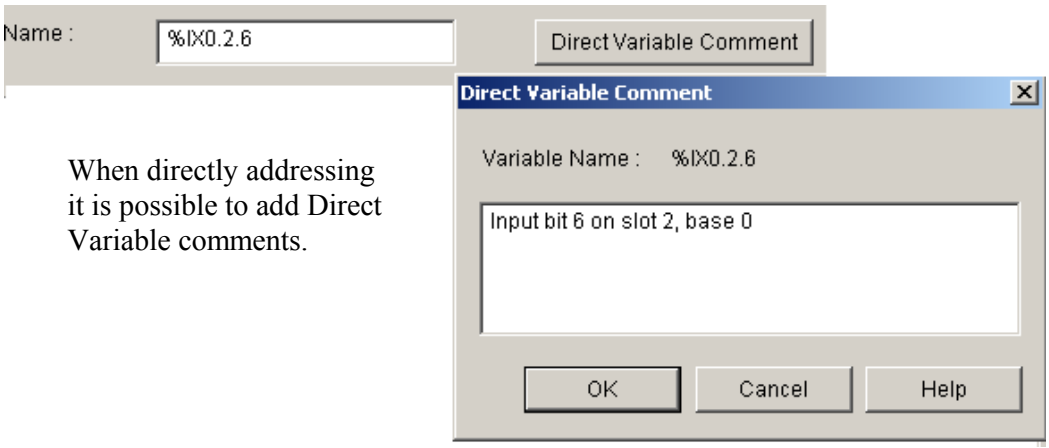
Right click on the mouse when the arrow is in the table area at the top of the ladder logic program.




| | Variable Name | Data Type | Memory All | Initial Value | Variable Kind | Used | Comments |
|---|---|---|---|---|---|---|---|
| 1 | DOWN | BOOL | <Auto> | | VAR | | down input |
| 2 | INST0 | FB Instance | <Auto> | | VAR | | up counter |
| 3 | INST1 | FB Instance | <Auto> | | VAR | | down counter |
| 4 | INST2 | FB Instance | <Auto> | | VAR | | up down counter |
| 5 | LOAD | BOOL | <Auto> | | VAR | | load input, loads pv value |
| 6 | PV | INT | <Auto> | 10 | VAR | | preset value |
| 7 | RESET | BOOL | <Auto> | | VAR | | reset |
| 8 | UP | BOOL | <Auto> | | VAR | | up input |

Variable table with variables assigned in the program.

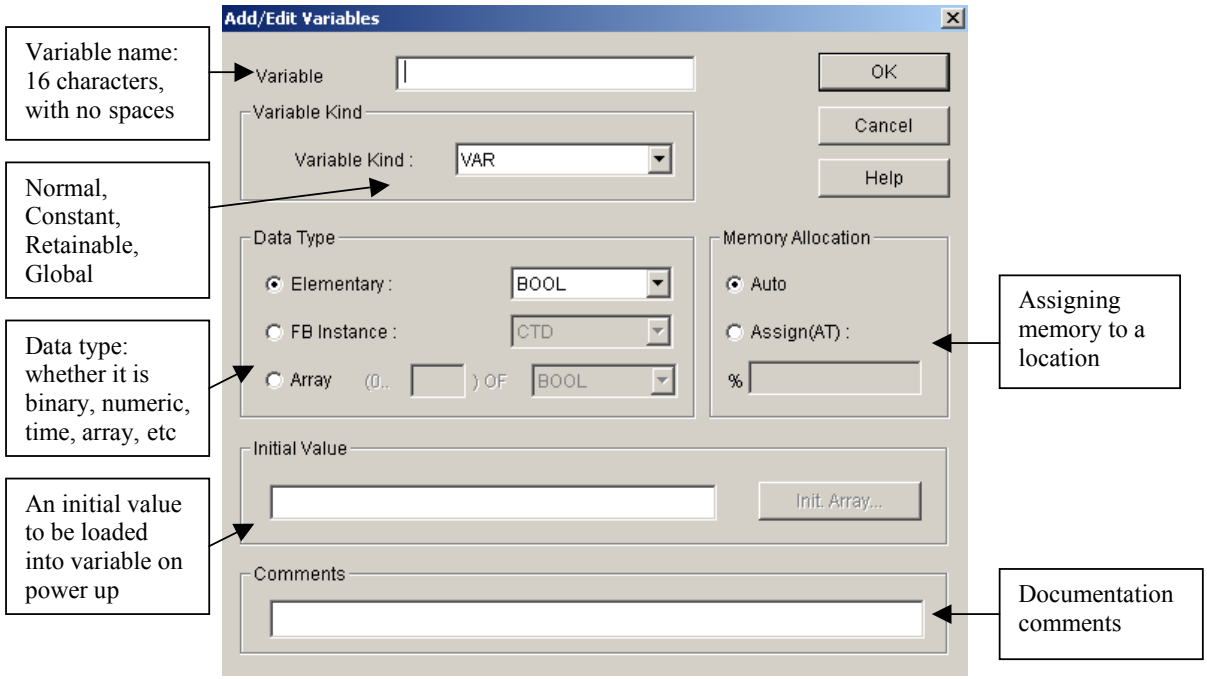
Directly addressing uses the percent sign % followed by the location prefix. The location prefix contains a location identifier (I, Q, M), followed by a size prefix (X, B, W, D, L) and completed with an expression indicator (for I and Q, base . slot. Data; for M, data (according to size prefix). bit of data).

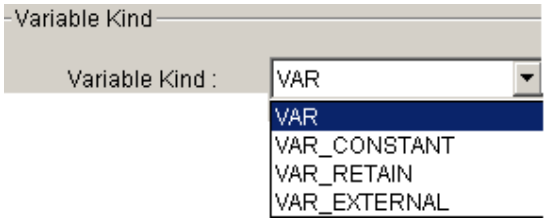



When directly addressing it is possible to add Direct Variable comments.

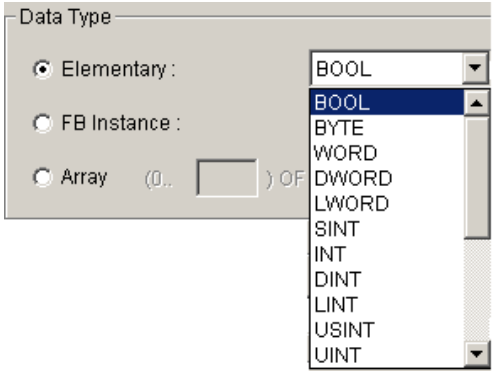
i.e. % I X 0 . 2 . 6 : Input, Bit size, Base 0, Slot 2, Bit 6.
% M W 32 . 7 : Memory, Word size, word 32, bit 7.

When naming a variable there is a little more information that has to be inserted.

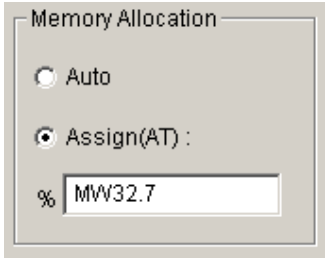



VAR: General read / write variable
VAR_CONSTANT: Read only, constant
VAR_RETAIN: Read / write, but keeps value on power down
VAR_EXTERNAL: Use to declare the variable as VAR_GLOBAL *(global variable)*




The data type of a variable depends on the type of data that the variable is representing. i.e. Integer value, time, binary, etc. This also is important, as the different types of data require differing amounts of memory size to store them.




Here we can allocate the variable to a memory location. This is much like the direct addressing.

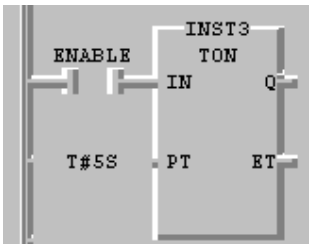

## *Time Variables*

Time variables are used in Timers for the preset value and need special attention. Data intended to be entered into timers must use advanced functions to convert to a Time Variable. This will be discussed further in the Advanced Function section.

Time variables have the prefix of: t#
The value is the entered before ending with the variable with the timing constraint.

i.e. A Timing Value of two days, seven hours, three minutes, twenty seconds and sixteen milliseconds, would become: t# 2 d 7 h 3 m 20 s 16 ms

The maximum time allowed is T#49d17h2m47s295ms (32 bits of ms unit)



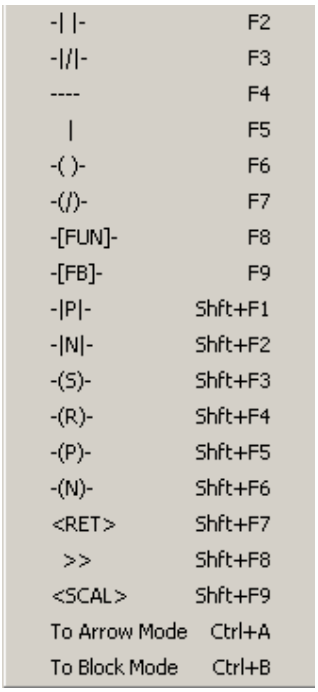

This is a 5s On-delay timer

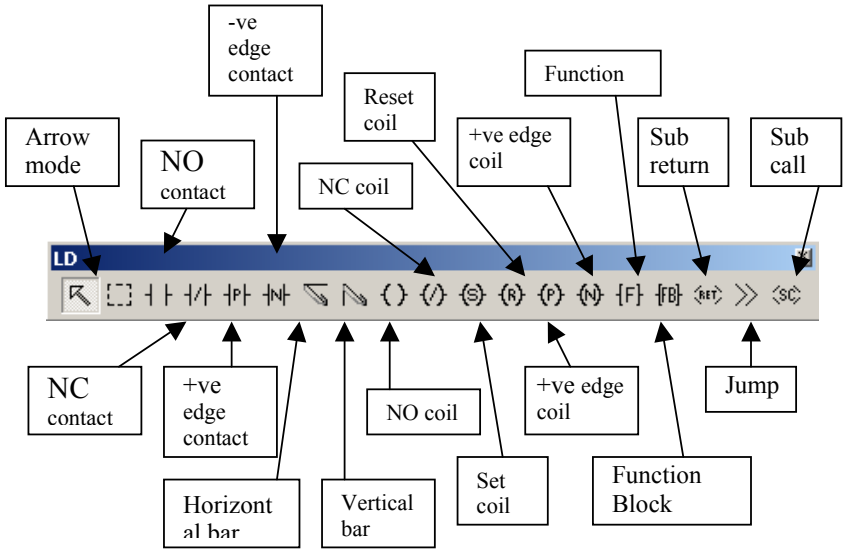
# Basic Ladder Logic

All ladder diagram programs contain basic Boolean logic and interlocking circuitry. It is important to master the basics as complicated programs are made of these simple programs.

## *Inputs and Outputs*

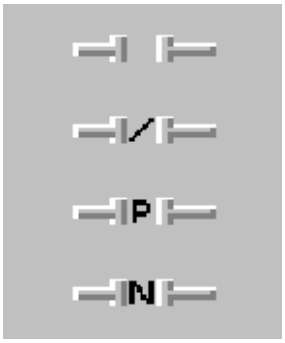
The inputs and outputs can be inserted by using the Icon bar and click on the desired icon or by using a hot key.




The inputs and outputs are of a Boolean type and operate as either ON or OFF.

### Inputs



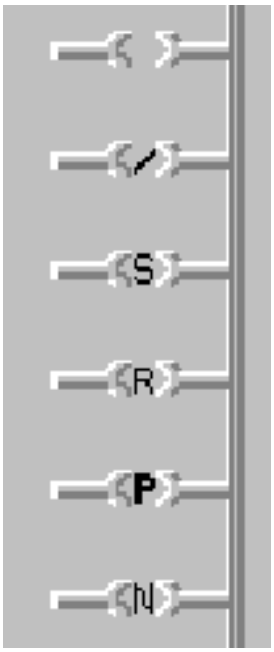

Normally Open contact.

Normally Closed contact.

Positive edge triggered contact.

Negative edge triggered contact.

### Outputs




Normally Open relay coil.

Normally Closed relay coil.

Set relay coil

Reset relay coil

Positive edge triggered relay coil.

Negative edge triggered relay coil.

## *Boolean Logic*

Boolean logic deals with binary data, (ON or OFF), with knowledge of some basic Boolean logic circuits most events can be accounted for and controlled.

AND Gate: Z = A AND B


OR Gate: Z = A OR B


NOT Gate: Z = NOT A

Or


## *Latching Circuits*

A latching circuit holds an output high when the input has been removed. There are two methods of latching circuit: Circuitry latch and Set / Reset coils.

Circuitry latch using the output as an interlock.

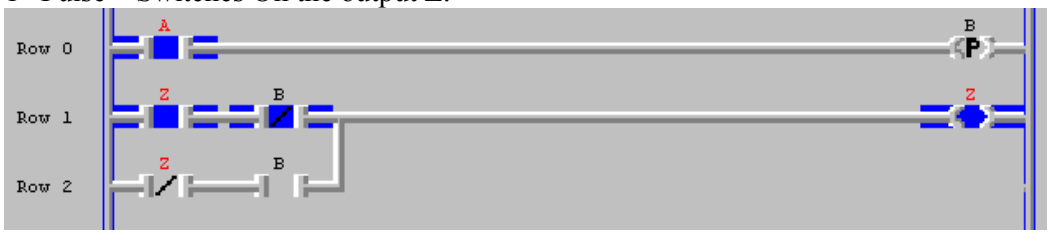

Using S R relay coils.


## *Flip / Flop Circuit*

A flip-flop circuit toggles the output. The first input pulse will set the output high and the second input pulse will reset.

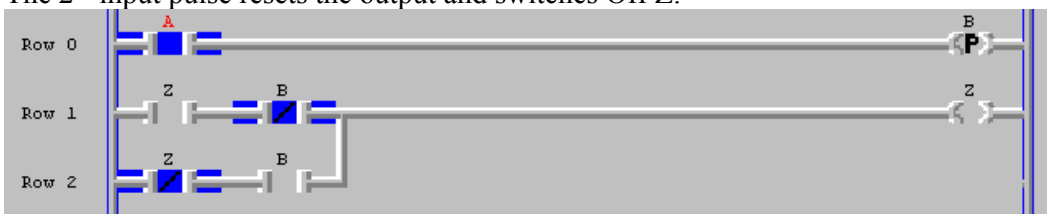
Flip-flop circuit diagram.


1st Pulse – Switches On the output Z.



The output Z is latched ON.


The 2nd input pulse resets the output and switches Off Z.




## *Ladder Programming Example*

Design a simple ladder circuit using a logical AND gate and an OR Gate to create a basic interlock.

First open GMWin and start a new project.

Select the Normally Open (NO) contact icon in the toolbox and click the right button of the mouse into position row ‘0’ and column ‘1’ in the LD window

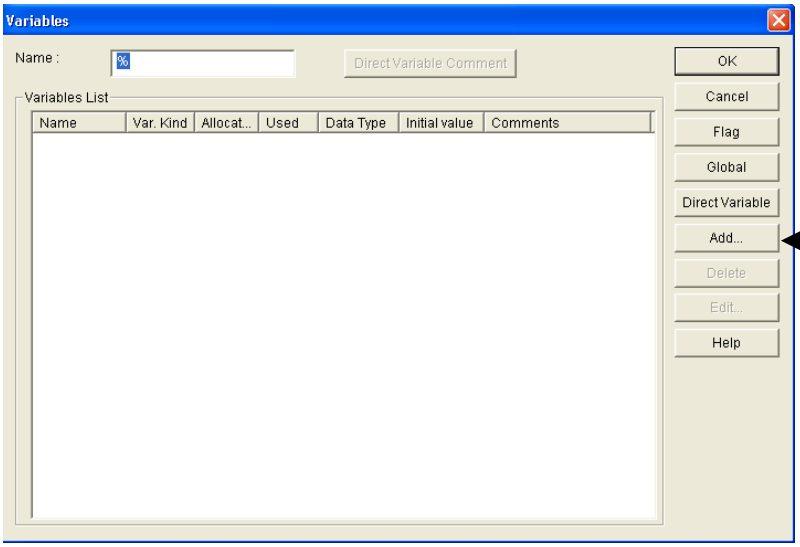

Next Select a Normally Closed (NC) contact icon in the toolbox and click the right button of the mouse on position row ‘0’ and column ‘2’ in the LD window

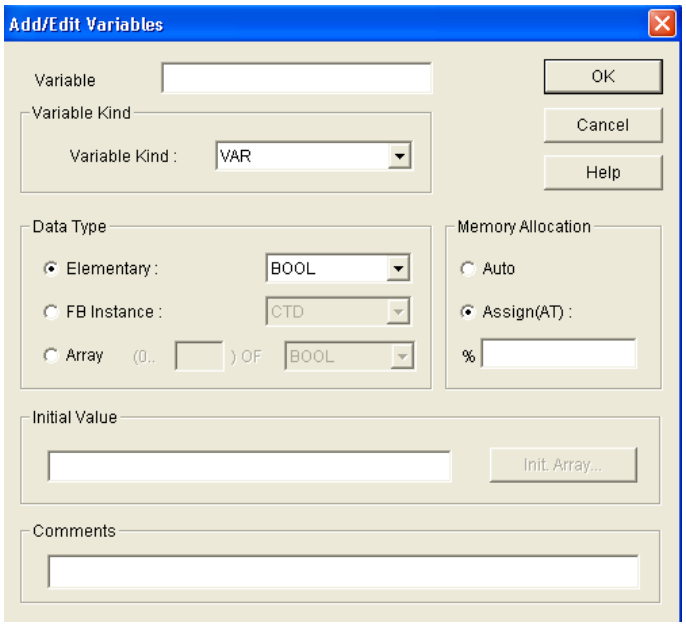

Next Select a normally open coil icon in the toolbox and click the right button of the mouse on position row ‘0’ at the far right hand side. You will see that it the line is automatically created so that it is connected across to the inputs.

Select the Normally Open (NO) contact icon in the toolbox and click the right button of the mouse on position row ‘1’ and column ‘1’ in the LD window


Select the Up line connection icon in the toolbox and click the right button of the mouse between row ‘1’ and row ‘0’and column ‘1’ in the LD window.


Now that the diagram has been entered we can enter the variables. Double click on the contacts and coils with the right mouse button to enter the Variables menu.

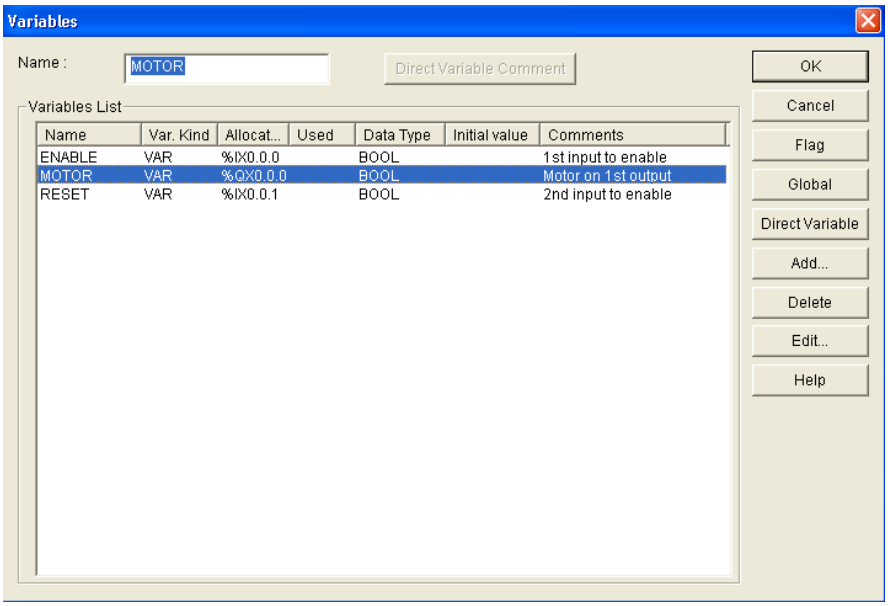





Enter the variable data. Then click done when complete

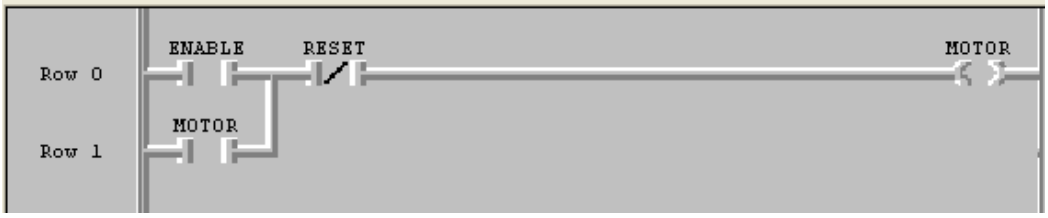
| Name | Type | Address | Comment |
|---|---|---|---|
| Enable | BOOL | %IX0.0.0 | 1st input to enable |
| Reset | BOOL | %IX0.0.1 | 2nd input to reset |
| Motor | BOOL | %QX0.0.0 | Motor on 1st output |

Keep adding variables until you have a variable menu like below. To assign variable to the contacts and coils, Double click on the contact or coil and simply select the variable from the menu and press OK.



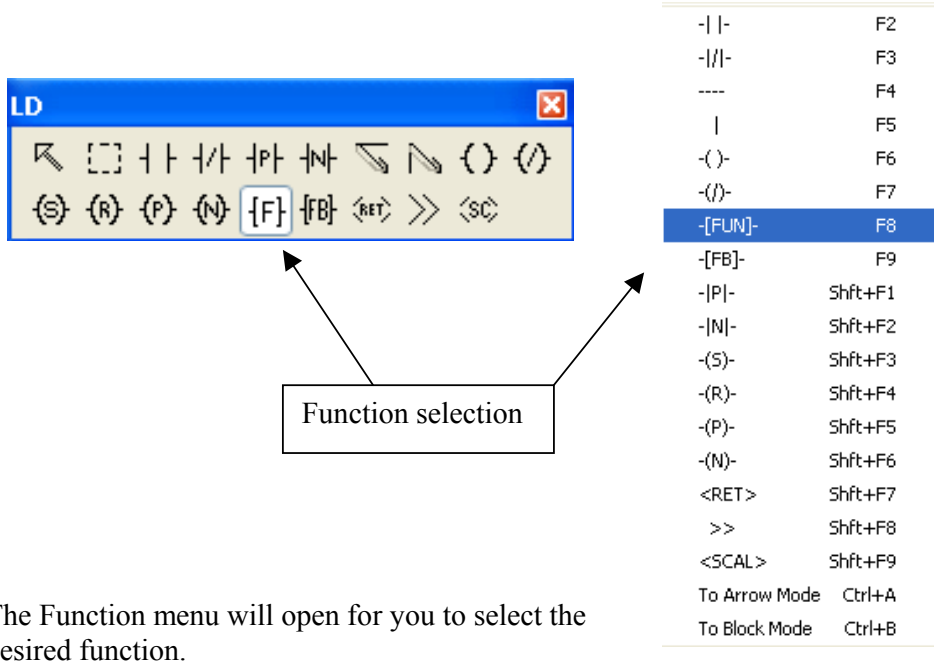

The program should now look like the one below.

| | Variable Na | Data Type | Memory All | Initial Value | Variable Kin | Used | Comments |
|---|---|---|---|---|---|---|---|
| 1 | ENABLE | BOOL | %IX0.0.0 | | VAR | | 1st input to |
| 2 | MOTOR | BOOL | %QX0.0.0 | | VAR | | Motor on 1st |
| 3 | RESET | BOOL | %IX0.0.1 | | VAR | | 2nd input to |

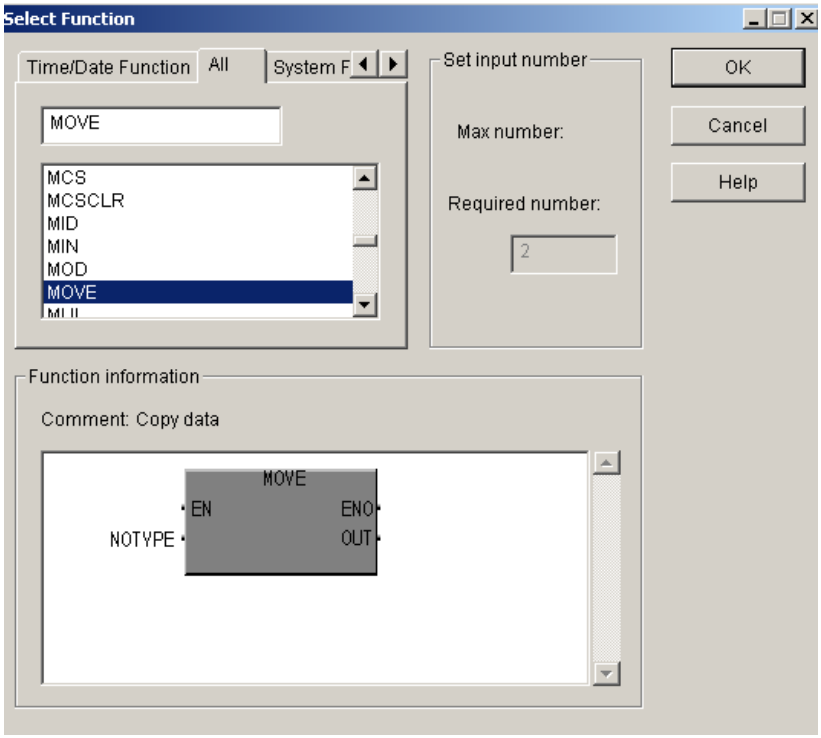


# Basic Functions

There are two methods of entering a function into a program: Selecting the Function icon or pressing the hotkey. Both methods attached the Function icon onto the mouse arrow and then simply click it into the diagram.



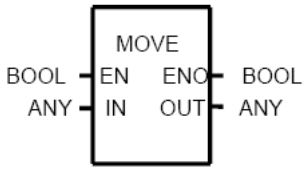

The Function menu will open for you to select the desired function.

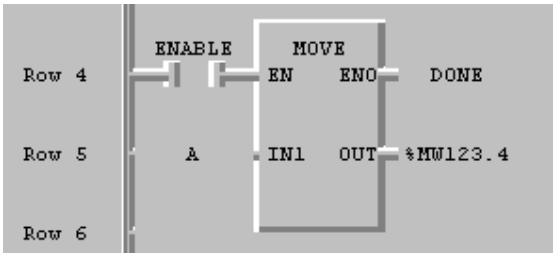



Select the function you want and enter the settings required. Press OK once complete.

## *Move Function*

A frequently used function. Used to move data from one memory location into another location.

| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN: value to be moved<br><br>**Output** ENO: without an error, it will be 1<br>OUT: moved value<br><br>**Variables connected to IN and OUT must be of the same type** |

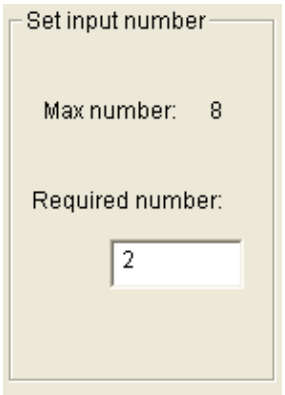


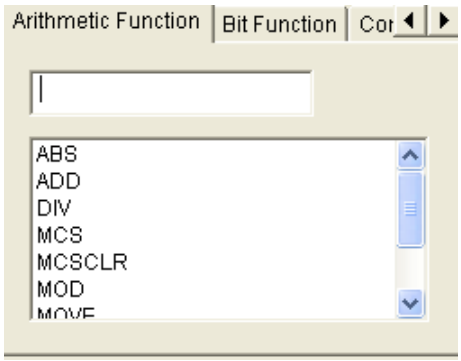

When the Enable input goes high, the data in A will be moved to memory location %MW123.4.

## *Arithmetic Functions*

The PLC can perform all mathematical functions. However the only PLC CPU that can perform true floating-point maths is the G4 CPUC. This means that the result of an arithmetic function will return an integer, unless using a GM4-CPUC.

Arithmetic functions are entered as any other Function, however you can select the number of inputs required. You can select the desired function easier by selecting the arithmetic tab, which lists only those particular functions.

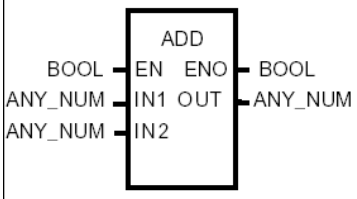


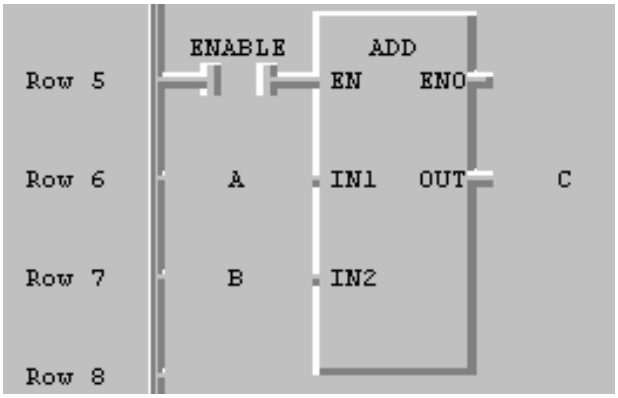

All arithmetic functions are available in a sub menu for ease of selection. Available functions include Add / Sub / Mul / Div /Mod

## Add Function

The Add function performs addition on up to 8 variables.

| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: value to be added<br>IN2: value to add<br>Input variable number can be extended up to 8<br><br>**Output** ENO: without an error, it will be 1<br>OUT: added value<br><br>IN1, IN2, ..., OUT should be the same data type. |

The Addition Function can have up to 8 eights. Select the number of inputs required for the function and click ok. Below is an example of a 2 input Add function.

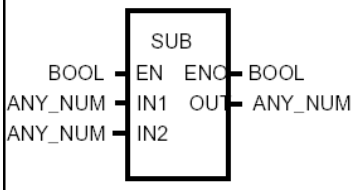



C = A + B

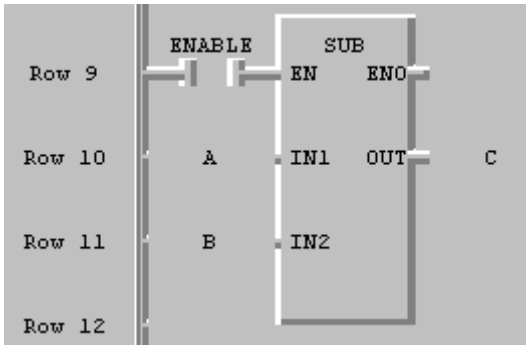
When enable goes high A is Added to B and stored in C.

## Sub Function

The Sub function, subtracts one variable from another.

| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: the value to be subtracted<br>IN2: the value to subtract<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: the subtracted result value<br><br>The variables connected to IN1, IN2 and OUT should be all the same data type. |

The Subtraction function can only have two inputs.

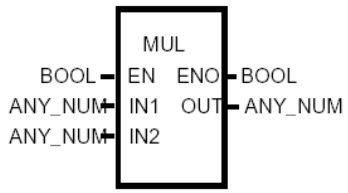



C = A – B

When Enable is set high, B is Subtracted from A and stored in C.

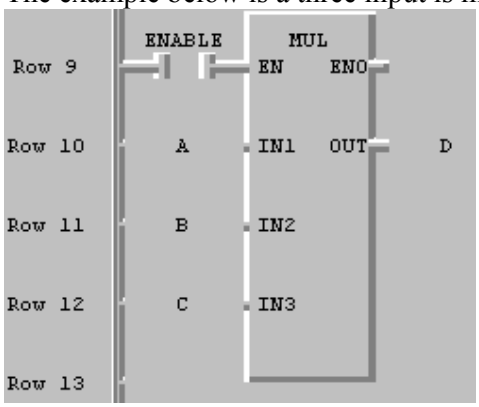
## Mul Function

The multiplication function can up to eight inputs selected.

| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: multiplicand<br>IN2: multiplier<br>Input is available to extend up to 8.<br>**Output** ENO: without an error, it will be 1<br>OUT: multiplied value<br>Variables connected to IN1, IN2, ..., OUT are all the same data type. |



The example below is a three input is multiplication function.

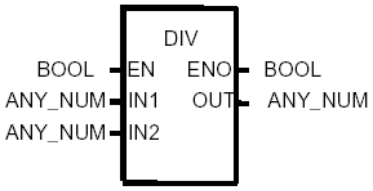


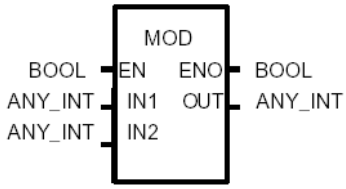

D = A x B x C

When the enable signal is active the calculation is performed (A x B x C) and stored in D.

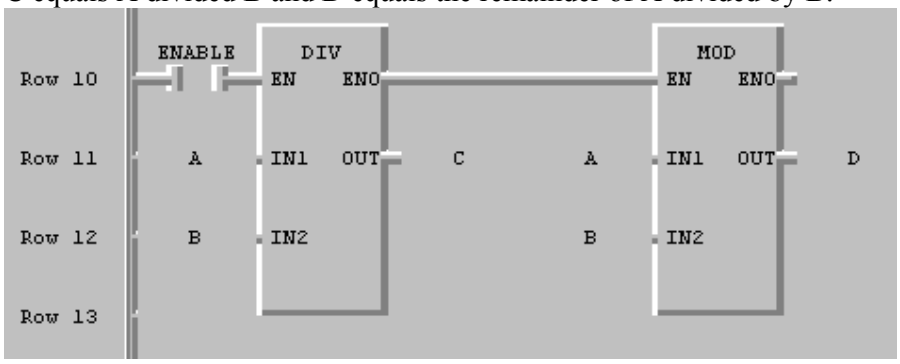
## Div and Mod Function

The divide function can only have two inputs and returns only a whole number. The Mod function calculates the remainder and returns the value as in integer.

| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: the value to be divided (dividend)<br>IN2: the value to divide (divisor)<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: the divided result (quotient)<br><br>The variable connected to IN1, IN2 and OUT should be all the same data type. |

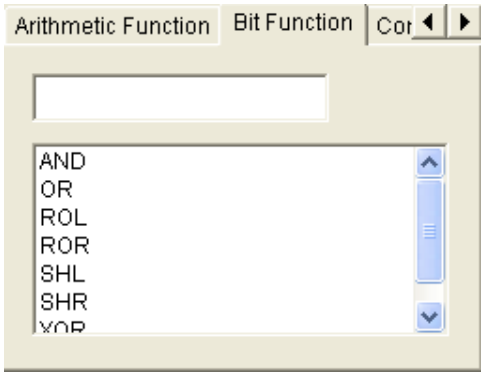
| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: dividend<br>IN2: divisor<br><br>**Output** ENO: without an error, it will be 1<br>OUT: dividing result (remainder)<br><br>IN1, IN2, ..., OUT should be all the same data type. |

C equals A divided B and D equals the remainder of A divided by B.



## *Bit Functions*

Bit functions and functions that manipulate the fundamental bits of data.

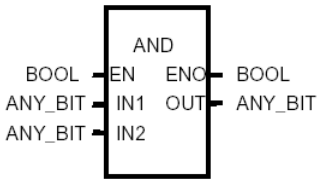


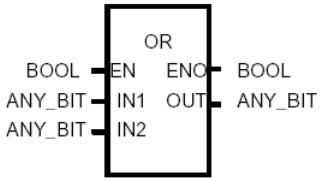

Depending on the type of Function, they can have a minimum of two inputs and an enable signal.

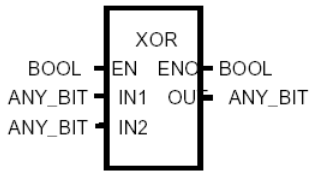
The bit functions include Boolean Logic Functions like AND, OR, and XOR but also include Rotate and Shift functions like ROR, ROL, SHR and SHL.

### AND, OR, XOR Functions

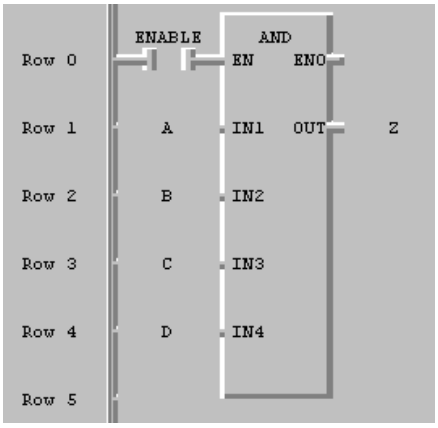
*These functions can also be performed using ladder logic. See Basic Ladder Logic, Boolean Logic.*

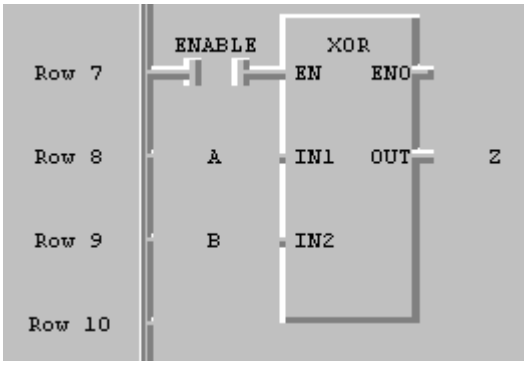
| Function | Description |
|---|---|
|   | **Input** EN: executes the function in case of 1<br>IN1: input 1<br>IN2: input 2<br>Input variables can be extended up to 8.<br><br>**Output** ENO: without an error, it will be 1<br>OUT: AND result<br>IN1, IN2, and OUT should be all the same data type. |

| Function | Description |
|---|---|
|   | **Input** EN: executes the function in case of 1<br>IN1: input 1<br>IN2: input 2<br>Input variables can be extended up to 8.<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: OR result<br><br>IN1, IN2, OUT should be all the same data type. |

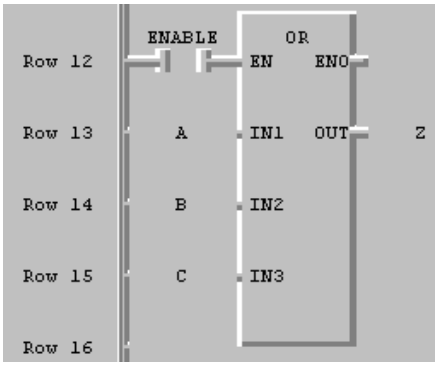
| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: the value to be XOR<br>IN2: the value to be XOR<br>Input variable number can be extended up to 8.<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: the result of XOR operation<br><br>IN1, IN2, OUT should be all the same data type. |

4 Input AND Gate
Z = A AND B AND C AND D



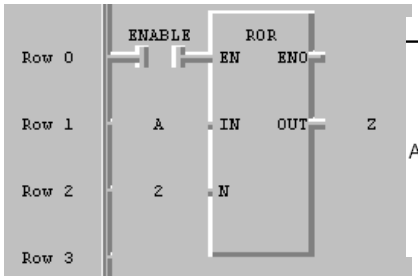

2 Input Exclusive OR
Z = A XOR B



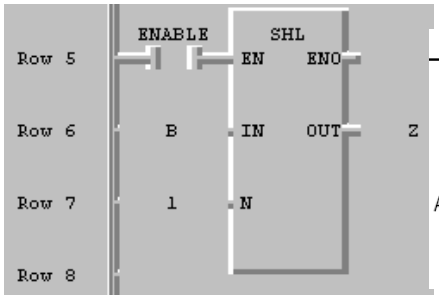

3 Input OR Gate
Z = A OR B OR C

## Shift and Rotate Functions

Shift and rotate functions operate on byte and word variable kinds. They perform bit multiplication and division.



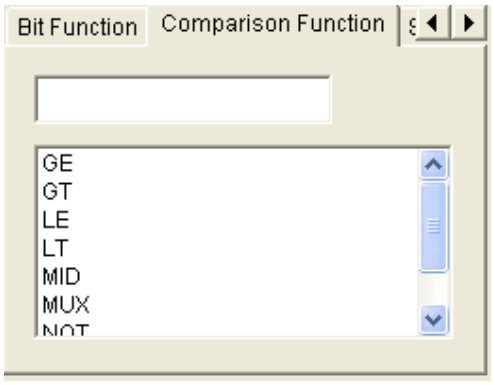

| Function | Description |
|---|---|
| ROR<br>BOOL — EN ENO — BOOL<br>ANY_BIT — IN OUT — ANY_BIT<br>INT — N | **Input** EN: executes the function in case of 1<br>IN: the value to be rotated<br>N: bit number to rotate<br>**Output** ENO: without an error, it will be 1.<br>OUT: the rotated value |




| Function | Description |
|---|---|
| SHL<br>BOOL — EN ENO — BOOL<br>ANY_BIT — IN OUT — ANY_BIT<br>INT — N | **Input** EN: If EN is 1, function is executed.<br>IN: bit string to be shifted<br>N: bit number to be shifted<br>**Output** ENO: without an error, it will be 1<br>OUT: the shifted value |

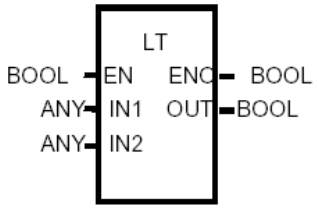
## *Compare Functions*

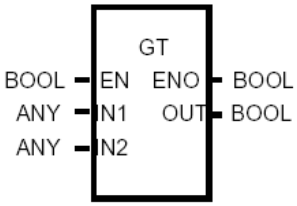
Comparison functions are used to evaluate data.

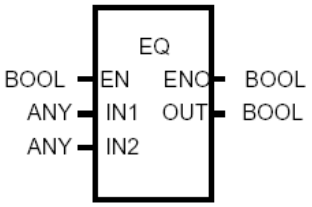


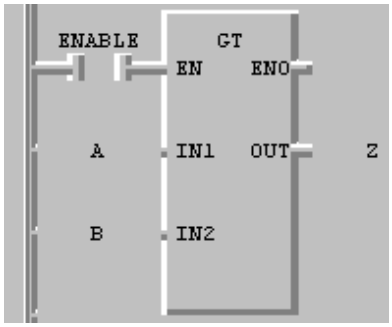

| | |
|---|---|
| GE | Greater or Equal |
| GT | Greater Than |
| LE | Less or Equal |
| LT | Less Than |
| EQ | Equal |
| MID | Takes the middle part of a character string. |
| MUX | Selection of 1 from a multiple of inputs. |
| SEL | Select one of two inputs |

## LT, EQ, and GT Functions

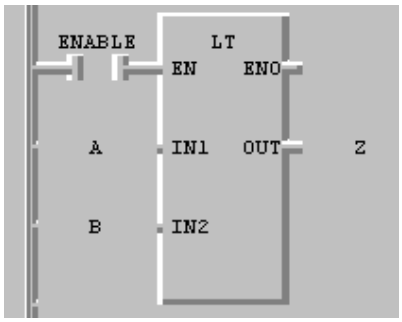
| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: the value to be compared<br>IN2: the value to compare<br>Input variable number can be extended up to 8.<br>IN1, IN2, ...should be the same data type.<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: comparison result value |

| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: the value to be compared<br>IN2: the value to compare<br>Input variable number can be extended up to 8.<br>IN1, IN2, ... should be the same data type.<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: comparison result value |

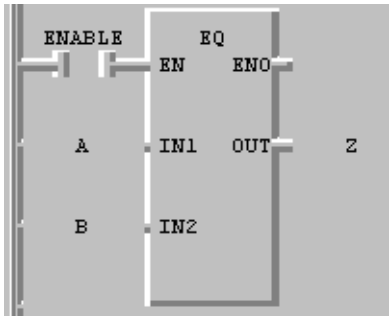
| Function | Description |
|---|---|
|  | **Input** EN: executes the function in case of 1<br>IN1: the value to be compared<br>IN2: The value to compare<br>Input variable number can be extended up to 8.<br>IN1, IN2, ... should be the same type.<br><br>**Output** ENO: without an error, it will be 1.<br>OUT: comparison result value |




If A is Greater Than B then the output Z will be high.




If A is Less Than B then the output Z will be High.

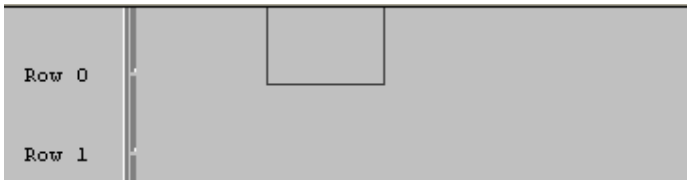



If A Equals B then the output Z will be High.

## *Function Programming Example*

Write a simple Move, Comparison and Add function program.

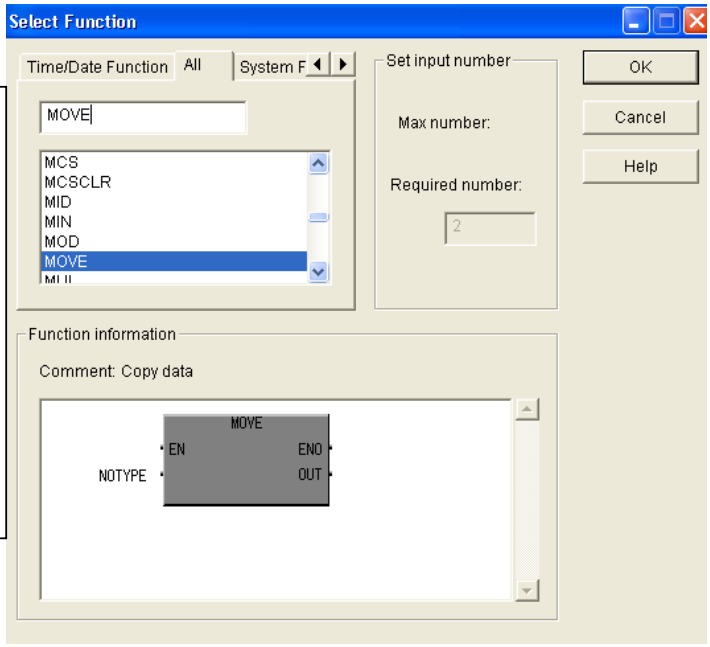
Select a Function by clicking the icon {F} in the toolbox with the right button of the mouse and put into position row '0' in from the first column.



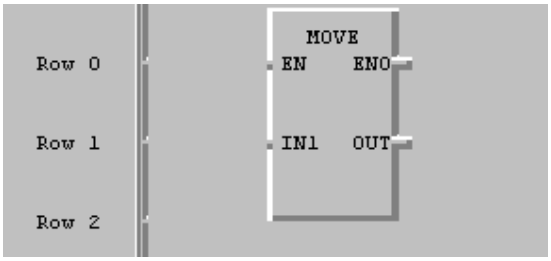

The Function menu will then pop up.

Either search through the functions or if you know the desired function name, enter it in the box.

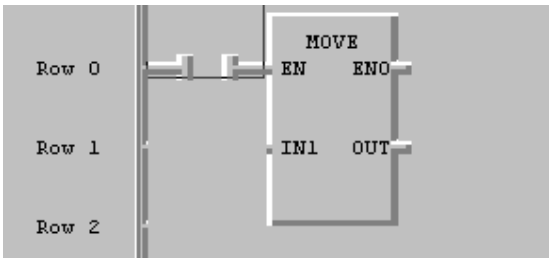
Type MOVE and then click OK.



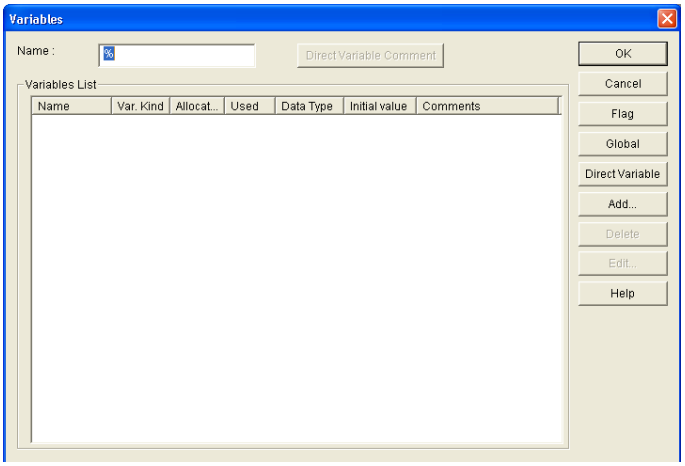

The Function is now in the ladder diagram. Note this particular function requires three rows.



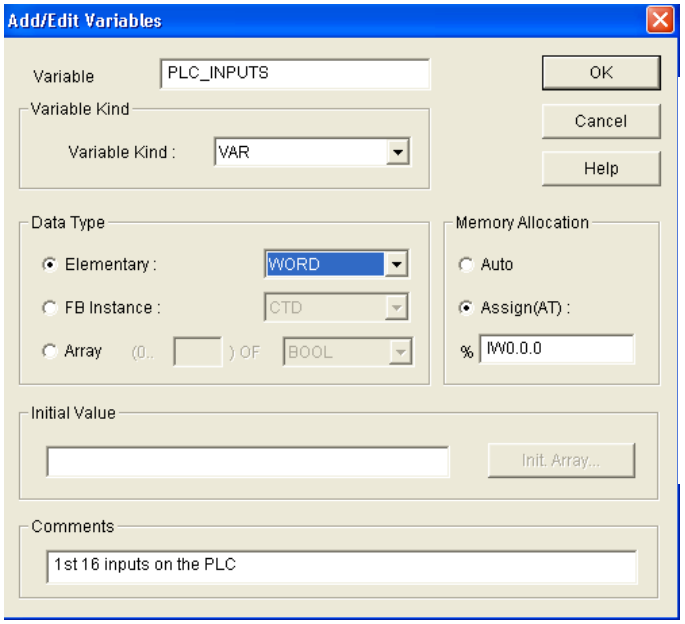

Now insert a NO contact in row 0, column 1.




To insert a new variable at the IN1 of the MOVE function, double click the right mouse button in the space to the left of IN1. This will open up the variables menu.



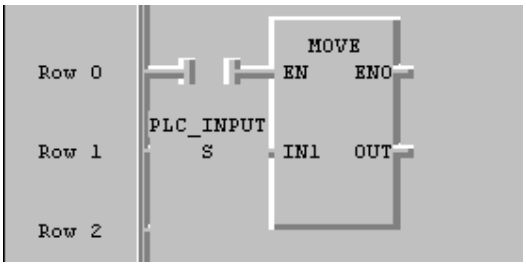

Click Add to insert a new variable.



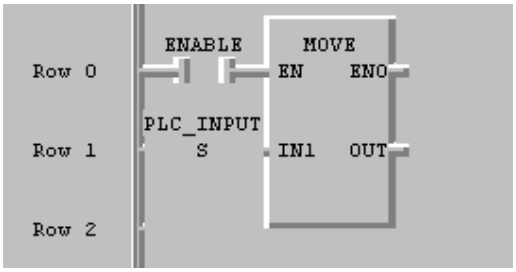

We are going to read the inputs of the PLC as a word. So we need to change the elementary to WORD.

Click OK when the details have been entered

The variable is now entered at the function. Note that the Functions Function Blocks only require the first input to be a contact and the rest of the inputs are named variables.

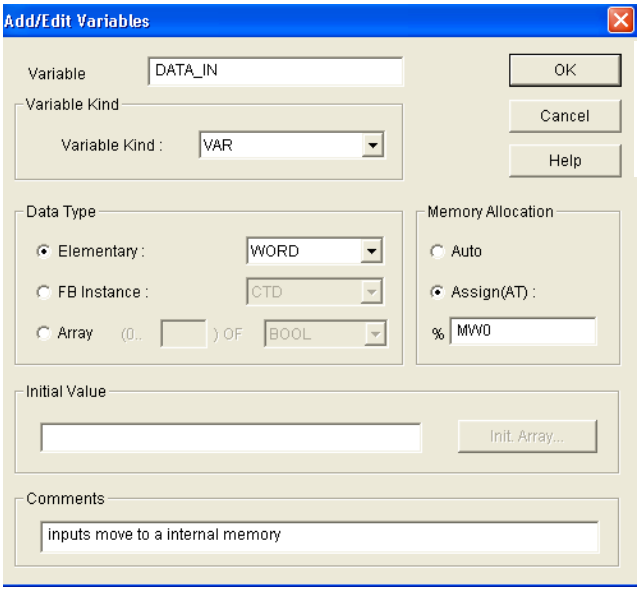



Double click the right mouse button on the input contact and enter the variable "Enable" as a Boolean and Auto allocated.

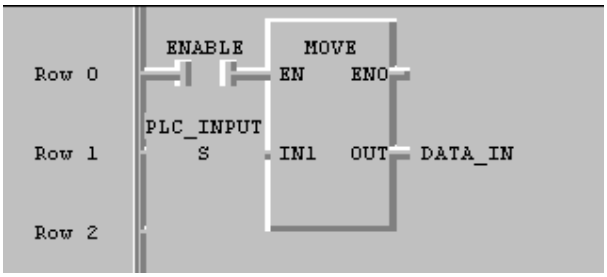



The input side is now set up on the function.

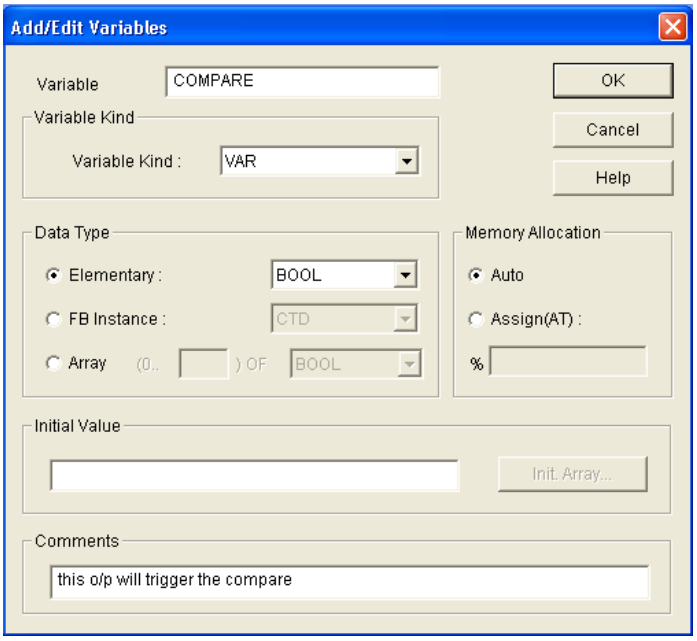
Now to set up the output of the MOVE function. Double click the right button on the mouse in the space to right of the OUT on the MOVE function. This will bring up the variable menu and we need to add a variable for the output, for data to be moved to.



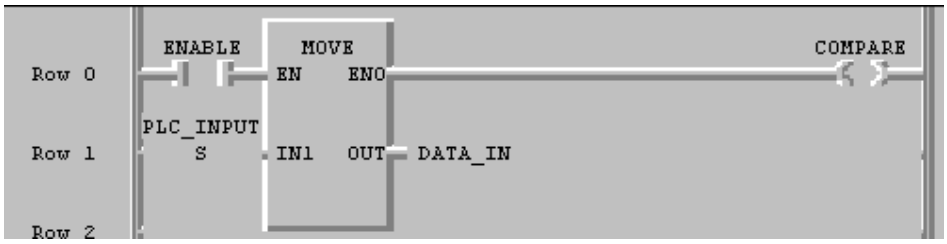

Enter the details and click OK.




Insert a NO coil off the ENO output of the MOVE function. It is not always necessary to do this however for this example we require it. Name the variable Compare, the type will be Boolean and auto allocate it.

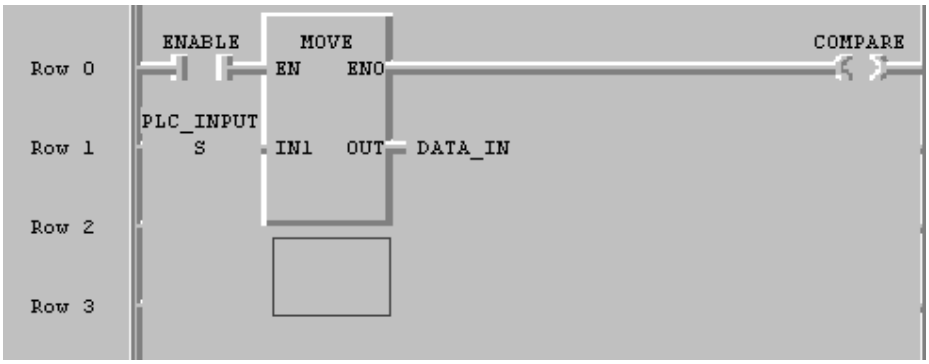



Enter the data and click OK.

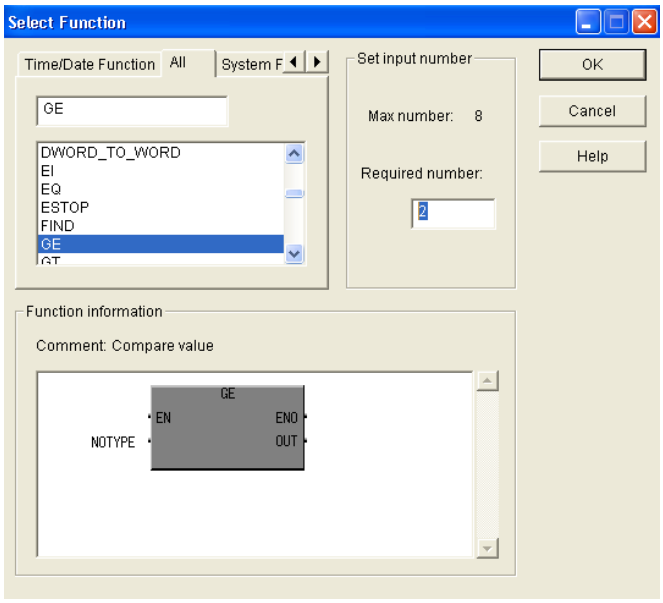



Now that the move function has been set up we can continue the program with setting up a compare function. We want to compare the DATA_IN to a fix value, if DATA_IN is greater or equal to the value 100 we want the output to go high. In this case we are going to use the function GE.

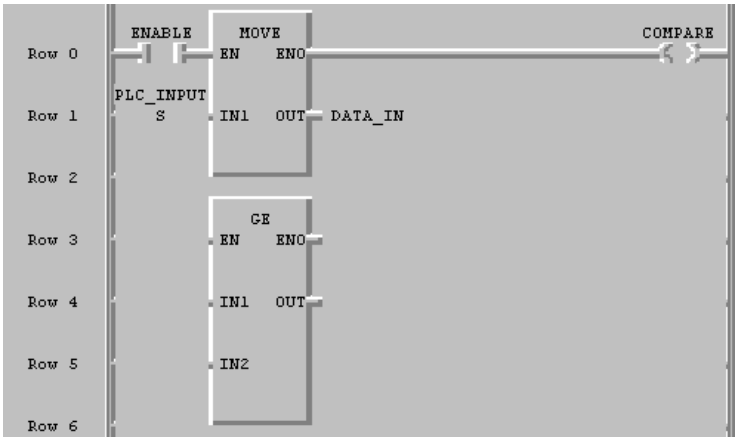
Select a Function by clicking the icon {F} in the toolbox with the right button of the mouse and put into position row '3' in from the first column.



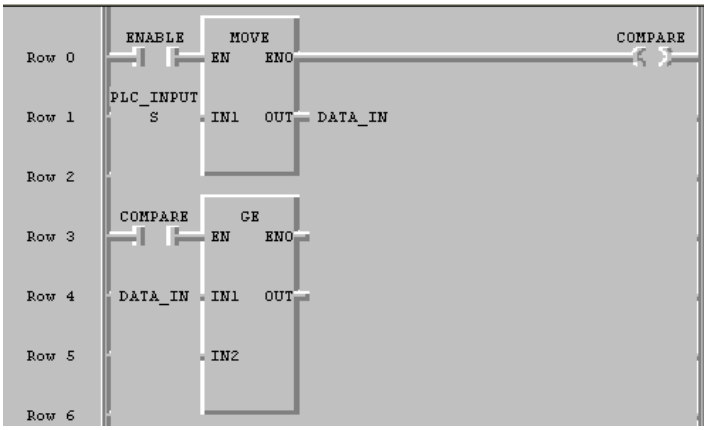

Type GE in the text box and set the input number to 2.



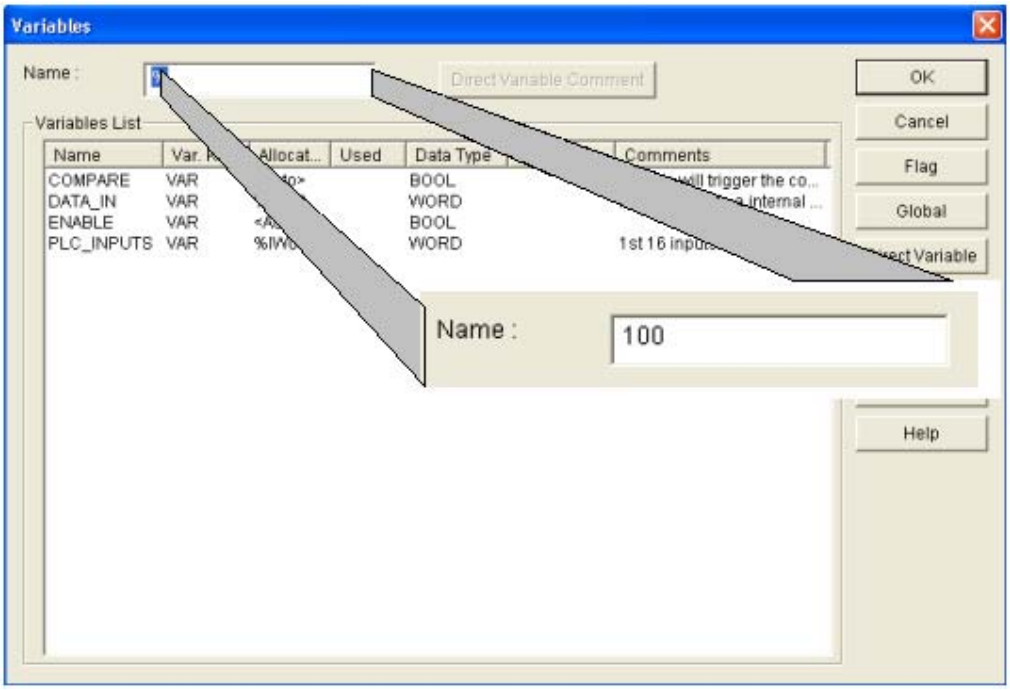

Click OK when the details have been entered.



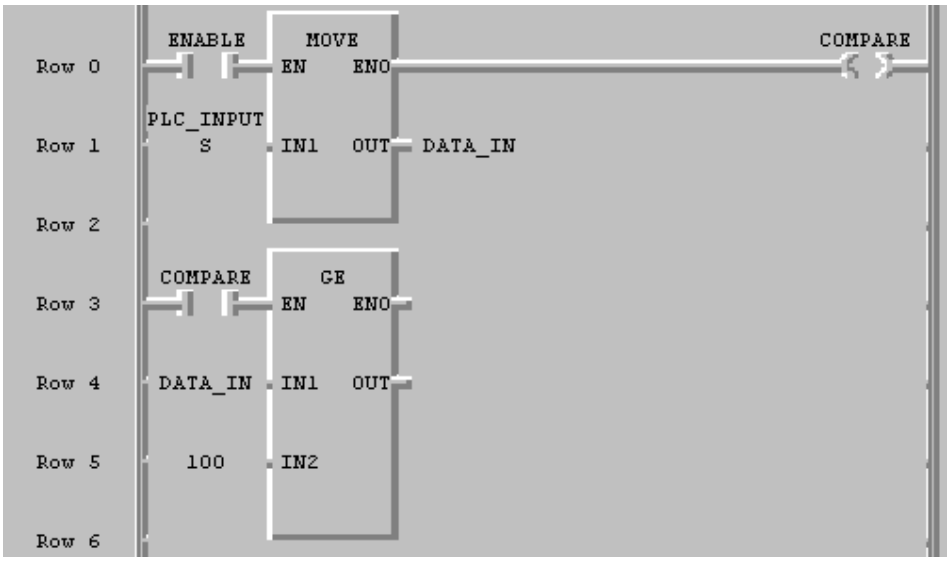

Enter a NO contact at EN and assign it to the variable COMPARE. Using the right mouse button and double click in the space to the left of IN1, assign the variable DATA_IN.



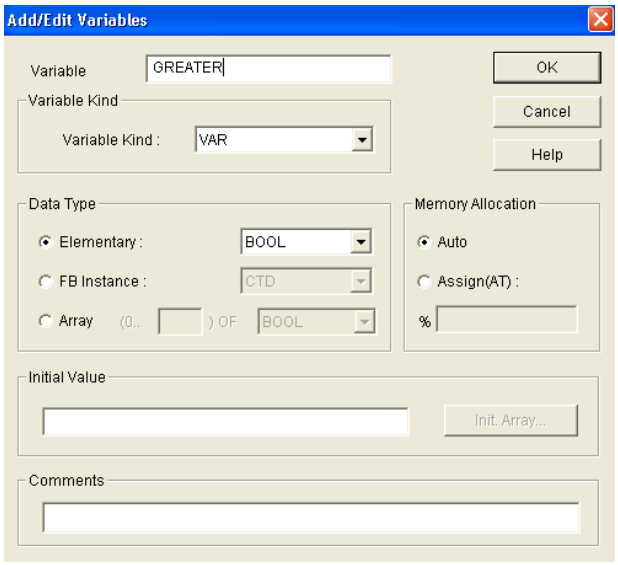

Double click the right mouse button in the space to the left of IN2 to bring up the variables menu.




Highlight and delete the % symbol to enter a constant value of 100. Click OK when complete.

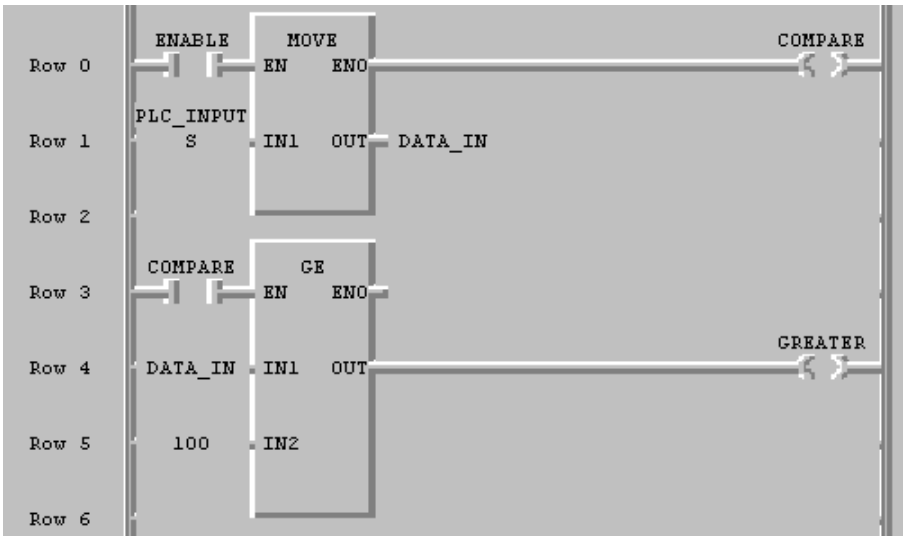



Now assign a NO coil to the output OUT of the GE function, and add a new variable to assign to the coil.




Enter a new variable named GREATER, of element type BOOL and auto allocate it.

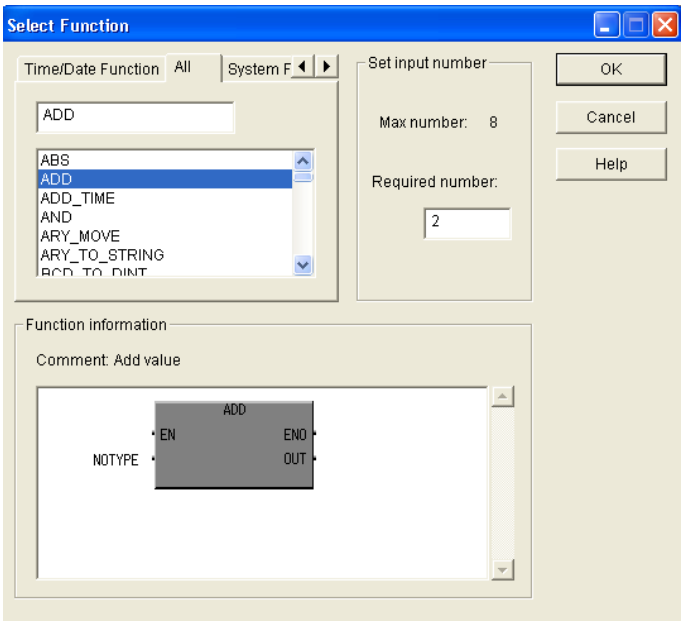
Click OK, when done.

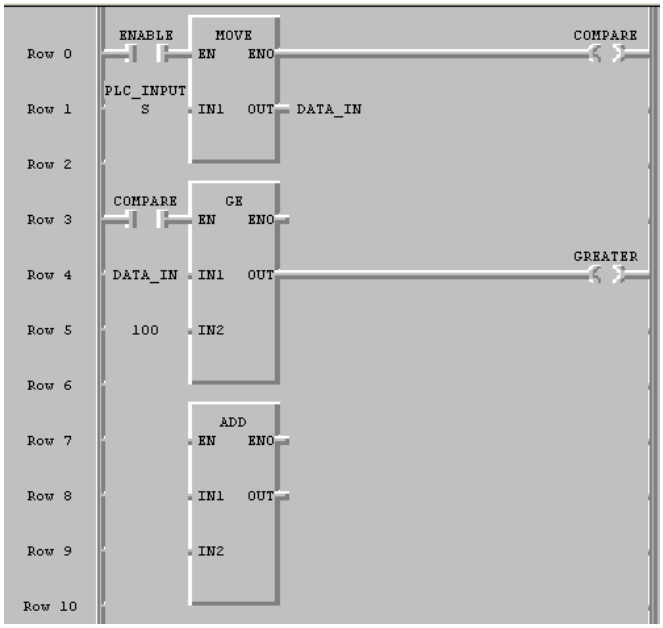



Now we want to set up the Add function select a Function by clicking the icon {F} in the toolbox with the right button of the mouse, put the function into position row '7' in from the first column.

Type Add in the text box and set the number of inputs to 2.

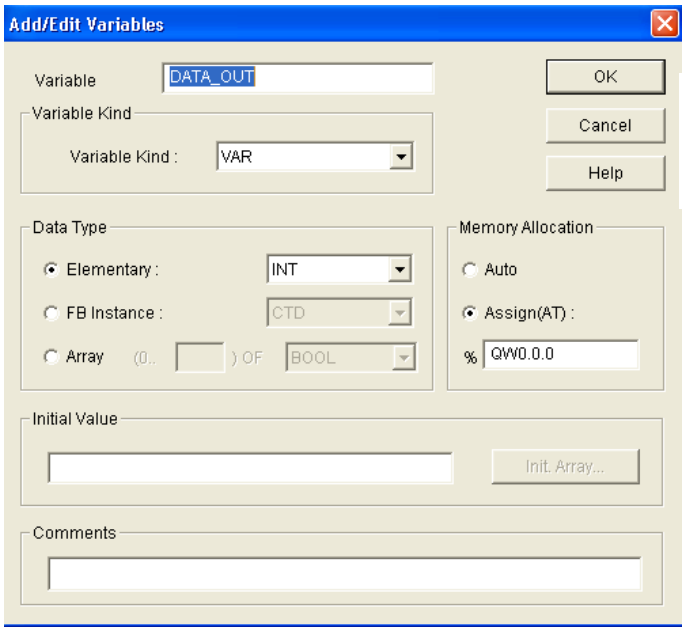
Click OK when completed.





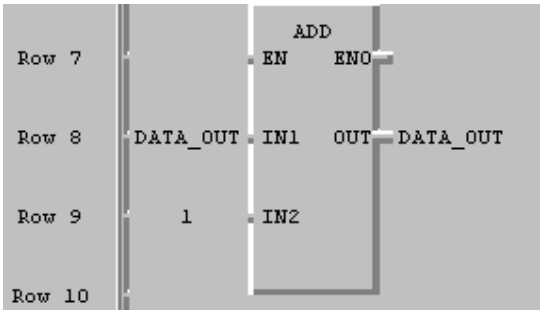

With the Add function we want to Add 1 to the outputs of the PLC every time the GREATER output is high.

Double click the right mouse button to the left of the input IN1 of the ADD function. Add a new variable called DATA_OUT, make the element type an INT (integer) and allocate the memory to %QW0.0.0. If we make the output the same as the input, each time the output is triggered the input will increment. Therefore double click the right mouse button in the space to the right of the OUT output of the ADD function.



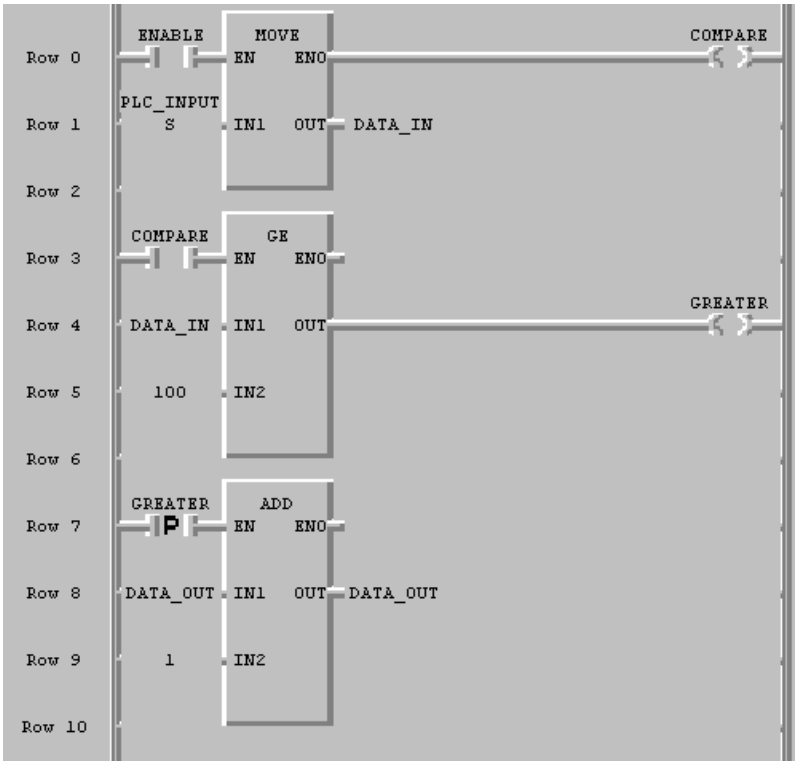

Click OK when done

Double click the right mouse button in the space to the left of the input IN2 and enter the constant 1.




Finally we need to set up the enable to trigger the ADD function when variable GREATER is high. However we only want one pulse per GREATER trigger, therefore we will use a leading edge pulse contact.

Select the rising edge pulse contact icon  in the toolbox and click the right button of the mouse on position row '1' and column '1' in the LD window

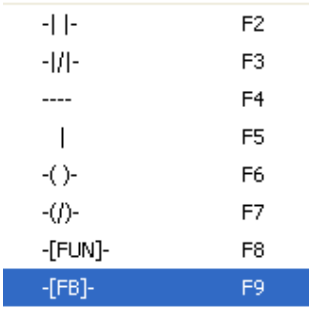



Now the program is complete, try simulating the program to see how it works.

# Basic Function Blocks

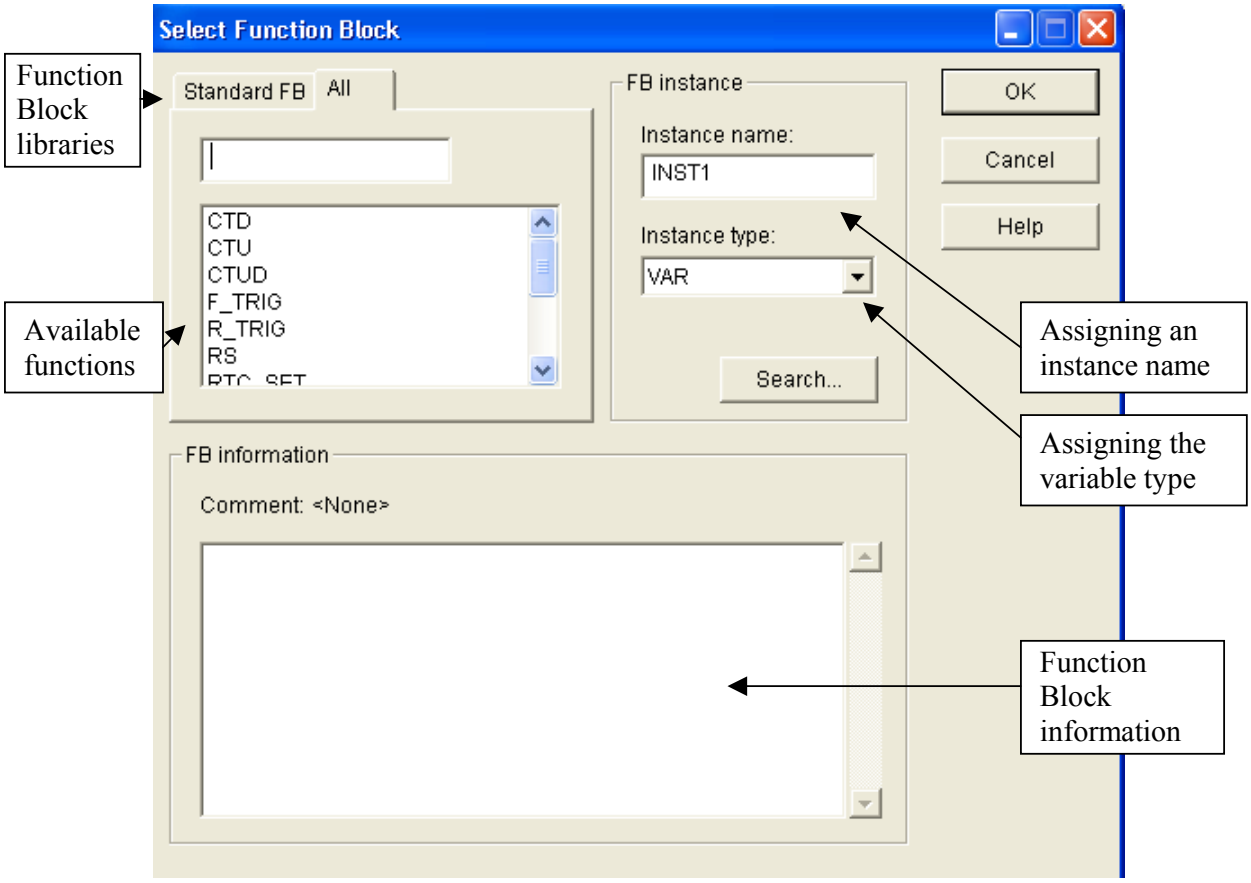
A Function Block (FB) can have several outputs and contains data inside. A Function Block is required to be declared on entry.

Enter a Function Block by clicking on the hotkey or selecting the icon.





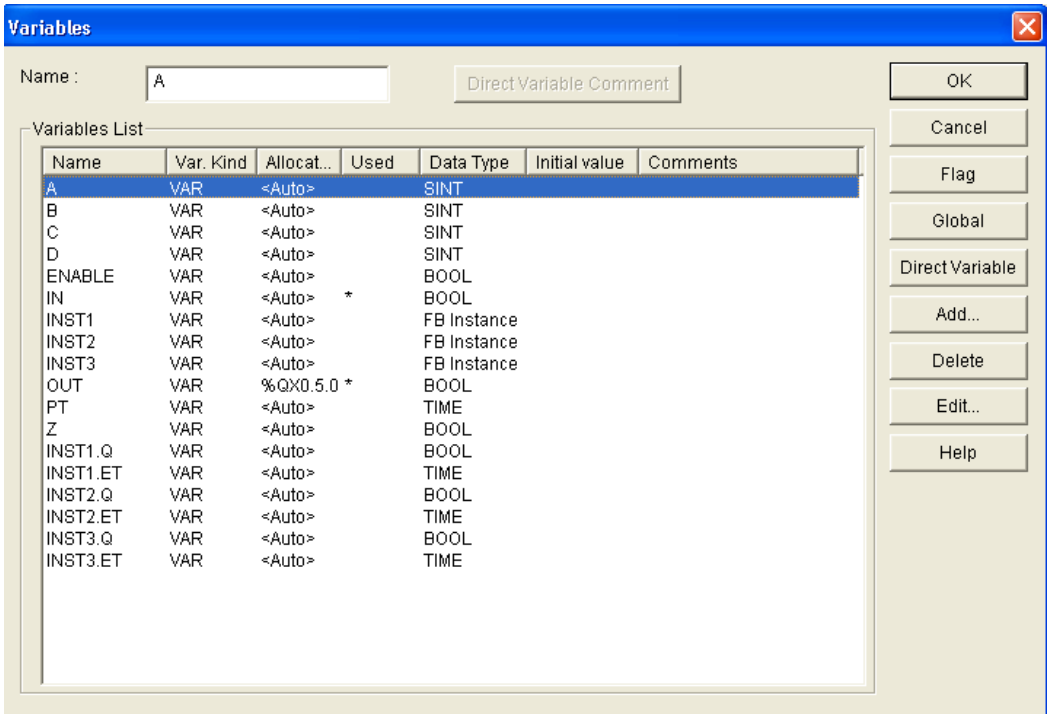
When you select the Function Block, it attaches to the mouse arrow. Click it into the programming area and the Function Block selection menu pops up.



## *Timer Function Blocks*

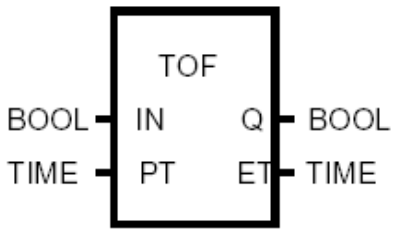
The three basic Timer Function Blocks are: TOF, Off-delay timer, TON, On-delay timer and TP, Pulse timer.

When the timers have been inserted GMWin creates the outputs to use elsewhere in the program.



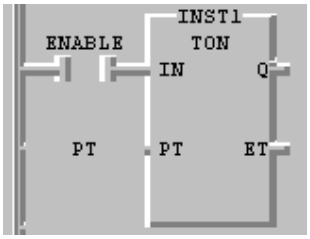

Timer Function Blocks create the outputs .Q and .ET. The .Q represents the output state of the timer and the .ET represents the Elapsed Time.

## TOF, Off Delay timer.

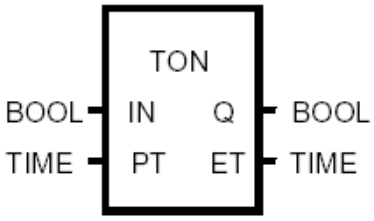
| Function Block | Description |
|---|---|
|  | **Input** IN: timer operation condition<br>PT: preset time<br><br>**Output** Q: timer output<br>ET: elapsed time |



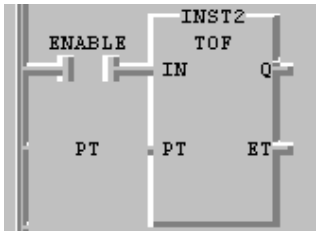
When enable goes high and the timer output is set high, when the enable then goes low the timing begins and the output remains high until the timers' time has elapsed.




## TON, On delay Timer.

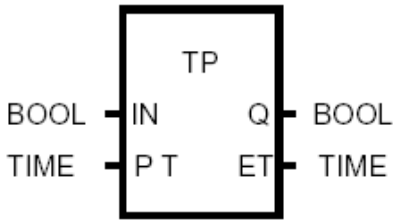
| Function Block | Description |
|---|---|
|  | **Input** IN: timer operation condition<br>PT: preset time<br><br>**Output** Q: timer output<br>ET: elapsed Time |





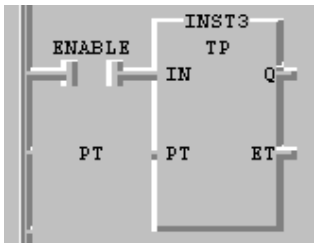

When the enable goes high the timer begins to count. The output will go high when the timing has elapsed. The output will remain high until the Enable input has been removed.

## TP, Timer Pulse.

| Function Block | Description |
|---|---|
|  | **Input** IN: timer operation condition<br>PT: preset time<br><br>**Output** Q: timer output<br>ET: elapsed Time |



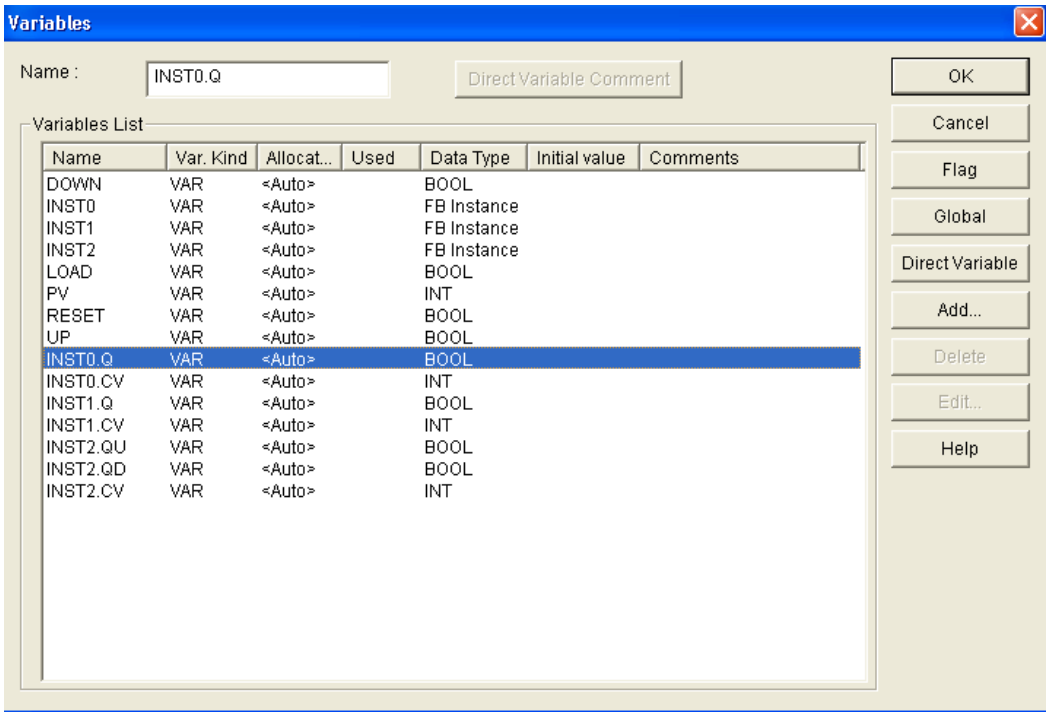
When the enable signal is set high the timing begins, the output will be set high for the duration of the timing. Once the timing has been completed the output goes low and the timing begins again. The output will pulse high-low whilst the Enable signal is on.



## *Counter Function Block*

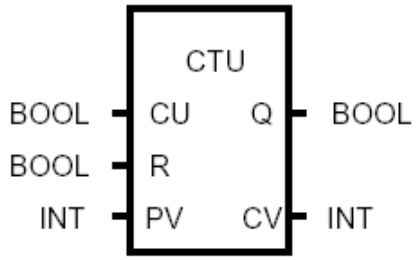
There are three basic types of Counter Function Blocks: CTU, CTD, CTUD.
The CTU Counter is an Up counter, the CTD is a Down Counter and the CTUD is an Up / Down counter (it is a combination of a CTU and CTD).

When a Counter Function Block is inserted GMWin creates the outputs for use in the program.



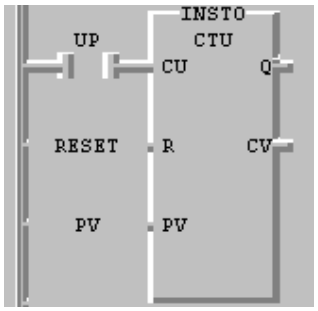

All counters have a .CV output, this is the Current Value. The Up and Down counters have a .Q output for when the counter is output is high. Finally the Up / Down Counter has an output state for both Low count condition and a High output condition.

## *CTU, Up counter.*

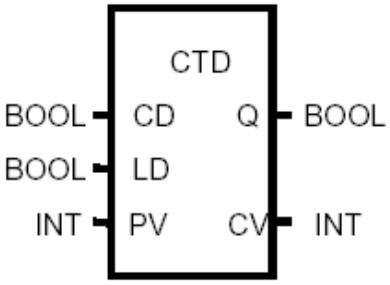
| Function Block | Description |
|---|---|
|  | **Input** CU: up counter pulse input<br>R: reset input<br>PV: loads a preset value<br><br>**Output** Q: increase counter output<br>CV: current value |



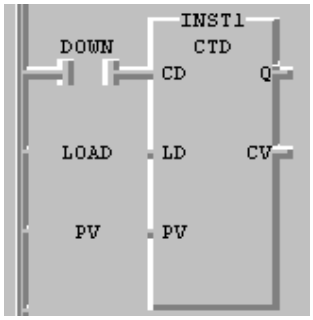
The Counter will count up every Up pulse input. The output of the counter will go High when, CV is equal to PV. The Current value will continue to go up on every Up input pulse and the output .Q will remain high until the Reset input is triggered. This then resets the Counter CV back to zero and the output will go off.




## *CTD, Down Counter*

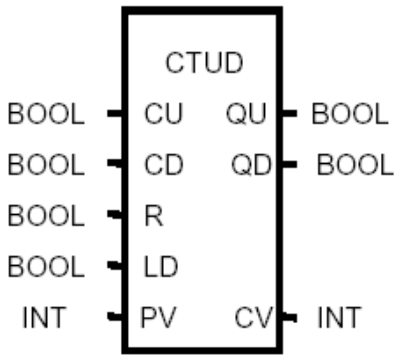
| Function block | Description |
|---|---|
|  | **Input** CD: down counter pulse input<br>LD: loads a preset value<br>PV: preset value<br><br>**Output** Q: down counter output<br>CV: current value |






The down counter works in the opposite way to the Up counter. There is no reset input but a Load input, when high this loads the counter with the Preset Value. The down input will then count down from the PV value loaded and the counter will go high when CV is equal to zero.

## *CTUD, Up / Down Counter.*

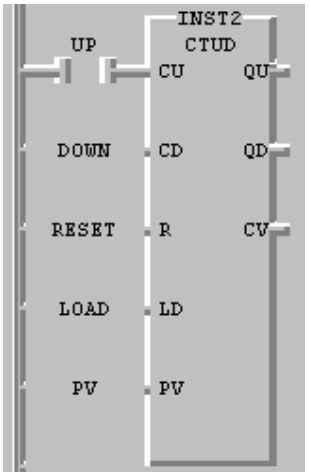
| Function Block | Description |
|---|---|
|  | **Input** CU: up counter pulse input<br>CD: down counter pulse input<br>R: reset<br>LD: loads a preset value<br>PV: preset value<br><br>**Output** QU: up counter output<br>QD: down counter output<br>CV: current value |



The Up / Down Counter is a combination of the two previous counters (CTU and CTD).

The CTUD has all the inputs of the CTD and CTU, plus it has an Up condition output .QU and Down condition output .QD. The Up condition output will go high when CV is equal to the PV value. It will then remain high whilst CV is greater than or equal to PV. The Down condition output .QD will go high when CV is equal to zero.

The Up input increments CV, whilst the Down input decrements CV. The Reset input, resets CV back to zero, whilst the Load input, loads the Preset Value (PV) into the Current Value (CV).



## *Function Block Programming Example*

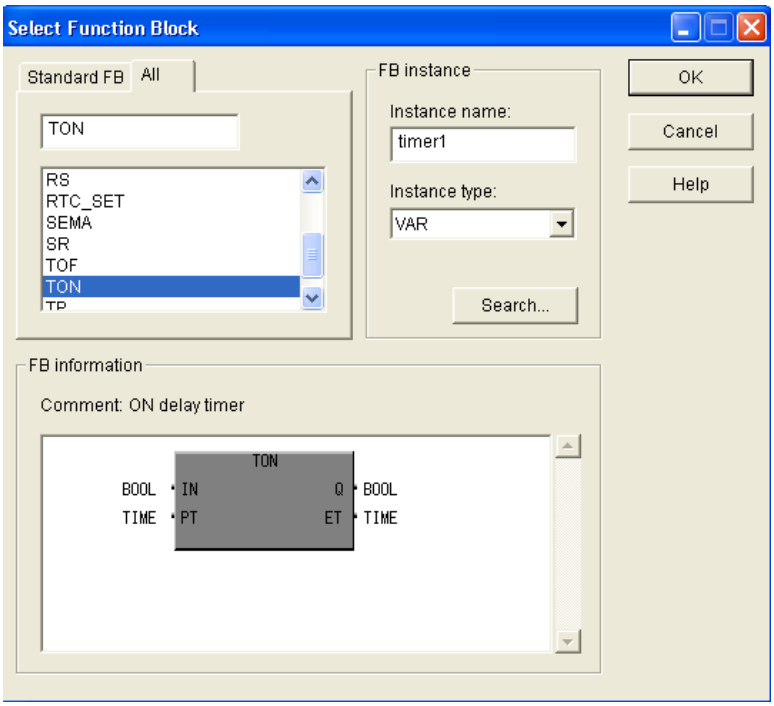
Design a simple timer and counter program that will count the timer output.

Select a Function Block by clicking the icon  in the toolbox with the right button of the mouse and put into position row '0' in from the first column.

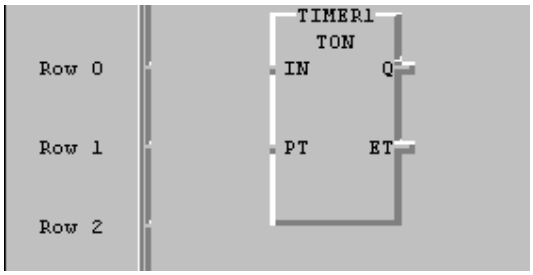

The Function Block menu will pop up.

Either search through the functions or if you know the desired function block name, enter it in the box.

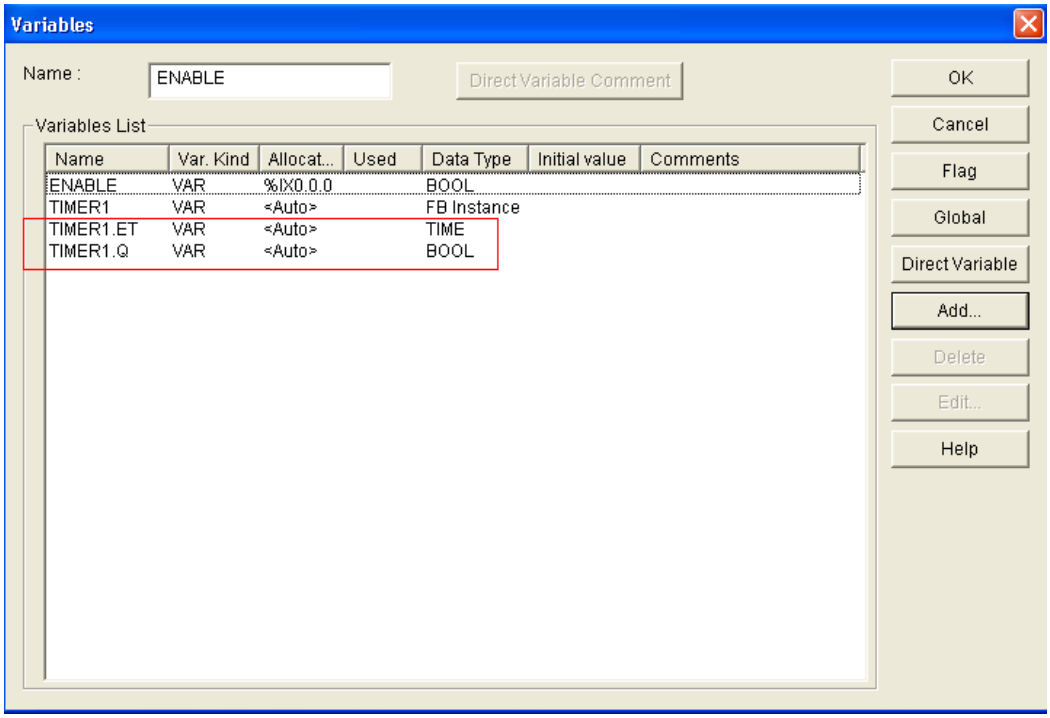
Type TON into the text box for an on delay timer

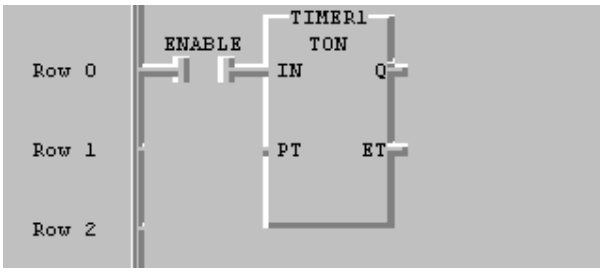



Give the timer the instance name timer1 and click OK.



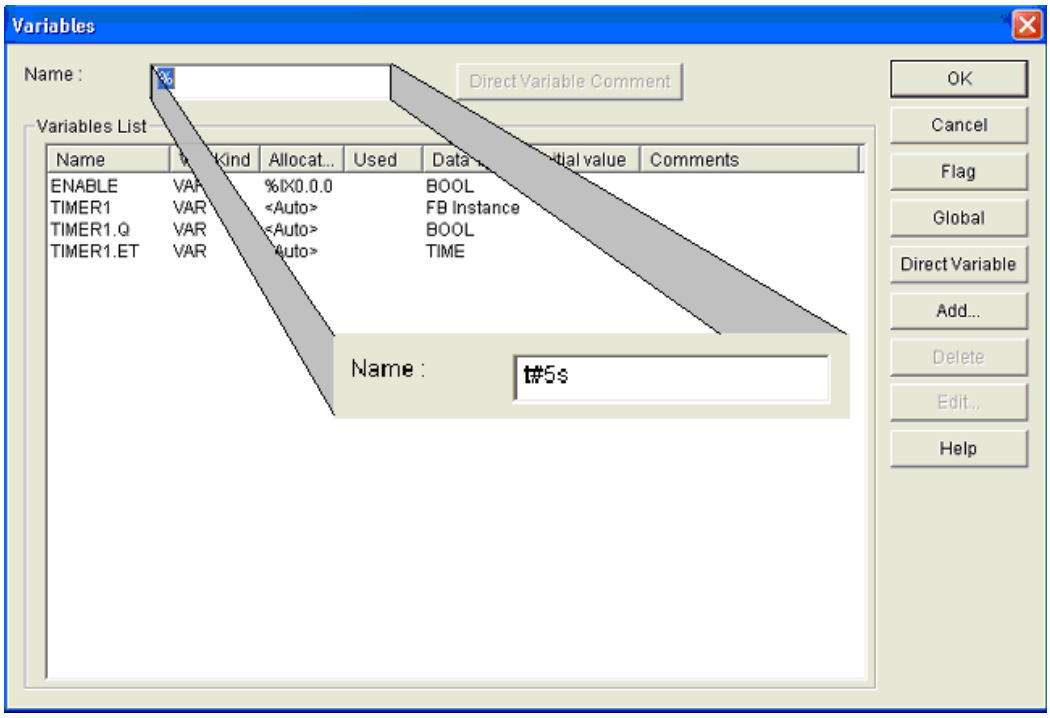

Insert a NO contact at the IN input to the timer and Add a variable. Name the variable Enable and allocate the address to %IX0.0.0 . You will notice that there are some variables that have been created already, TIMER1.Q and TIMER1.CV. These are the output and current value of the timer. They can be used elsewhere in the program simply by assigning them to inputs and contacts.

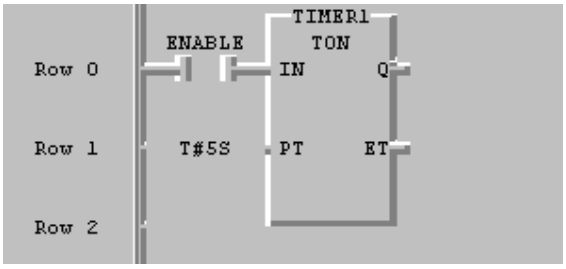



Double click the right mouse button in the space to the left of the input PT. This brings up the Variable menu. We are now going to enter a Preset Time for the timer.

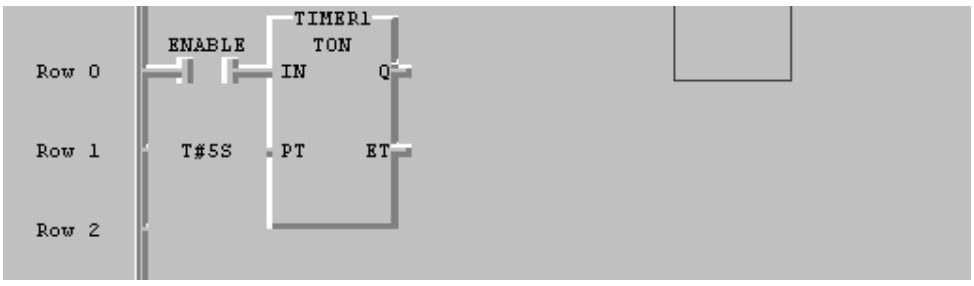
Delete the % sign and insert the data, t#5s. This is the prefix for a five seconds time.



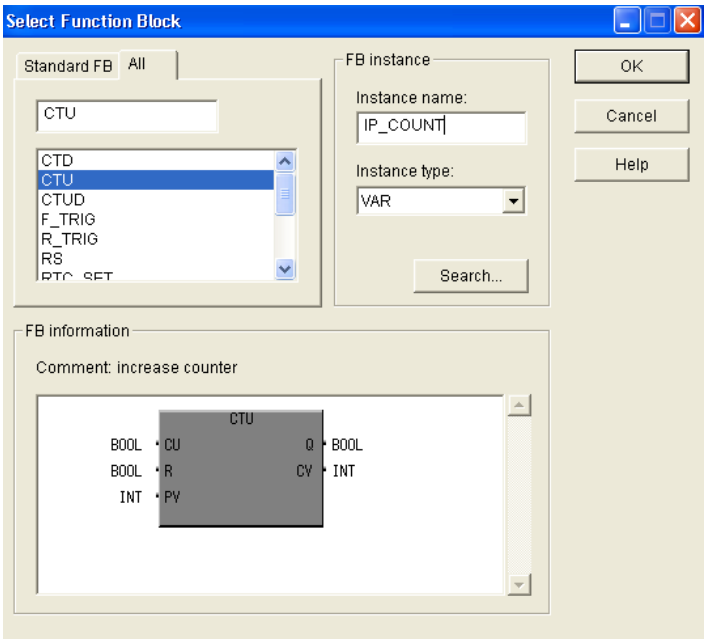

There is no need to allocate output variables as they have already been created: TIMER1.CV and TIMER1.Q

We now want to insert a Counter, select the Function Block icon by click on it in the toolbox with the right button of the mouse and putting it three columns to the right if the timer function block.



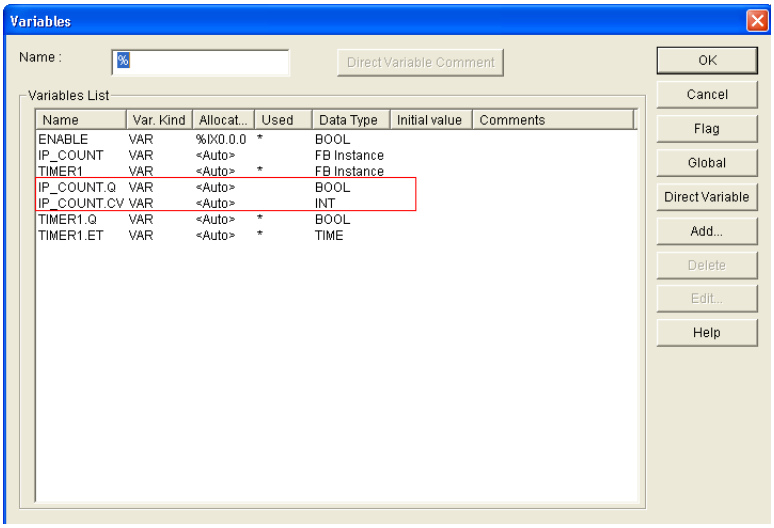
Either search through the functions or if you know the desired function block name, enter it in the box.

Type CTU into the text box for an UP counter



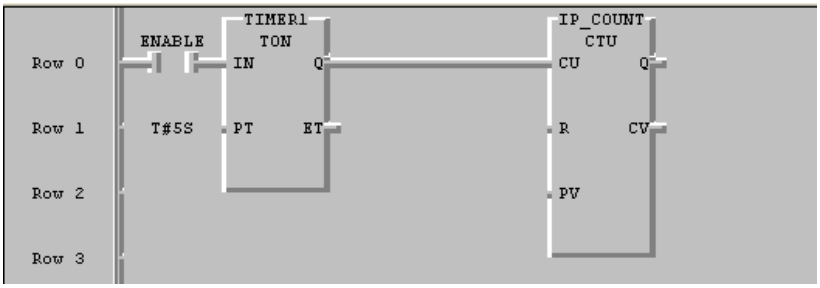

Give the timer the instance name IP_COUNT and click OK.

As with the timer function block the counter function block automatically creates outputs, in the case: IP_COUNT.Q and IP_COUNT.CV



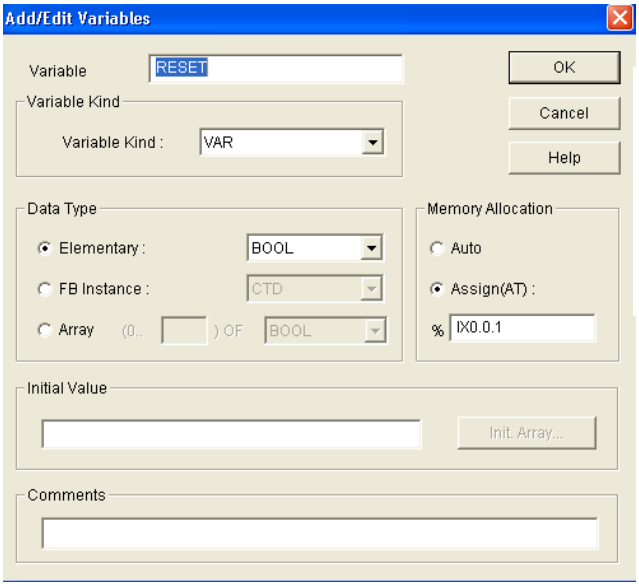

These outputs can be used elsewhere in the program.

We now need to connect the output TIMER1.Q to the UP input of the counter. Select the horizontal line connection icon  in the toolbox and click the right button of the mouse to connect the spaces between the timer function block and counter function block.



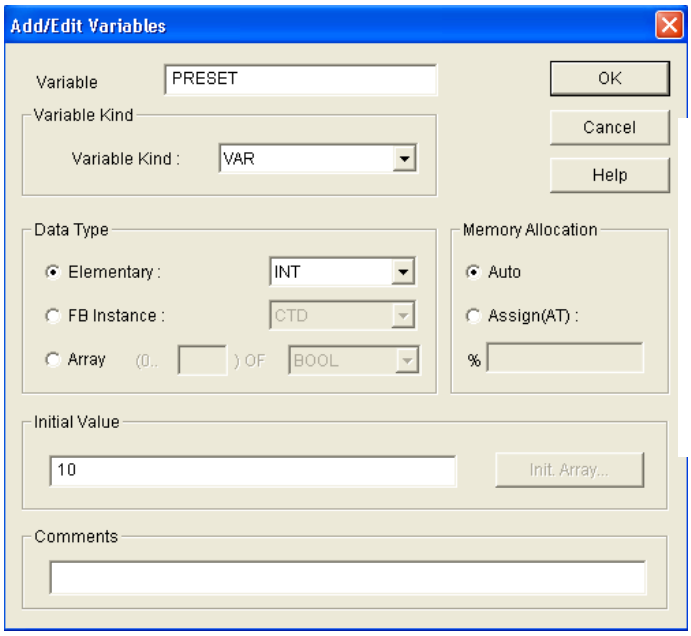

Now we need to assign variables to the inputs on the counter function block. Input R is a reset input of type BOOL and input PV is the preset value that the counter will count up to, it is of type INT.

Double click in the space to the left of input R, with the right mouse button and add a new variable called RESET.



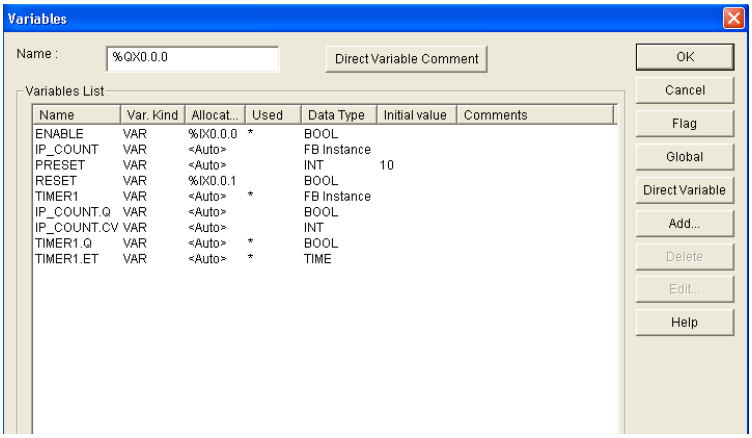

Assign the variable to the memory address IX0.0.0 and click OK

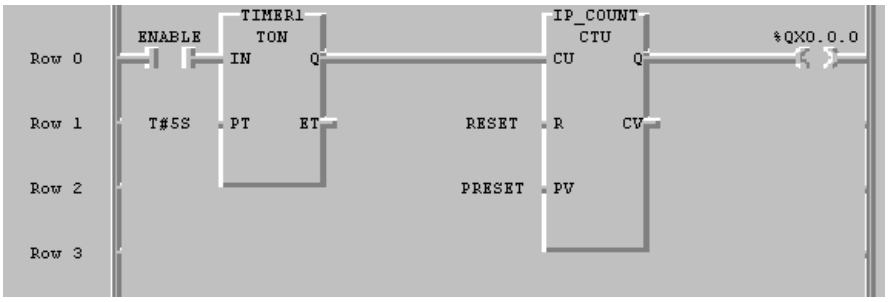
Double click in the space to the left of input PV, with the right mouse button and add a new variable called PRESET.




Leave the variable as Auto allocated but give it an initial value of 10. Click OK to complete.

Next Select a normally open coil icon {} in the toolbox and click the right button of the mouse at the output Q of the counter. Directly address this output to %QX0.0.0 by double clicking the right mouse button on the coil to open the variable menu.



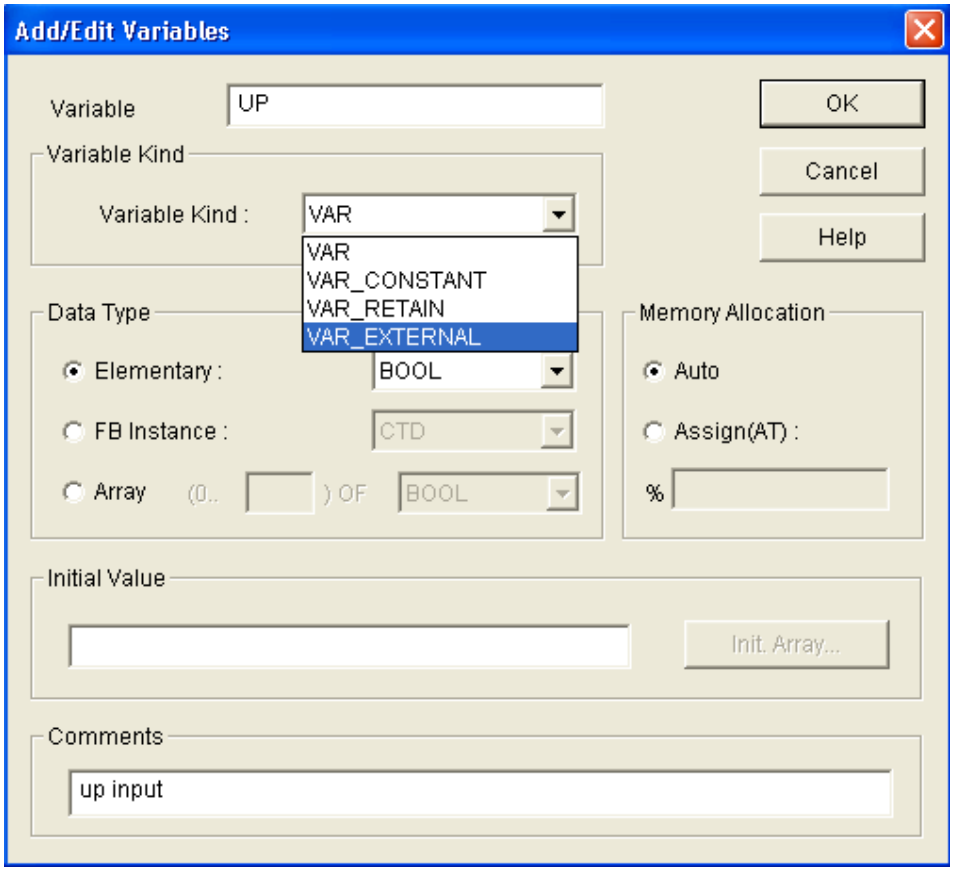

When the ENABLE input is switch ON the timer will count to five seconds. When 5s has elapsed the timer output Q will go high, this will trigger the counter input and the counter current value will be incremented by one. When the counter current value reaches ten, the counter output Q will go high and trigger the coil output %QX0.0.0

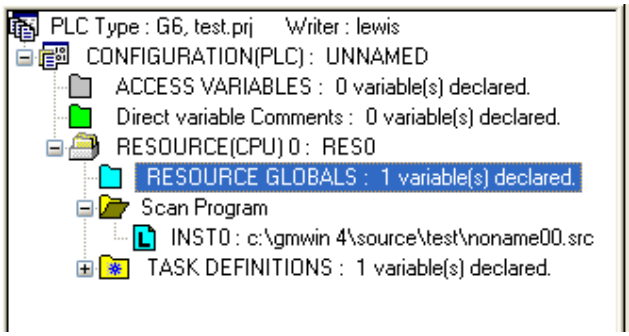
# Multiple-Source Programming

## *Global Variables*

Global Variables can be used in multiple Programs within a Project, unlike regular variables.

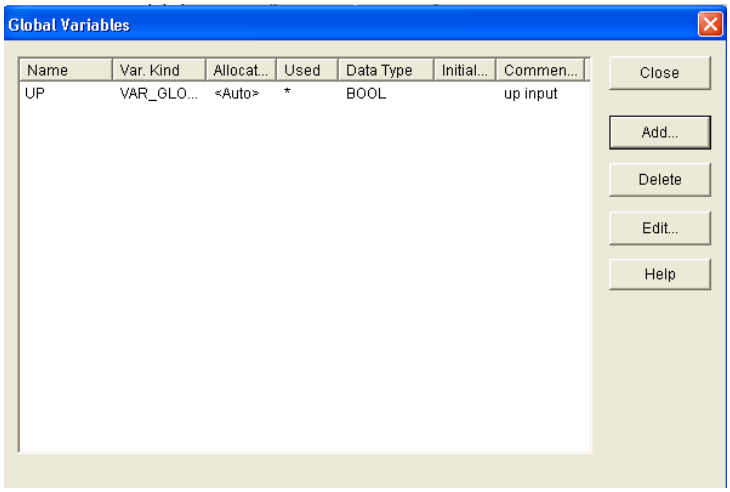
One way to declare a Global Variable is to assign it to VAR_EXTERNAL type, when entering the variable in a program.

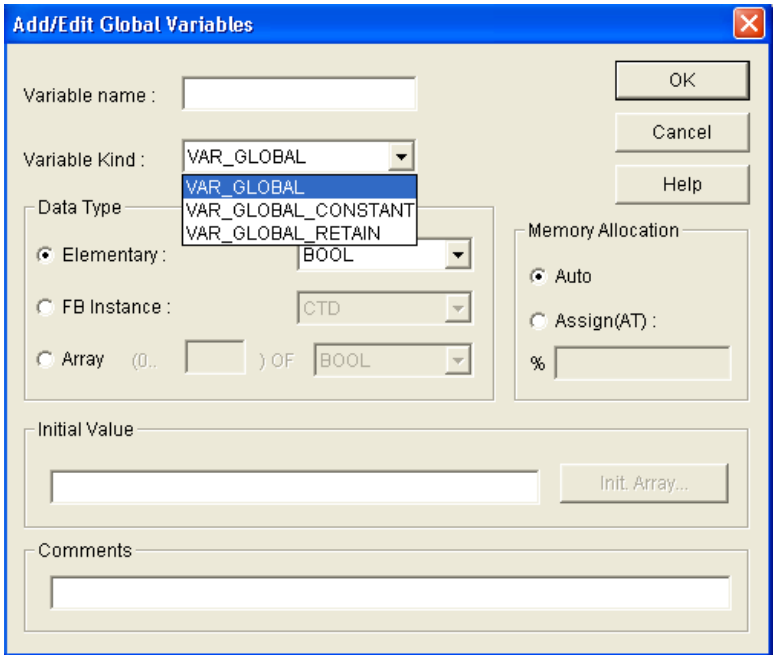



You will know see that the Resources Global menu in the project tree has a Global variable declared.

Another method is to double click on the RESOURCES GLOBALS menu in the project tree and 'Add' a Variable as usual.



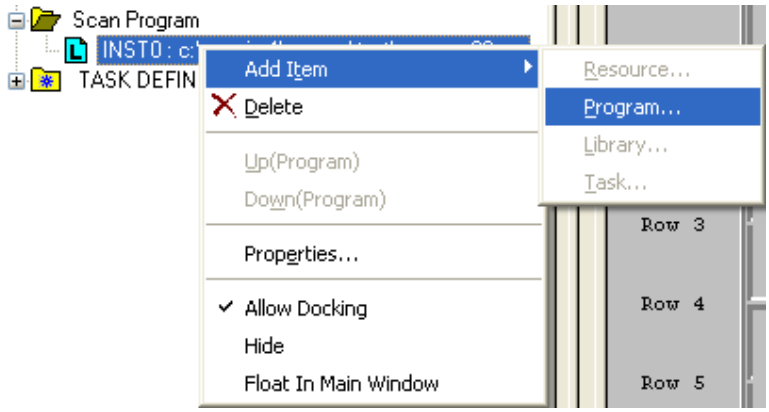

Enter a Variable as normal, however there are a couple of different Variable Kinds to select from.
Var_Global: normal variable.
Var_Global_Constant: Constant global variable
Var_Global_Retain: Global variable with power down retain.

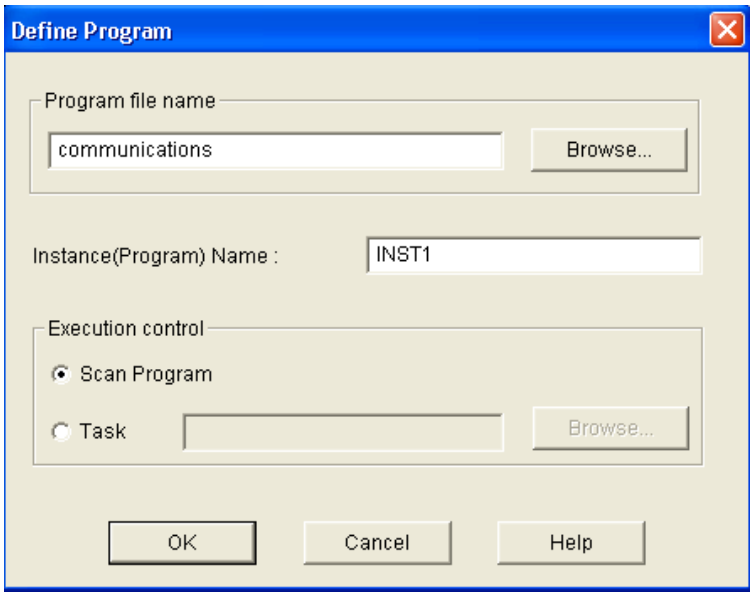
## *Multiple LD Programs*

It is possible to have more than one program in a GMWin Project. This allows the programmer to have a dedicated program to perform a specific function, for example one program can control the communications and another to control the logic of a machine process.

Variables declared in one program will not be available in other programs unless declared as Global.

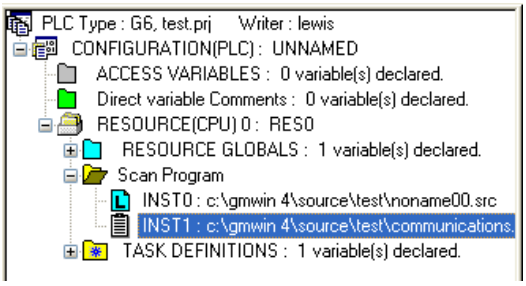
To enter a new program right click on the project tree and select Add Item, Program.



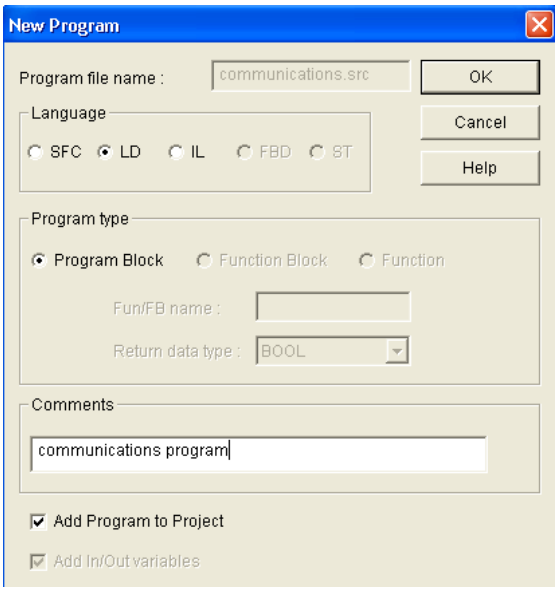




A Program must be given a name and an Instance name.

The programs will then be put in order of instance name.



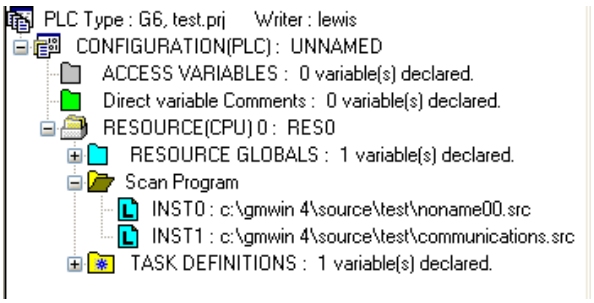

Now a blank program has been created, to select it as a Ladder Diagram, double click on it and select the option.

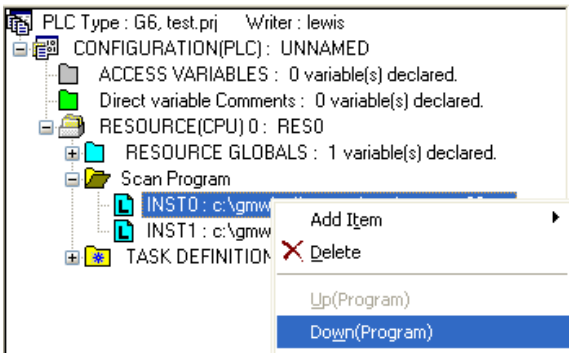



On selection of Language, click OK

Then continue programming as before.

The scan cycle of the Project will process the programs linearly. In this case INST0 will be processed before INST1. However the order can be changed.

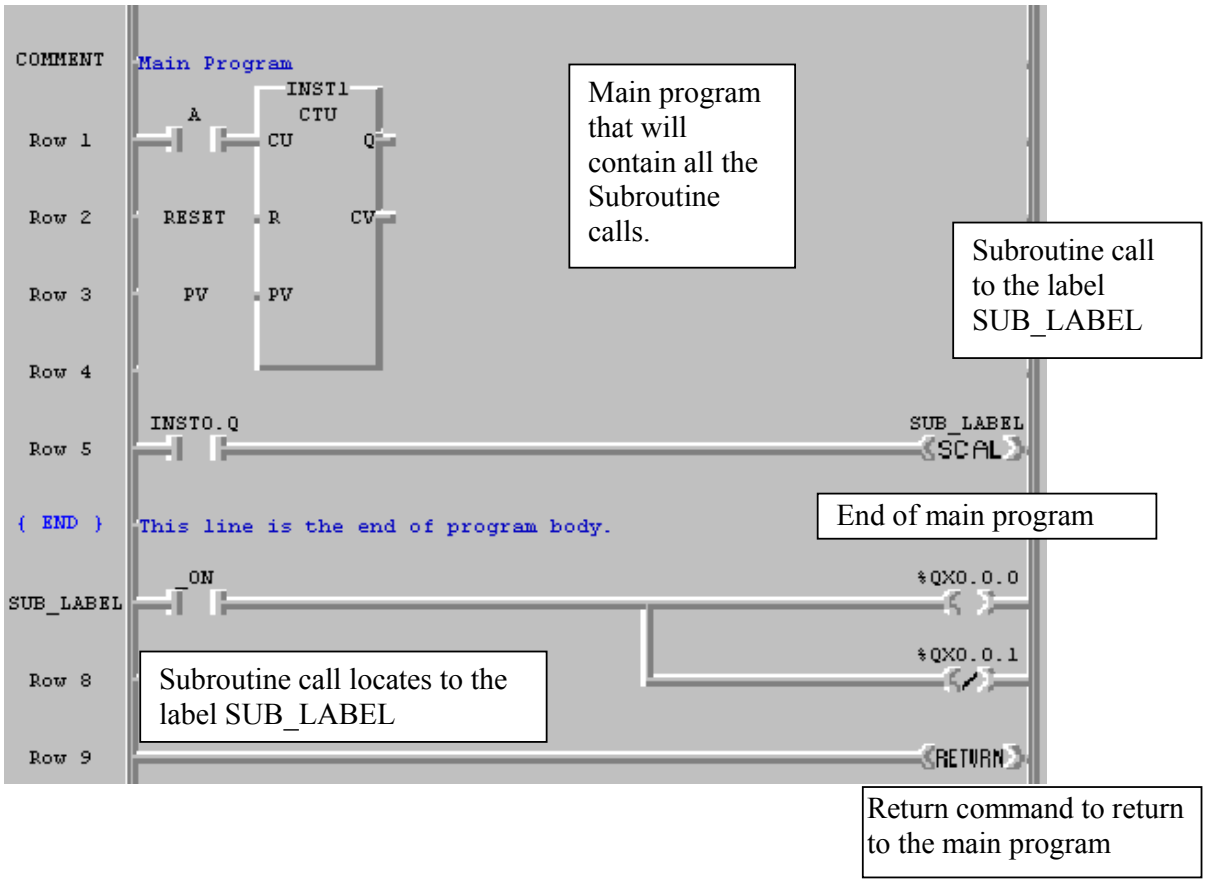


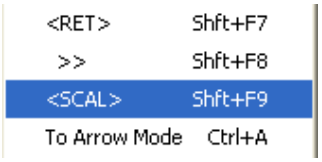

To Change the order of the Programs, right click and select Up or Down (Program)

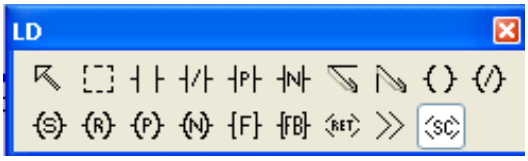
## *Subroutines*

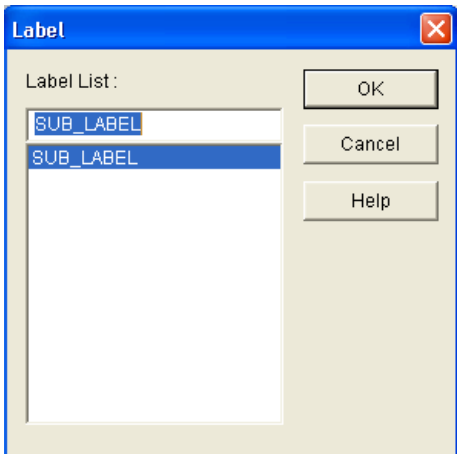
A Subroutine is a grouping of logic that must be performed given a certain condition. To use Subroutines the programmer needs to use Sub Call and Return from commands. A Sub Call command is similar to a Jump command however there are some subtle differences. A Sub Call function is required to return to where it was called from and then it the PLC will continue linearly to process code. Whereas a Jump command skips code to and processing is continued at a given location.




To enter a Subroutine call, select the icon or use the hot-keys short cut.



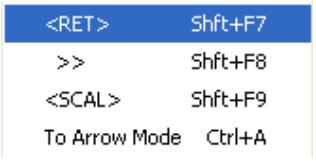



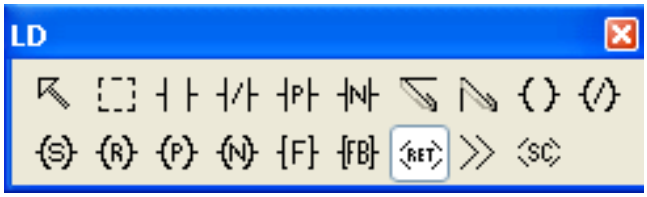



Then double click on the SCAL function call and enter the Label to go to.

Either select a pre-registered label or enter a Label directly

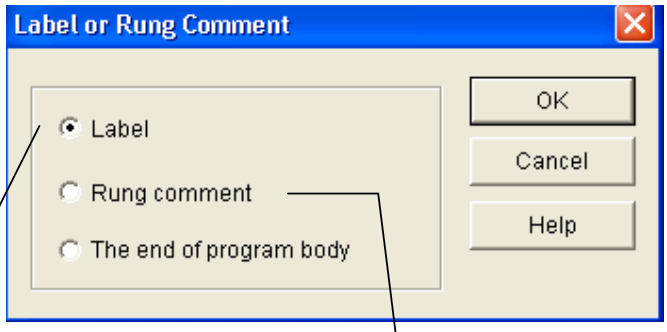
To enter a Return call, select the icon or use the hot-keys short cut. A return call doesn't require a coil to operate it, simply enter it at the end of the subroutine (as shown in the example).



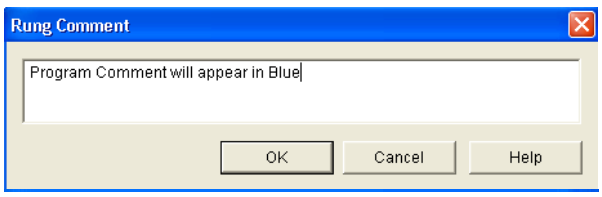

To enter Comments, an End of Main Program statement or a Label, double click on a Row number and a menu will pop up.

Select the desired option and enter the relevant data.





Enter a new label or select from the list

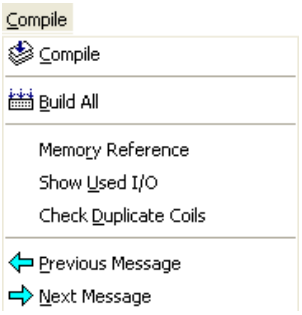



Enter the program comments to be seen in the ladder diagram.

# Downloading and Online Options

## *Compiling and Building*

Prior to downloading the Project needs to be compiled and built. This prepares the Project for downloading to the PLC and checks for any errors.

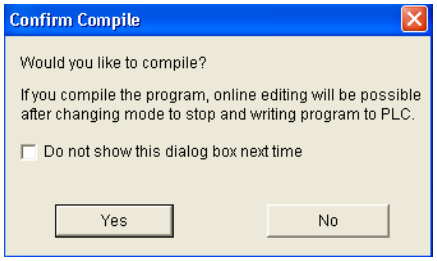


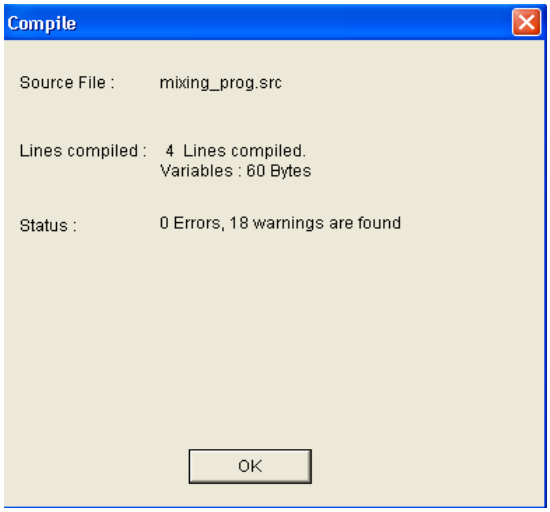


The compile options prepare the programs for downloading. The programs are checked for errors

Compile: Makes just the one program you are currently working on.
Build All: Makes the complete project.

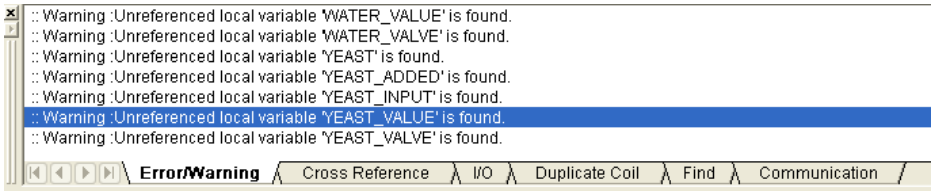
Clicking the Compile option brings up this message



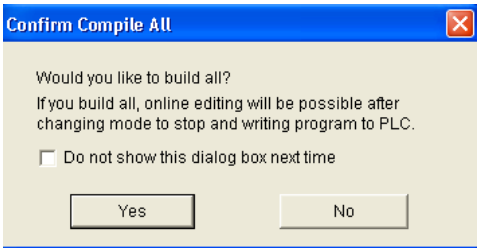

When the program has compiled it informs the user of any errors or warnings.

Errors will stop the program from operating, whereas warnings just inform you of potential issues but do not impact on downloading the program.

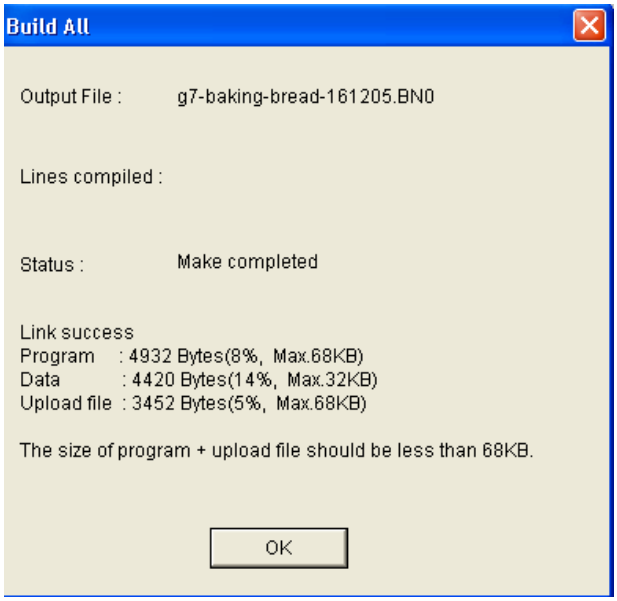


The compile messages are shown in the output window and can be cycled through using the message buttons in the Compile drop down menu.

Clicking the Build All option brings up this message



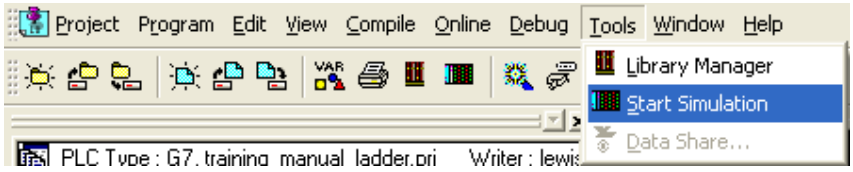

Building the whole program, links the entire project and shows the memory used.
It shows the Program memory size, Data size and upload file size, along with the maximums it shows the percentage used.



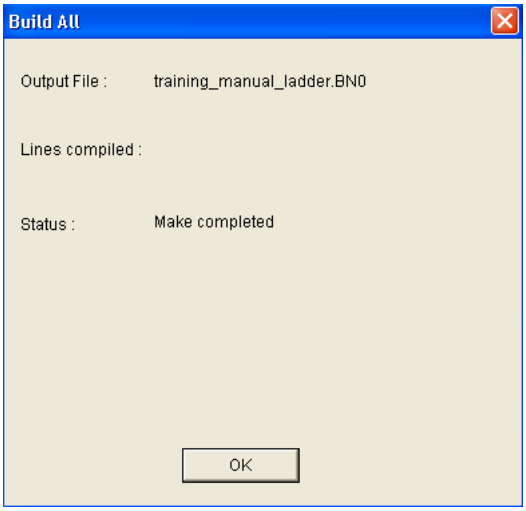

## *GMWin Simulation*

In GMWin there is a powerful simulation tool to verify your program without connecting a PLC. As GMWin is designed for use with the complete range of G-series PLC's the simulator looks like a slot and rack type PLC.

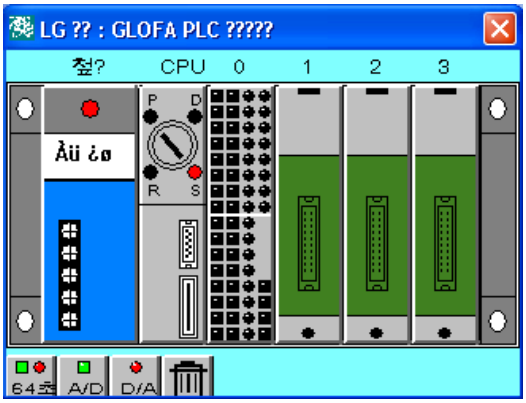
To open the PLC Simulator click on the icon  with the right mouse button or select the simulator option from the Tools menu.

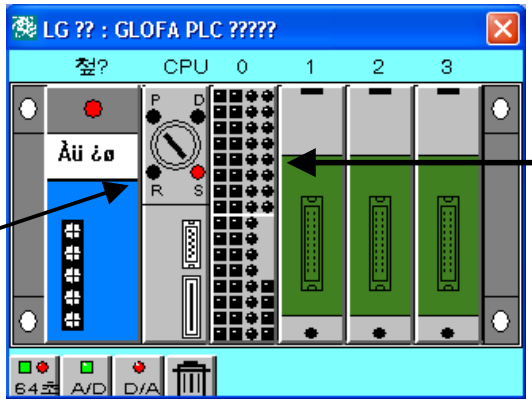


When the simulation software is started the project is built. Click OK to continue with the simulation.




The simulation PLC is similar to a G4 or G6 PLC. When simulating a G4 or G6 program it is important to insert the I/O modules as addressed in the program. With a G7 program there will be a default 60 I/O card in slot zero and then the user can add modules where necessary.
i.e. %IX0.0.0 = slot 0
%QX0.2.3 = slot 2



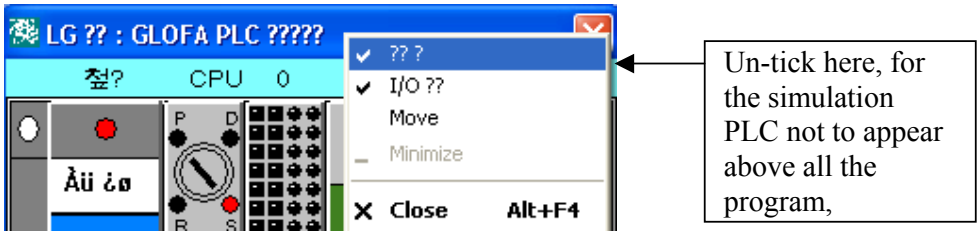




To put the PLC in RUN mode use the right mouse button to switch the dial from STOP (S) to RUN (R). Click on the circle above R.

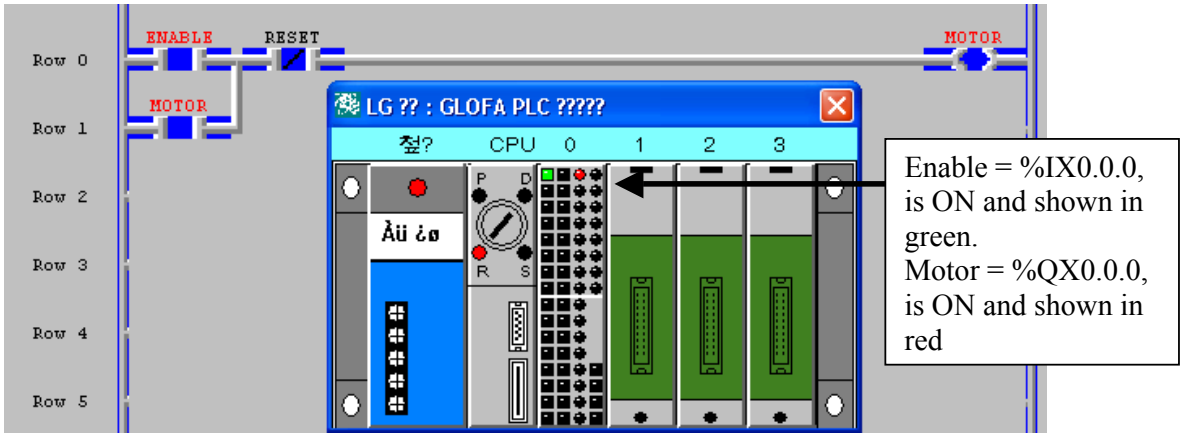
The inputs in the slot are square and the outputs are round. When ON the inputs go green and outputs go red

To insert a digital input, digital output, analogue input or analogue output module click the right mouse button and drag the module to the desired slot location. To remove a module click the right mouse button and drag it to the trash icon

The simulated PLC will stay on top of all program, however you can change this option by left click the mouse on the blue bar at the top.



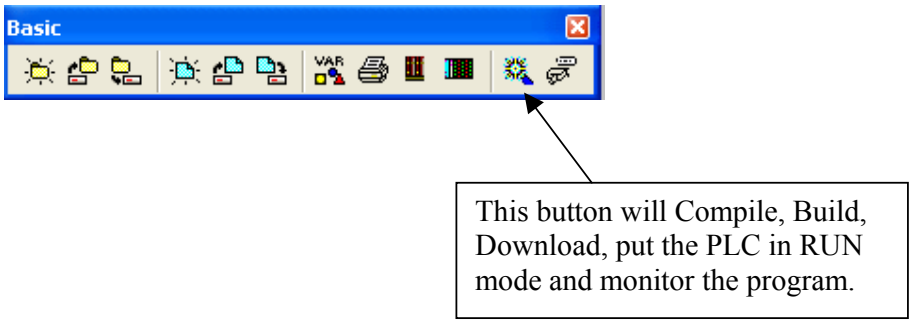

When the PLC is in RUN mode the program power rails are in blue as are the contacts and coils that are ON.

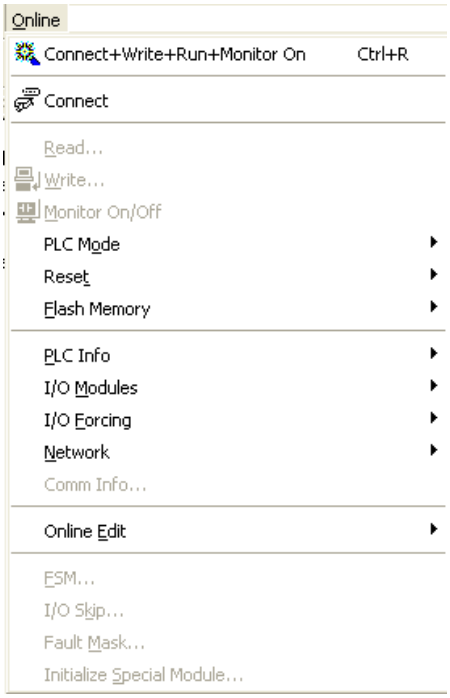



When the variable is ON the variable name also changes colour from black to RED.

## *Downloading*

Once the program has been compiled it is ready to be downloaded. However there is a button that will compile the program, build the project and download to the PLC.

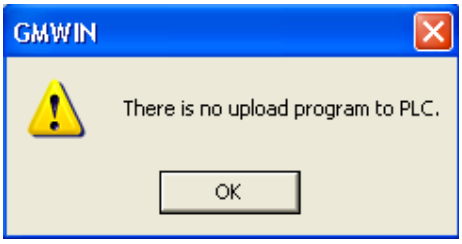




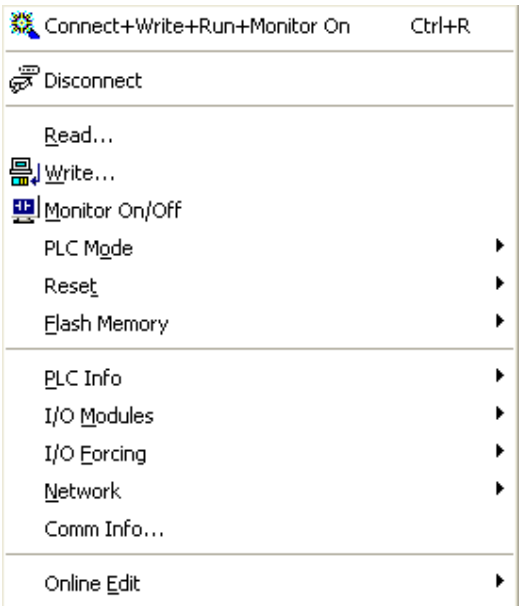

To connect to the PLC, either use the Connect option on the Online menu or press the connect button on the Basic buttons.

When connected the greyed out options will become available.

If there is no program in the PLC or the security option has been selected then this message will pop up when the user connects to the PLC.



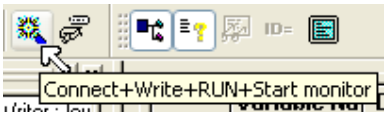

The connect button in the toolbar at the top will now be appear pressed



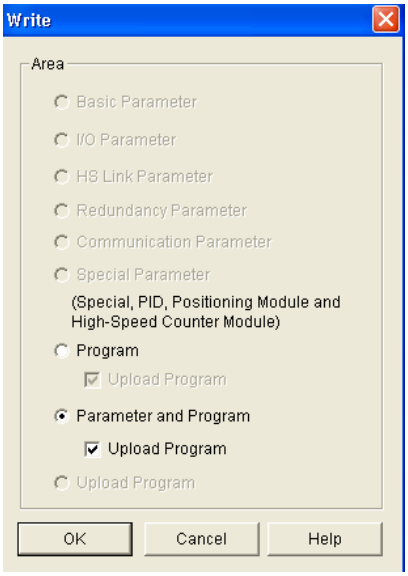

The grey-out online options are now available.
Once connected to the PLC it is now possible to:

- Write and read to the PLC.
- Switch the mode between RUN, STOP and PAUSE.
- Write and Read to the Flash memory.
- Check the PLC information, useful for if an error occurs in the PLC.
- Check the I/O modules connected.
- Enable the High Speed Networks.
- Edit the program ONLINE. This allows the user to make

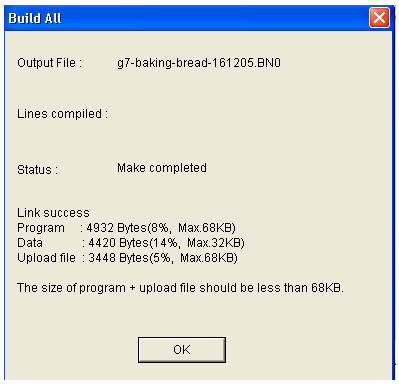
Once the program is ready to be downloaded, select the Connect + Write + RUN + Start monitor button to program the PLC.



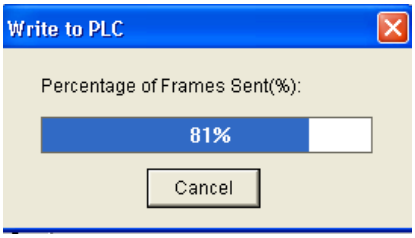

The user is then prompted for what they want to download.

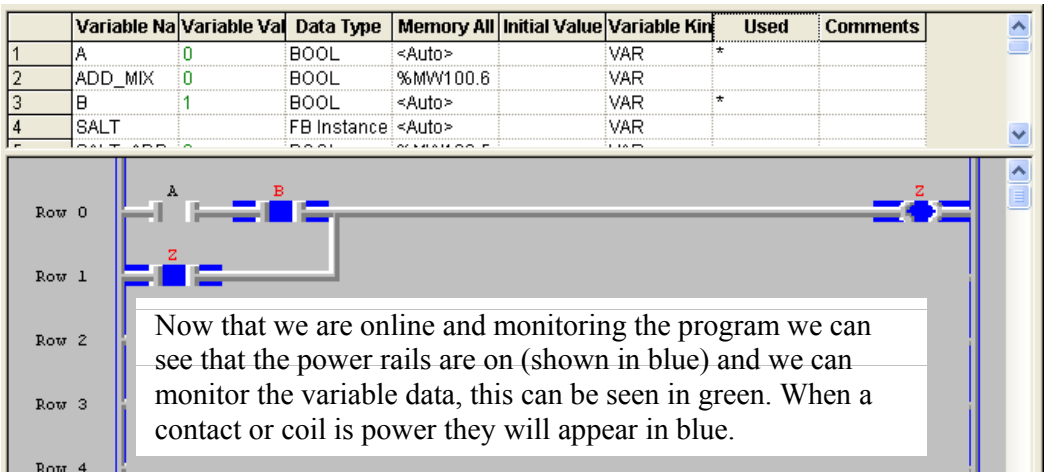



For security, if you do not wish for anybody to be able to upload your program back off the PLC, un-tick the upload option.




The project is then Compiled and Built before being downloaded to the PLC

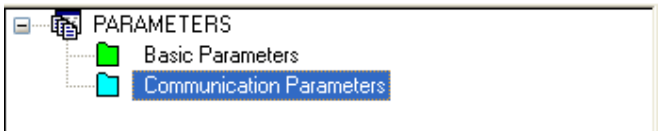



Now that we are online and monitoring the program we can see that the power rails are on (shown in blue) and we can monitor the variable data, this can be seen in green. When a contact or coil is power they will appear in blue.

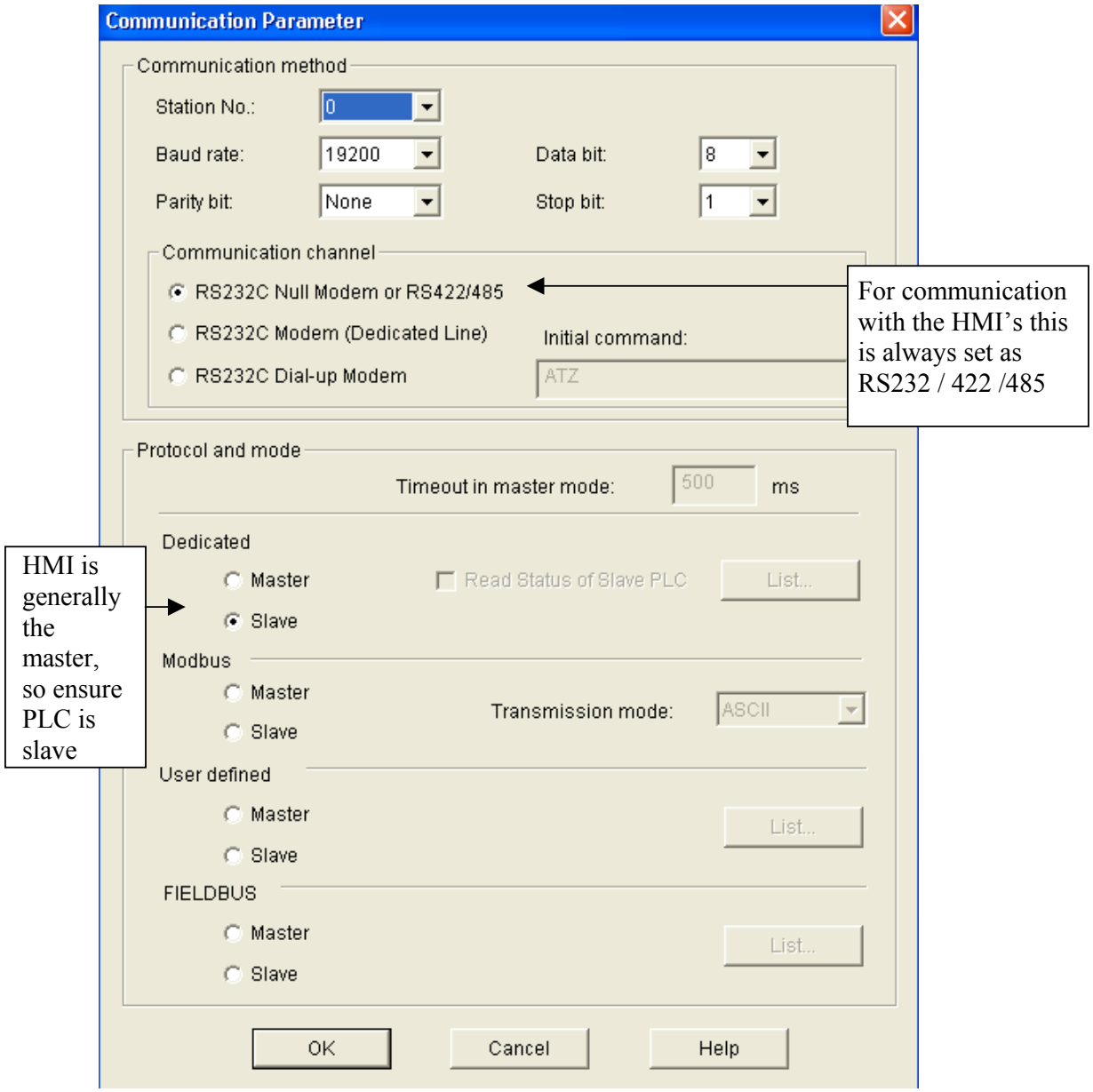
## Basic Communication

For communications with the IMO HMI's range (both PMU and MI-text terminal), the basic communication parameters will need to set. The communication parameters menu can be found in the parameter tab.




The parameters need to be set to match the HMI. Generally the HMI will be the master and the PLC the slave.

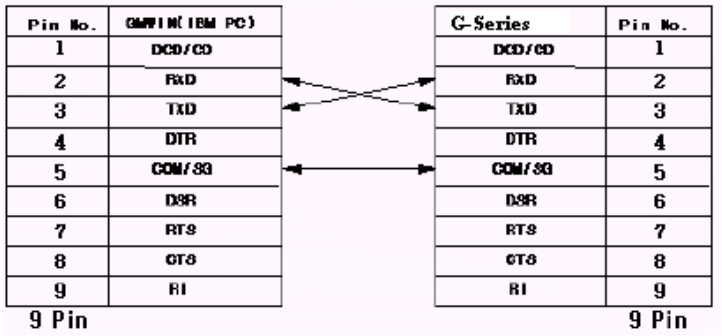
The key settings to ensure communication with the HMI are that the Baud rate, Stop bit, Start bit, Data bit and Station number. They all must match what has been entered in the HMI's communication settings.

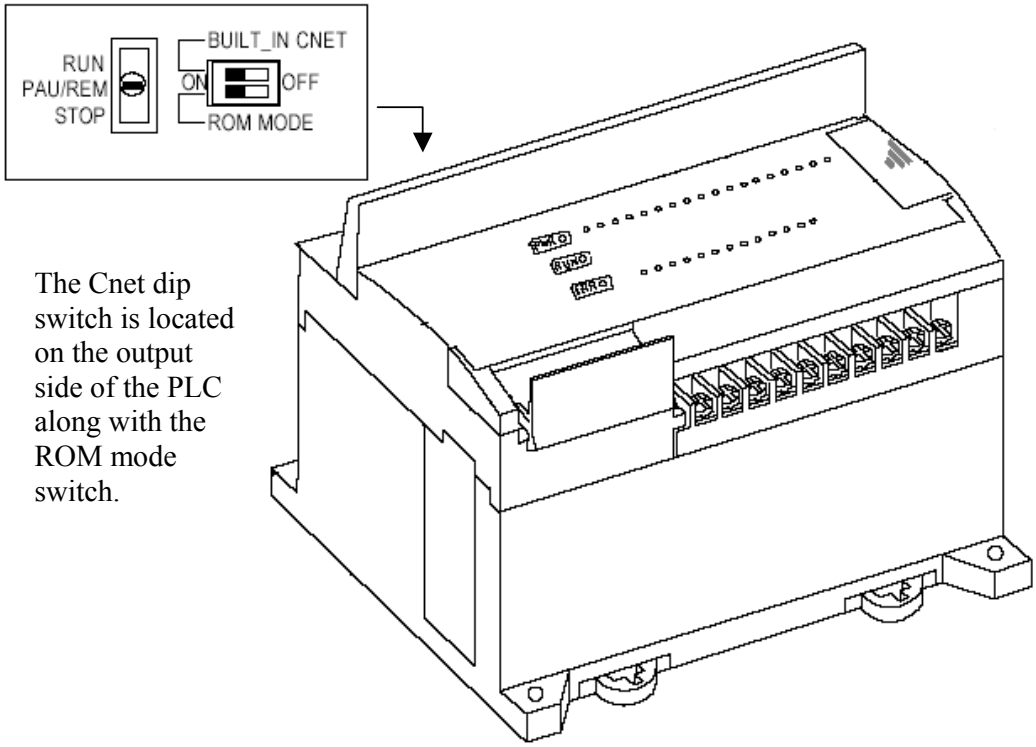

Communication Parameter
Communication method
Station No.: 0
Baud rate: 19200
Data bit: 8
Parity bit: None
Stop bit: 1
Communication channel
RS232C Null Modem or RS422/485
RS232C Modem (Dedicated Line)
RS232C Dial-up Modem
Initial command:
ATZ
For communication with the HMI's this is always set as RS232 / 422 /485
Protocol and mode
Timeout in master mode: 500 ms
Dedicated
Master
Slave
Read Status of Slave PLC
List...
HMI is generally the master, so ensure PLC is slave
Modbus
Master
Slave
Transmission mode: ASCII
User defined
Master
Slave
List...
FIELDBUS
Master
Slave
List...
OK
Cancel
Help

## *G7 PLC Communication Dip Switch Setting*

On the G7 PLC the 9 pin socket is two communication ports in one, RS232 and at the flick of a dip switch RS422/RS485.

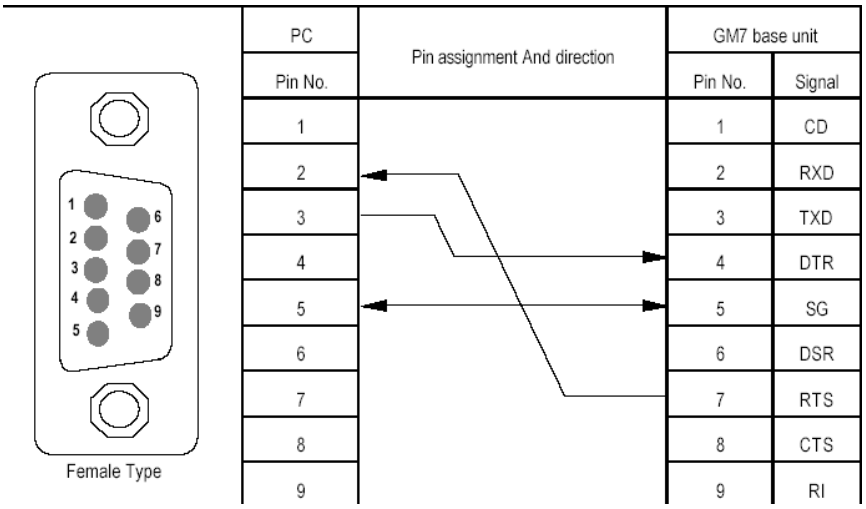
When the Cnet switch is in the off position the Cnet communication is not enabled and the Loader protocol can be used. Loader protocol is RS232.



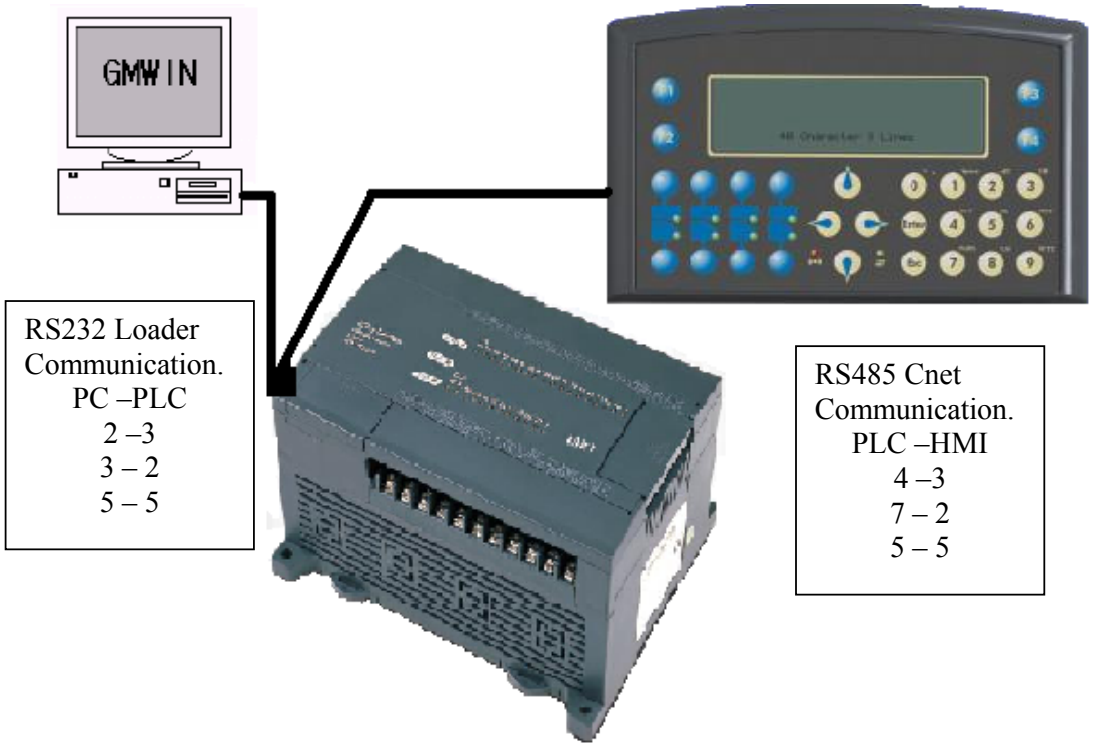

The Cnet dip switch is located on the output side of the PLC along with the ROM mode switch.

When the Cnet dip switch is in the on position the G7 PLC can communicated on a Cnet protocol. This is a RS422 / 485 protocol and has the following wiring

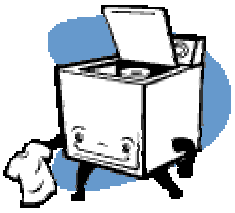



With the G7 PLC it is possible to communicate to both the HMI and PC. The Cnet dip switch needs to be in the on position and the HMI will communicate on Cnet protocol, whilst the PC will remain on Loader.

The advantage of this setting is that the PLC can be monitored whilst it is still 'live' communicating with the HMI.

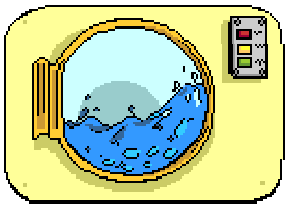


# Programming Tutorial Example – Washing Machine



## *Specification*

Design a GMWin project with a ladder program to run a simple washing machine program. The washing machine has four inputs and six outputs. The washing machine will run two wash cycles: White wash and Colour wash.



### Machine I / O

| | INPUTS | OUTPUTS |
|---|---|---|
| 1. | Start | Detergent + Water In |
| 2. | White Wash | Fresh Water In |
| 3. | Colour Wash | Water Drain |
| 4. | Lid Closed | Drum Rotate |
| 5. | | Spin Dry |
| 6. | | Lid Open Lamp |

### Washing machine cycles

The White Wash or Colour Wash is selected by a rotary switch (i.e. only one type can be selected).

| | Wash Time | Rinse Time | Spin Time |
|---|---|---|---|
| White Wash | 10 minutes | 5 minutes | 4 minutes |
| Colour Wash | 7 minutes | 4 minutes | 3 minutes |

## *The Program Cycle*

1. White Wash or Colour Wash is selected by a rotary switch (i.e. only one type can be selected).
2. When the lid is closed and the start button is pressed, Detergent + Water are pumped in for 1 minute.
3. The drum rotates for the specified wash time, depending on the type of wash selected.
4. The drum is drained for 1 minute.
5. Fresh water is poured in for 1 minute.
6. The drum is rotated for the specified rinse time, depending on the type of wash selected.
7. The water is drained for 1 minute.
8. The drum is rotated for the specified spin time, depending on the type of wash selected.
9. The lid open lamp will operate if the lid is opened, and the wash sequence cannot start.
10. If the lid is opened at any time during the wash cycle, the cycle is suspended and only continues when the lid is closed again.

## *Beginning to Program*

It is a good programming practice to map the known variables to addresses in the PLC before starting to program.

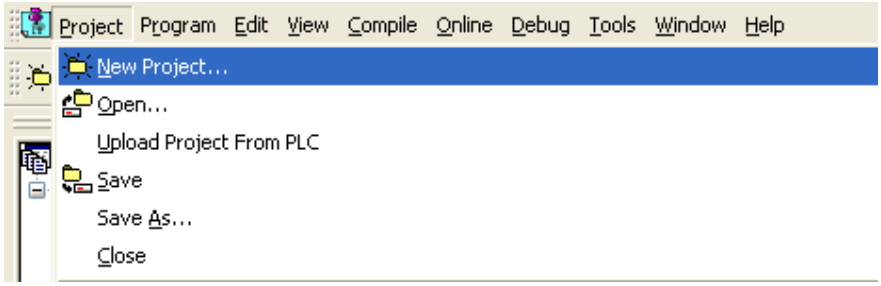
| INPUTS | Address | OUTPUTS | Address |
|---|---|---|---|
| **Start** | **%IX0.0.3** | **Detergent + Water In** | **%QX0.0.0** |
| **White Wash** | **%IX0.0.5** | **Fresh Water In** | **%QX0.0.1** |
| **Colour Wash** | **%IX0.0.6** | **Water Drain** | **%QX0.0.2** |
| **Lid Closed** | **%IX0.0.7** | **Drum Rotate** | **%QX0.0.3** |
| | | **Spin Dry** | **%QX0.0.4** |
| | | **Lid Open Lamp** | **%QX0.0.5** |

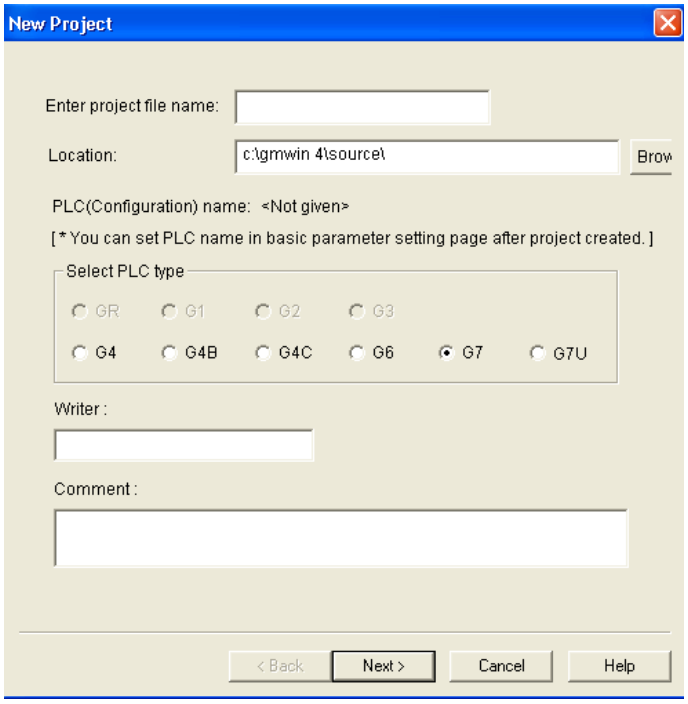
Open GMWin and create a new project.

Double click on the icon 

to start GMWin.

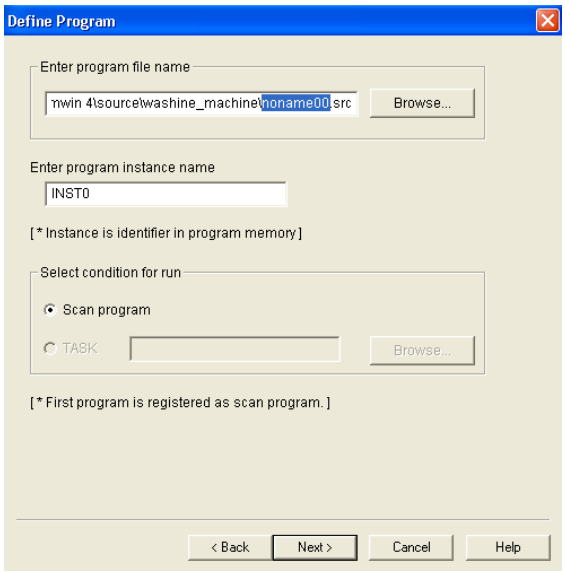
Set up a new project



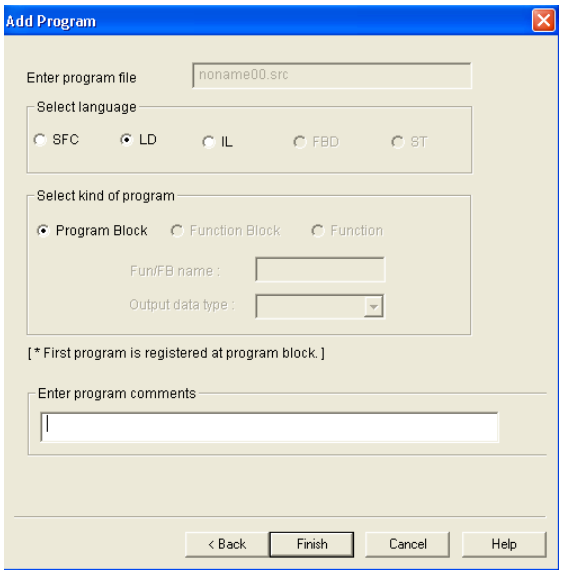

| | |
|---|---|
| Project Name | Washing_Machine |
| Base Type | G7 |
| Writer | Your name |
| Comments | Washing machine tutorial |

Enter the above details and click Next



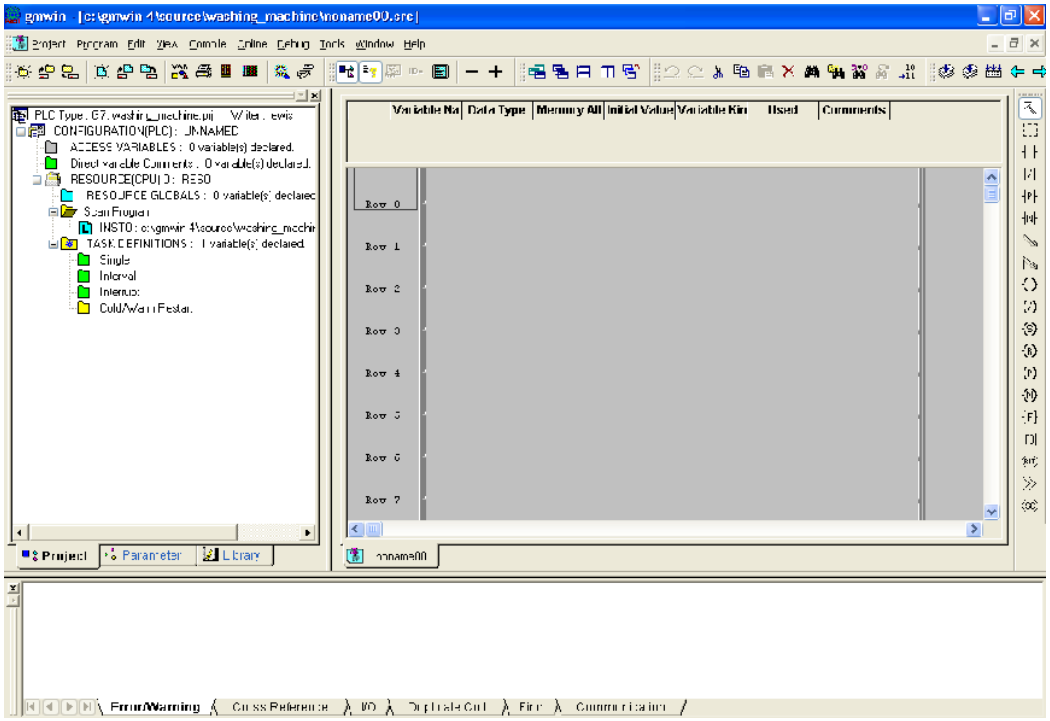

Highlight “noname00.src”
and type: Washing_program.src

Click Next when complete



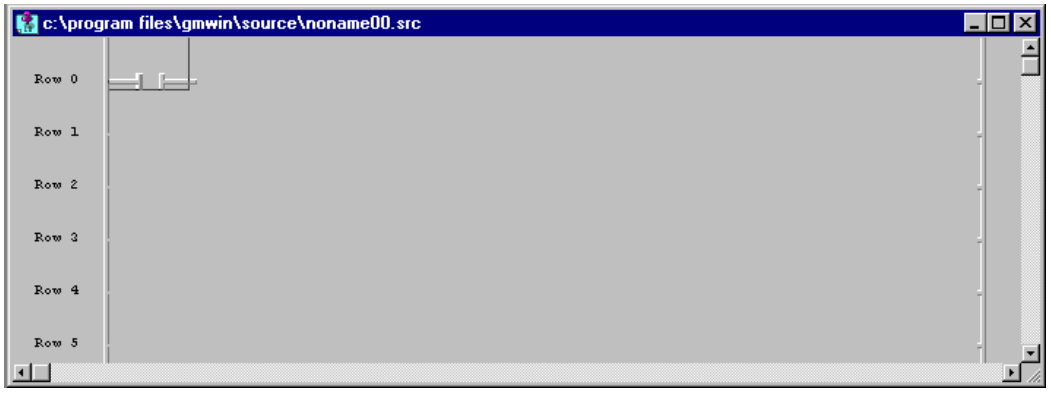

Select Ladder (LD) and click Finish.

Now the project has been made we are ready to create a Program.

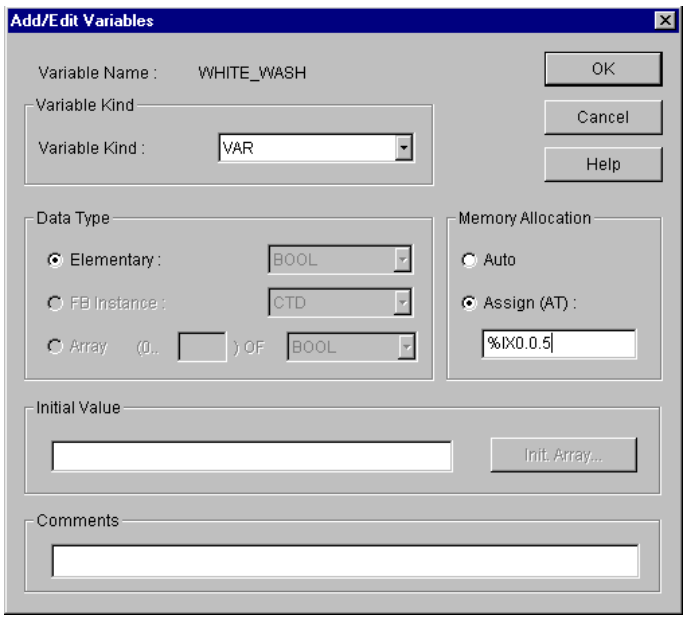


## 1. White Wash or Colour Wash is selected by a rotary switch.

Select the NO contact icon  in the toolbox and click the left button of the mouse on position row ‘0’ and column ‘1’ in the LD window.

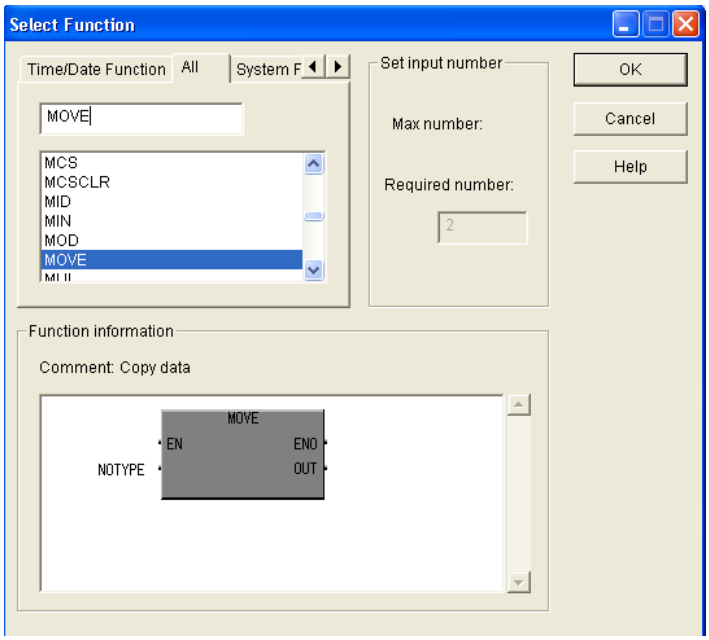


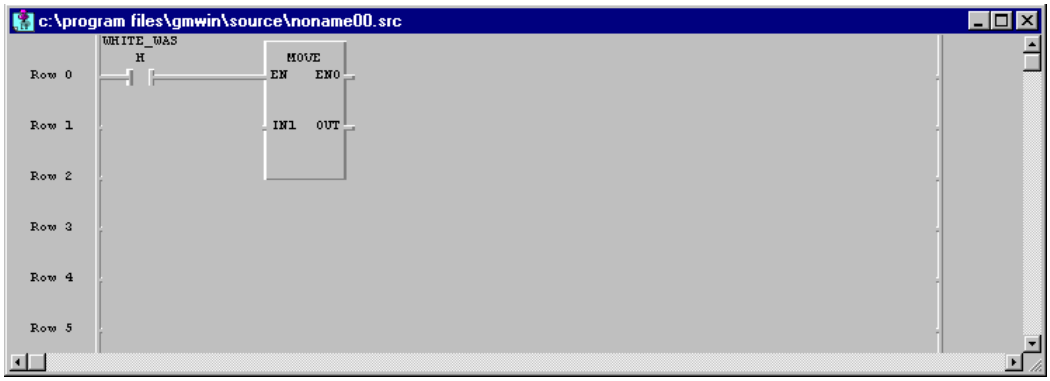

Assign a variable name to the NO contact and allocate the relevant IP address to the variable name. (As mapped out before programming)



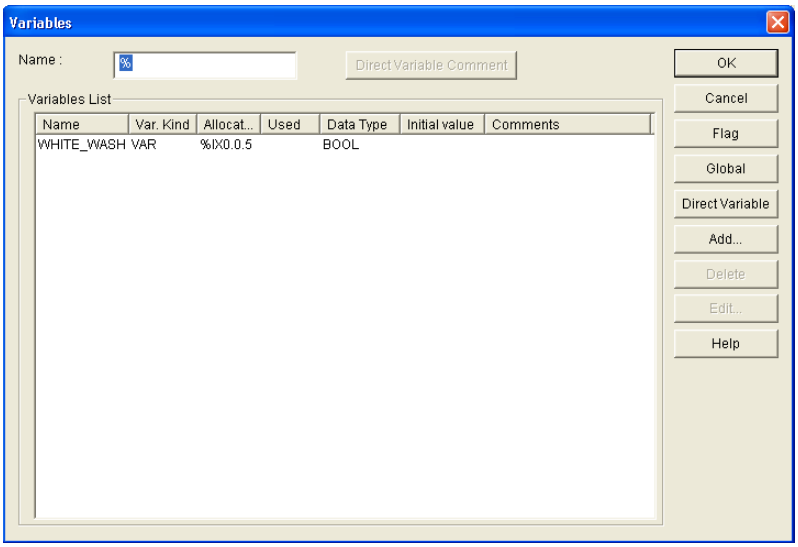

The same timer can operate from different preset times. This can be achieved by moving a time literal into a variable, which can then be used as a preset time.

Select  in the toolbox using the mouse and insert a **MOVE** function after the NO contact.

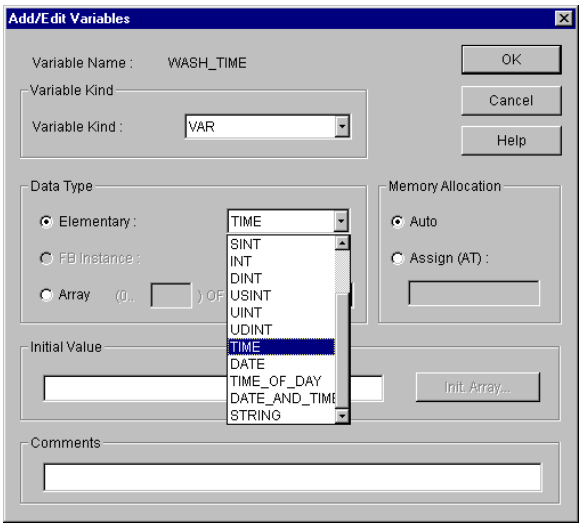


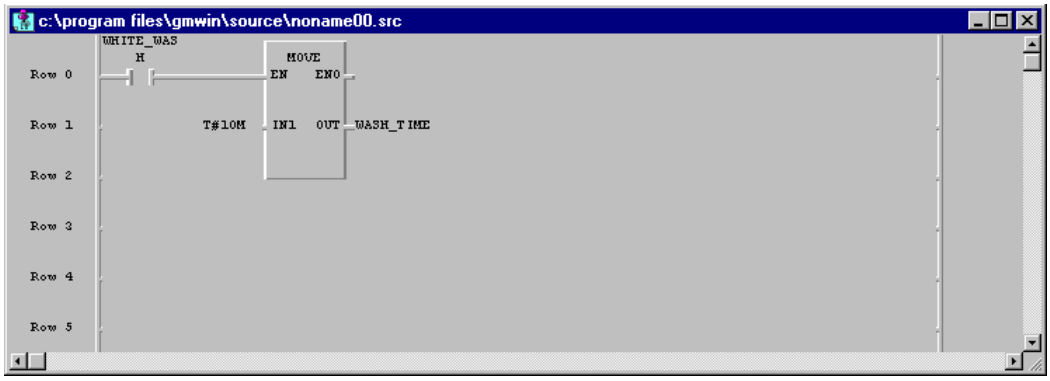

Double Click on the area to the left of **IN1**. The Variables dialog box will be activated. Enter the time expression for 10 minutes.



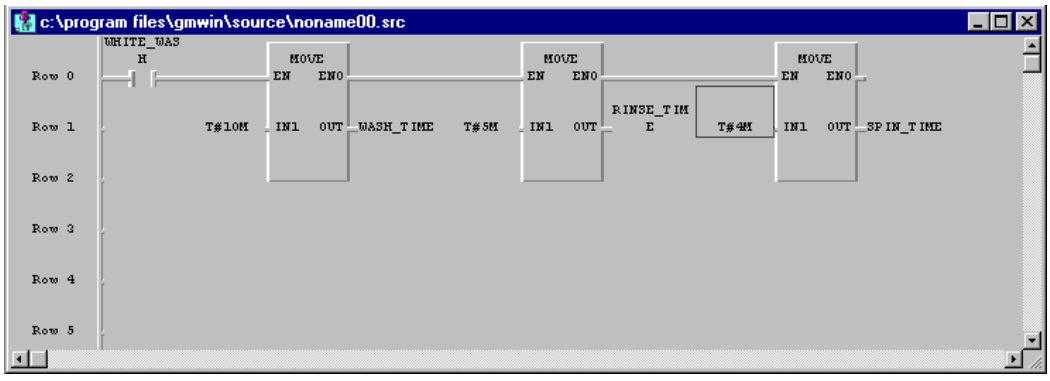
Double Click on the area to the right of **OUT**. Enter the Variable name **WASH_TIME**, as a **TIME** Data type.



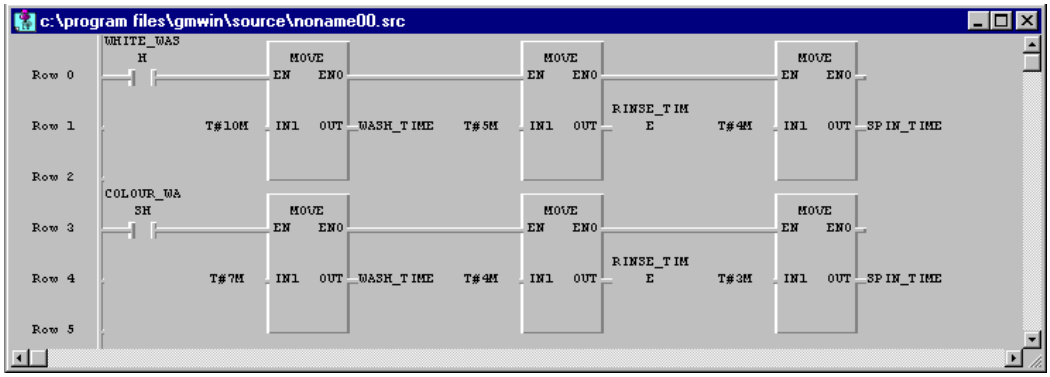

On the rising edge of the NO contact activation the time value of 10 minutes (T#10M) is moved into the variable named **WASH_TIME** with a time data type.




The other two variables for the White Wash Cycle can be linked in series to the NO contact.



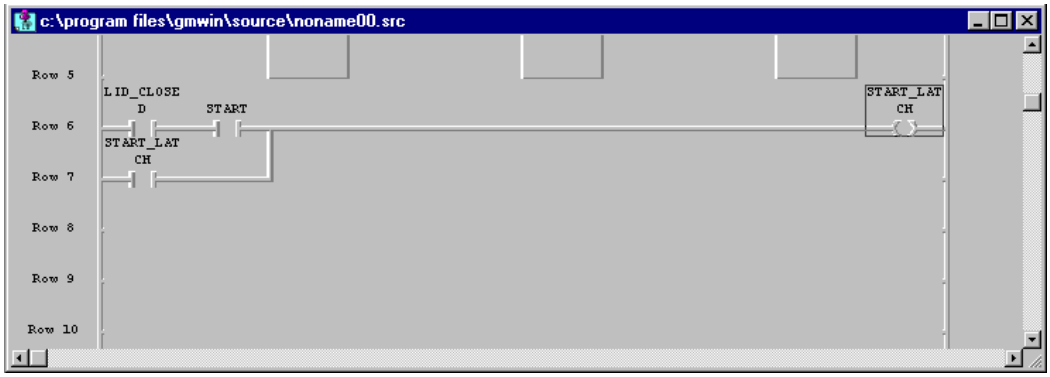
Repeat for the Colour Wash Cycle. Move the relevant time values into the **WASH_TIME**, **RINSE_TIME** and **SPIN_TIME** Variables.




## 2. When the lid is closed and the start button is pressed, Detergent + Water are pumped in for 1 minute

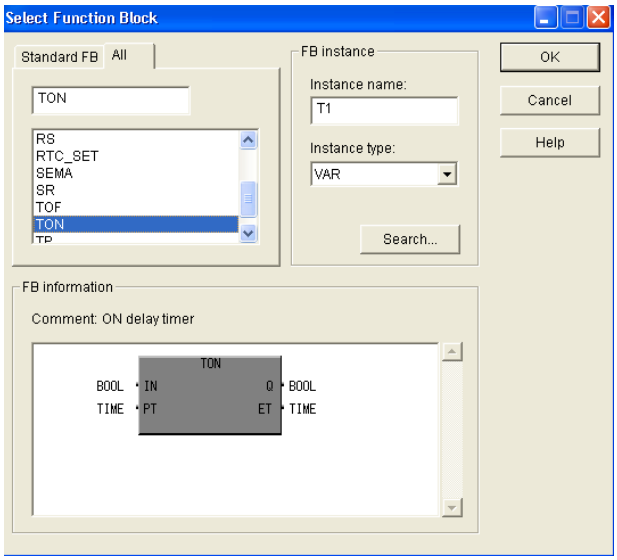
Create a latch using the lid closed and start inputs. Create three variables, **LID_CLOSED**, **START** and **START_LATCH**. **LID_CLOSED** and **START** are allocated to the relevant inputs and **START_LATCH** is auto allocated.

Insert an output coil by clicking on the icon  with the mouse and inserting it to the program on the right hand side. The same Add / Edit Variables menu will pop up so that you can name the variable.



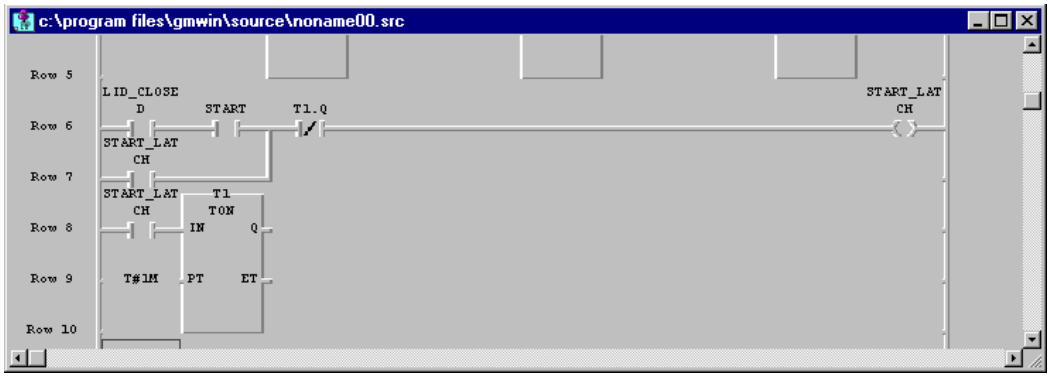

Use the **START_LATCH** bit to operate an ON delay timer for 1 minute.

To insert an On Delay Timer select the Function Block icon  using the mouse.



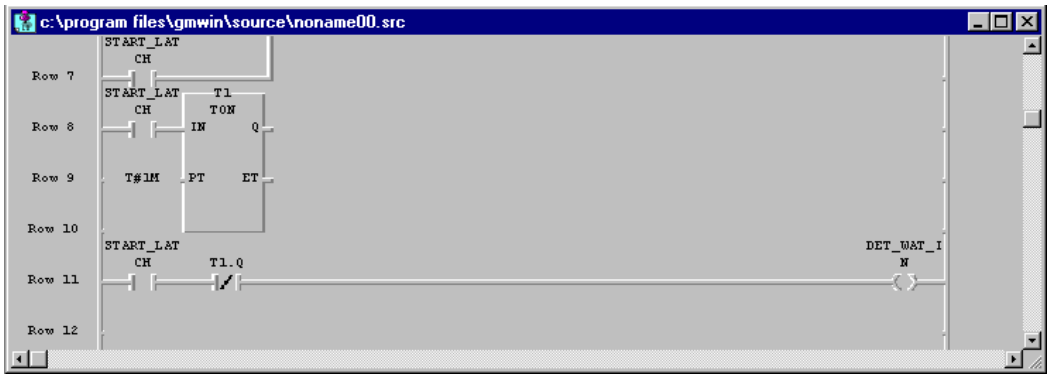

Select TON from the list and enter the instance name as T1.

Name the **TON** timer as **T1**. Enter the time value T**#1M** as the Preset Time (PT). Use the T1 timer output bit, **T1.Q** to break the **START_LATCH**.

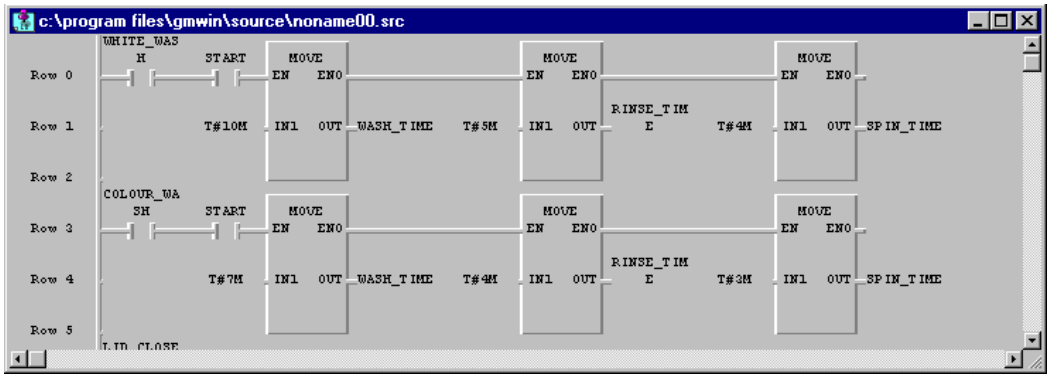



Also use the **START_LATCH** bit, in series with a NC output bit of the **T1** timer, **T1.Q**, to operate the Detergent and Water in output, **DET_WAT_IN** assigned to **%QX0.0.0**.

To insert a Normally Closed (NC) coil click on the icon  with the mouse and insert it into the program where required.

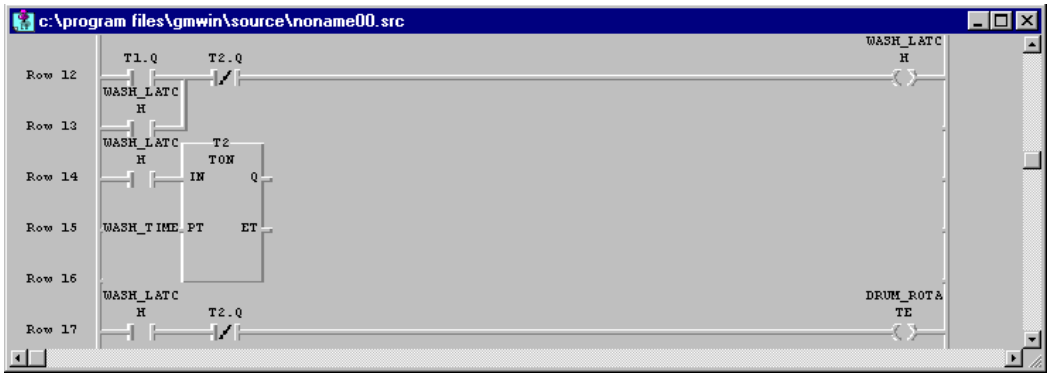


Link the **START** bit in series with the colour/white wash selection at the start of the program. The selection of program will only happen at one point in the wash cycle. If the wash selector is changed during the program, the settings for the current cycle will remain the same and not change until the next cycle.



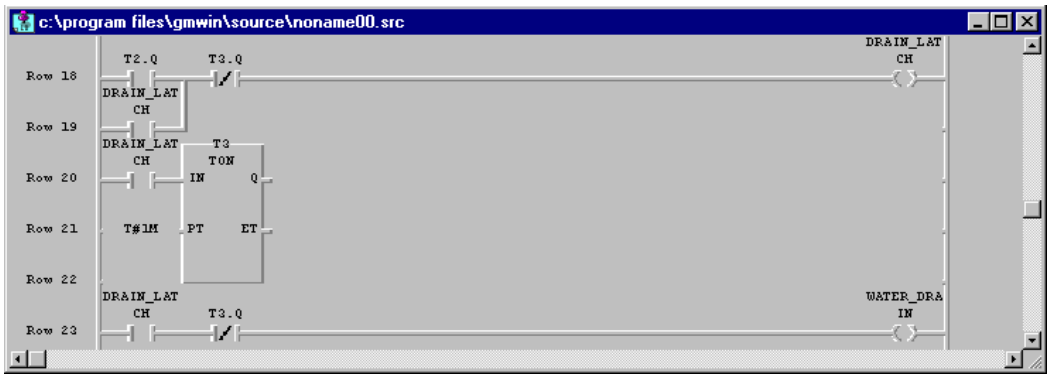

## 3. The drum rotates for the specified wash time, depending on the type of wash selected.

After the detergent and water have been pumped in for 1 minute, the output bit from the **T1** timer, **T1.Q**, can be used to start the drum rotation timer and output. Create a latch called **WASH_LATCH**, and use this latch to operate the timer and the output. With two options for the length of time that the drum rotates, Colour and White wash, the **WASH_TIME** variable is used as the Preset Time (PT) for the On delay timer.



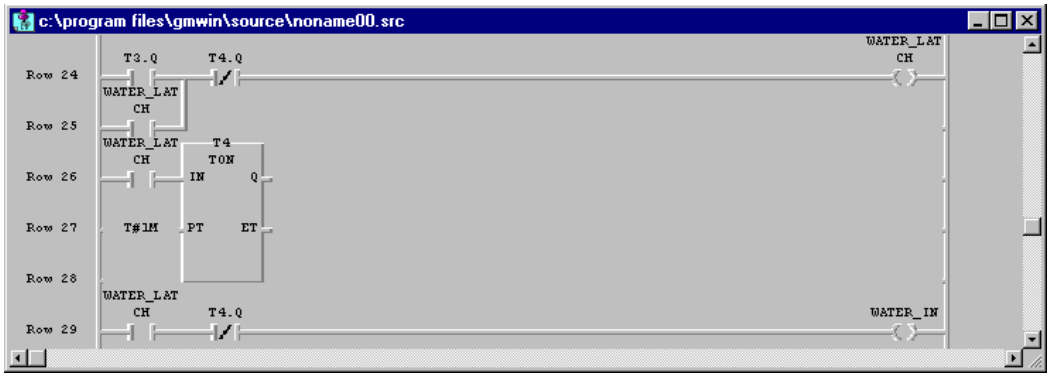
## 4. The drum is drained for 1 minute.

The resulting bit from the wash timer, **T2.Q**, is used to latch a bit to operate the drum drain output and a 1 minute delay.



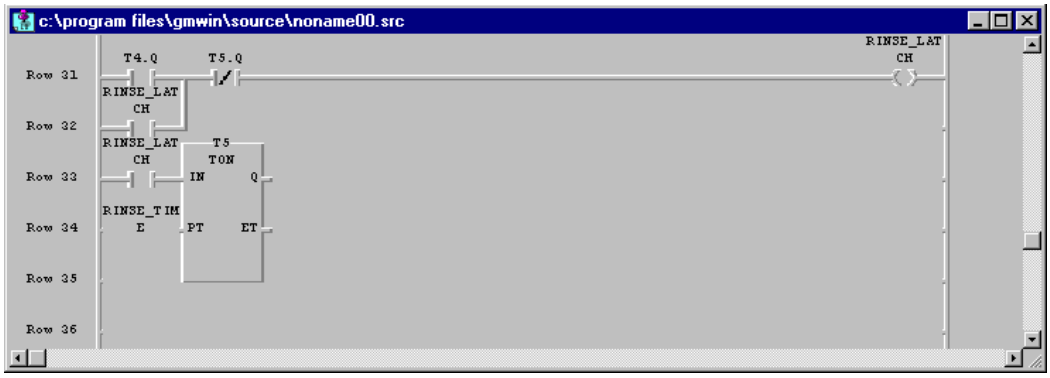

## 5. Fresh water is poured in for 1 minute.

The resulting bit from the drain timer, **T3.Q**, is used to latch a bit to operate the fresh water in output and a 1minute delay.



## 6. The drum is rotated for the specified rinse time, depending on the type of wash selected.

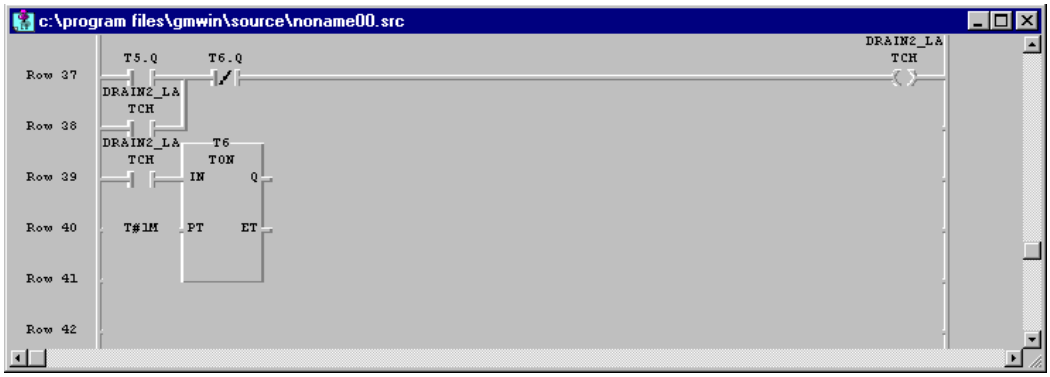
The resulting bit from the fresh water timer, **T4.Q**, is used to latch a bit to operate the drum rotate output and the **RINSE_TIME** delay. As the **DRUM_ROTATE** output is already used in row 17, and can only be assigned to an output coil once in the program, the drum rotate condition is linked in parallel with the output on row 17.



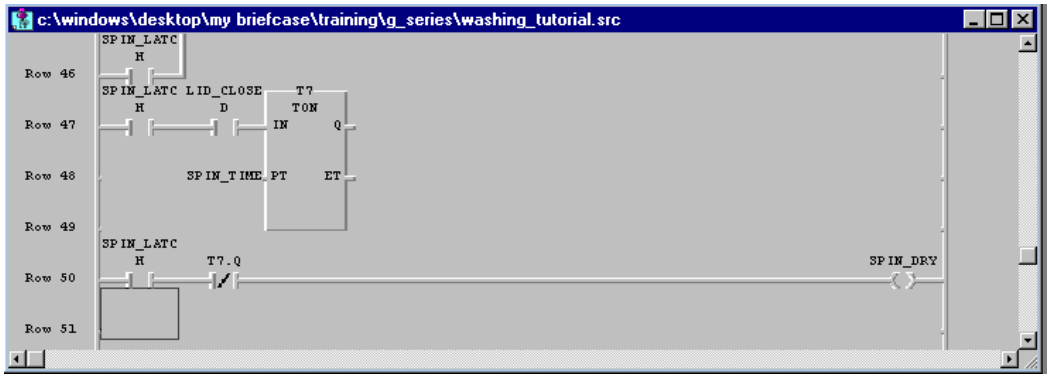


## 7. The water is drained for 1 minute.

The in the program resulting bit of the rinse timer, **T5.Q**, is used to initiate the drain timer and output. Again the drain output has been used previously so the initiating bit is used in parallel in row 24.

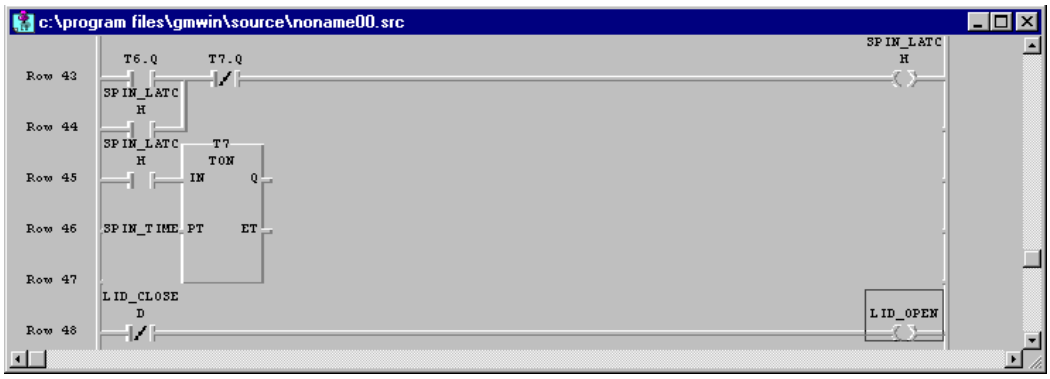


## 8. The drum is rotated for the specified spin time, depending on the type of wash selected.



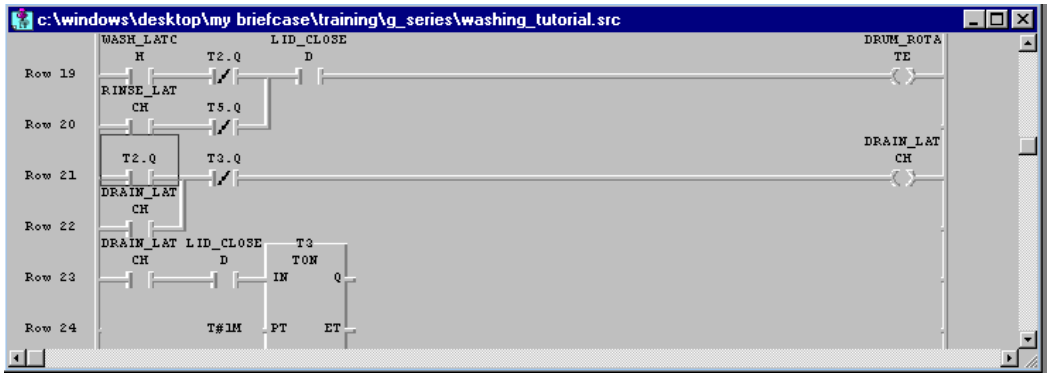

## 9. The lid open lamp will operate if the lid is opened, and the wash sequence cannot start.

Use a NC condition of the lid switch input to operate an output lid open indicator.

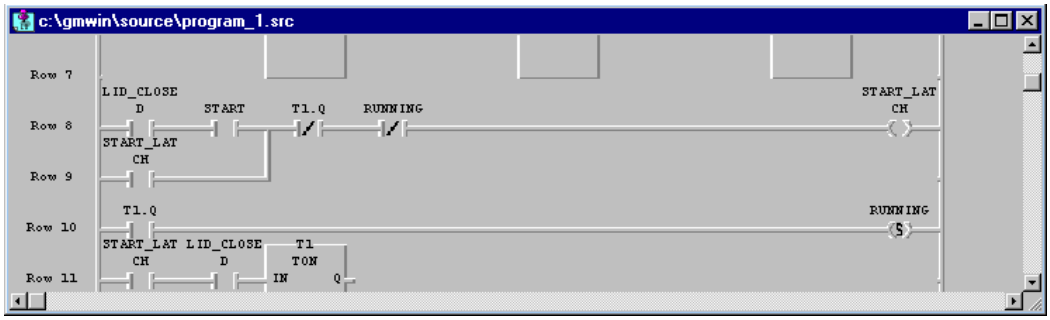


## 10. If the lid is opened at any time during the wash cycle, the cycle is suspended and only continues when the lid is closed again.

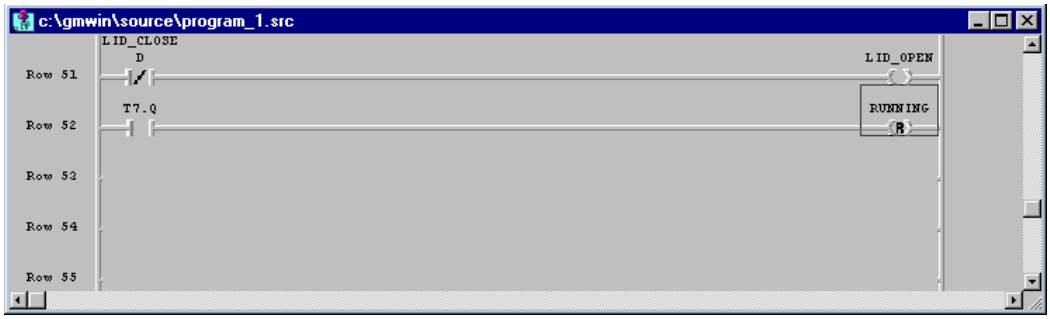
The lid switch input could also be placed in series with any line where an action is performed. This will stop the cycle at the point where the lid is opened and only restart again when the lid is closed.




To ensure the **START** button does not restart the program again during the cycle, insert a NC contact on row 8 after the **T1.Q** NC contact. Create a new variable **RUNNING** and assign to the contact.
Insert a line and add a NO contact with variable **T1.Q**. Add a set coil with the variable **RUNNING**.



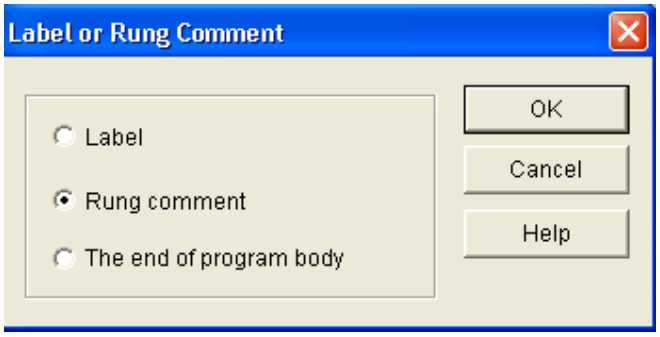

After the last time, **T7**, add a NO contact **T7.Q** operating a reset coil with the variable **RUNNING**.



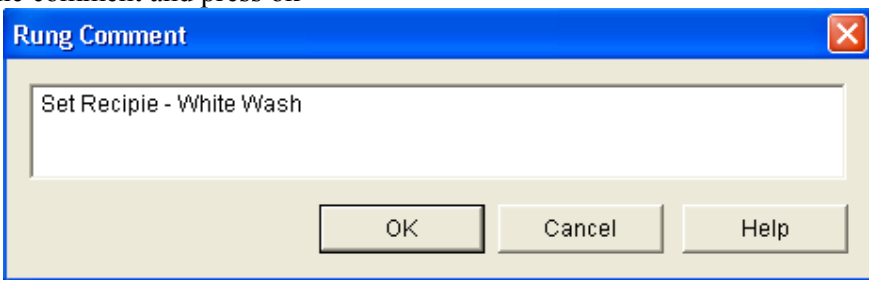

Place the **RUNNING** bit in series with the recipe selection, to inhibit changes to the preset time during the cycle.

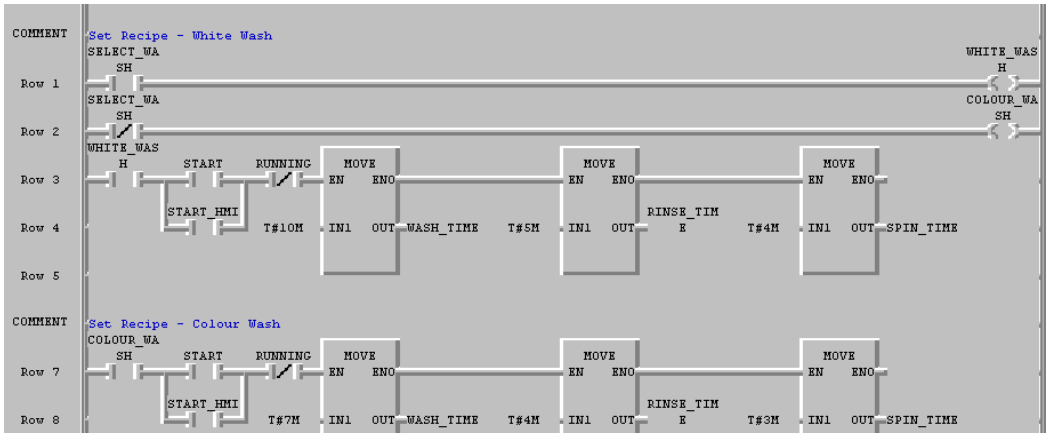
Rung comments can be added by double clicking on the row number on the left power rail, selecting the rung comment option and entering the comment in the dialog box.

Double clicking brings up this menu option. Select Rung comment and click OK



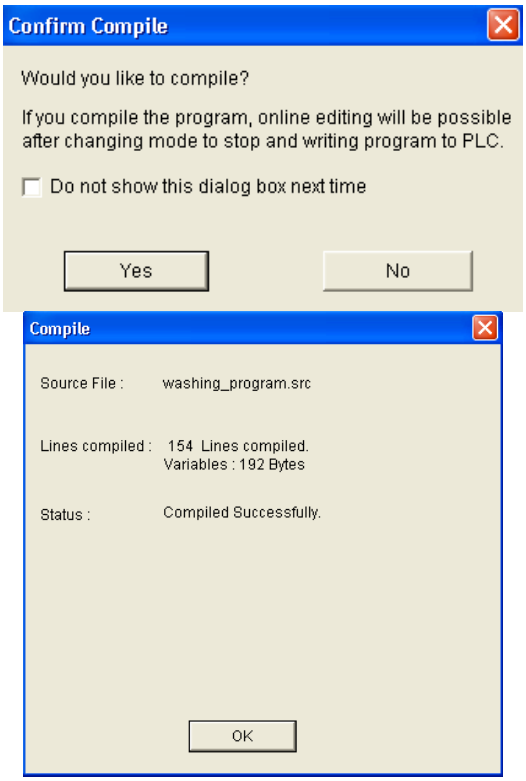

Enter the comment and press ok



## *Compile and Build the Project*

Once the program has been written has been written Compile the program by clicking on the icon  with the mouse.



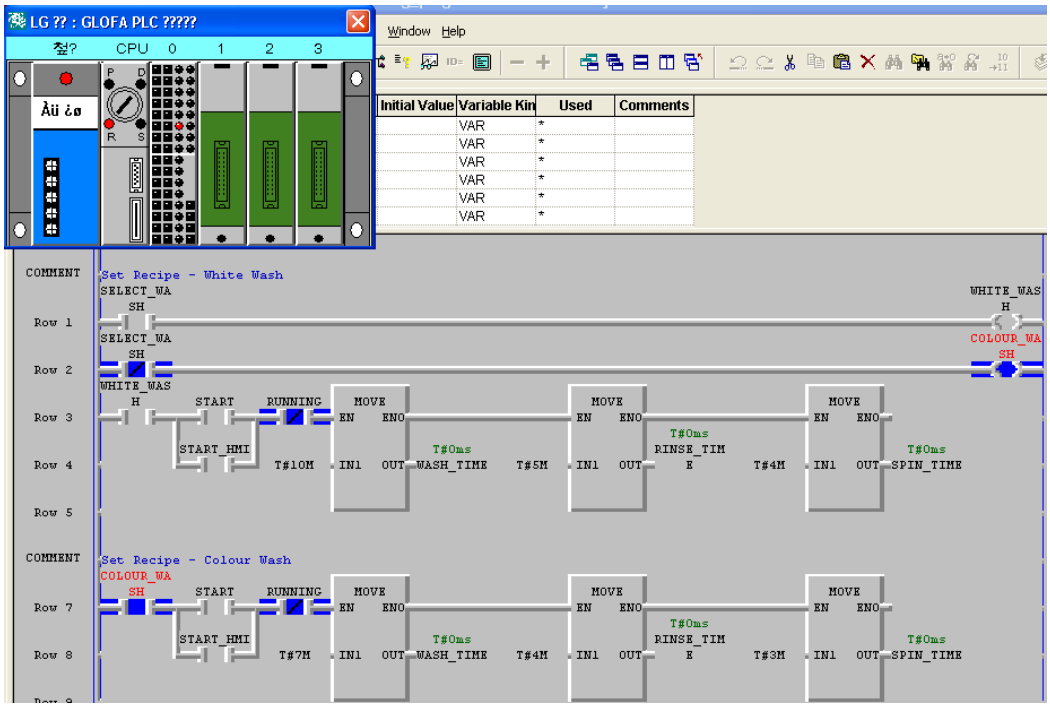

## *Simulate the Program*

To simulate the program click on the icon  with the mouse. This will automatically build the program and if there are no errors open up the simulation software.

The simulated PLC looks represent the G4 PLC. This is because GMWin is used for the complete range of G-series PLCs.

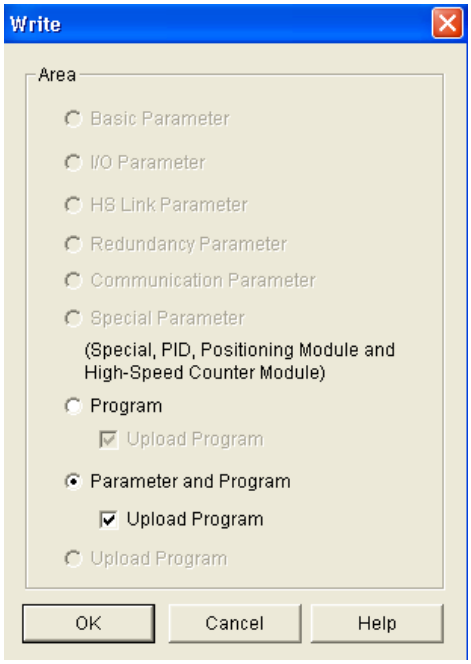
Switch the Simulation PLC from Stop (S) to Run (R) and now you can simulate the program. Input and output cards can be added to the simulation PLC, the inputs are square and outputs round, when active they are red.

On the program the power rails are active and shown in blue, as are active coils and contacts. The active variable names also go red. Timer and counter current values are shown in green.




## *Download the Program to the PLC*

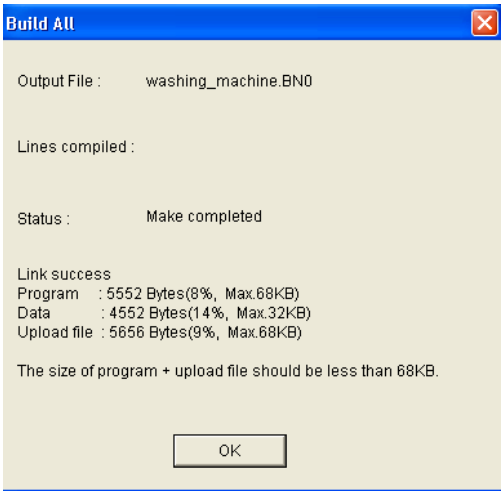
Connect the PLC to the computer serial port using the KIC-50A programming cable. Click on the connect + write + run + monitor  icon with the mouse. This will then bring up the write to PLC options.




The upload option enables the program to be read from the PLC by a user without the original project. If you do not want other user to have access to your program, un-tick the box

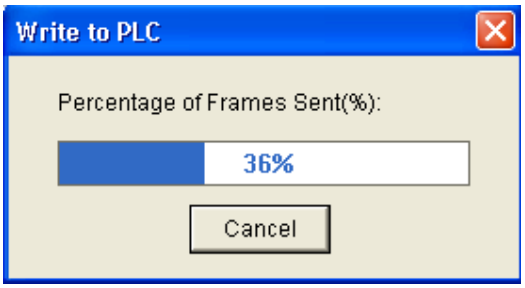
The Project is then built before downloading to the PLC.

Once the program is built a menu pops up displaying the size of the project.

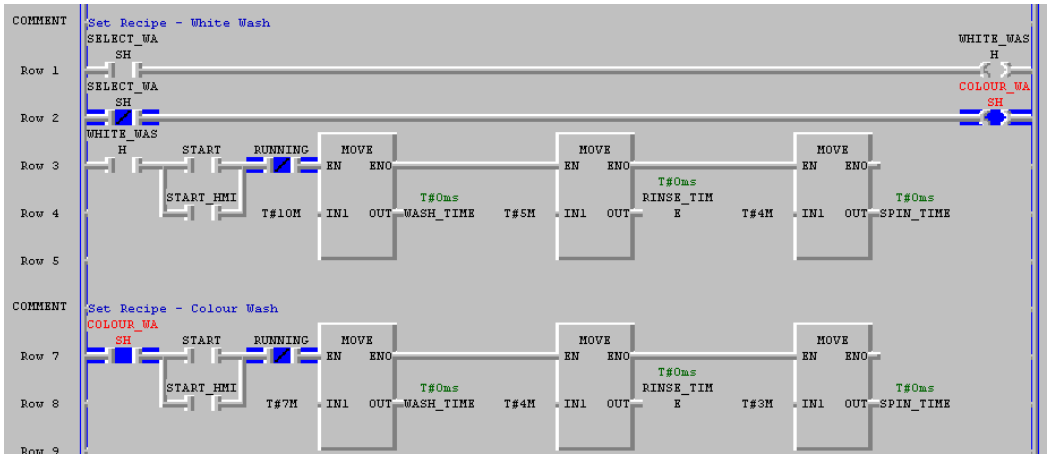



Click OK to download project

The project then downloads to the PLC.




Just like in the simulator, when monitoring the live program, it can now be seen with power active to the rails.



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# Tutorial 1 – IMO Greenhouse

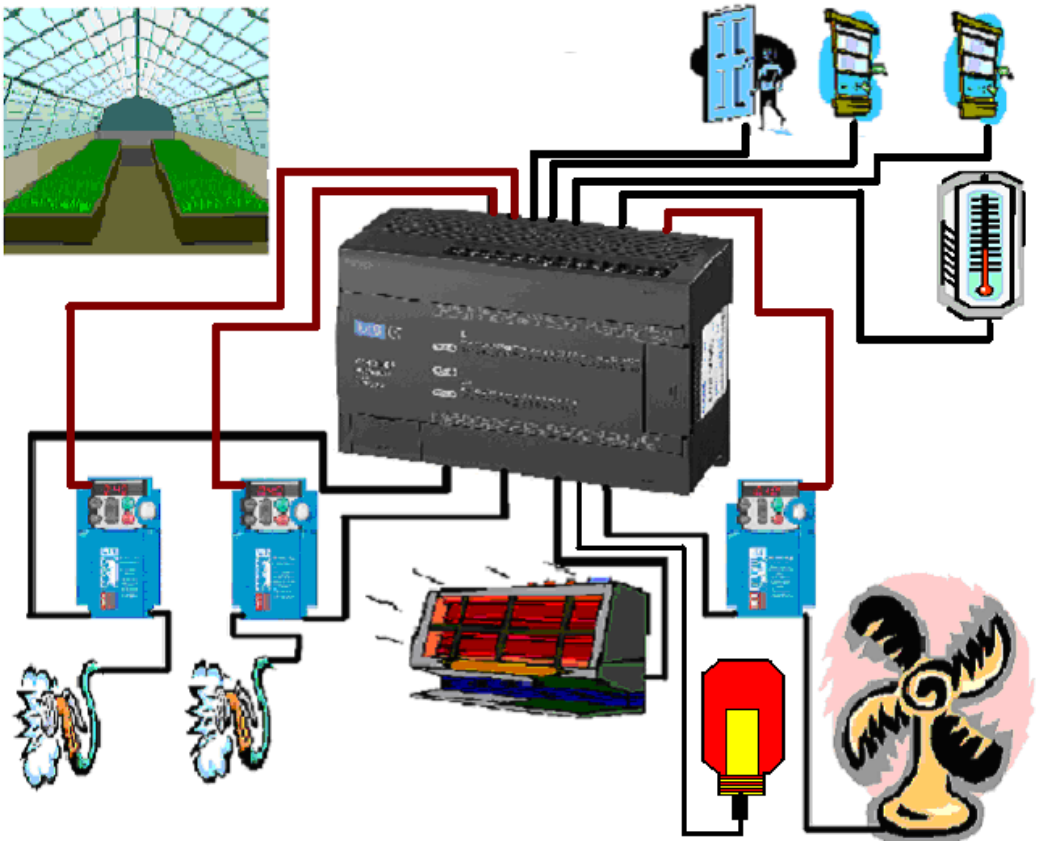
The plants in the greenhouse must be watered every 3 hours. There are two IMO Jaguar drives which control two pumps supplying the plants with water. They must not come on at the same time.

If the greenhouse gets too hot then a cooling fan must be switched on. Likewise if the greenhouse gets too cold then the heater must be switched on. The fan and heater cannot be on at the same time. The PLC has an On/Off input from a temperature controller to regulate the temperature.

The water sprinkler must not switch on if the door is open and the iSmart must display if either of the two windows are open.

The customer in time would like in time, to add a HMI to the system but for now he would like to log how many times the door has been opened.

There is also a feed back system from the drives to inform the PLC when a drive is down. If any of the drives are not operational then this will flash the lamp.

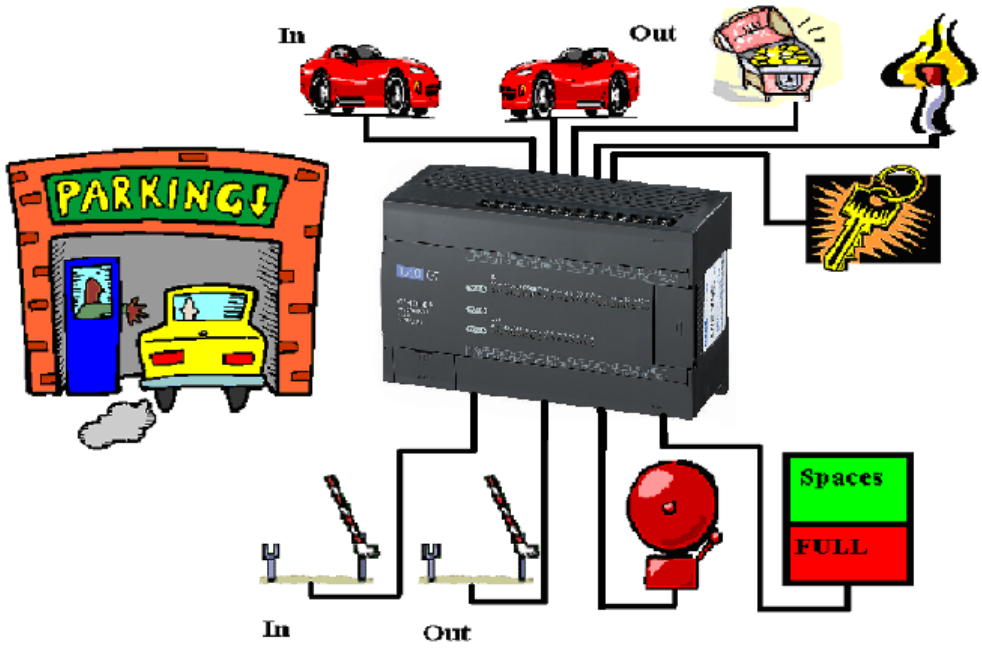


# Tutorial 2 – IMO Car park

Design a simple car park system to monitor and control the number of cars in the IMO Car Park.

The maximum capacity of the car park is 20 cars. The entrance is separate to the exit at which there will be barriers. The entrance barrier will rise when the driver has pushed the entrance button and there are available spaces. The exit barrier will rise on the car approaching and having settled an appropriate fee. The exit barrier will automatically rise when there is a fire alarm, the entrance gate will not open and the bell will sound.

To reset the fire alarm the car park attendant must use a key.



## Topics Covered in the Advanced Course

- SFC and LD Programming
- Tasks
- Inserting Libraries
- Communications
    - DeviceNet
    - Modbus
    - RNet
    - Dedicated
    - Profibus
- Expansion Units
    - Analogue
    - Expansion I/O
    - Communication Modules
- Slot and Rack PLCs
- Creating User defined Functions / Function Blocks
- Smart I/O

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