U90 Ladder Software Manual

3/06

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Getting Started

Opening a new project

To open a new project:

- On the Project menu, click **New**.
- On the Standard toolbar, select **New** .
- On the keyboard, press **Ctrl** + **N**

Opening a project

To open an existing project

- On the Project menu, click **Open**. The Open dialog box appears. Select the file you want to open.
- On the Standard toolbar, select **Open** . The Open dialog box appears. Select the file you want to open.
- Ctrl + O. The Open dialog box appears. Select the file you want to open.

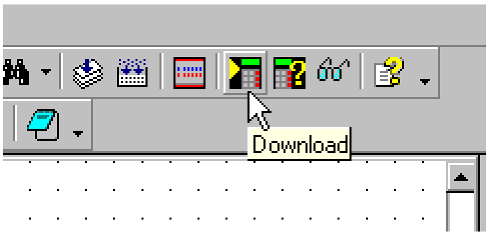
Downloading a Project

The Download process transfers your project from the PC to the controller. Before you can download a project, you must connect the PLC to your PC via a proprietary programming cable.

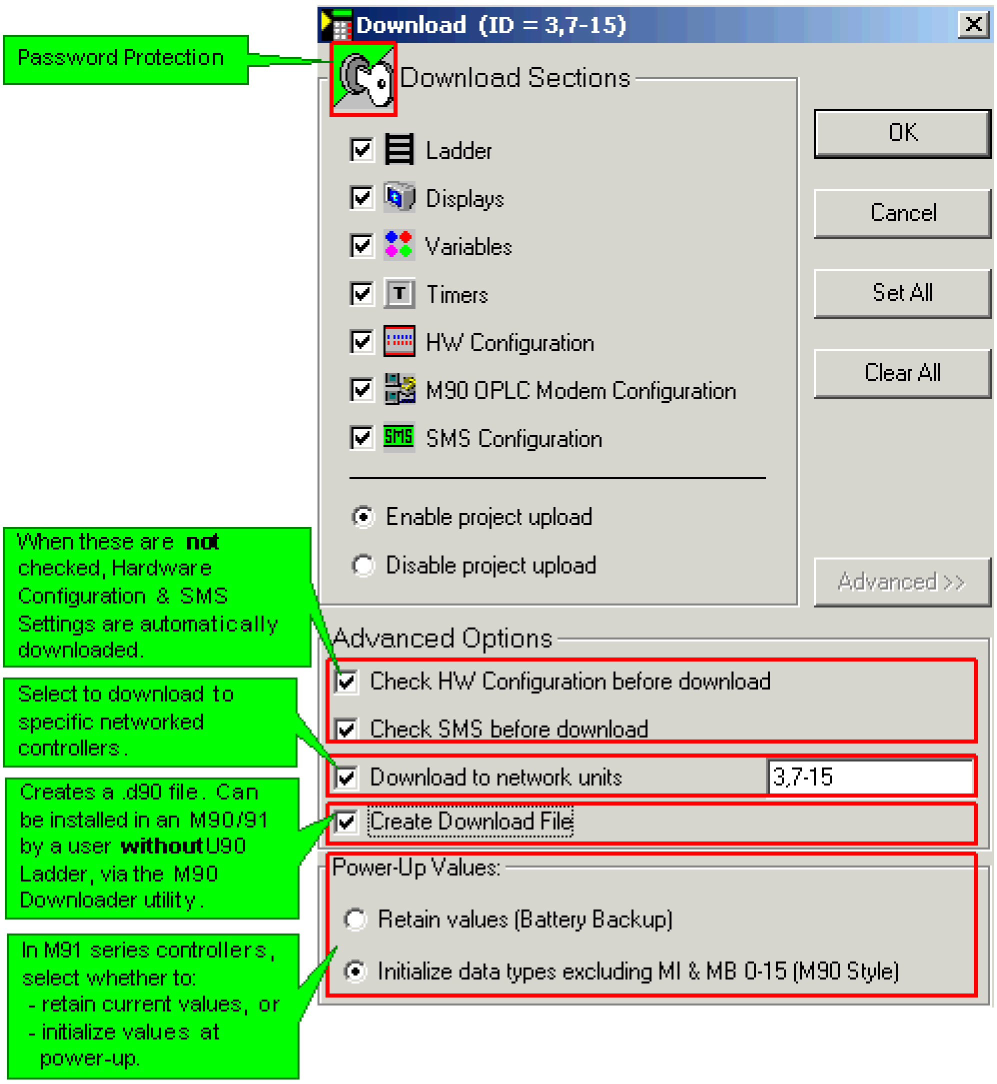
Note that M90/91 PLCs comprise a built-in serial port for this purpose. Jazz controllers do not comprise serial ports. Add-on port modules, such as the JZ-PRG programming kit which is available by separate order, plug into the Jazz Jack to provide an interface for program download.

To download a project to a controller:

1. Connect the PC to the PLC.
2. Click the **Download** icon on the Standard toolbar.



3. The Download Window opens with Download Sections. Those sections which have yet to be downloaded to a controller will be selected. If you have made no changes in the project since the last download, you have to select the Download Sections manually. Click OK.

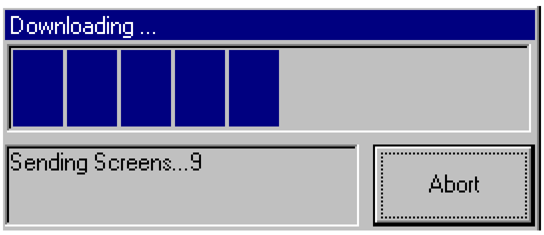


The key at the top tells you if the project is password protected. If so, the password will have to be supplied at upload.

Note Ladder Image and Project Symbols option. If you do not select this option, the Ladder program cannot be uploaded to a PC for editing. You only be able to view the uploaded program in STL. To enable the Ladder program to upload from the PLC into a PC, select this option.

Note the different Power-up value (Battery Backup) options.

4. The Downloading Progress window opens. This window closes when download is complete.



Are USB port adapters available?

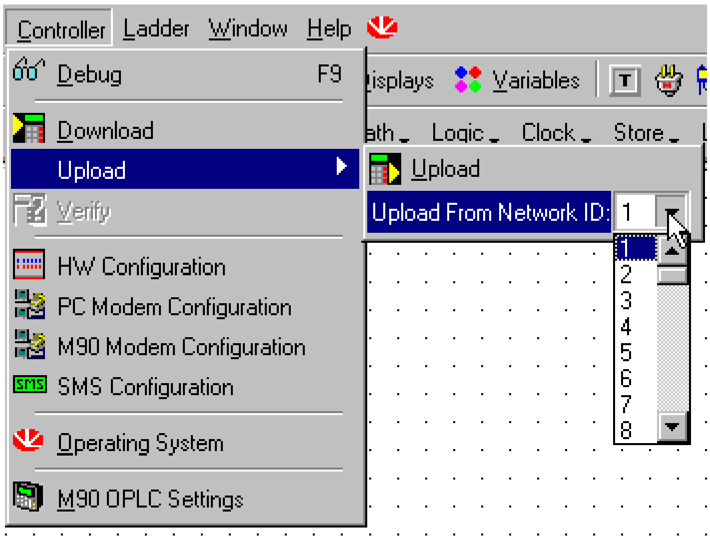
If your PC contains only USB ports, you can connect a Unitronics OPLC via a compatible, external USB-to-serial converter.

Unitronics offers a USB-to-serial converter that has been tested for compatibility with OPLC controllers. This converter can be ordered from local Unitronics distributor, using part number MJ10-22-CS35.

Uploading a Project

1. Select Upload from the Controller menu.
2. Two options are displayed: Upload, and Upload from Network ID.
3. Upload from:

- - a stand-alone PLC by clicking on the Upload button
- - from a specific M90 on a network by selecting the M90's ID number as shown below.



4. All sections of the project in will upload.

Note • Note that if the program is protected by a password, you must supply this password in order to upload.

• Security restriction: if a PLC operator enters a wrong password 3 times, the PLC **automatically disables program upload** for that program.

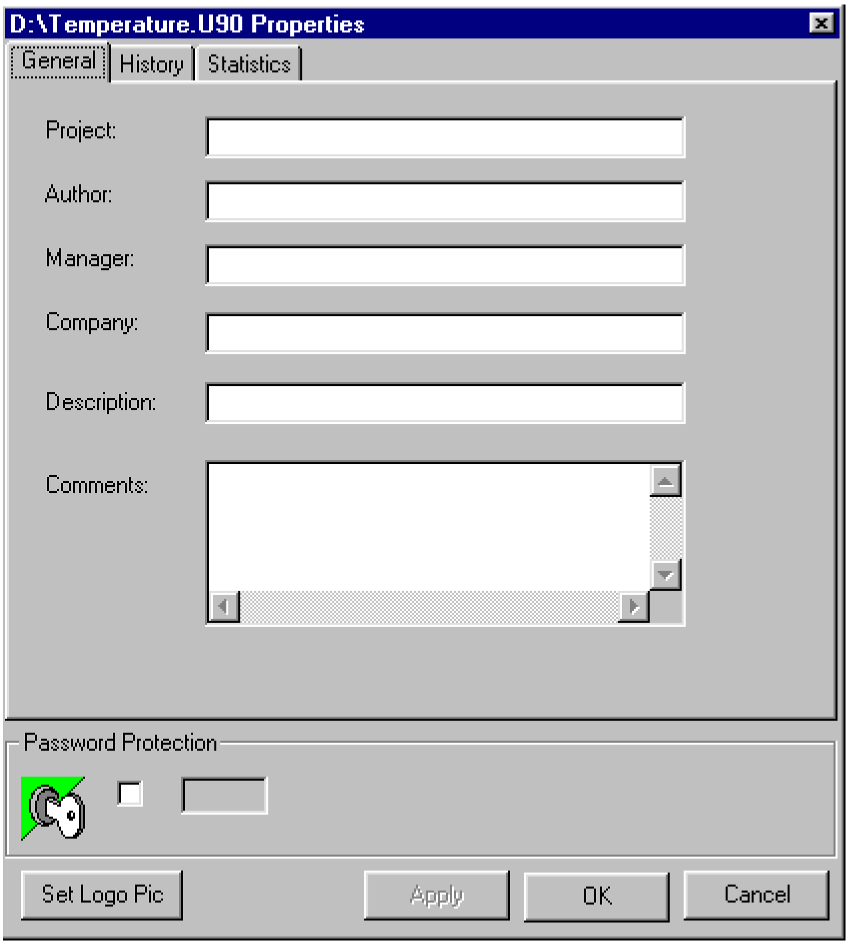
Project Properties

Project properties include:

- General information, including password protection
- History
- Statistics

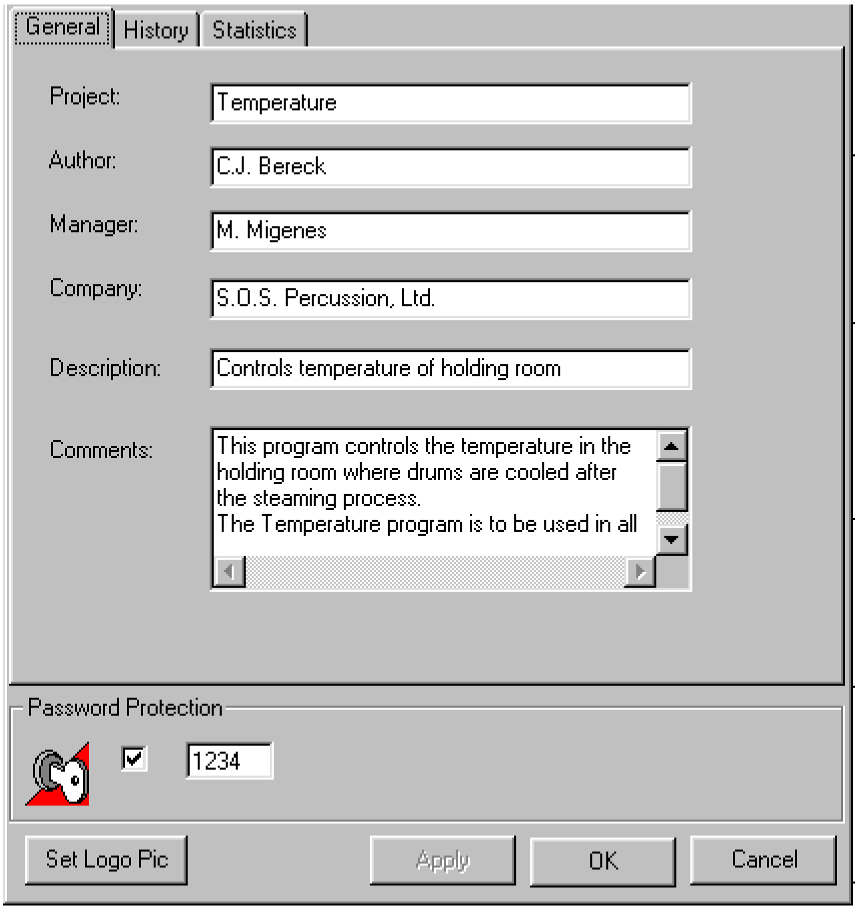
To access program properties

1. Display project properties by selecting Properties from the Project menu. The project Properties box opens.
2. Select property topics by clicking the tabs.



General

When you select General, the fields are blank. You enter all of the project information manually. An example is shown below.



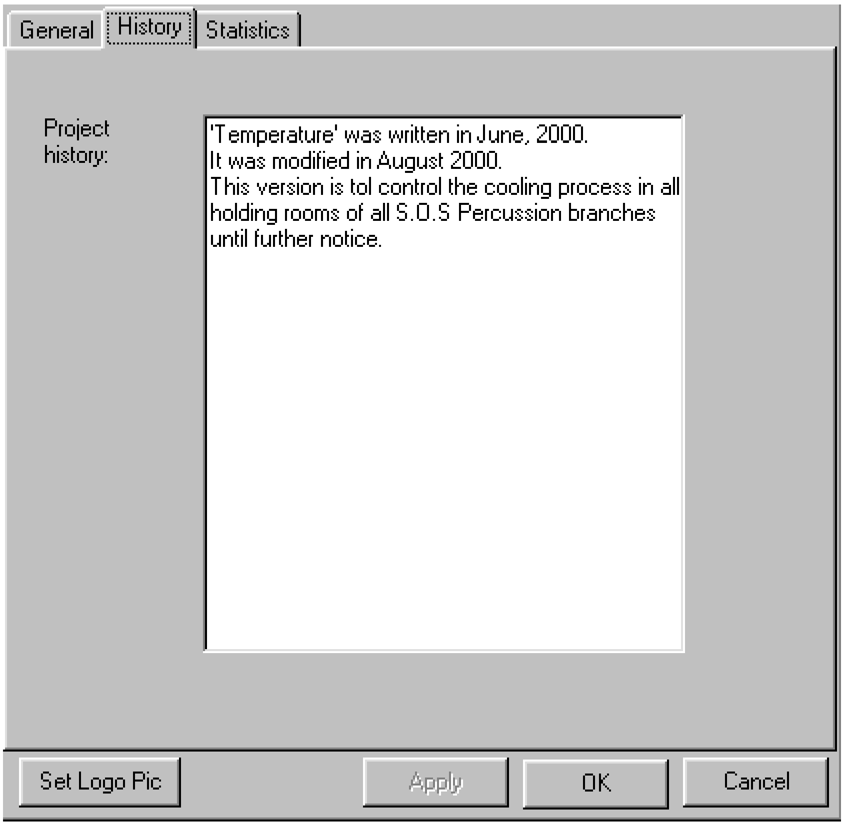
Password

You can apply password protection to your program. This will prevent anyone who does not have the password from uploading the program from the PLC.

Note • Security restriction: if a PLC operator enters a wrong password 3 times, the PLC **automatically disables program upload** for that program.

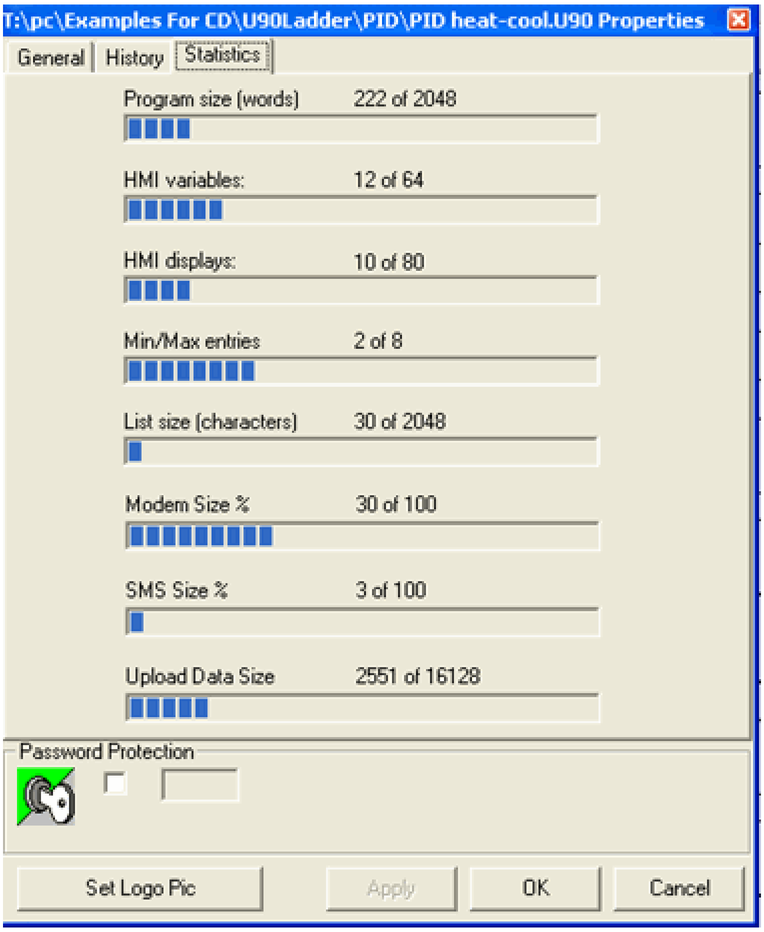
History

When you first open History, the field is blank. Enter the desired text as shown below.



Statistics

When you open Statistics, the progress bars show how much of the project's available space is in use. The statistics update automatically.



Set Logo Pic

You can also import your company's logo into your project. Then, when you print sections of your project, the logo will be printed at the top of each page.

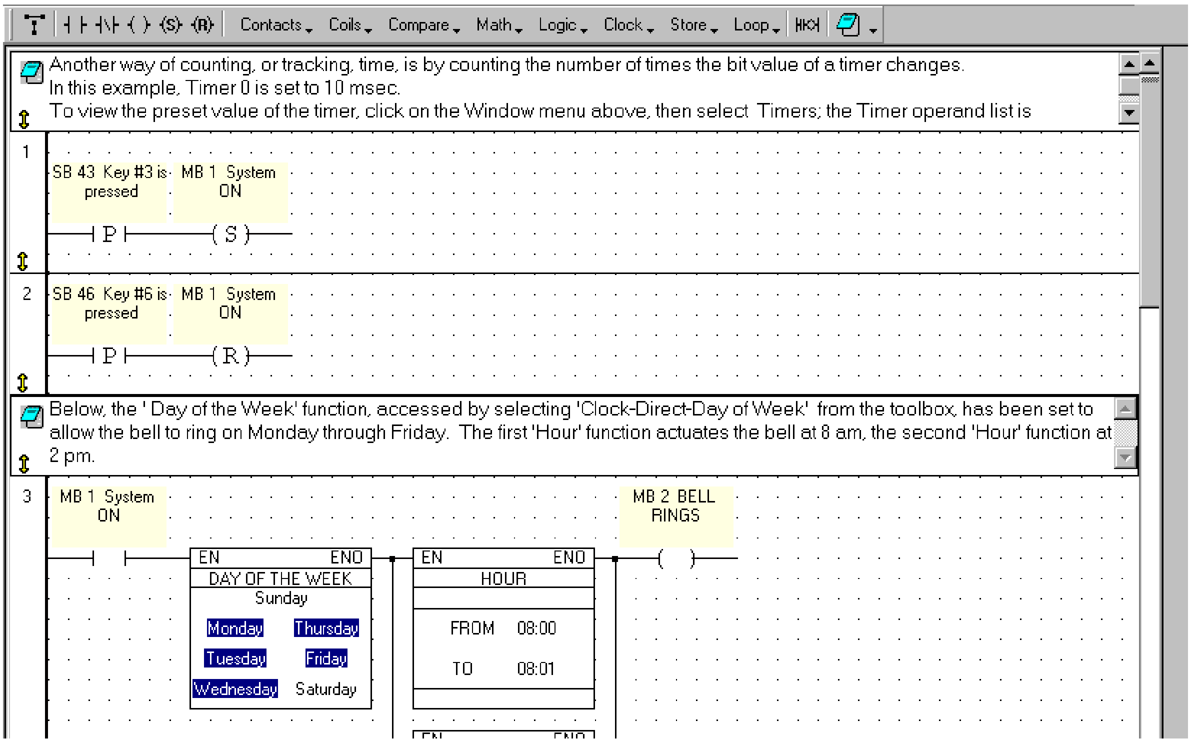
Ladder Editor

Use the Ladder Editor to create the Ladder diagram that will form the backbone of your project application. Ladder diagrams are composed of contacts, coils and function block elements. Power flows from left to right in a Ladder diagram.

Use the Ladder Editor to:

- Place and connect Ladder program elements.
- Apply Compare, Math, Logic, Clock and Loop functions.
- Place Comments on Ladder nets.

Ladder Editor view:



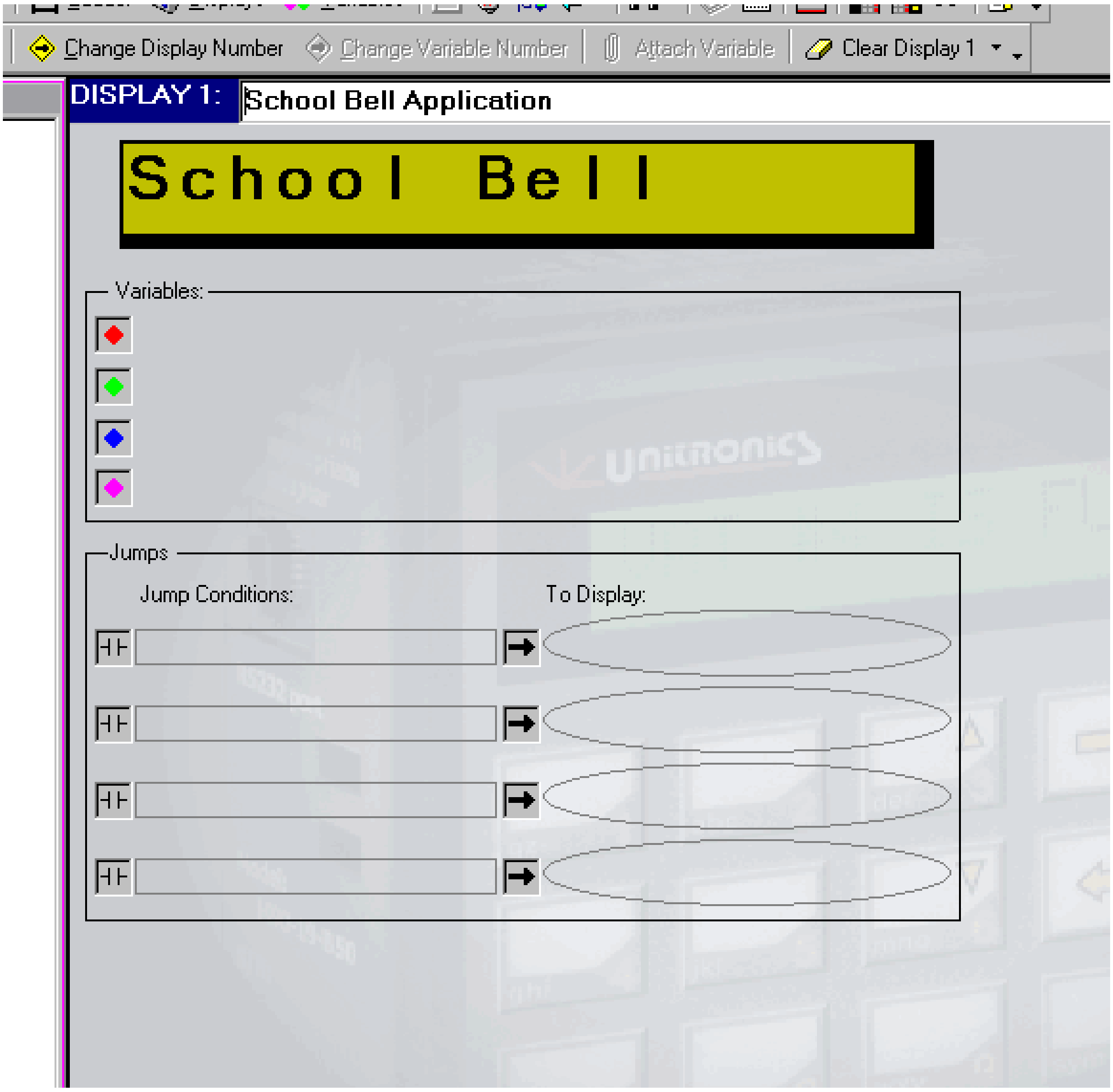
Using the HMI Display Editor

Use this editor to create your HMI application for customizing the operating panel functions to the control task.

Use the Display Editor to:

1. Create text displays that will appear on the LCD. You can create up to 80 displays.
2. Link display text to a variable. You can define up to 50 variables.
3. Configure links, or up to four jumps, to a display.
4. Format the LCD variable display.

Display Editor view:



PLC Display Language

The LCD embedded into M90 series controllers only supports English-language characters.

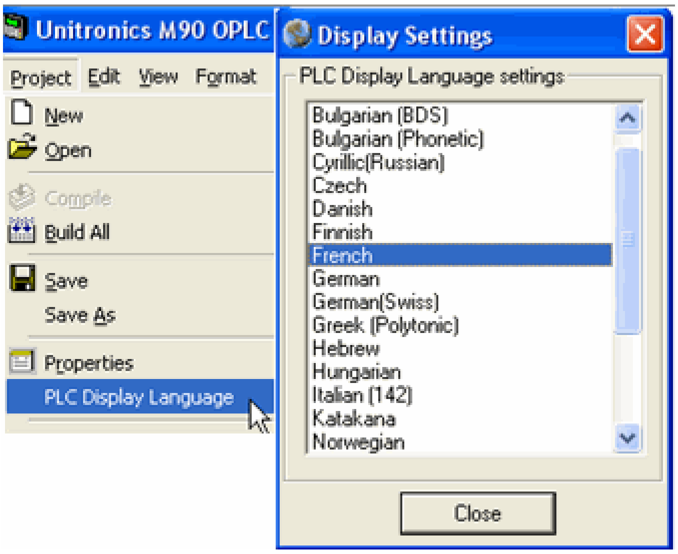
However, certain PLC models are 'multilingual' and can display other languages, if the Windows keyboard layout of the PC you use to build the U90 Ladder application supports that language.

U90 Ladder versions 4.00 and up contain the PLC Display Language option.

When you install U90 Ladder, the Display Settings box opens.

English is the default language. Selecting another language enables you to type that language into the HMI Display.

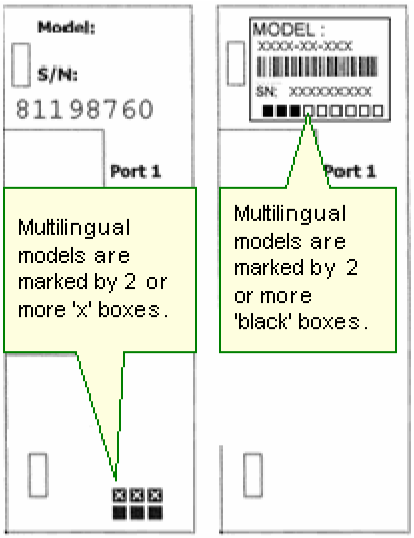
After installation, you can change the PLC Display Language at any time



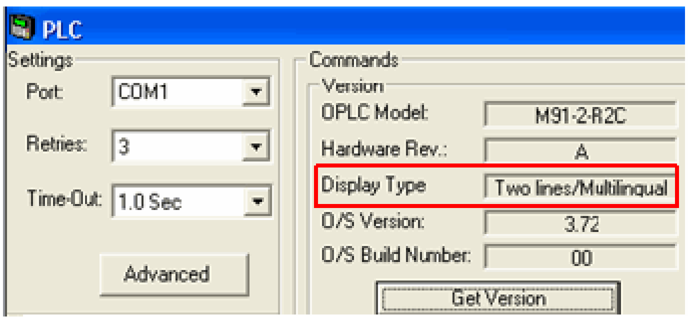
How to identify Multilingual models

You can see whether a PLC supports Multilingual Displays

- By checking the side of the controller containing the COM ports



- By connecting the PLC to the PC and running U90 Ladder Controller>PLC>Get Version

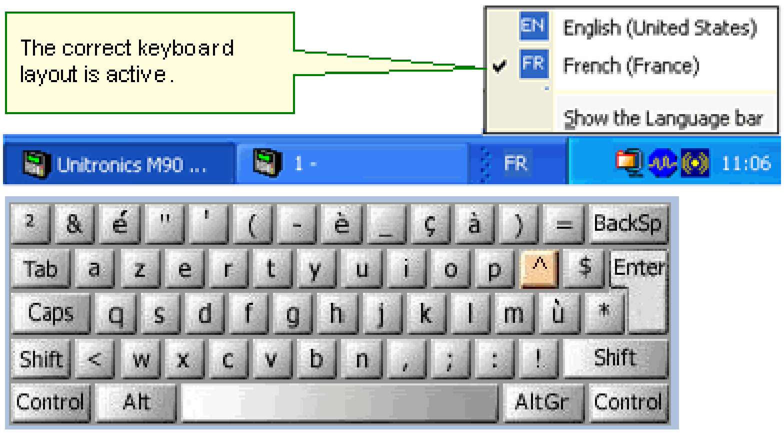


Note • Certain older PLC models may be incorrectly declared as Multilingual PLCs in Hardware Configuration and after Get Version. In these cases, check the right side of the controller as described above.

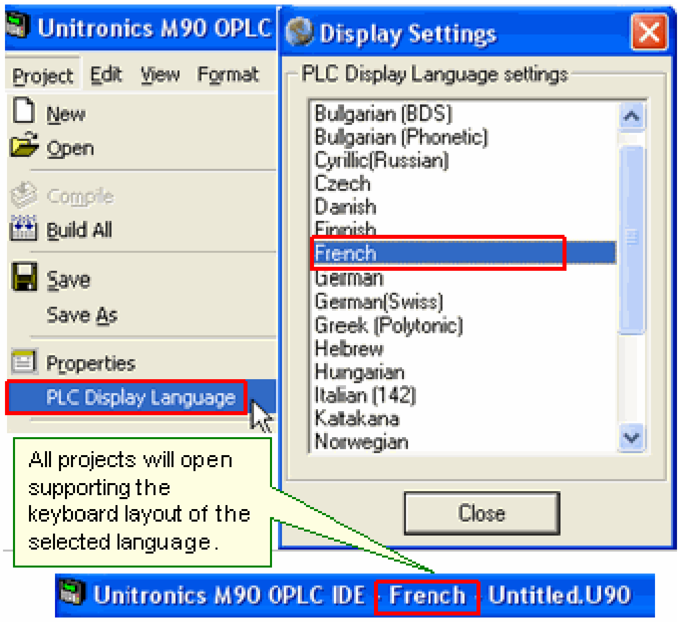
Changing the PLC Display Language

This example below assumes that you are using a PC that is enabled for both English and French keyboards.

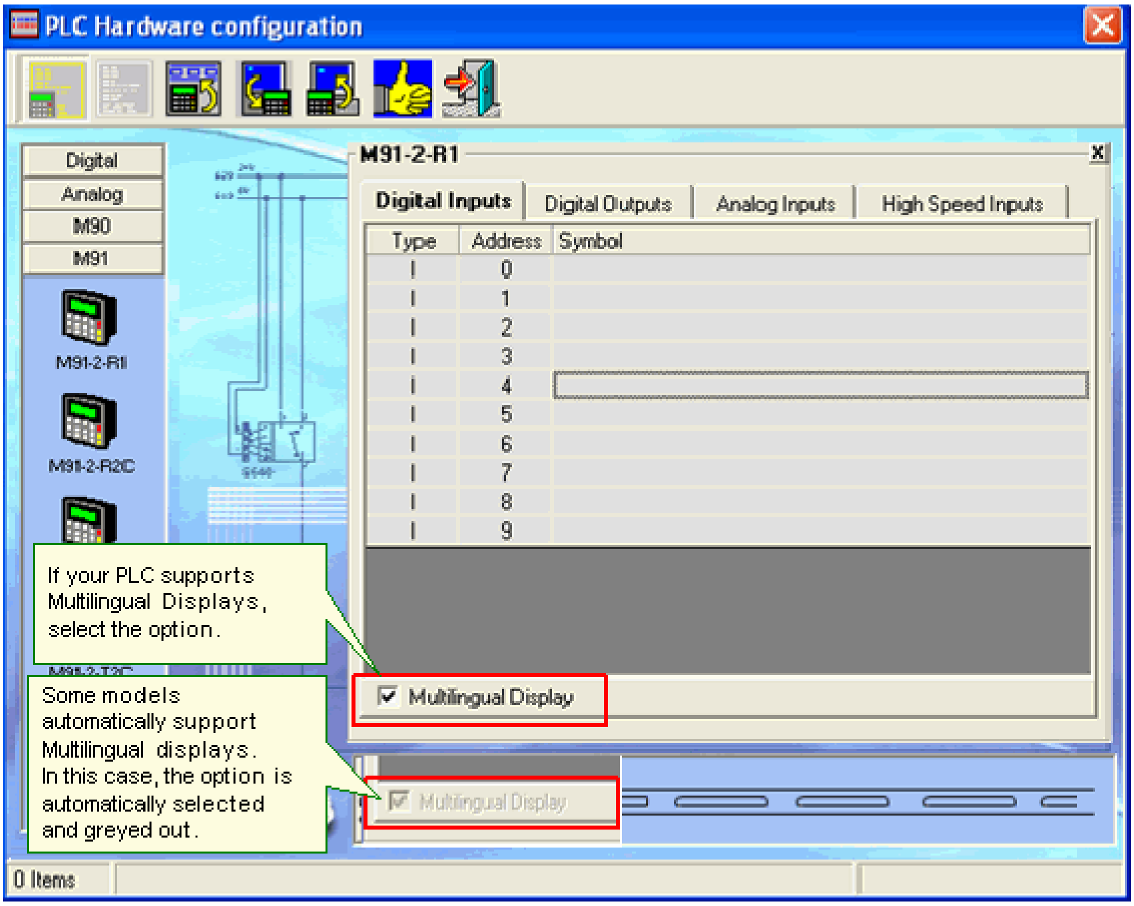
1. The correct Windows Keyboard Layout must be active as shown in the next figure. To learn more about this topic, search for Keyboard Layouts in Windows Help. Information on keyboard layouts and language locales is available from http://www.microsoft.com/globaldev/reference/default.mspx.



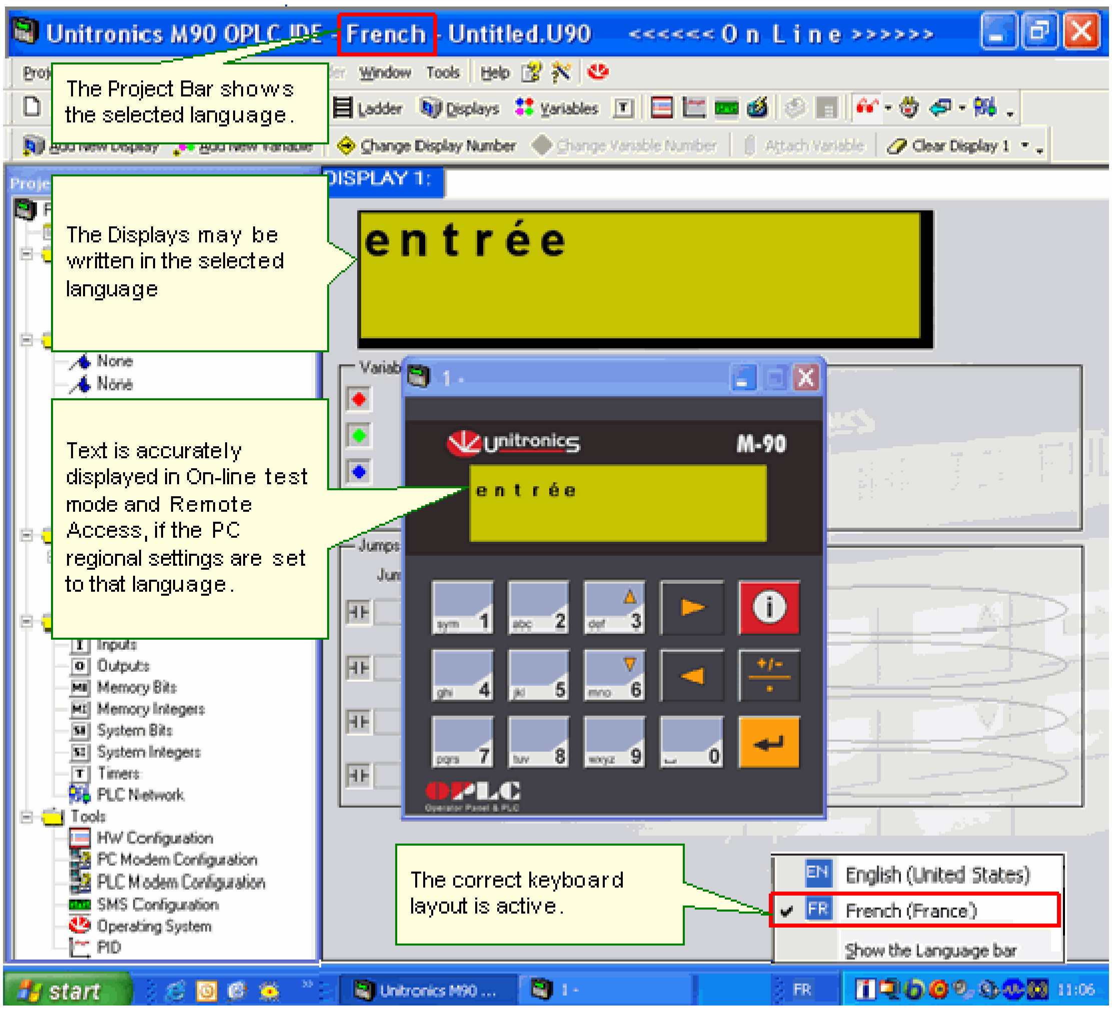
2. In PLC Display Languages, you must have selected the desired language. If you performed this step when U90 Ladder was installed, you do not need to repeat it; any new project is automatically set to the language selected in Keyboard Layout.



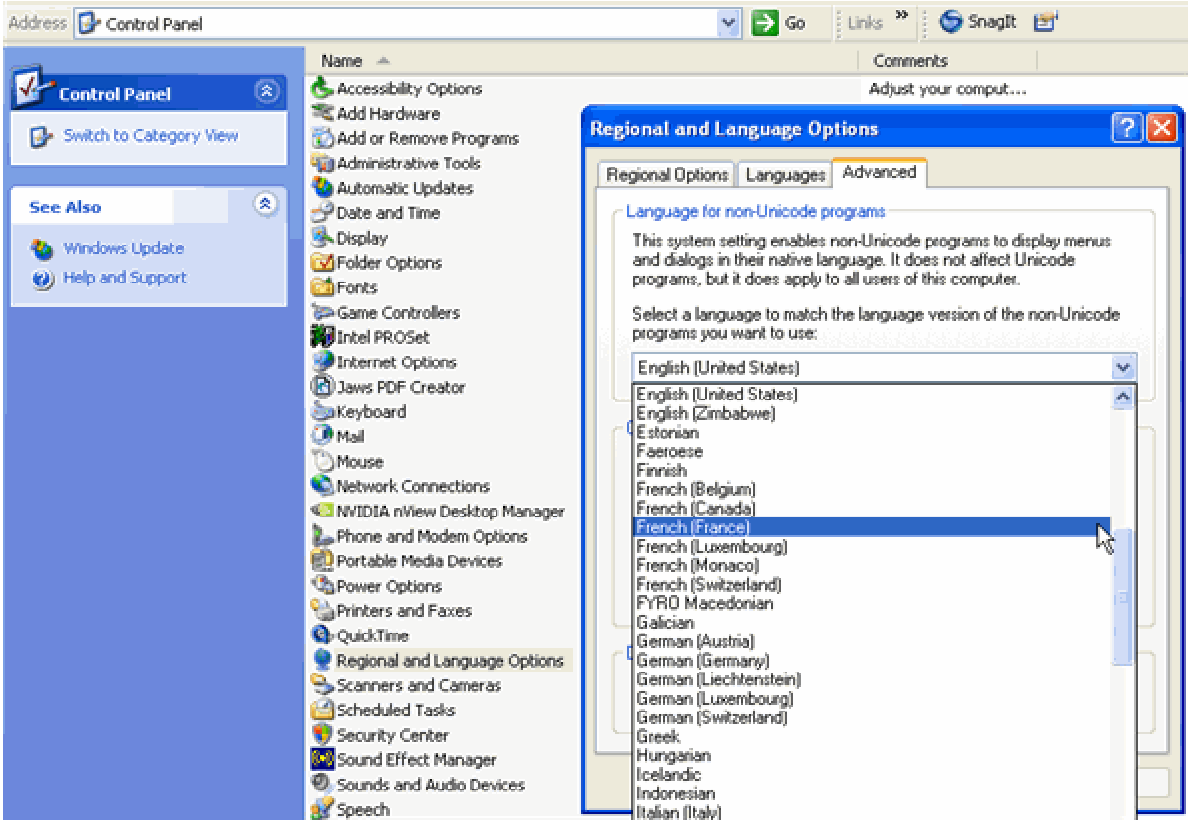
3. In Hardware Configuration:
   - If your PLC supports Multilingual Displays, select that option.
   - Some models automatically support Multilingual displays. In this case, the option is automatically selected and greyed out.



4. If all of the previous conditions have been filled, you can now type text in the desired language. Note that the text is accurately displayed in On-line Test mode and in Remote Access, if the PC regional settings are set to that language.



Note that you may have to set the non-Unicode display language in Windows Regional and Language Options> Advanced tab.



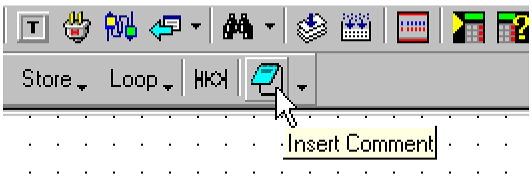
Comments Tool

You can insert comments into the Ladder Editor to label different parts of your program. Comments can be written in Notepad and added later to the project using **Cut** and **Paste** functions.

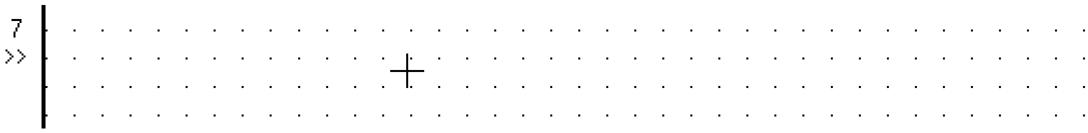
These Comments are 'internal' comments for the programmer(s). The Comments are not downloaded to or displayed on the controller.

To insert comments:

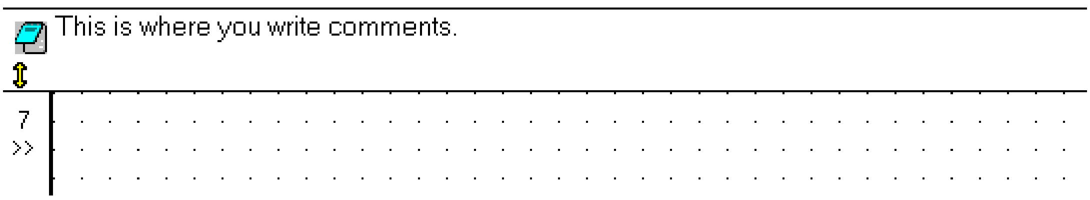
1. On the Ladder toolbar, click **Insert Comment** icon .



2. Move your cursor to the net in which you wish to insert a comment and click.



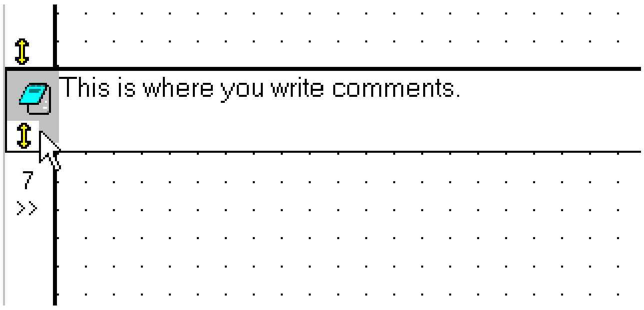
3. The Comment will appear above the net.
4. Type in your comments.



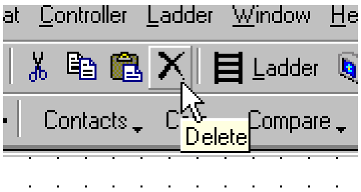
Deleting Comments

To delete a single Comment

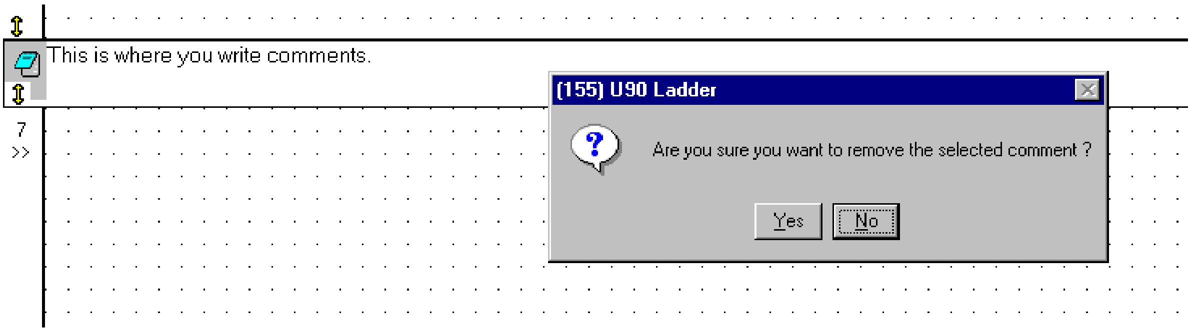
1. Select the Comment you want to delete.



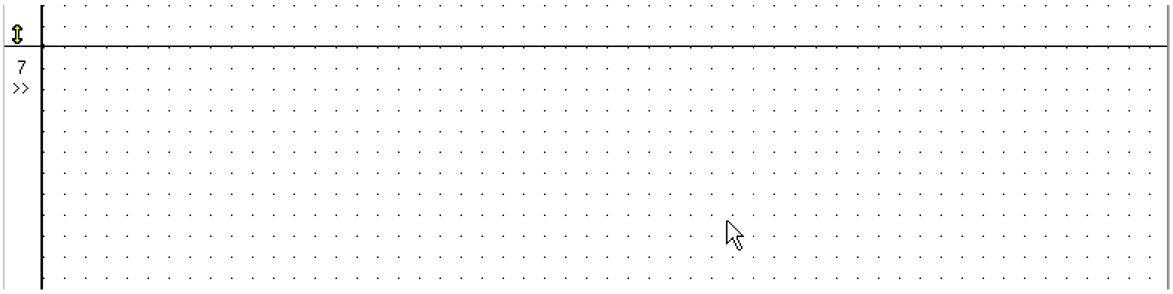
2. Click Delete on the Standard toolbar.



3. A dialog box prompts you to confirm your choice.



4. The net now appears without the Comment.



To delete all Comments

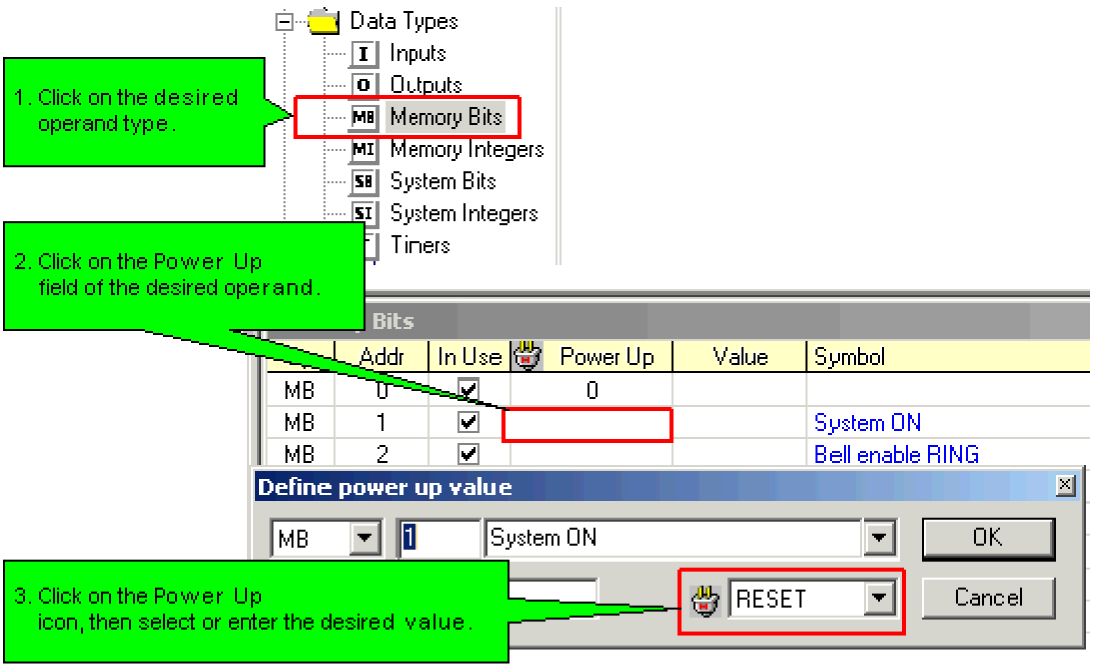
You can delete program comments by selecting Delete Comments from the Edit menu. During the same programming session, you can click Undo to restore comments; please note that up to 10 Undo actions are supported.

Power-up

You can assign Power Up values to most Data Types. These values are written into the operand by the program when the controller is turned on. Outputs, MBs, SBs can be set or reset; integer values can be written into MIs and SIs.

You can assign Power Up values when you place an element into a net, or by opening a Data Type list as shown below.

Note • If an operand has been assigned a Power-up value, it is a referenced operand and will not appear in the Unreferenced Operand list.



Hardware Configuration

Use Hardware Configuration to define:

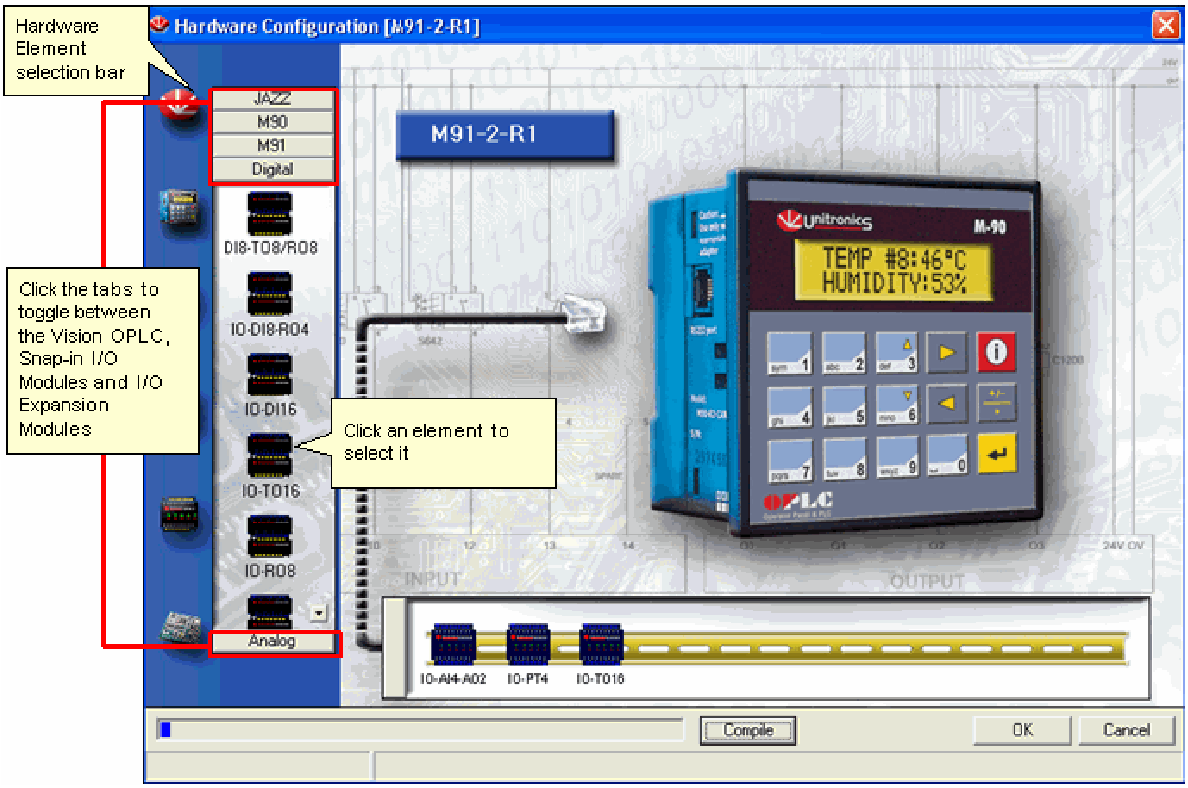
- **The controller model**
  Your selection defines the options available for your current project, such as I/Os and communications options.
- **I/Os**
  You can link operands to I/Os, whether located on-board or on I/O Expansion Modules.

Hardware Configuration opens automatically when you first create a new project. In order to open Hardware Configuration in an existing project, either select Hardware Configuration from the View menu or click the  button on the toolbar.

Click on the appropriate icon to select the controller model and any I/O Expansion modules required by your application.

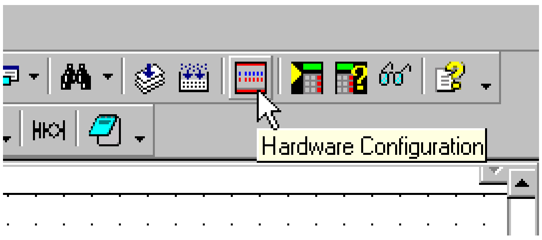
After you select the controller model or I/O Expansion Modules connected to the controller, you can configure I/Os: analog, digital, high-speed counter/shaft-encoder/frequency measurers, PT100; and PWM high-speed outputs.

Note • U90 Ladder will not download a project to a controller unless that model is the one selected in Hardware Configuration.

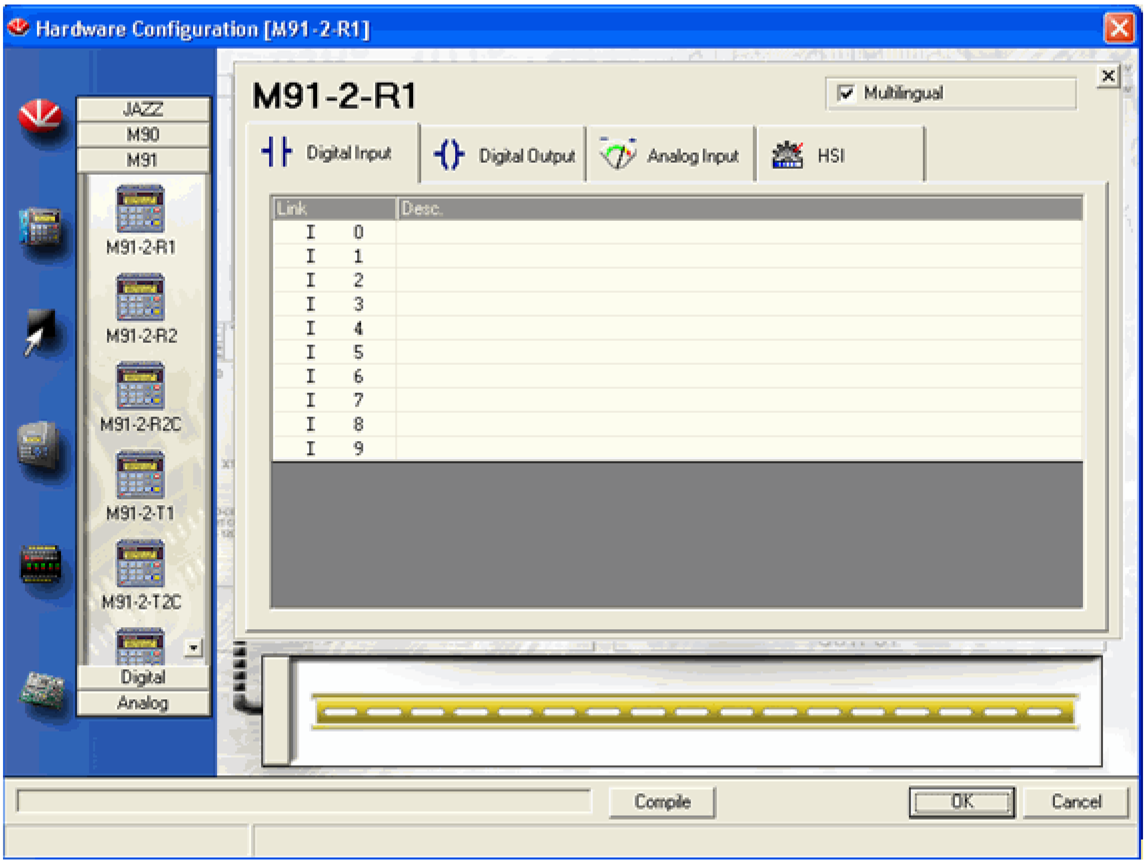


Selecting the Controller Model

1. Click **Hardware Configuration** on the Standard toolbar to open the Hardware Configuration window.



3. Select the appropriate model.
   Hardware Configuration displays the options for that model.



Hardware Configuration is featured in several sample applications, such as the applications ' HSC x 1000', 'HSC saved', 'High-speed Output', 'Motor Speed', and 'Expansion HSC Reset'. These applications may be found by selecting Sample U90 Projects from the Help Menu.

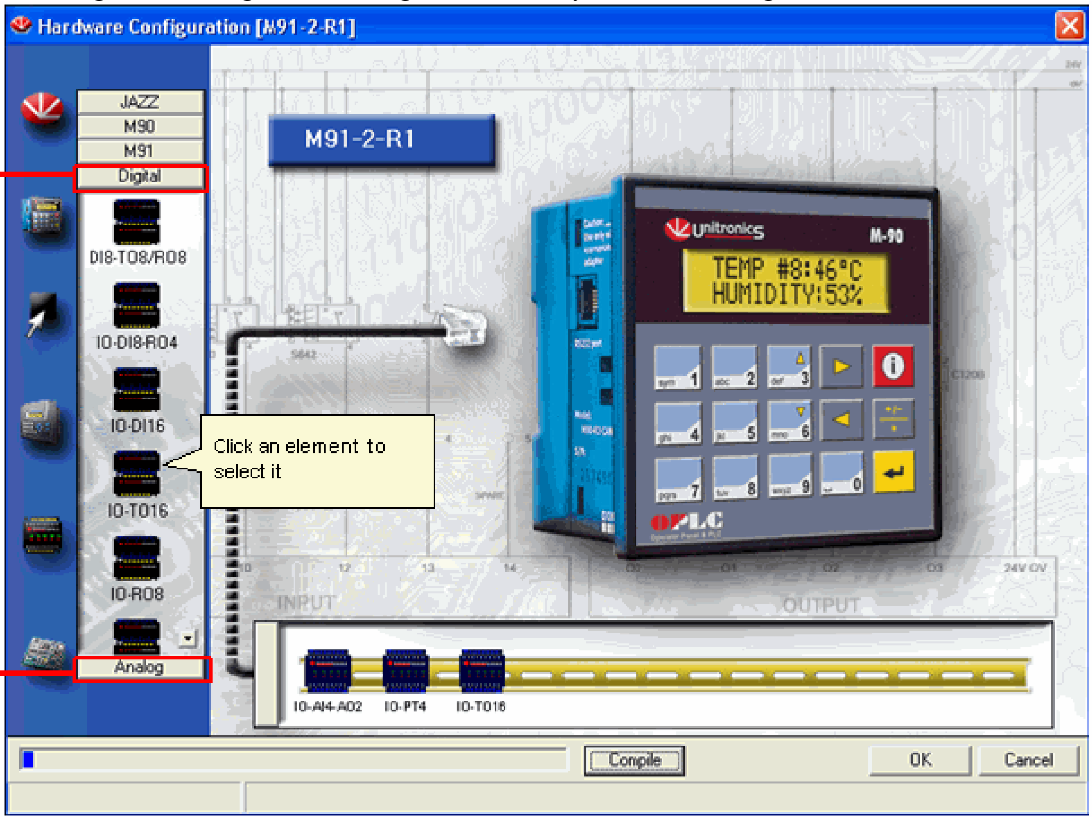
Configuring I/O Expansion Modules

Certain controllers can be hooked up to I/O Expansion Modules. Note that Jazz controllers are not currently compatible with I/O Expansion Modules.

You must configure the controller according to the I/O Expansion Modules you are connecting.

1. Click **Hardware Configuration** on the Standard toolbar.

2.Click on the Digital or Analog tab, according to the module you are connecting.

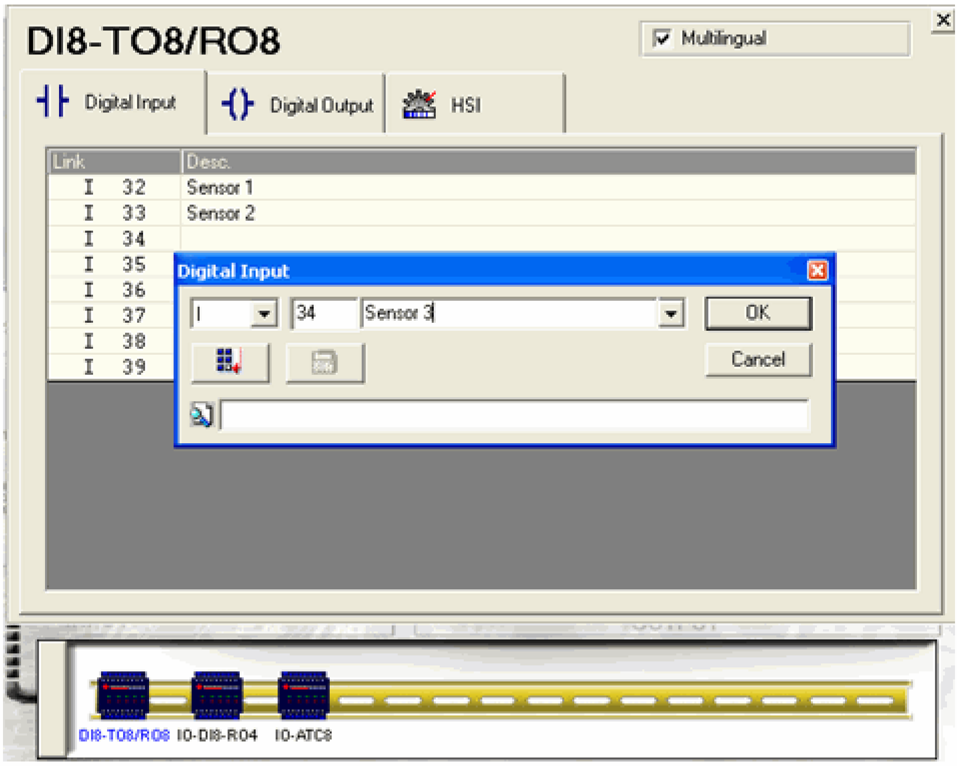


2.Click the appropriate I/O module. The selected module will appear on the Model Expansion bar. You can also drag and drop a module onto the bar.

3.Continue adding I/O expansion modules according to your expansion configuration.

4.Click an I/O expansion icon in the Model Expansion bar. The I/O Details window opens.

5.Click the appropriate Inputs / Outputs to enter the desired descriptions.

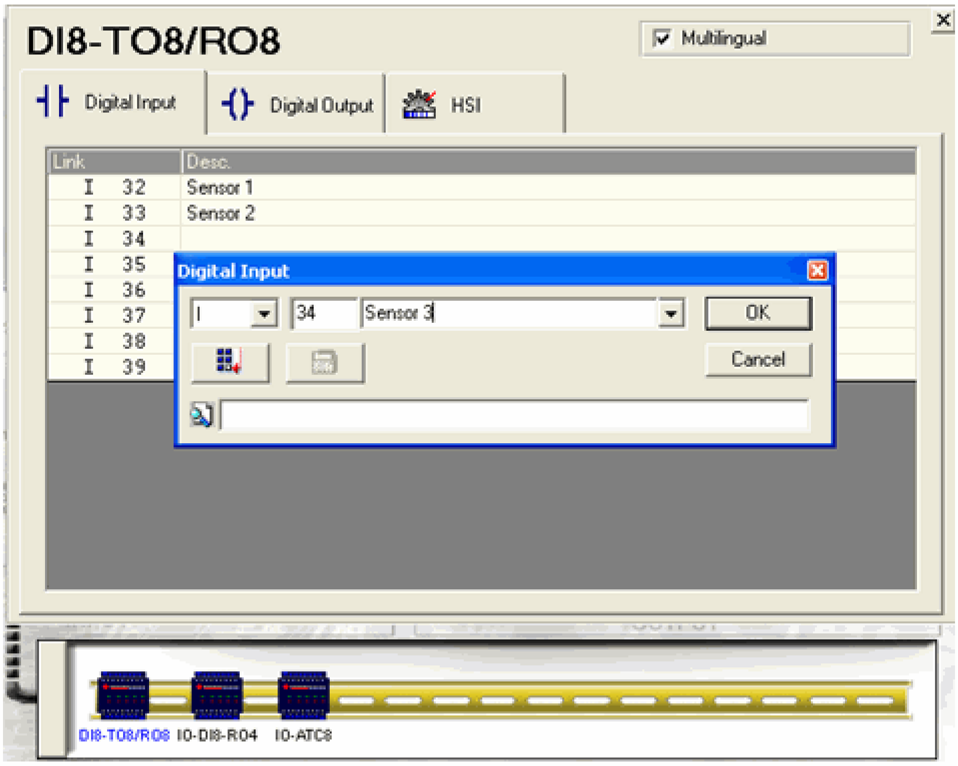


To remove an I/O Expansion Module from the bar, right-click it and select Remove.

Note • If your application does not require that you use all of the I/Os on a particular I/O expansion module, do not select the unused I/Os when you configure the module. Selecting unused I/Os may add to the program's scan time

Configuring I/Os: Linking Operands

1. Double-click an I/O expansion icon in the Model Expansion bar. An I/O Details window opens.



2. Click the appropriate Inputs / Outputs to enter the desired Addresses and Symbols.

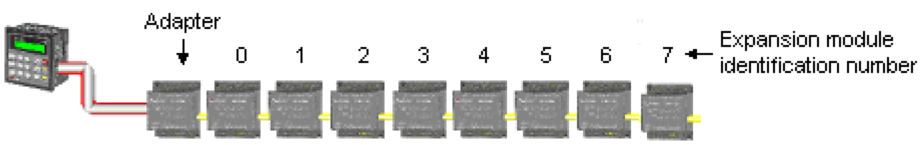
3. The Addresses and Symbols appear in the I/O Details window.

Note: If your application does not require that you use all of the I/Os on a particular I/O Expansion Module, do not select the unused I/Os when you configure the module. Selecting unused I/Os may add to the PLC's scan time.

Addressing: I/O Expansion Modules

Inputs and outputs located on I/O expansion modules that are connected into an M90 OPLC are assigned addresses that comprise a letter and a number. The letter indicates whether the I/O is an input (I) or an output (O). The number indicates the I/O's location in the system. This number relates to both the expansion module's position in the system, and to the position of the I/O on that module.

Expansion modules are numbered from 0-7 as shown in the figure below.



The formula below is used to assign addresses for I/O modules used in conjunction with the M90 OPLC.

X is the number representing a specific module's location (0-7). Y is the number of the input or output on that specific module (0-15).

The number that represents the I/O's location is equal to: **32 + x • 16 + y**

Example

- Input #3, located on expansion module #2 in the system, will be addressed as I 67, 67 = 32 + 2 • 16 + 3
- Output #4, located on expansion module #3 in the system, will be addressed as O 84, 84 = 32 + 3 • 16 + 4.

EX90-DI8-RO8 is a stand-alone I/O module. Even if it is the only module in the configuration, the EX90-DI8-RO8 is always assigned the number 7. Its I/Os are addressed accordingly.

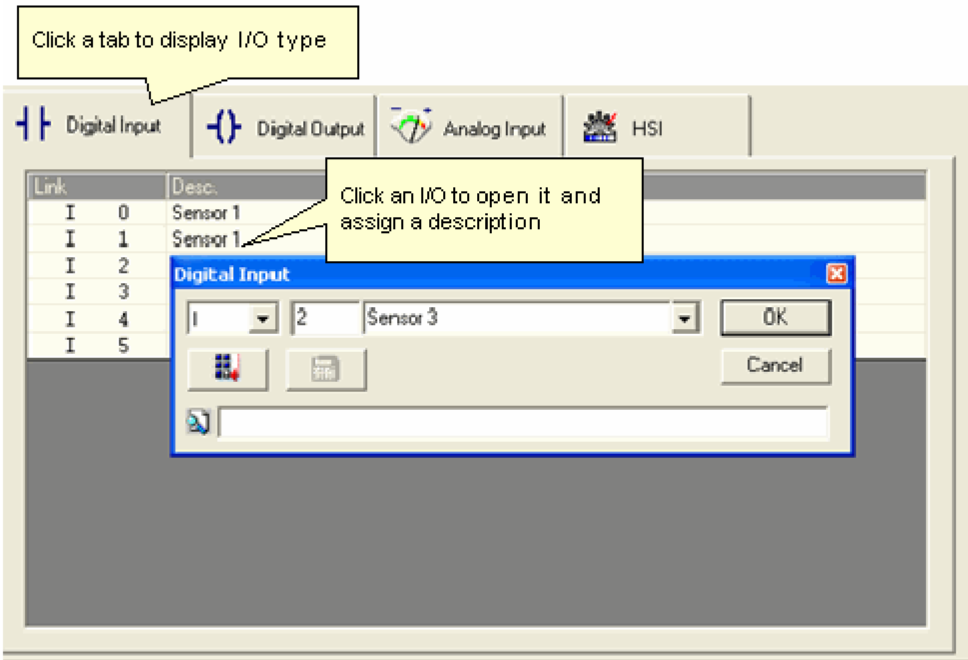
Example

- Input #5, located on an EX90-DI8-RO8 connected to an M90 OPLC will be addressed as I 149, 149 = 32 + 7 • 16 + 5

Configuring Digital I/Os

The process for configuring inputs and outputs is the same, simply make the appropriate selections in Hardware Configuration.

1. If Hardware Configuration is closed, open it and double-click the image of the controller to display the I/O options.
2. Click a tab to select the I/O type.
3. Click an I/O to assign it a description.

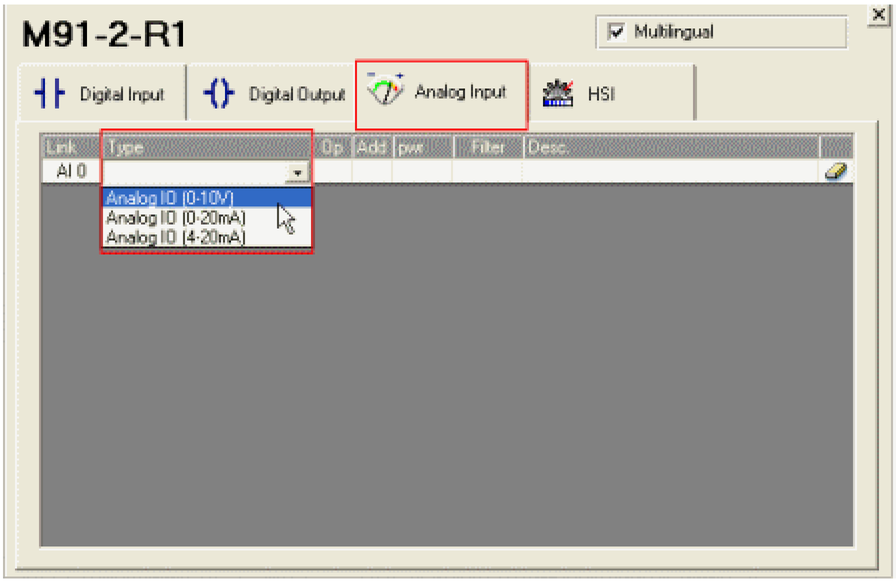


Configuring an Analog Input or Output

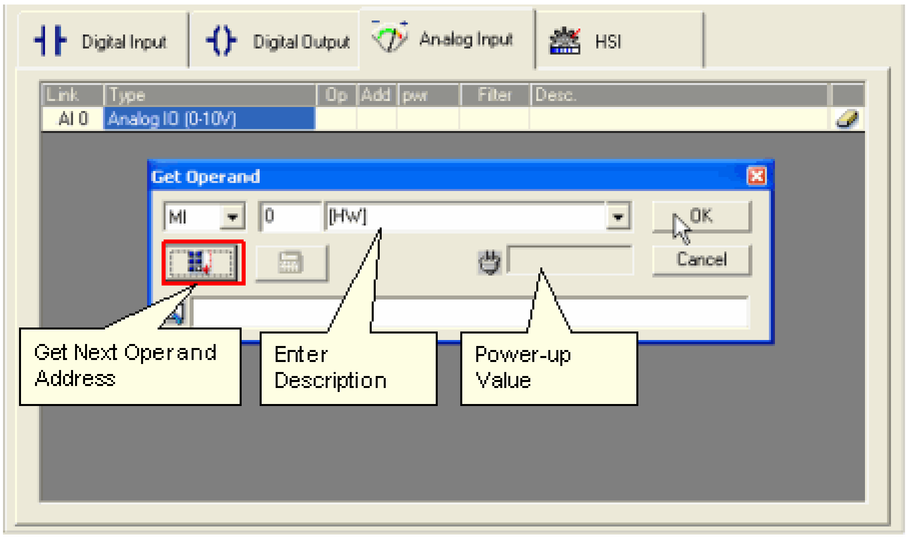
The process for configuring inputs and outputs is the same, simply make the appropriate selections in Hardware Configuration.

To attach an Analog Input to an MI:

1. In **Hardware Configuration**, click the controller to display its options, and then click the Analog tab.
2. Click the **Type** field, then select the desired type of input. The **Get Operand box** opens.



4. Enter the desired operand address and a description for the operand. You can either type in an address, or click **Get Next Operand Address**. You can also assign an operand Power-up value.



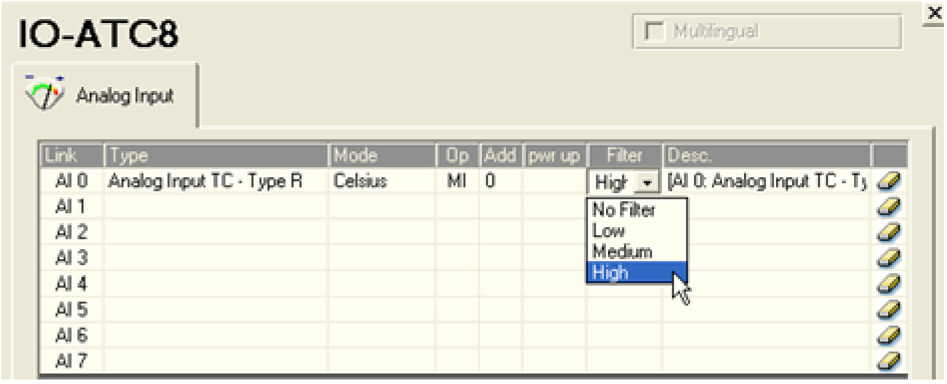
7. The Analog Input is now part of the configuration.

Filters

Analog filter options, defined in Hardware Configuration, are available in certain controller models and I/O expansion models that offer analog inputs, such as the IO-ATC8. Note that 10-bit inputs do not offer filters.

Using a filter can help protect your system from fluctuating input readings. The filter processes values on a FIFO (First In First Out) basis. The filtering process is run after each new analog reading.

The Filter field, shown below, is activated after you define the analog input.



Filter Types	
Low	Calculates the average of the last two readings
Medium	Takes the last 4 readings, eliminates the lowest and highest values, then calculates the average of the 2 remaining values.
High	Takes the last 8 readings, eliminates the two lowest and the tow highest values, then calculates the average of the 4 remaining values.

Notes • Details regarding an I/O's specific resolution, conversion methods, and rates are given in the technical specifications supplied with Unitronics' controllers and I/O modules.

Analog I/O Ranges

Note that devices used in conjunction with Unitronics controllers must be calibrated according to the available range. Below, Range refers to the value contained by the register that is linked to the I/O in Hardware Configuration.

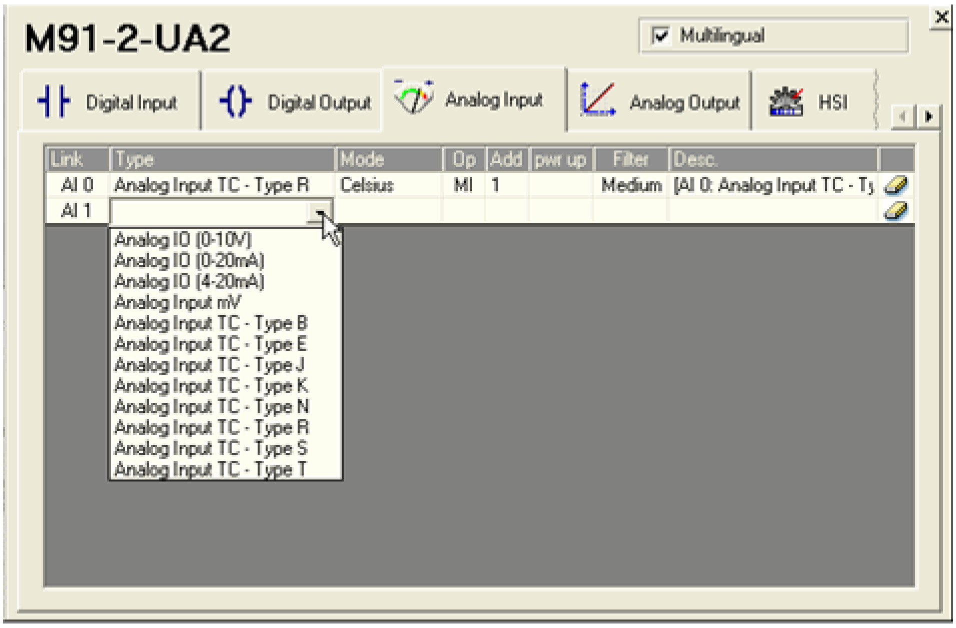
Analog output values are contained in the register that you link to the output in Hardware Configuration.

Model number	**Resolution**	**Range**
V200-18-E1 (Snap-in I/O module) V120-12-R1, V120-12-R2C M90 controllers (analog input) M91-19-R1, M91-19-R2, R2C	10 bit (0-10V, 0-20mA, 4-20mA)	0-1023, 1024 units (except at 4-20mA) 204 to 1024, 820 units (at 4-20mA)
V120-12-UN2 M90-19-UN2 M91-19-TC2	14 bit (0-10V, 4-20mA) Temperature ranges appear in the following table	0-16383, 16384 units (except at 4-20mA) 3277-16383, 13107 units (at 4-20mA)
IO-AI4-AO2 *Input*	12 bit (0-10V, 0-20mA, 4-20mA)	0-4095, 4096 units (except at4-20mA) 819 to 4095, 3277 units (at 4-20mA)
Output	12 bit +sign (±10V, 0-20mA, 4-20mA)	0-±4095(except at4-20mA) 819 to 4095, 3277 units (at 4-20mA)

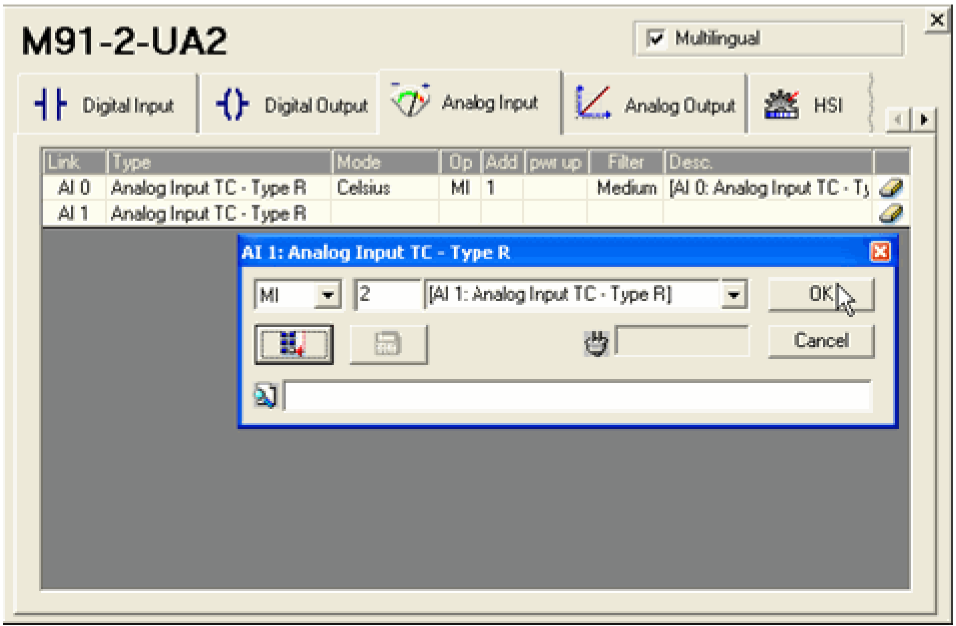
Model number	Type	Input ranges	Range
V120-12-UN2	mV	-5 to 56mV	-50 to 506°C
M90-19-UN2	B	200 to 1820°C (300 to 3276°F)	2000 to 18200°C (3000 to 32760°F)
M91-19-TC2	E	-200 to 750°C (-328 to 1382°F)	-2000 to 7500°C (-3280 to 13820°F)
	J	-200 to 760°C (-328 to 1400°F)	-2000 to 7600°C (-3280 to 14000°F)
	K	-200 to 1250°C (-328 to 2282°F)	-2000 to 12500°C (-3280 to 22820°F)
	N	-200 to 1300°C (-328 to 2372°F)	-2000 to 13000°C (-3280 to 23720°F)
	R	-0 to 1768°C (-32 to 3214°F)	-0 to 17680°C (-32 to 32140F)
	S	-0 to 1768°C (-32 to 3214°F)	-0 to 17680°C (-32 to 32140°F)
	T	-200 to 400°C (-328 to 752°F)	-200 to 4000°C (-3280 to 7520°F
IO-PT4		-50° to 460°C	-500° to 4600°C

Configuring a Thermocouple: M91 OPLC series

1. Click **Hardware Configuration** on the Standard toolbar.
2. Click the M91 tab on the left-hand bar.
3. Click the appropriate M91 model to select it and display the model's I/O options.
4. Click the Analog Inputs tab.
5. Click the Type field, then select the desired type of input. The **Select Operand and Address** box opens.



6. Enter the desired address and a description for the register.



7. The thermocouple is now part of the configuration.

High-Speed Counters (HSC), Shaft Encoders, Frequency Measurer

Different controller models offer high-speed counter functions of the following types:

- **Shaft encoder, at resolutions x2 and x4**

  Selecting the shaft encoder function enables the counter to count both up (-3, -2, -1, 0, 1, 2, 3, …) and down (3, 2, 1, 0, -1, -2,-3 …). Note that the input requires you to use pnp-type shaft encoders.

- **High-speed counter**

  If you select the high-speed counter function that does not include Reset, note that you must reset it within your Ladder program. This type of counter only counts up.

- **High-speed counter + reset**

  If you select the high-speed counter function with reset, the counter is capable of counting up within the positive range, 0-32767. This function uses the next-to-last input as a counter reset. Since the reset is done via the hardware, the reset is immediate and independent of the program scan.

- **Frequency measurement, at 100, 500, and 1000 msec**

  This counts the number of pulses over the selected period of time (sample rate): 100 msec, 500 msec, or 1000 msec (1 second), expressing the result in Hertz. For example, 155 pulses counted over 100 msec is equal to 1550Hz; 155 pulses counted over 500 msec is equal to 310Hz.

Some of the sample programs installed together with U90 Ladder include high-speed counters of different types.

HSC Types & Functions

High-speed counter functions are built into the controller hardware. This is why you do not 'build' a high-speed counter within your Ladder program. Instead, you define it as part of the PLC's hardware configuration by:

1. Selecting the counter type as shown below
2. Linking it to an MI that contains the counter value.

Note that the counter value is an integer with a range of -32768 to +32767. After the counter reaches the maximum value of +3,2767 it will continue to count in the negative range.

The **last** on-board input on an M90 is the actual counter, and is capable of counting 5,000 pulses per second. Note that the high-speed input is a pnp-type input, requiring a nominal voltage of 24V, a minimum of 15V.

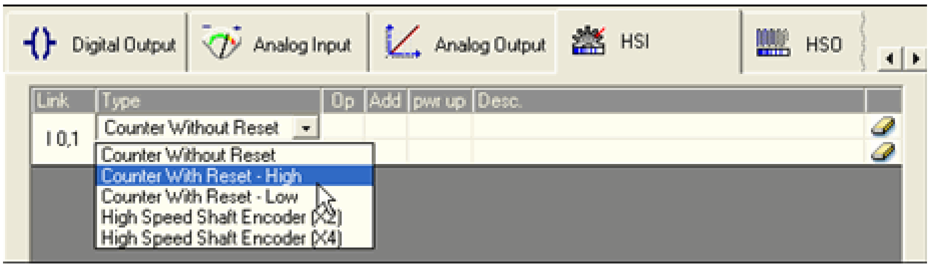
The next-to-last input also serves a purpose in certain high-speed counter functions:

- Shaft encoder function: the next-to-last input serves to indicate the direction of the encoder.
- High-speed counter + reset function: the next-to-last input serves to reset the counter.

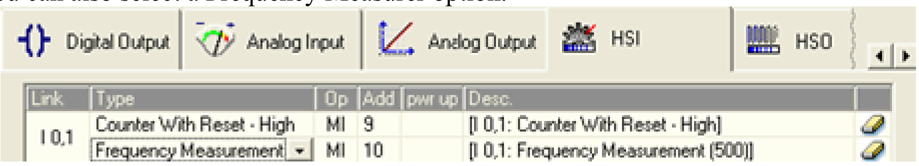
When the next-to-last input is used in a high-speed counter function, it is normally OFF. It remains OFF until it receives a signal; the input then turns ON, stopping and resetting the high-speed counter. The high-speed counter begins counting pulses only after the counter reset turns OFF. Note that SB 10 High Speed Counter Reset Enable must be ON; it is ON by default.

Configuring a High-speed counter

1. Open Hardware Configuration.
2. Click on the icon representing your controller model. The appropriate hardware model window opens.
3. Select a high-speed counter type by clicking the drop-down arrow to display the options, then clicking one.



4. The Select Operand Address box opens. Select an MI to contain the counter value, and then click OK.
5. You can also select a Frequency Measurer option.



This MI contains the counter value which is current at the last program scan. Use this MI in your program like any other MI. You can reset the counter by placing a 0 value into this MI via the Store function. Note that in order to reset the counter, SB 10 High Speed Counter Reset Enable must be turned ON; SB 10 is ON by default.

Compare Functions and Counter Values

It is probable that a counter value will **not** be read at the exact moment that a Compare function in your program is being carried out. This can cause an Equal (=) function to miss the desired counter value; if the counter does not reach the value required by the Equal function at the moment the function is carried out, the Equal function cannot register that the value has been reached. To avoid this problem, use functions Greater Than Or Equal To (≥) and Lesser Than Or Equal To (≤).

High-Speed Output: PWM

You can use certain outputs as High-speed Outputs (HSO) via PWM (Pulse Width Modulation).

- **Duty Cycle**

  The ratio of the "on" period of a cycle to the total cycle period. This value may be from 0-1000, and is expressed as a percentage.

  If, for example, the constant 750 is stored into the Duty Cycle operand, the duty cycle is equal to 75.0% This means that the pulse will hold a positive state during 75.0% of the total cycle.

- **Frequency (F)**

  Note that **F=1/T**, where **T** is the duration time of a complete cycle. Frequency settings differ from npn to pnp output type.
  - npn: You can use a value of 0, or a value from 8-50000Hz (50kHz).
  - pnp: You can use a value of 0, or a value from 8-1500HZ.

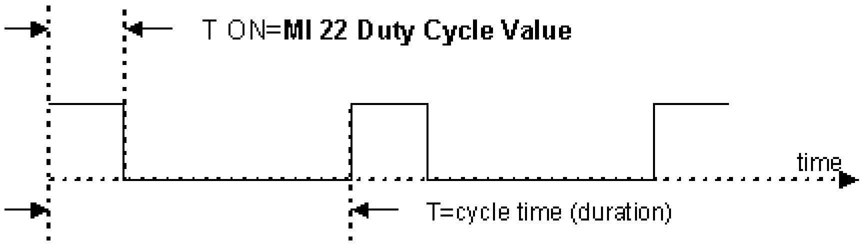
  Other frequency values are not supported.

- **Run**

  Changes the operating mode of the output from normal output mode to HSO mode:

  0 (SET)=Normal Mode, 1 (RESET): HSO Mode.

In the figure below, **MI 22 Duty Cycle Value** is equal to 250. This results in the duty cycle being 25% of the total cycle time.



Note • If values out of range enter the Duty Cycle and Frequency operands, their values remain unchanged—the operands retain the last legal values stored.

M90

M90 OS versions 2.00 (B01) and later enable you to use the last on-board output of M90 models T1 and T1-CAN in either:

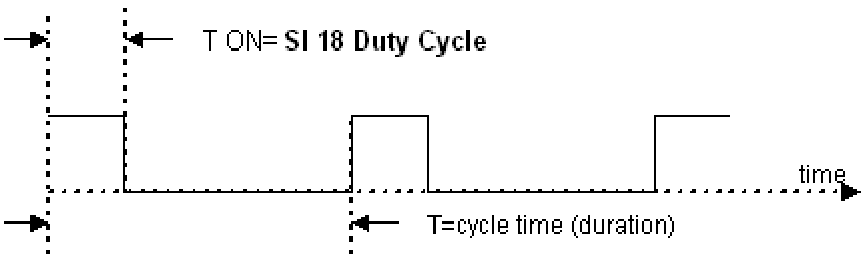
- High Speed Output (HSO) mode
- Normal output mode.

Using HSO mode gives you the ability to use an output as a PWM (Pulse Width Modulation) output. You can also use an output in HSO mode together with stepper motor controllers.

To use HSO mode:

1. Use System Integer SI 16 HSO Mode to change the operating mode of Output 11 from Normal mode to HSO mode: 0=Normal Mode, 1: HSO Mode.
   This should be part of your program's Power-up tasks.
2. Set the output frequency (F) by storing a value into SI 17 HSO Frequency.
3. Set the duty cycle—the ratio of the "on" period of a cycle to the total cycle period—by storing a value into SI 18 Duty Cycle.
4. Use SB 16 HSO RUN to control the output; when SB 16 is ON, Output 11 operates.

In the figure below, SI 18 is equal to 250. This results in the duty cycle being 25% of the total cycle time.

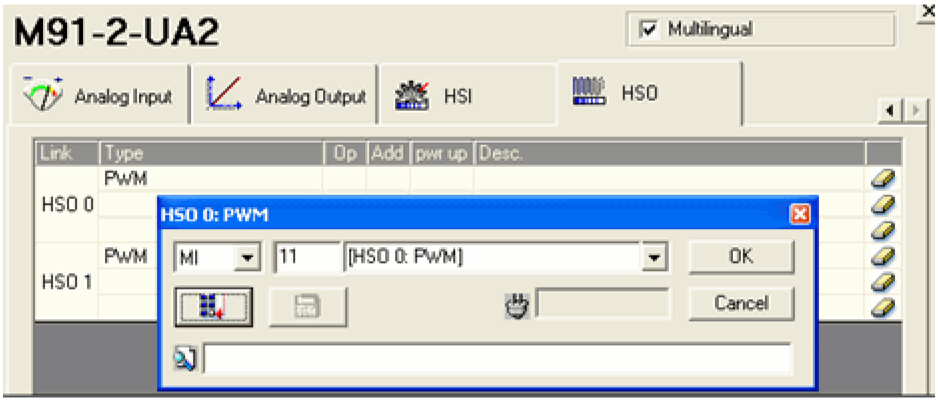


Note that:

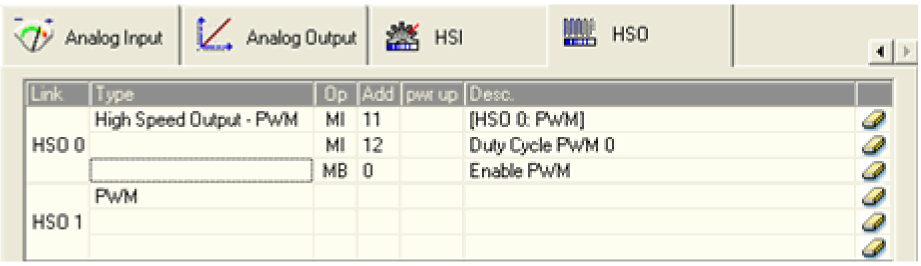
- If you store out-of-range values into SI 17 and SI 18, their values remain unchanged—they retain the last legal values stored.
- Note 2. All parameters except SI 16 may be changed during run-time.

M91

1. Open Hardware Configuration.
2. Click on the icon representing your controller model. The appropriate hardware model window opens.
3. Select the appropriate M91 model to display the model's I/O options.
4. Click on the High Speed Outputs tab, then select High Speed Output (PWM).



5. The Select Operand and Address box will open 3 times, enabling you to link MIs for Common Frequency & Duty Cycle, and MB for Enable Output.



6. The PWM output is now part of the configuration.

Immediate: Read Inputs & HSC, Set/Reset Outputs

You can perform the following immediate actions, without regard to the program scan.

- Set SB 116 to immediately read the status of specific inputs and high-speed counter values. When SB 116 turns ON, the current input value written into linked SBs, current high-speed counter values are written into linked SIs.
- Set the appropriate SBs to immediately clear high-speed counter values.
- Set the appropriate SBs to immediately Set/Reset Outputs.

Note that:

- Values are stored in linked SBs and SIs according to your controller model.
- In the Ladder, inputs and high-speed counters retain the values updated at the beginning of the scan. Only the linked operands listed below are immediately updated. However, immediate changes in output status are immediately updated in the Ladder.

Use the tables below to determine which actions, SBs, and SIs are relevant to your model controller.

M90/91

M90 Model	Input #	Value stored in:	HSC #	Value stored in	HSC #	Immediate Clear	Output #	Set/ Reset via:
M90-T	I 6 I 7	SB 112 SB 113	HSC 0	SI 44	HSC 0	SB 117	None	
M90-T1 **M90-T1-CAN**	I 8 I 9 I 10 I 11	SB 110 SB 111 SB 112 SB 113	HSC 0	SI 44	HSC 0	SB 117	O 8 O 9 O 10 O 11	SB 120 SB 121 SB 122 SB 123
M90-19-B1A **M90-R1** **M90-R1-CAN** **M90-R2-CAN** **M90-TA2-CAN**	I 8 I 9	SB 112 SB 113	HSC 0	SI 44	HSC 0	SB 117	None	
M91-19-TC2 **M91-19-UN2** **M91-2-UN2** **M91-19-T1** **M91-2-T1**	I 0 I 1 I 2 I 3	SB 110 SB 111 SB 112 SB 113	HSC 0 HSC 1	SI 44 SI 45	HSC 0 HSC 1	SB 117 SB 118	O 0 O 1 O 10 O 11	SB 120 SB 121 SB 122 SB 123
M91-19-R1 **M91-2-R1** **M91-19-R2** **M91-19-R2C** **M91-2-R2C**	I 0 I 1 I 2 I 3 I 4 I 5	SB 110 SB 111 SB 112 SB 113 SB 114 SB 115	HSC 0 HSC 1 HSC 2	SI 44 SI 45 SI 46	HSC 0 HSC 1 HSC 2	SB 117 SB 118 SB 119	O 0 O 1 O 2	SB 120 SB 121 SB 122
M91-2-T38	I 0 I 1 I 2 I 3	SB 110 SB 111 SB 114 SB 115	HSC 0 HSC 1	SI 44 SI 46	HSC 0 HSC 1	SB 117 SB 118	O 0 O 1 O 10 O 12 O 13 O 14 O 15	SB[120] SB[121] SB[122] SB[123] SB[124] SB[125] SB[126] SB[127]
M91-19-UA2 **M91-2-UA2**	I 0 I 1	SB 110 SB 111	HSC 0	SI 44	HSC 0	SB 117	O 0 O 1	SB 120 SB 121

M91-19-T2C	I 0	SB 110	HSC 0	SI 44	HSC 0	SB 117	O 0	SB 120
M91-2-T2C	I 1	SB 111	HSC 1	SI 45	HSC 1	SB 118	O 1	SB 121
M91-2-R34	I 2	SB 112	HSC 2	SI 46	HSC 2	SB 119	O 10	SB 122
	I 3	SB 113					O 11	SB 123
	I 4	SB 114						
	I 5	SB 115						
M91-2-R6C	I 0	SB 112	HSC 0	SI 45	HSC 0	SB 117	O 0	SB 120
	I 1	SB 113					O 1	SB 121
							O 2	SB 122

Jazz

Jazz Model	Input #	Value stored in:	HSC #	Value stored in	HSC #	Immediate Clear	Output #	Set/ Reset via:
JZ10-11-R10	I 0	SB 110	HSC 0	SI 44	HSC 0	SB 117	O 0	SB 120
JZ10-11-T10	I 1	SB 111	HSC 1	SI 45	HSC 1	SB 118	O 1	SB 121
	I 2	SB 112					O 2	SB 122
	I 3	SB 113					O 3	SB 123
	I 4	SB 114						
	I 5	SB 115						
JZ10-11-R16	I 0	SB 110	HSC 0	SI 44	HSC 0	SB 117	O 0	SB 120
	I 1	SB 111	HSC 1	SI 45	HSC 1	SB 118	O 1	SB 121
	I 2	SB 112					O 2	SB 122
	I 3	SB 113					O 3	SB 123
	I 4	SB 114					O 4	SB 124
	I 5	SB 115					O 5	SB 125
JZ10-11-T17	I 0	SB 110	HSC 0	SI 44	HSC 0	SB 117	O 0	SB 120
	I 1	SB 111	HSC 1	SI 45	HSC 1	SB 118	O 1	SB 121
	I 2	SB 112					O 2	SB 122
	I 3	SB 113					O 3	SB 123
	I 4	SB 114					O 4	SB 124
	I 5	SB 115					O 5	SB 125
							O 6	SB 126

Analog Input Value--Out Of Range

Expansion modules

If an expansion module's analog input is receiving current or voltage in excess of the absolute maximum rating, the corresponding Out Of Range indicator lights up.

IO-AI4-AO2
Analog value: from 0 to 4095 (12 bit). If the analog input is:

- Below 0V/0mA, then the analog value will be 0.
- Above 10V/20mA (about 2% above the full scale), then the analog value will be 4096.

IO-ATC8
Analog value: from 0 to 16383 (14 bit). If the analog input is:

- Slightly below 0V/0mA (about 0.5% below 0V/0mA), then the analog value will be -1.
- Slightly above 10V/20mA (about 0.5% above the full scale), then the analog value will be 16384.
- If the analog input is greatly below or above of the analog input range, but still within the range of the absolute maximum rating, then the analog value will be 32767.

M90 models

M90-19-B1A, M90-R1, and M90-R2-CAN
Analog value: from 0 to 1023 (10 bit). If the analog input is:

- Below 0V/0mA, the analog value will be 0.
- Above 10V/20mA, the analog value will be 1023.

M91 models

M91-19-R1, M91-19-R2, and M91-19-R2C
Analog value: from 0 to 1023 (10 bit). If the analog input is:

- Below 0V/0mA, then the analog value will be 0.
- Above 10V/20mA (about 2% above the full scale), then the analog value will be 1024.

M91-19-TC2, M91-19-UN2, and M91-19-4UA2
Analog value: from 0 to 16383 (14 bit). If the analog input is:

- Slightly below 0V/0mA (about 0.5% below 0V/0mA), then the analog value will be -1.
- Slightly above 10V/20mA (about 0.5% above the full scale), then the analog value will be 16384.
- Greatly below or above of the analog input range, but still in the range of the absolute maximum rating, then the analog value will be 32767.

Note that the absolute maximum rating of the analog inputs for all the units is +/- 15V.

HMI

Display

What is an HMI?

HMI stands for Human Machine Interface. This is the interface between the operator and the controller.

The HMI is the controller operating panel. The panel comprises a numeric keypad and a LCD screen that displays text.

The keypad is used to input data into the application, such as Timer values.

The PLC's Display screen can show operator messages, variable information from the program and system information.

HMI messages are created in the Display Editor.

Variable information fields are created in the Variable Editor.

HMI applications are featured in several sample applications, such as the applications ' Display Jumps from Ladder', 'Names from List Var', 'Password', 'Special characters on List', 'Display of Events', and '5 Vars on Display'. These applications may be found by selecting Sample U90 Projects from the Help Menu.

What are Displays?

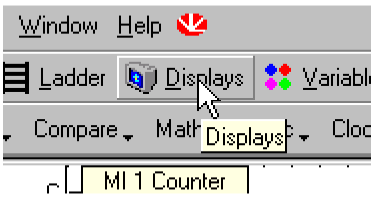
Displays are shown on the controller's LCD screen according to the program conditions you set in your HMI program. Use the Display editor to create the HMI text, define the variable fields & parameters and assign jump conditions.

Note that only the English character set is supported.

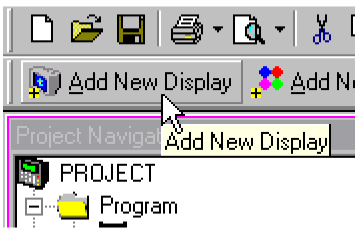
Creating and Naming a Display

To create a Display:

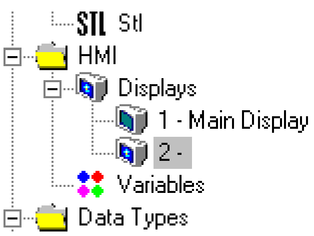
1. Click the Display icon on the Standard toolbar. The Display Editor will open.



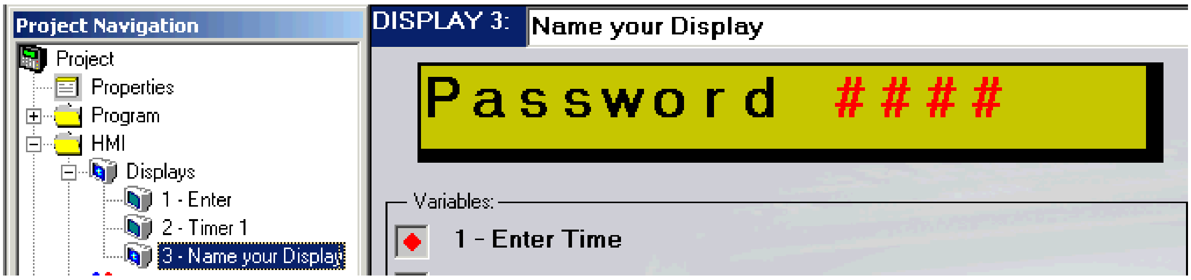
2. Click the Add New Display icon in the HMI toolbar.



3. A new Display is created.



4. Place the cursor in the name field.
5. Type in a name. Press enter.

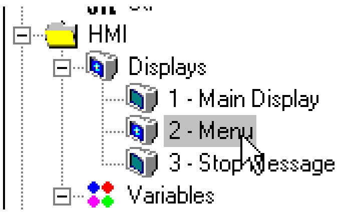


The Display name also appears with the Display number in the Project Navigation Tree.

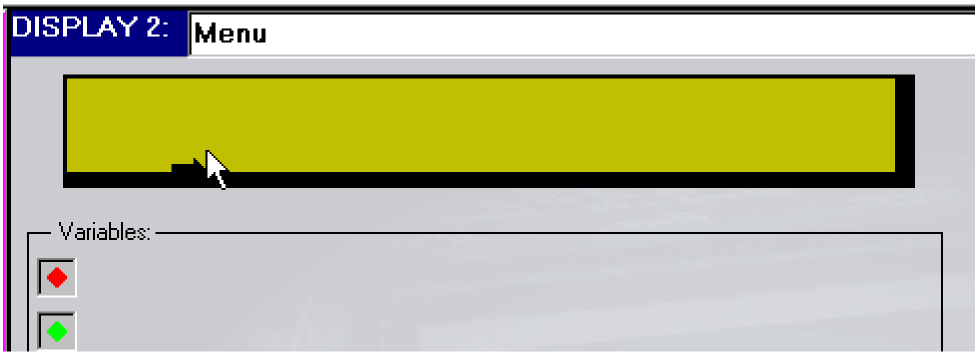
Creating a fixed text Display

To create a fixed text Display:

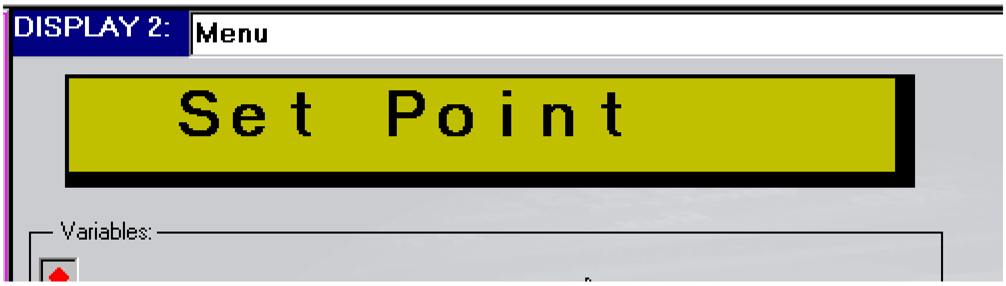
1. Select the desired Display from the Navigator Window.



2. The Display opens in the Display Editor.



3. Type in the fixed text to be displayed.



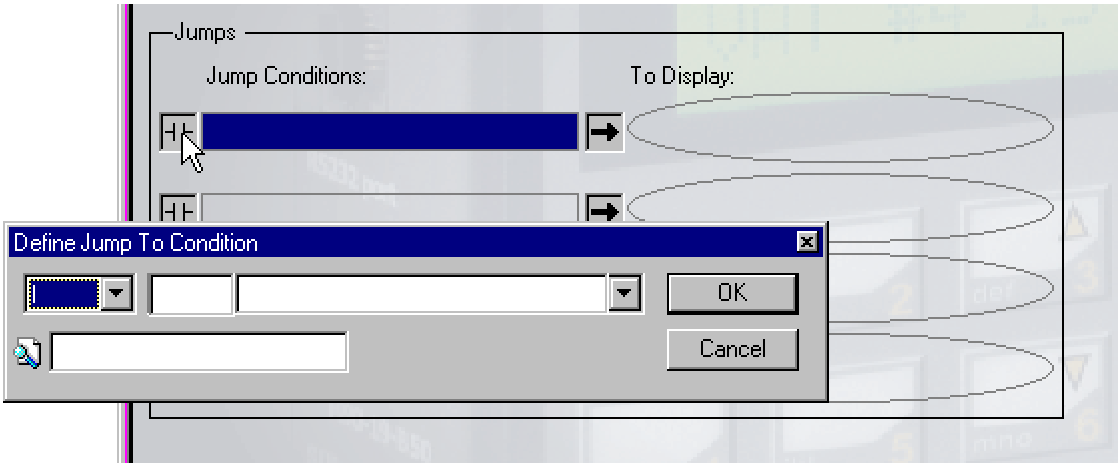
Note that only the English character set is supported.

Jump to Display: scrolling between Displays

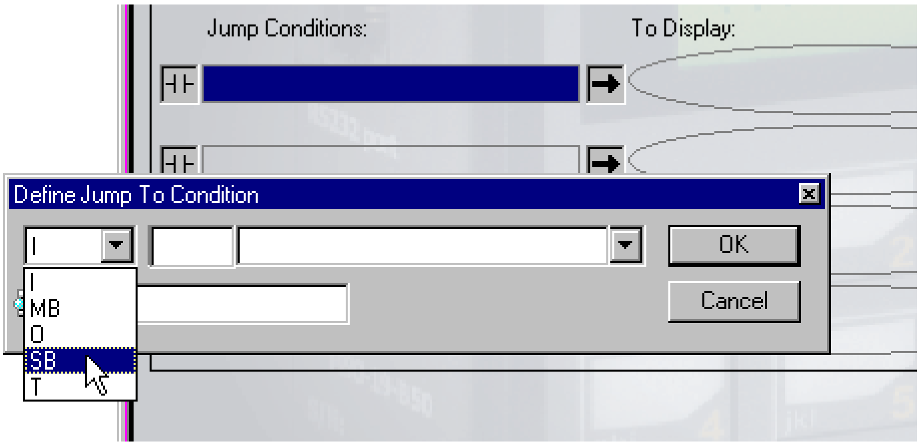
Display Jumps allow you to move between Displays via the keypad or any bit positive transition. You can create up to 4 Jumps for each Display in the Display Editor. If you want to create more than 4 Jumps for a Display, you must create the logic conditions in the Ladder Editor.

To create a jump:

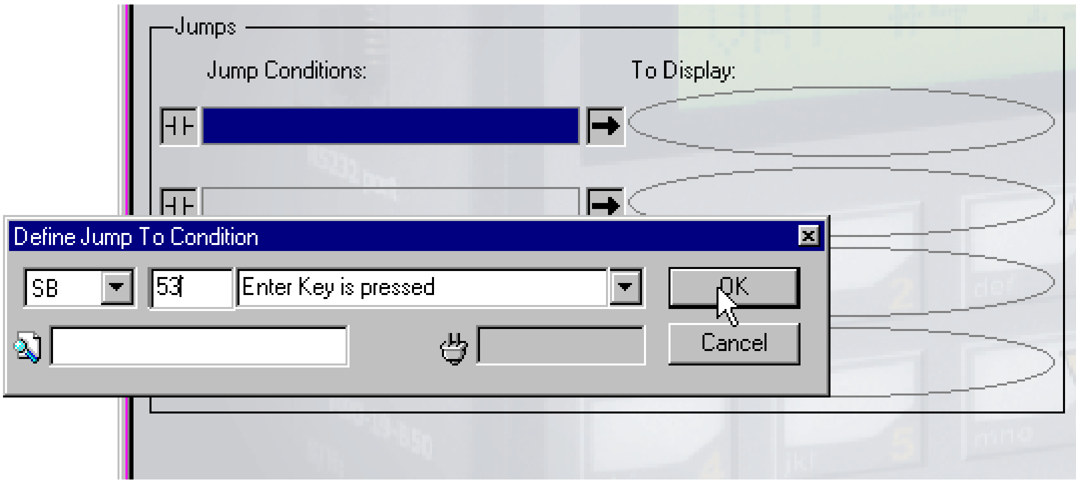
1. Click on a Jump Condition and the Define Jump to Condition dialog box opens.



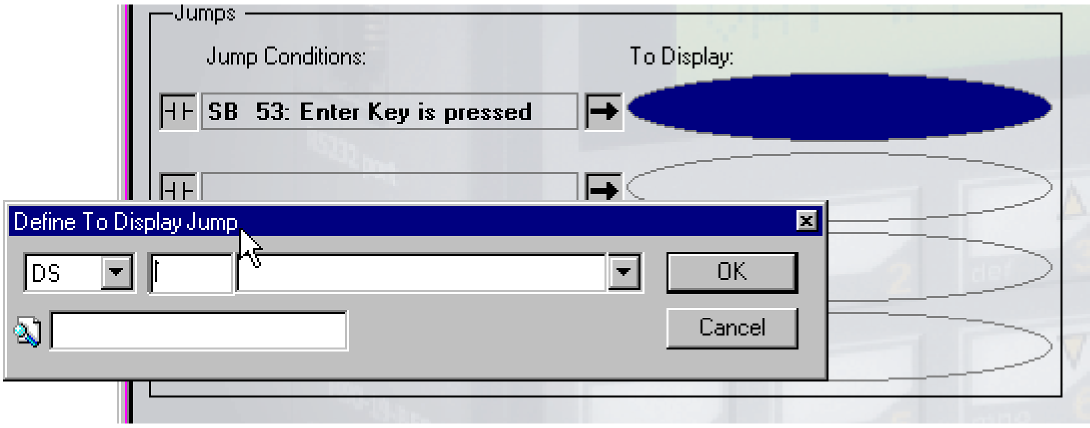
2. Select a Jump Operand from the drop-down menu.



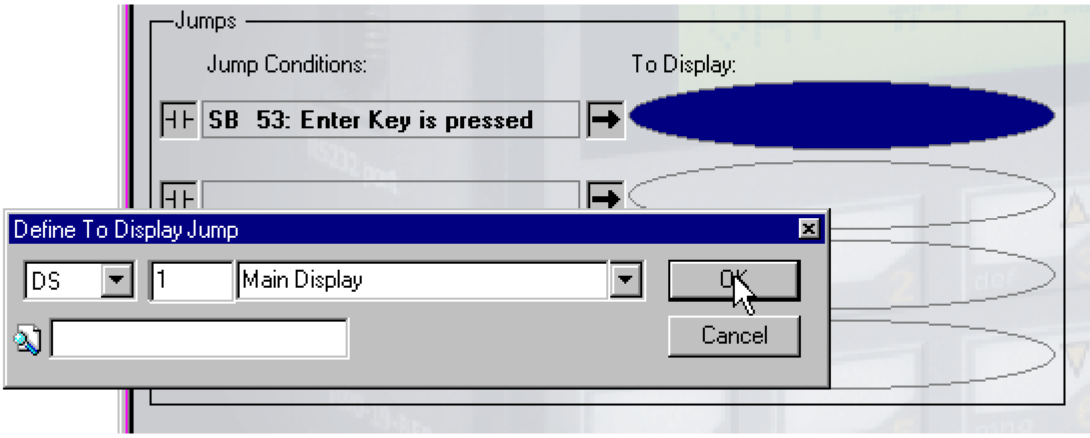
3. Enter the desired Address and symbol for the Jump Operand. Click OK.



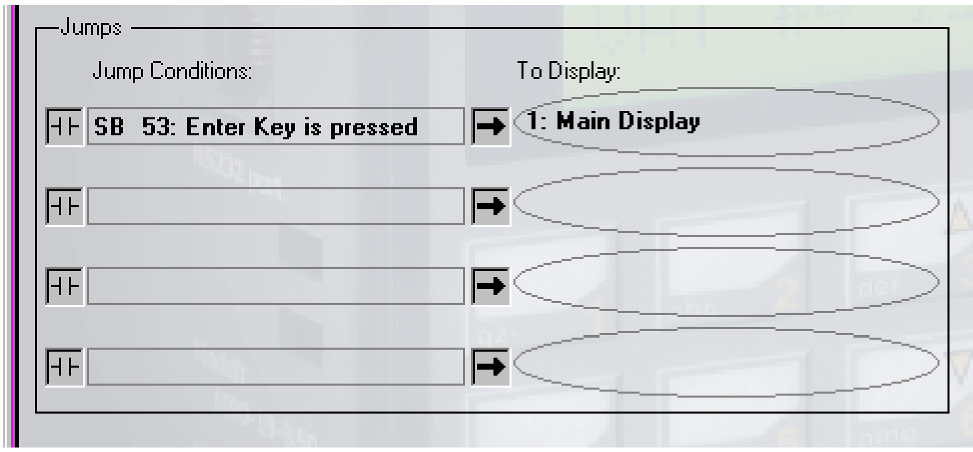
4. The Define To Display Jump dialog box opens.



5. Enter the Display number to which you want to jump. Click OK.



6. The result will be:



Note that Display Jump conditions based on MBs can **only** be linked to MB 0-127; jumps may not be linked to MB 128 -255.

Note When an HMI keypad entry variable is active, and the Enter key is pressed on the controller keypad, SB 30 HMI Keypad Entries Complete turns ON. This can be used as a Jump condition.

In addition , note that a Display may contain a total of 4 variables. Each one has an SB:

- SB 31 HMI Var 1 Keypad entry completed
- SB 32 HMI Var 2 Keypad entry completed
- SB 33 HMI Var 3 Keypad entry completed
- SB 34 HMI Var 4 Keypad entry completed

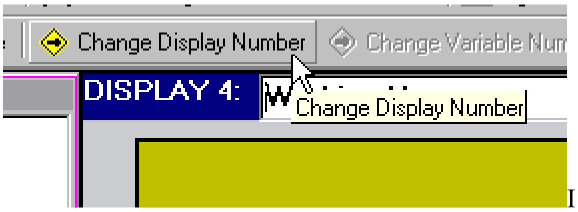
The condition of these SBs may be used as Jump Conditions, or to drive calculations in your program.

Changing a Display number

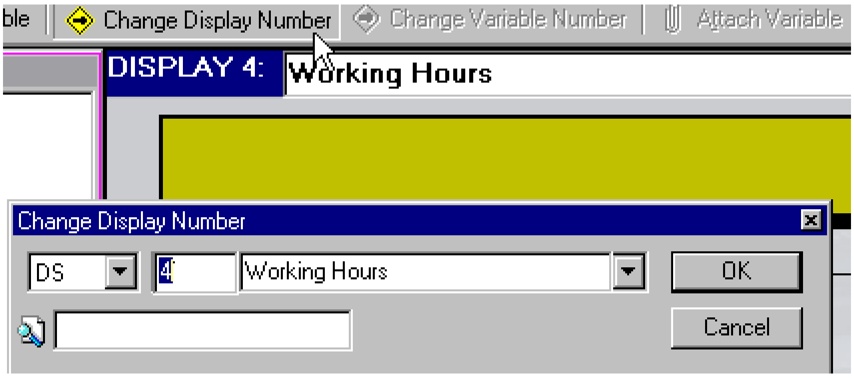
To change a Display number:

In the Display Editor:

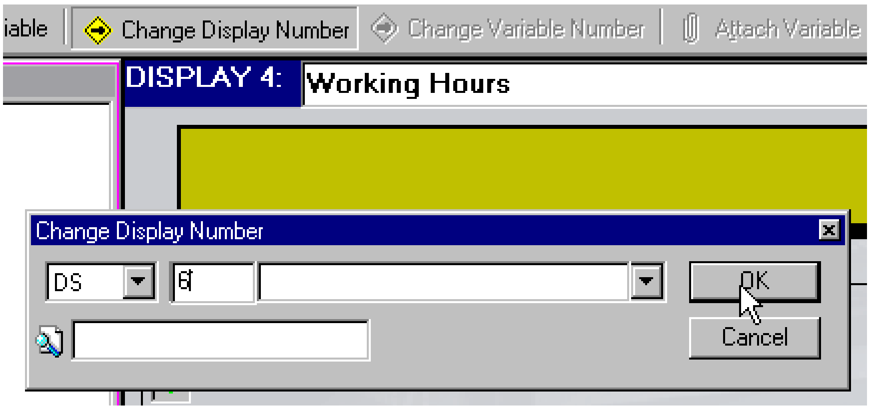
1. On the HMI toolbar, click the Change Display icon.



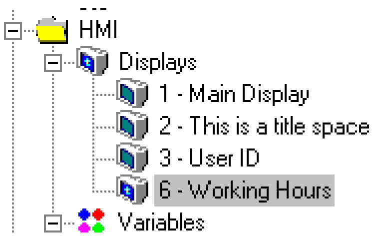
2. The Change Display Number dialog box opens.



3. Enter the new Display number in the Address field. Click OK.



4. The Display number changes. The Display title is unchanged.

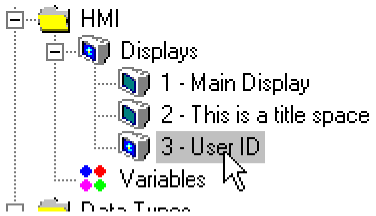


Deleting a Display

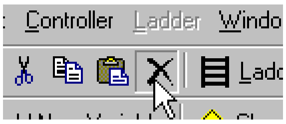
To delete a Display:

In the Display Editor:

1. In the Navigation Window, click on the Display number you want to delete. The Display will open in the Display Editor.



2. On the Standard toolbar, click **Delete**.

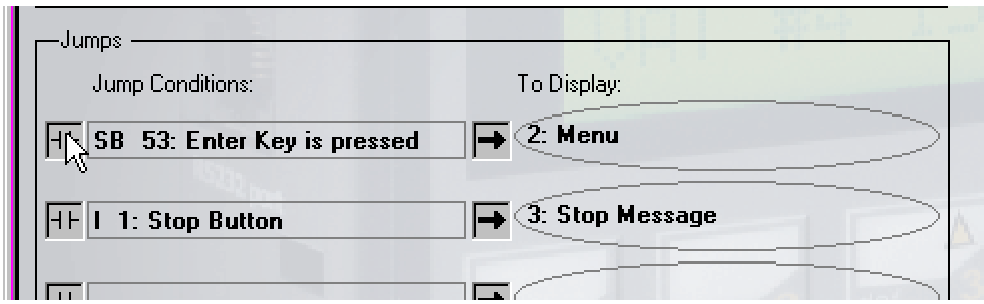


3. The Display is deleted. You see that the Display number disappears from the Navigation Window.

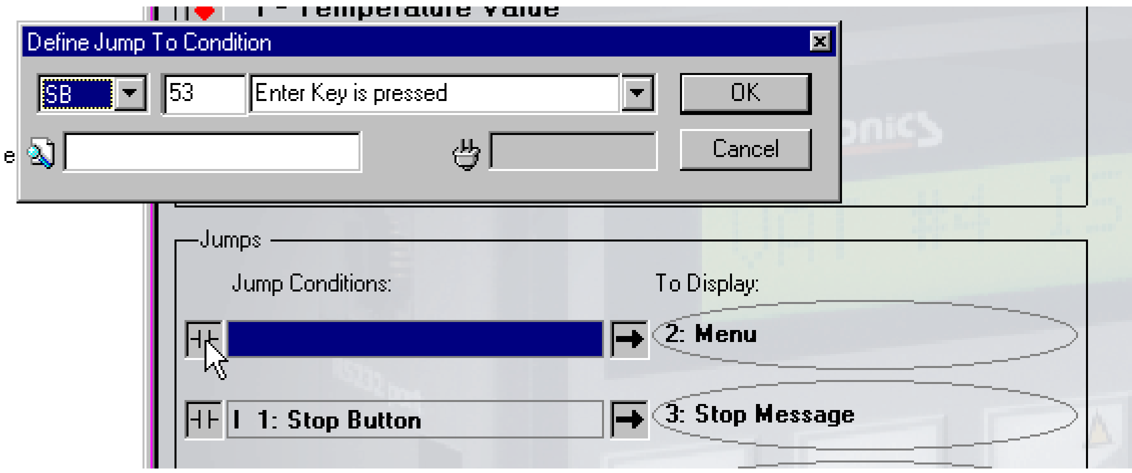
Changing a Jump condition

To change a Jump condition:

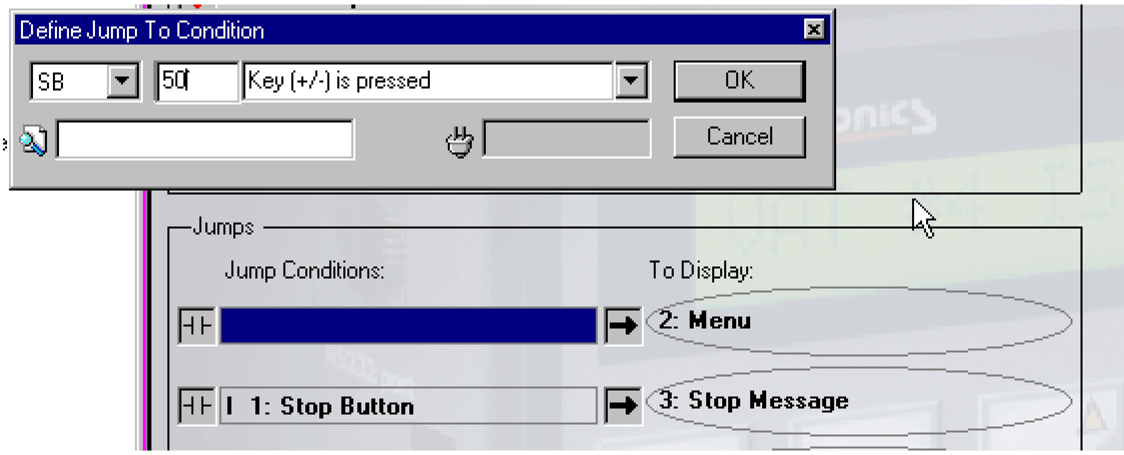
1. Click on the Jump Condition in the desired Display.



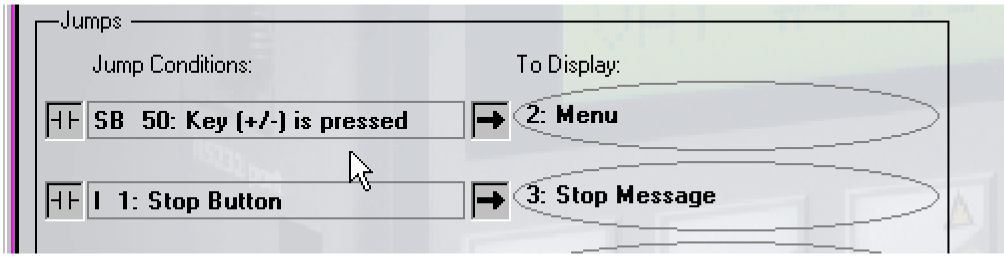
2. The Define Jump to Condition dialog box opens.



3. Make the appropriate changes.



4. The new Jump Condition now appears in the Display Editor.

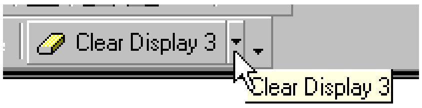


Clearing a Display

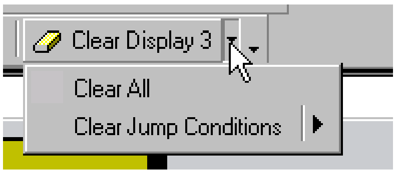
To clear the contents of a Display:

In the Display Editor:

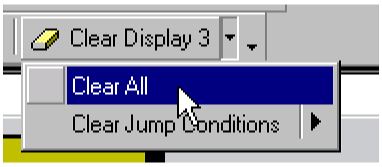
1. On the HMI toolbar, click the Clear Display icon.



2. Open the Clear Display menu. You can clear all Display parameters - or - only Jump conditions



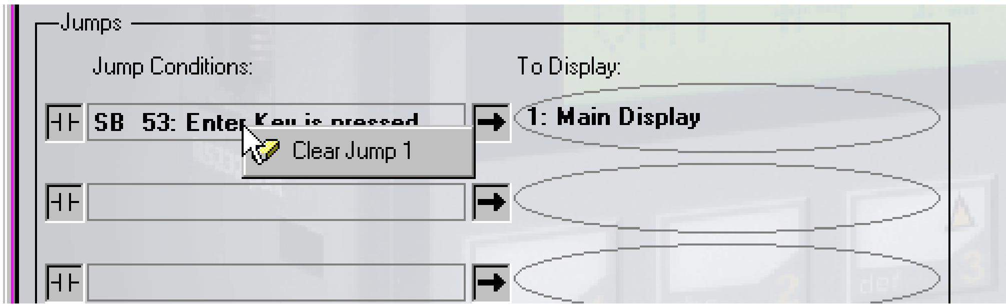
3. Select the parameters you wish to clear.



Clearing Jump conditions

To clear an existing Jump condition:

1. Right click on the Jump.
2. The Clear Jump icon appears.



3. Click the icon to clear the Jump.

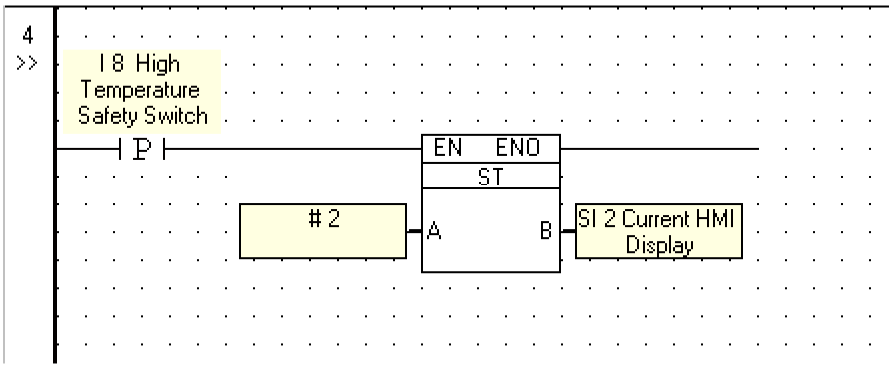
Creating more than four Jumps for a Display

You can create up to 4 Jumps for each Display in the Display Editor. If you want to create more than 4 Jumps for a Display, you must create the logic conditions in the Ladder Editor.

SI 2 contains the Current HMI Display number. You can jump to a specific Display by writing the Display number into SI 2.

Example:

- Writing #5 into SI 2 will cause Display #5 to be displayed on the controller.
- Writing #8 into SI 2 will cause Display #8 to be displayed on the controller.

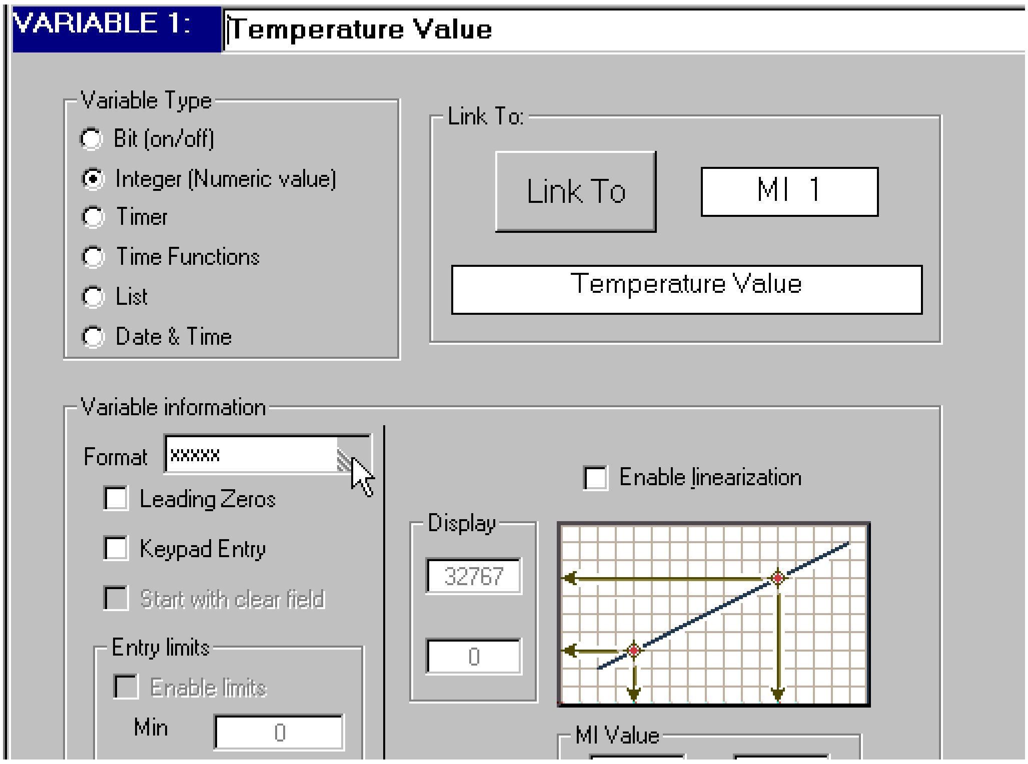


Take care to create the Displays **as well as** the logic conditions.

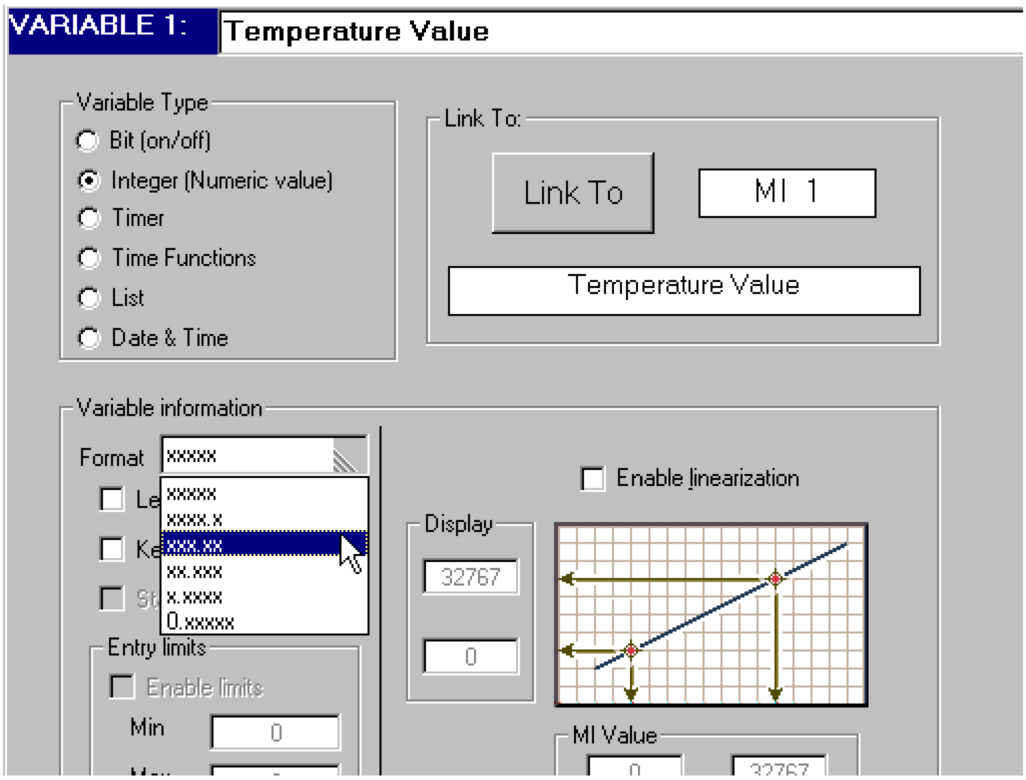
Display Formats for MI and SI Values

To set the display format for a MI or SI value:

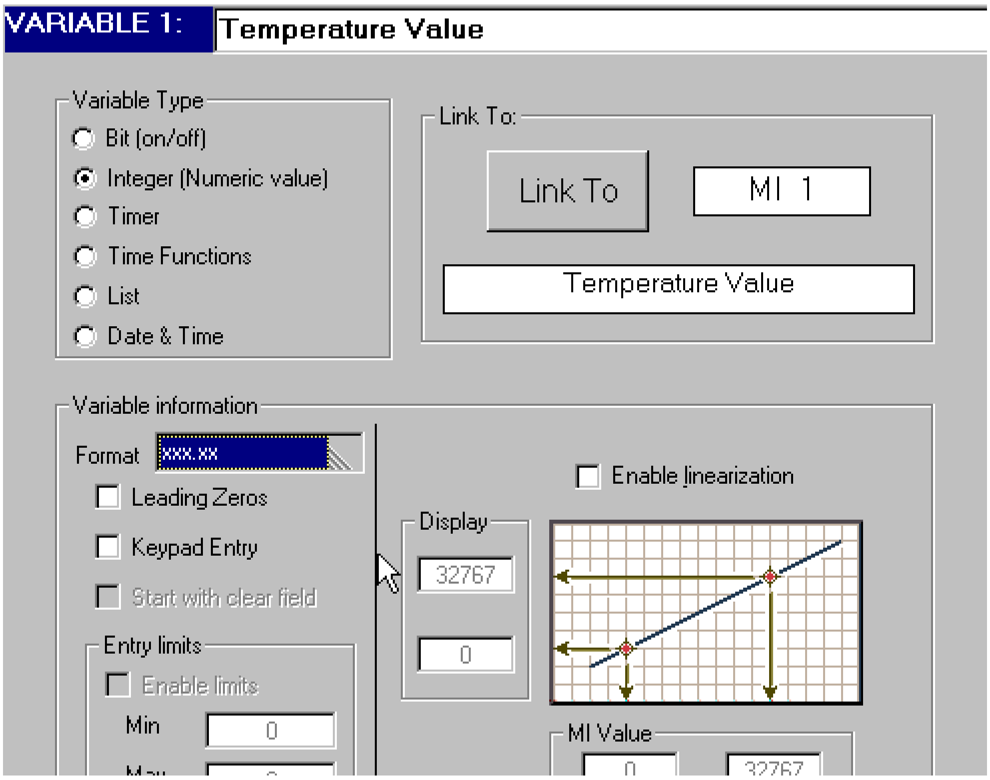
1. Open the Format menu in the Variable information box in the Variable Editor.



2. Select a Variable Format.

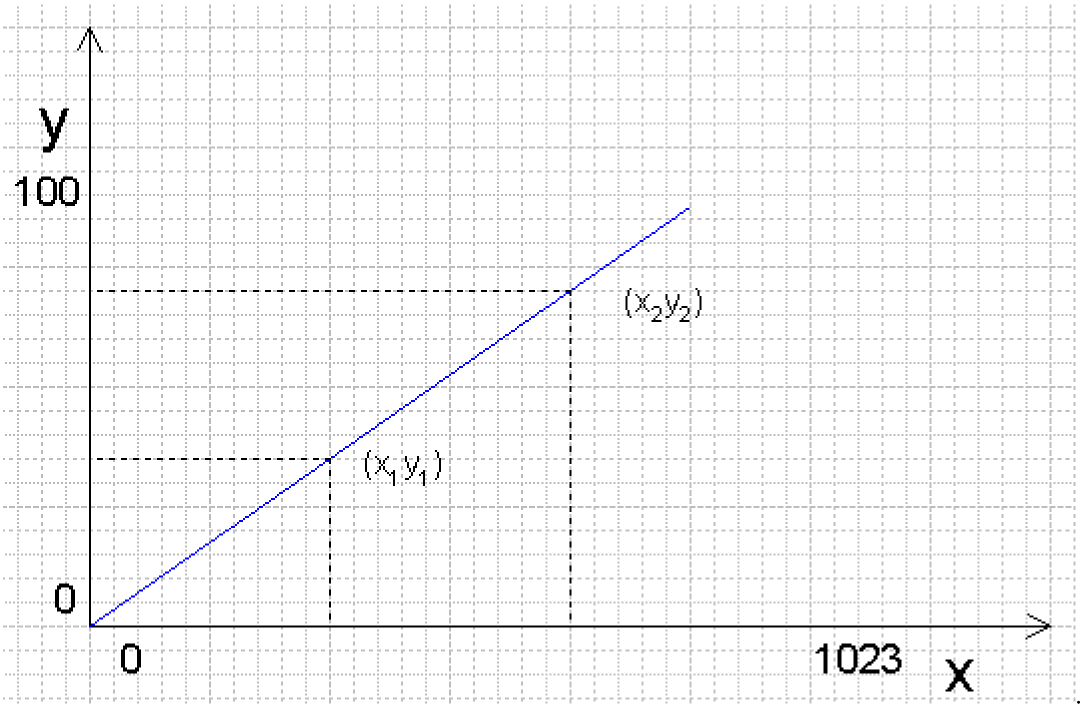


3. The selected format appears in the Format window.



Linearization

Linearization can be used to convert analog values from I/Os into decimal or other integer values. An analog value from a temperature probe, for example can be converted to degrees Celsius and displayed on the controller's display screen.



Linearize values for Display

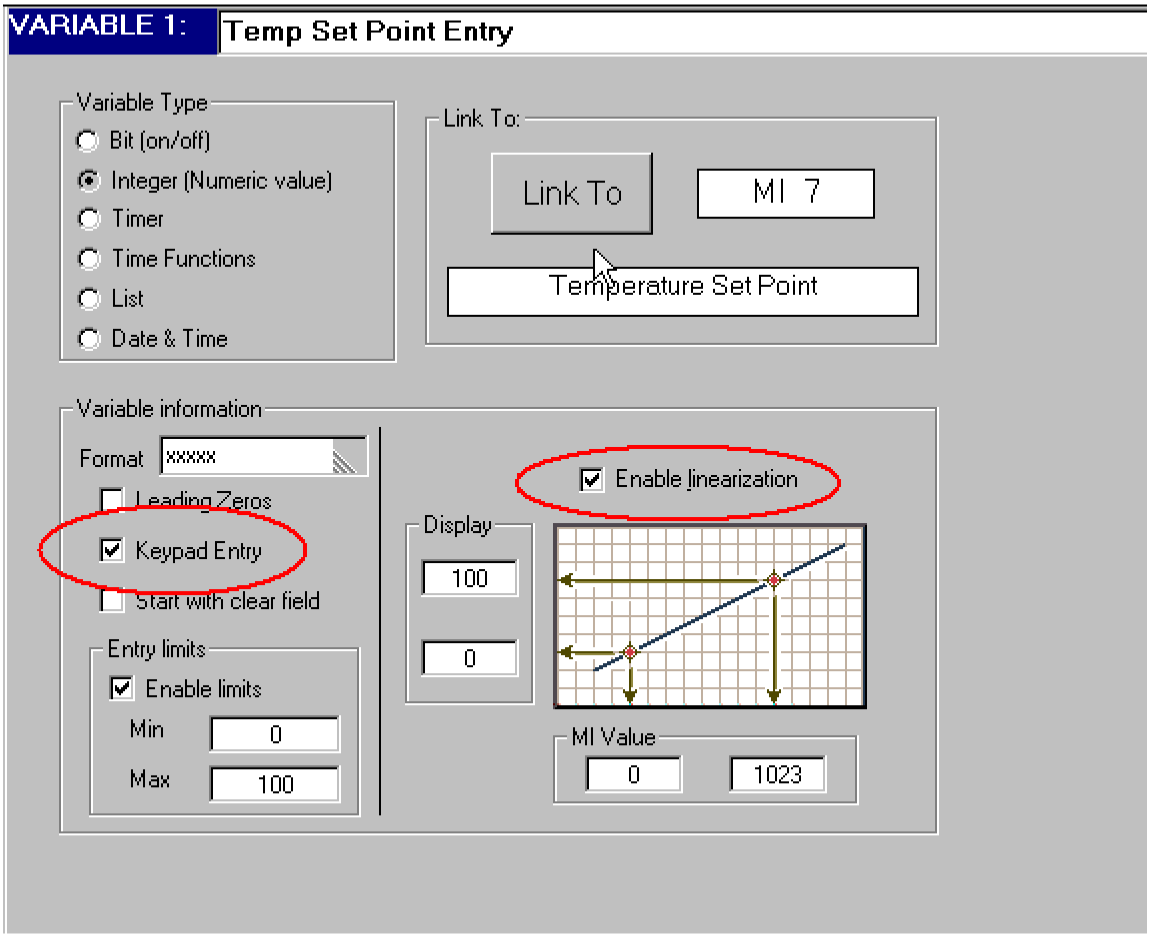
Note that the linearized value created in this way may be displayed-- **but** the value **cannot** be used anywhere else within the project for further calculations or operations.

You can enter an Analog value, such as temperature, via the keypad, then convert that value into a Digital value for comparison with a digital value from a temperature probe by selecting **Enable Linearization** in the linked Variable.

This conversion process is Reverse Linearization.

To enable Analog to Digital conversion:

1. Create a Display for entering the analog value.
2. Create an Integer Variable.
3. Select keypad entry and enable linearization.
4. Enter the linearization values for the x and y axes.



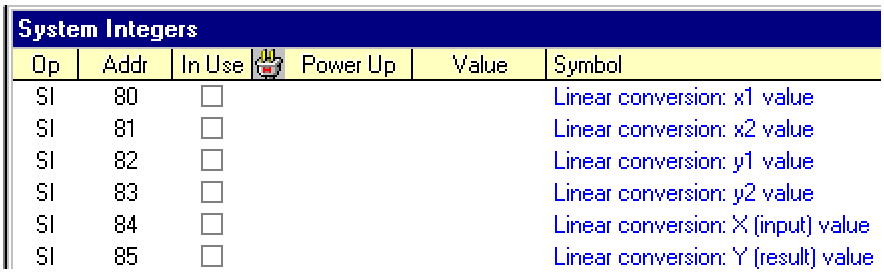
According to the above example:

- A temperature entry of 100^0 C will be converted to 1023 Digital value.
- A temperature entry of 50^0 C will be converted to 512 Digital value.

Linearize values in the Ladder

You can also linearize values in your Ladder and display them on the LCD.

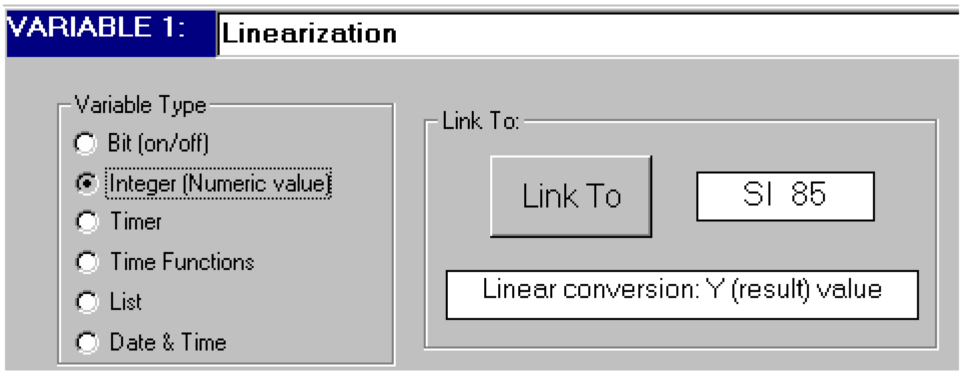
1. In your Ladder project, use SI 80 - 85 to set the (x,y) variable ranges. Use SB 80 to activate the **Linearization** function.



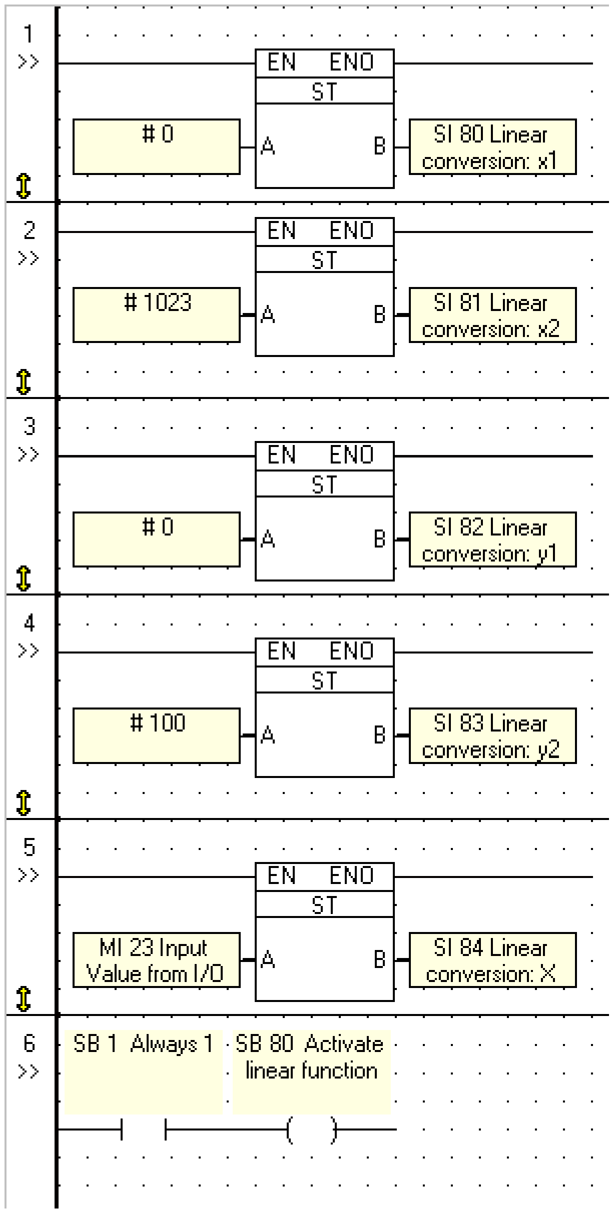
System Integers

Op	Addr	In Use	Power Up	Value	Symbol
SI	80	☐			Linear conversion: x1 value
SI	81	☐			Linear conversion: x2 value
SI	82	☐			Linear conversion: y1 value
SI	83	☐			Linear conversion: y2 value
SI	84	☐			Linear conversion: X (input) value
SI	85	☐			Linear conversion: Y (result) value

The linearization values created here can be displayed by linking SI 85 to a Display;the value **can** be used elsewhere within the project for further calculations or operations.



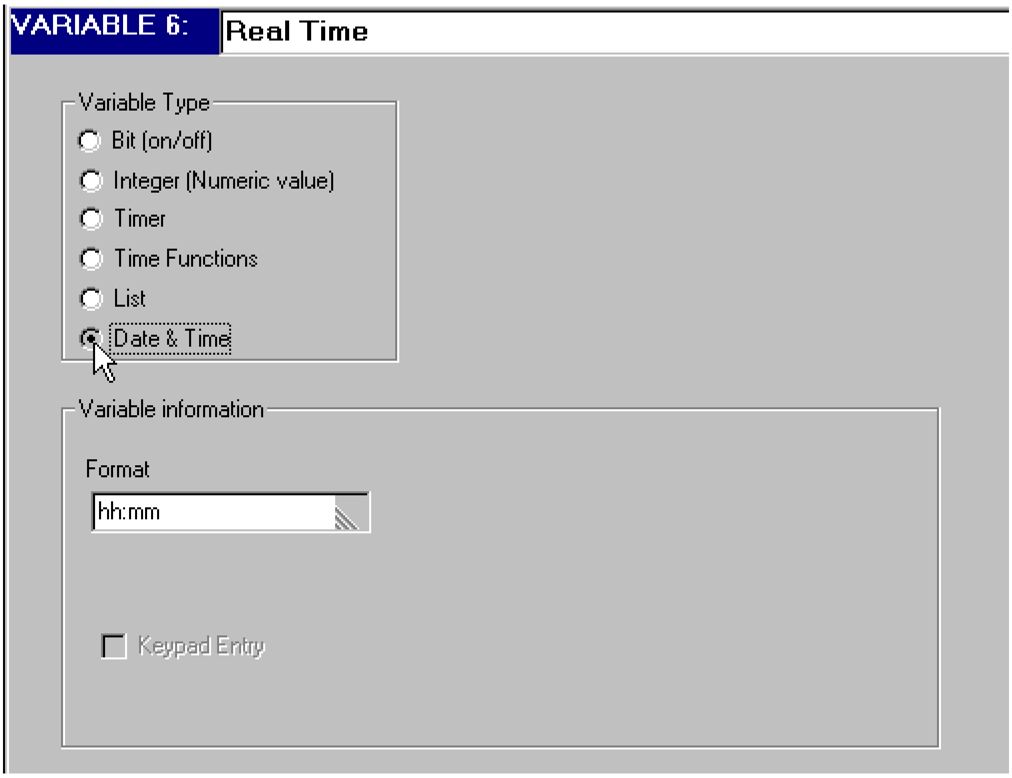
Example: write the variable ranges into SI 80 - 83, then writing an analog input into SI 84:



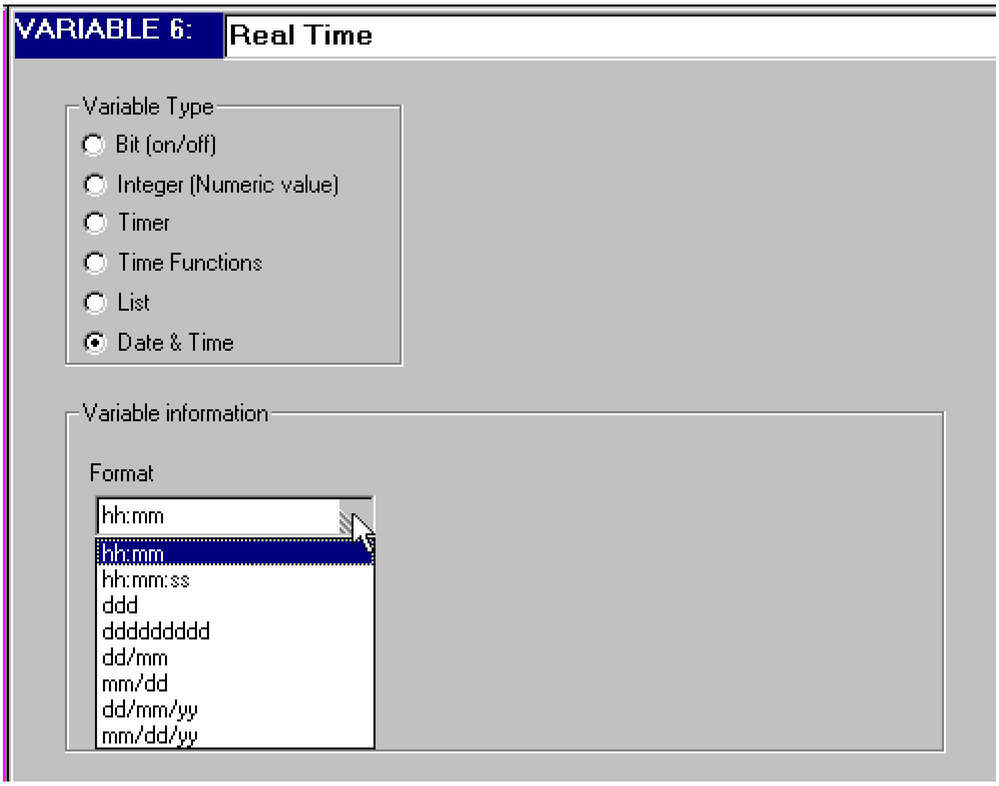
Display the Time and Date on the LCD

To display the time and date on the display screen:

1. Select **Date & Time** from the Variable Type check box in the Variable Editor.



2. Select the Time & Date Format in the Variable information box.



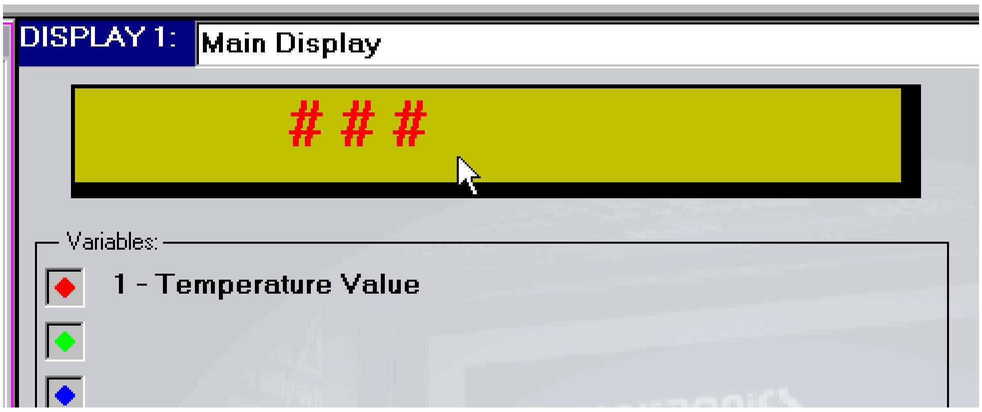
Make sure to define a Display field **large enough** for the selected Date & Time format.

Displaying Special Symbols on the LCD

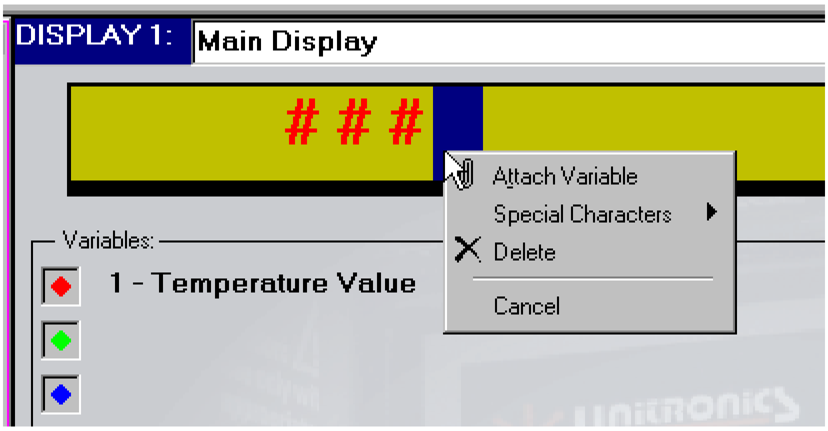
There are a number of Special Symbols such as arrows and degree signs, that may be displayed on the M90's LCD.

To enter a Special Symbol into a Display:

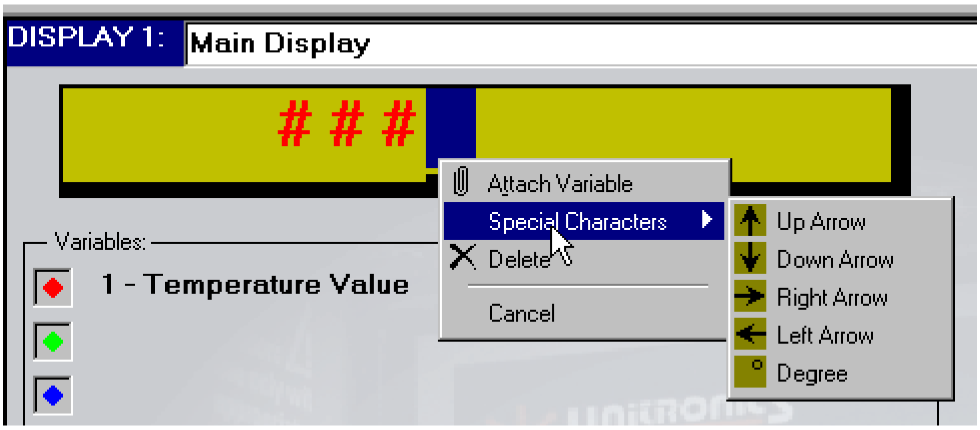
1. Choose the position in the Display field .



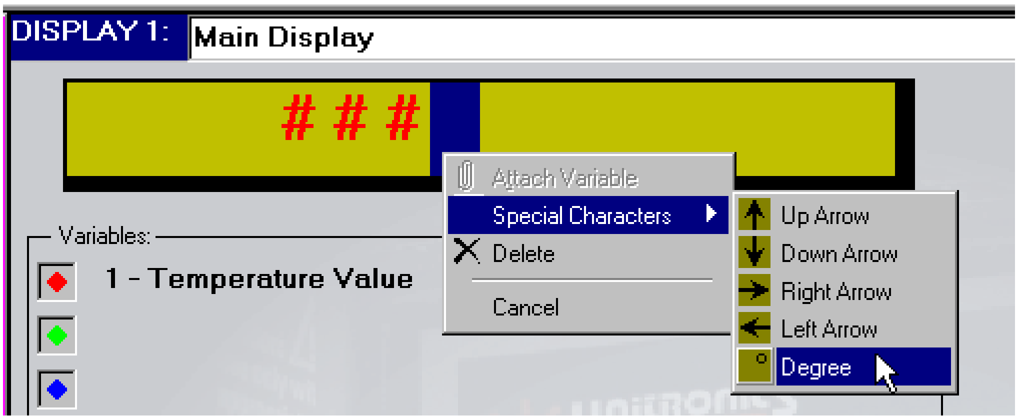
2. Right click to open the Variable modification menu.



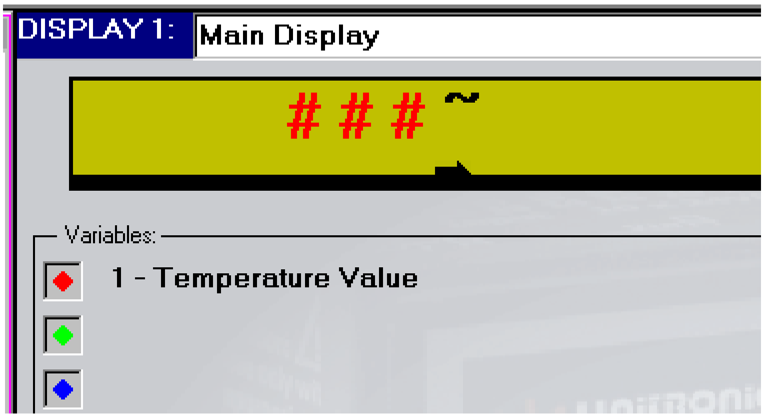
3. Select **Special Characters** from the menu. The Special Characters menu opens.



4. Select the Special Character you wish to add.



5. A ~ symbol will appear in the Display screen to show you that a Special Symbol was inserted. The selected symbol will appear on the controller.



Display Integer values as ASCII or Hexadecimal

You can:

- Display the values in an MI vector as ASCII characters.
- Display a register value in hexadecimal format.

To do this, attach a numeric Variable to a Display. The variable uses linearization to display the value(s) in the desired format.

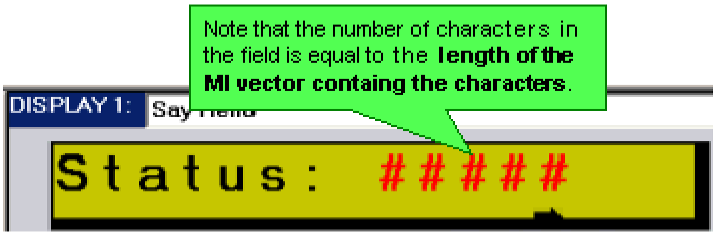
Note that non-supported ASCII characters will be shown as <space> characters.

ASCII -Hexadecimal character table

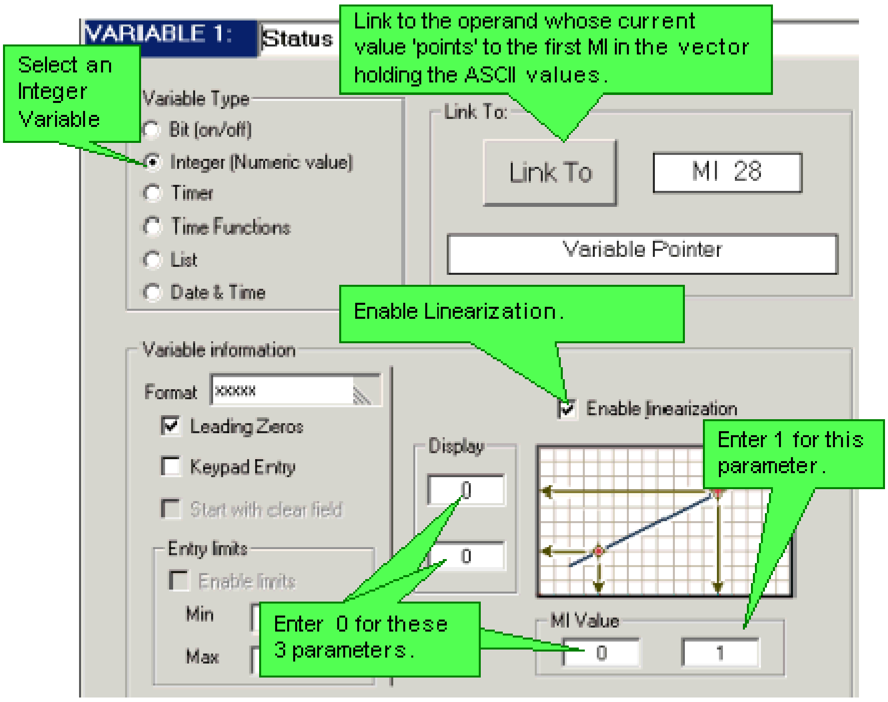
Vector as ASCII

When the application shown in the example below is downloaded, the ASCII characters 'Hello' will be displayed on the display screen when Key #3 is pressed.

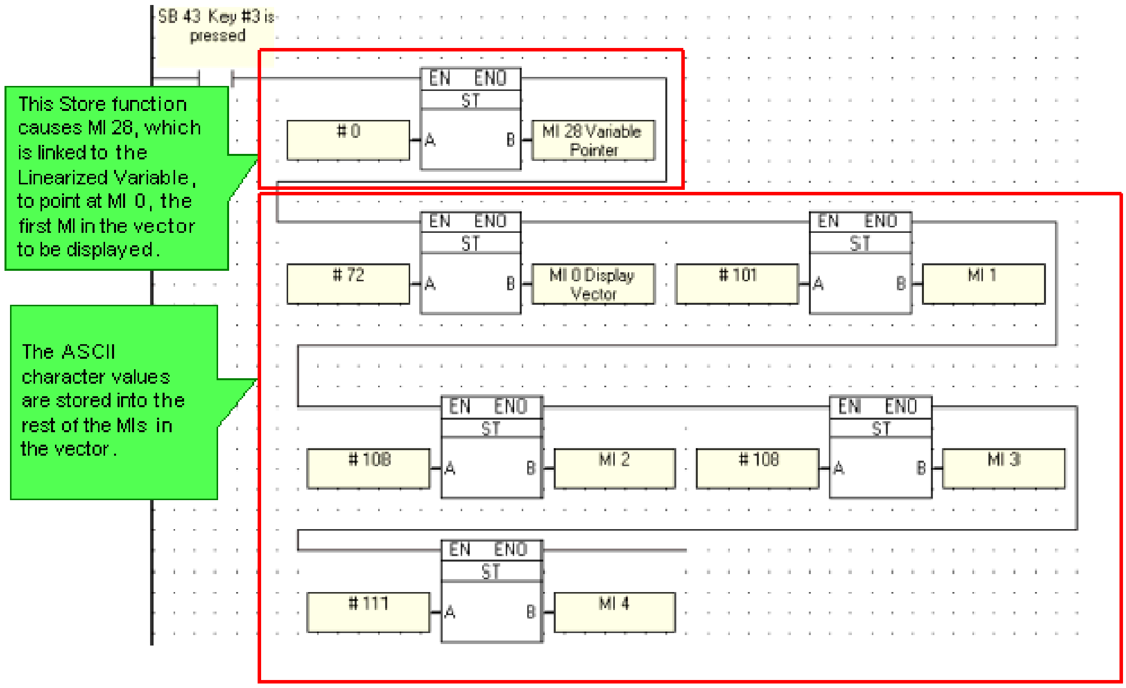
1.Create a Variable Field in a Display, then attach a Variable.



2.Define the Variable as shown below.



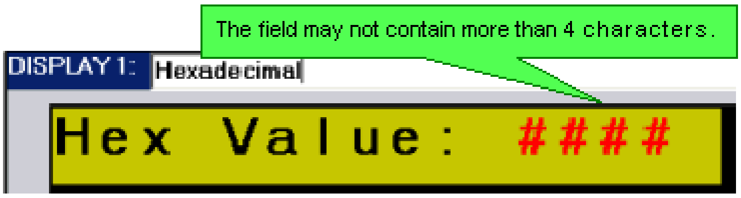
3.The Ladder net below sets the Variable pointer and stores ASCII values into the MI vector.



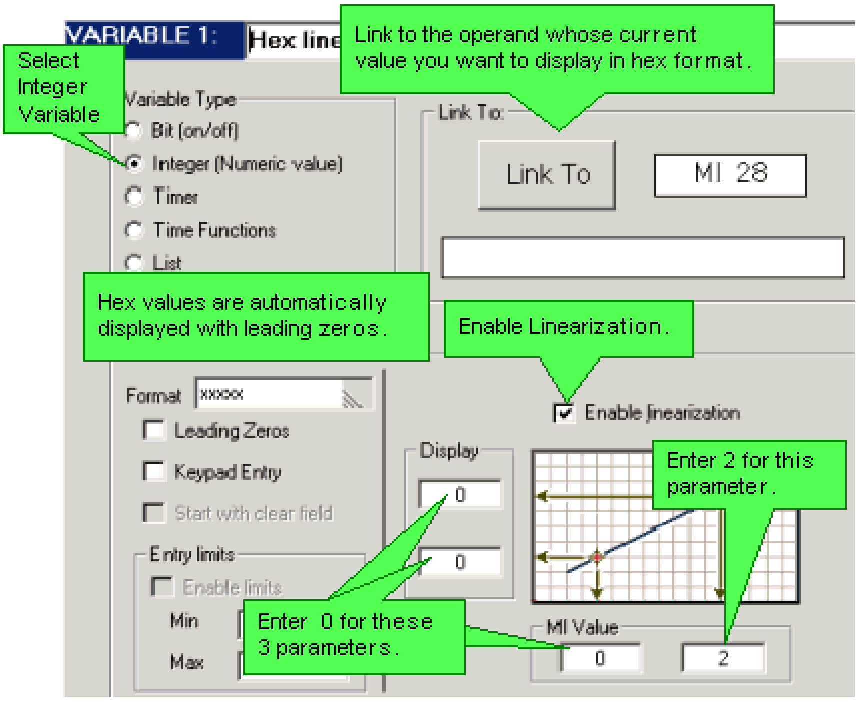
Register Value in Hexadecimal

When the application shown in the example below is downloaded, the hexadecimal value of 63 will be displayed on the display screen.

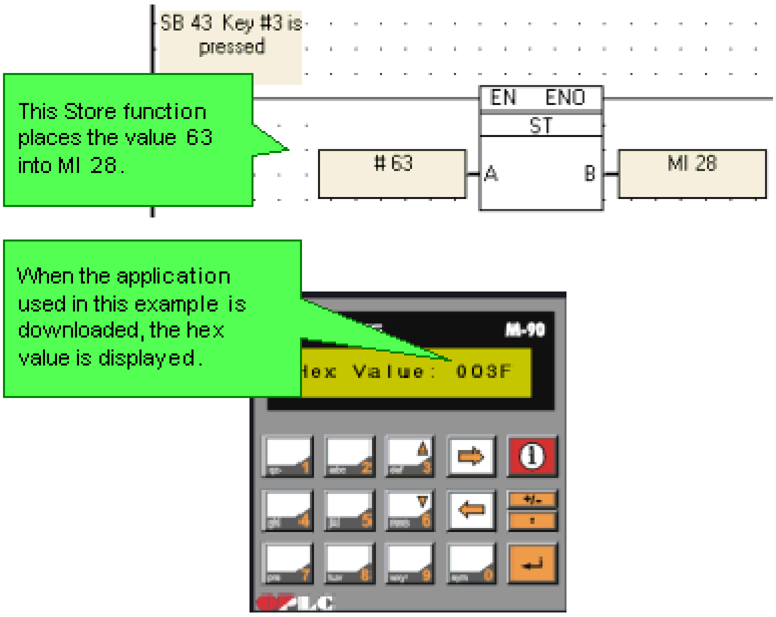
1. Create a Variable Field in a Display, then attach a Variable. Note that if the field is too short, only the right-most characters are displayed. For example, the hex value 63(3F) cannot be shown in a field one character long.



2. Define the Variable as shown below.



3. The Ladder net below stores the value into the MI.

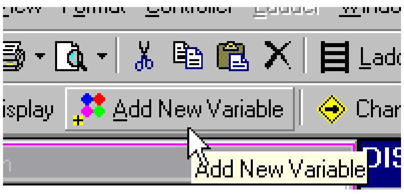


Scrolling between Displays via keypad

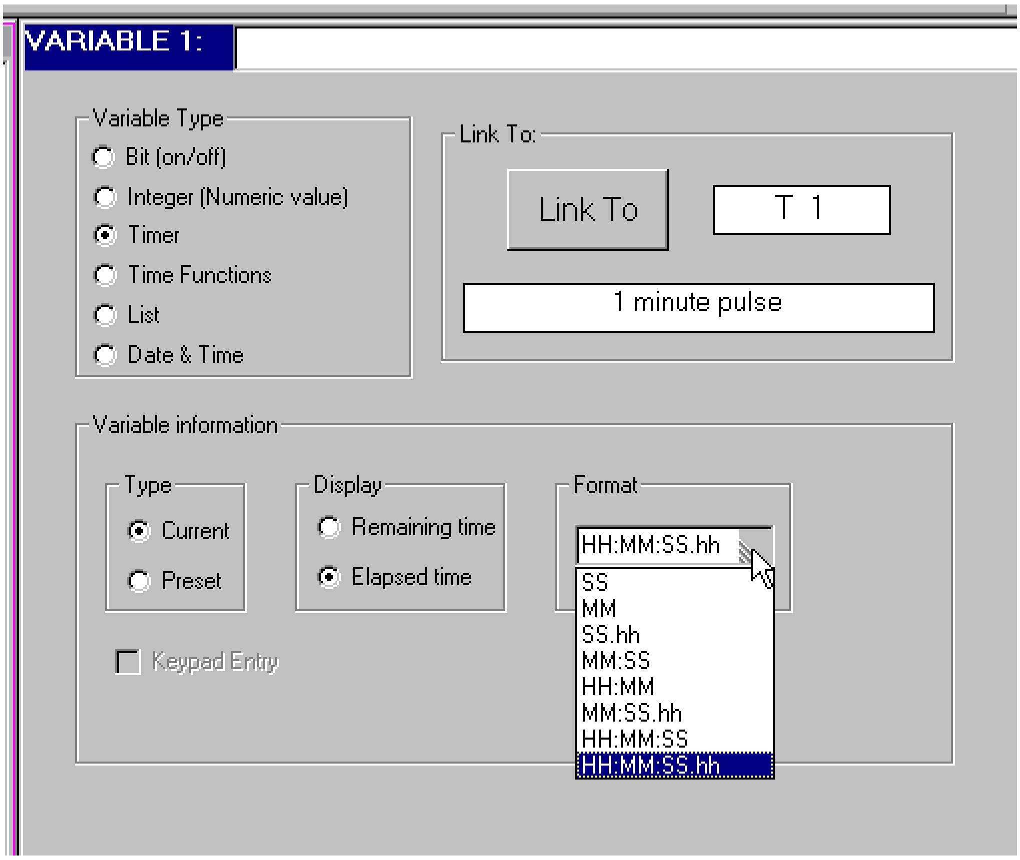
Use Jump conditions to scroll between Display screens using the keypad.

Selecting a Timer Display format

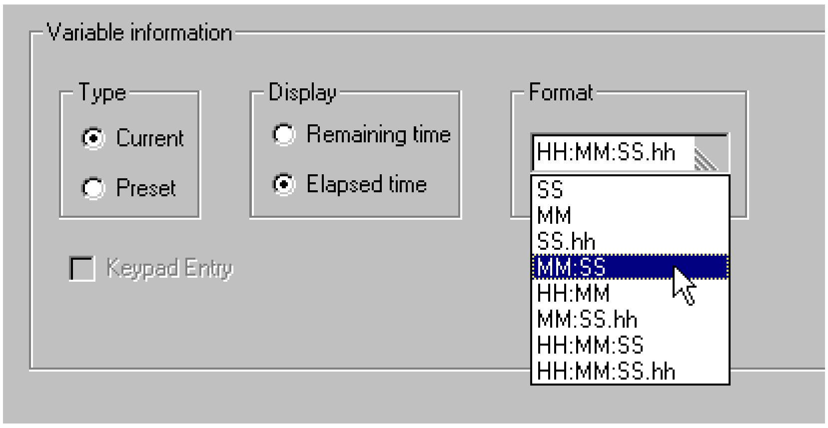
1. Click the Add New Variable icon on the HMI toolbar.



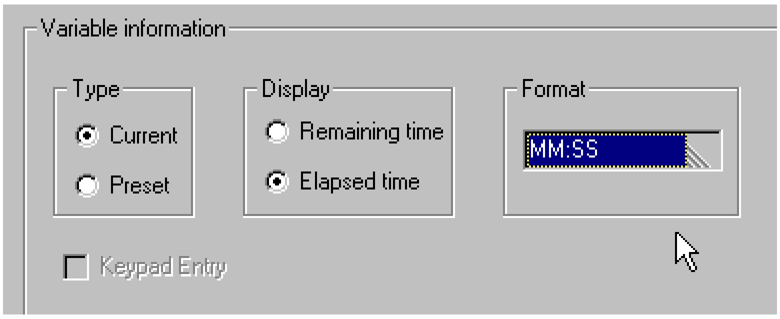
2. Select Timer, then link the desired T operand.
3. Open the Timer format drop-down menu in the Variable Editor.



3. Select the Timer format from the drop-down menu in the Variable Editor.



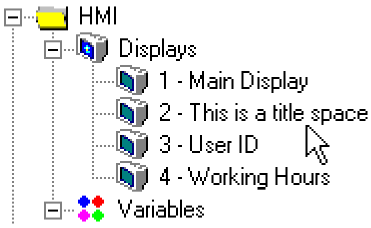
4. The selected format is displayed in the Format window.



Toggling between Displays

To move quickly between Displays:

1. Click the Display number in the Navigation Window that you want to view .



2. The Display immediately appears in the Display Editor.

How many displays can I create?

Yes, there is a limit of 80 text displays. Do remember that, in addition to the text displays, there are 120 List Variables that can be displayed on a controller.

Variable

You insert Variables into a Display to:

- Show varying values and text on the controller screen.
- Enter values into the controller.

Use the Variable Editor to link variables to the operands that contain the data you want to use in your program. You can use variables in your HMI program to display text that varies according to current conditions or events. Variable integers also can receive data input from the keypad keys, such as an employee ID number, or a set point for process control.

Displaying Variable Values in a Display

To display data from an HMI variable within a display, you must:

- Create a field within the display that is long enough to hold the variable data.
- Attach a variable to the field.

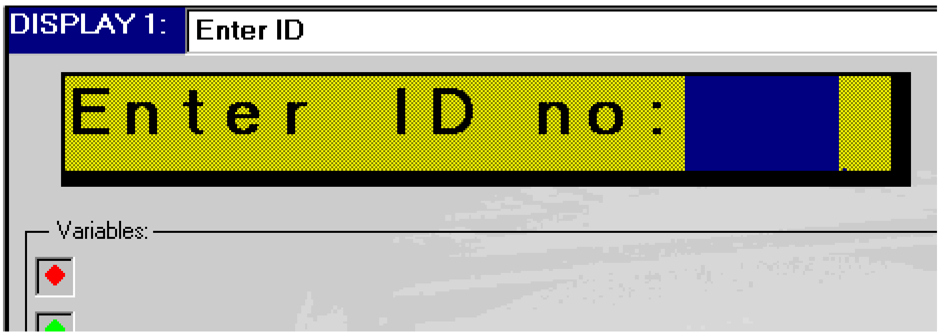
To Create a Field

1. Click your cursor in the display. This is the starting point of the field.
2. To create the field, either:
3. Drag the cursor across the display. The field you create is automatically highlighted in blue.

   OR

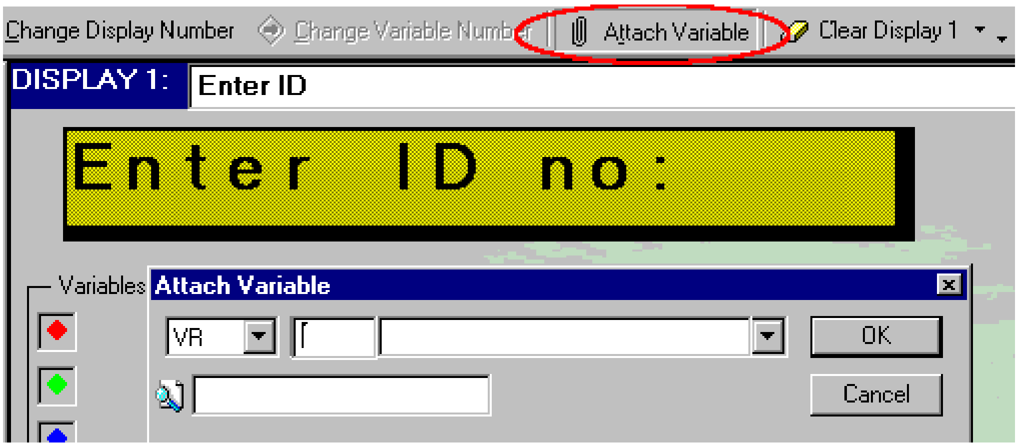
4. Hold the SHIFT key down, and press the right-pointing arrow key. Each time you press the arrow key, a space is automatically highlighted in blue.

In the figure below, the display contains a field two spaces long.

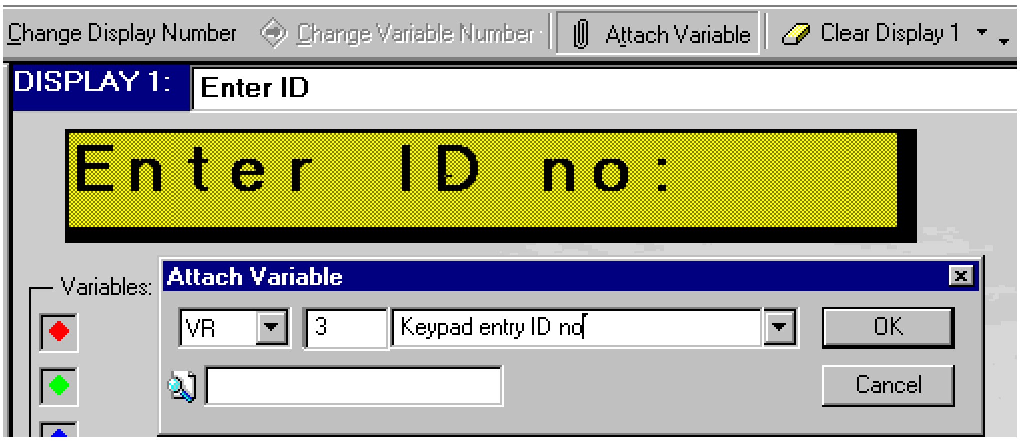


To Attach a Variable

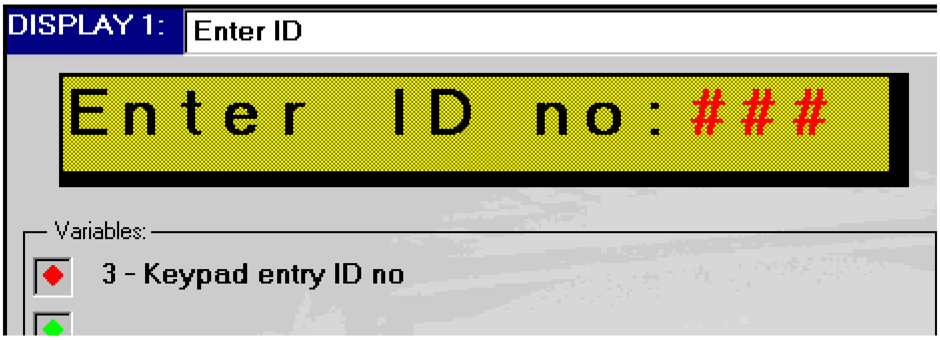
1. Click Attach Variable on the HMI toolbar. T he Attach Variable dialog box opens as shown below.



2. Enter the number of the desired variable as shown below and press OK. If you do not enter a variable number, the program assigns a default variable.



3. The variable-linked spaces now appear as red pound signs, and the variable itself appears in the Variable pane of this Display as shown below.



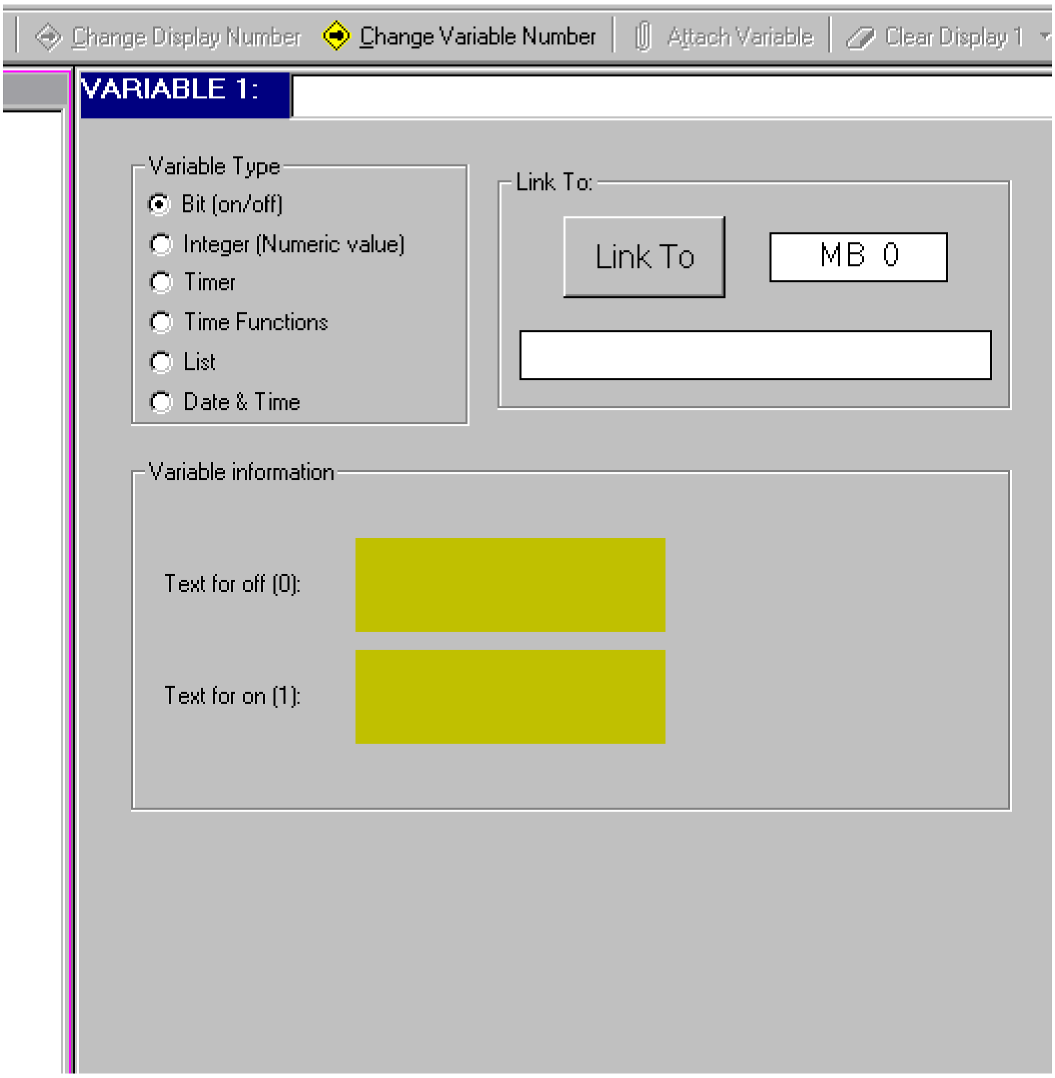
Use the Variable Editor to:

- Set variable types and properties.
- Create up to 120 list variables to display fixed text messages.
- Enable data entry via the keypad.

Up to fifty variables may be included in your application. The different types of variables are listed below.

Variable Type	**Linked to**	**Display Options:**
Bit	MB	Create a text display for ON and OFF.
Integer	MI	Choose integer display format; enable linearization and keypad entry.
Timer	T	Display either elapsed time or remaining time and allow timer modification via the keypad.
Time Functions	MI	Display and modify Time function from hour up to year.
List	MI	Create up to 120 additional fixed text messages for different values of an MI / SI.
Date & Time	RTC	Set the display format (from Hours/Minutes to Month/Day/Year) and enable keypad entry.

Variable Editor view:



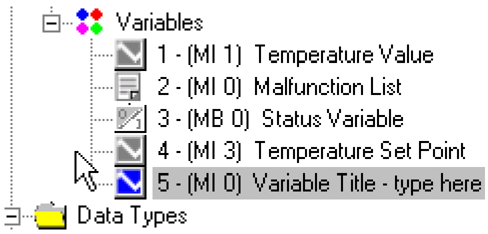
Naming a Variable

To assign a title to a Variable:

1. Open a Variable in the Variable Editor.

2. Type the Variable name in the title field.

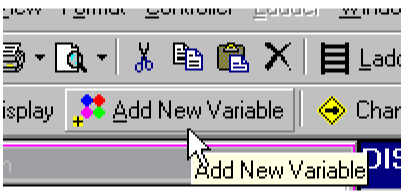
The Variable name appears with the Variable number in the Navigator window.



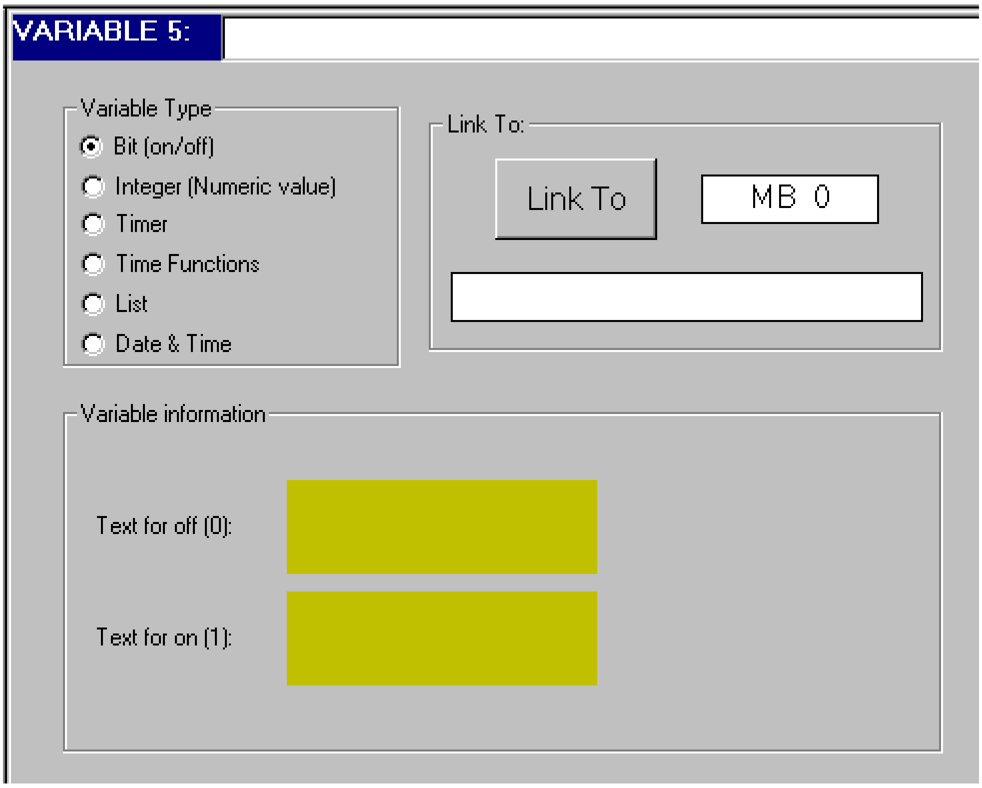
Creating Variables

To create a new Variable:

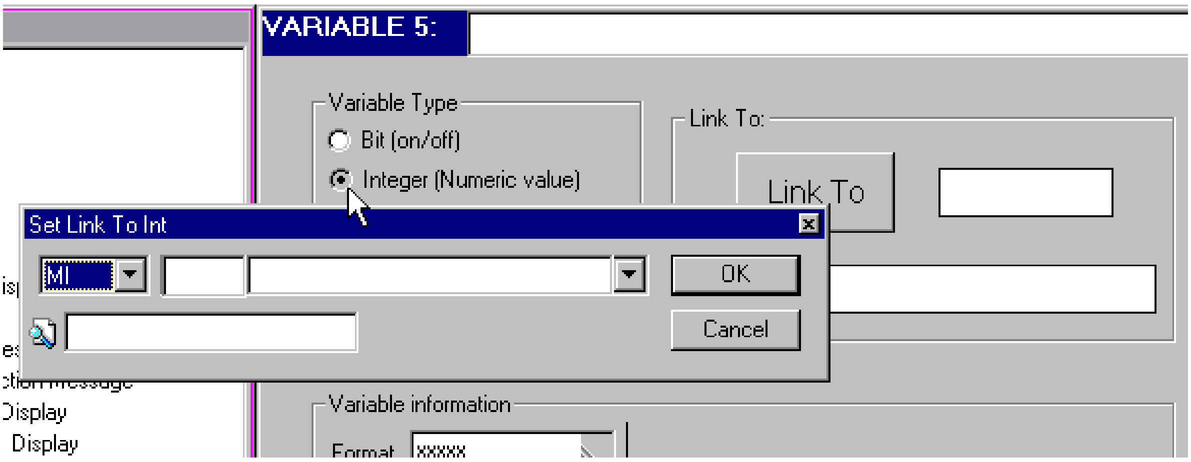
1. Click the Add New Variable icon on the HMI toolbar.



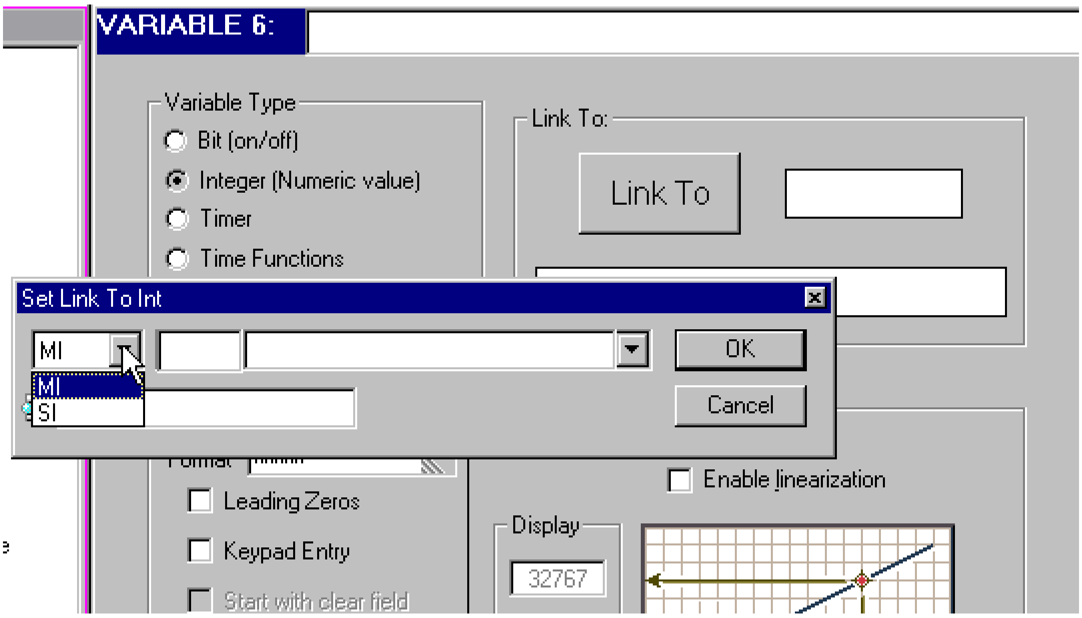
2. A new Variable opens in the Variable Editor.



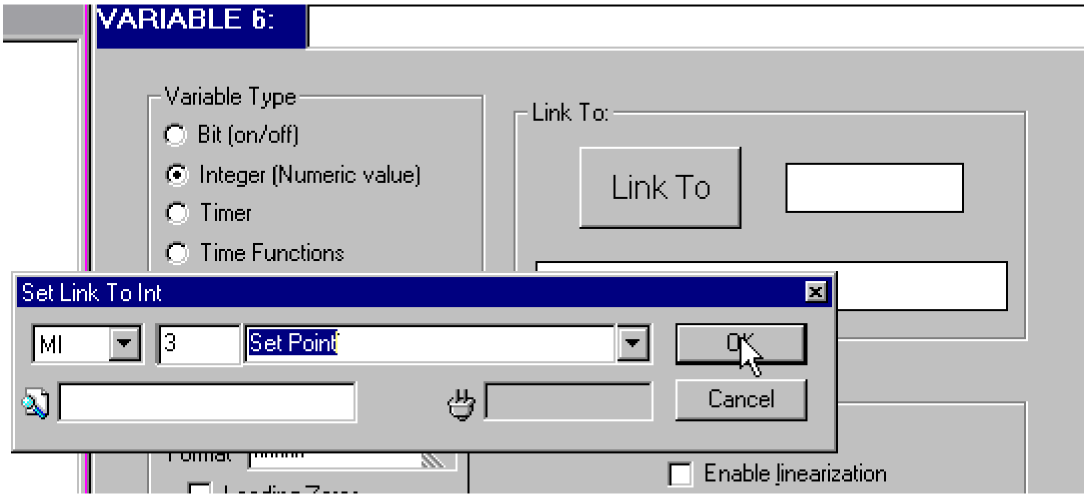
3. Select the desired Variable Type.



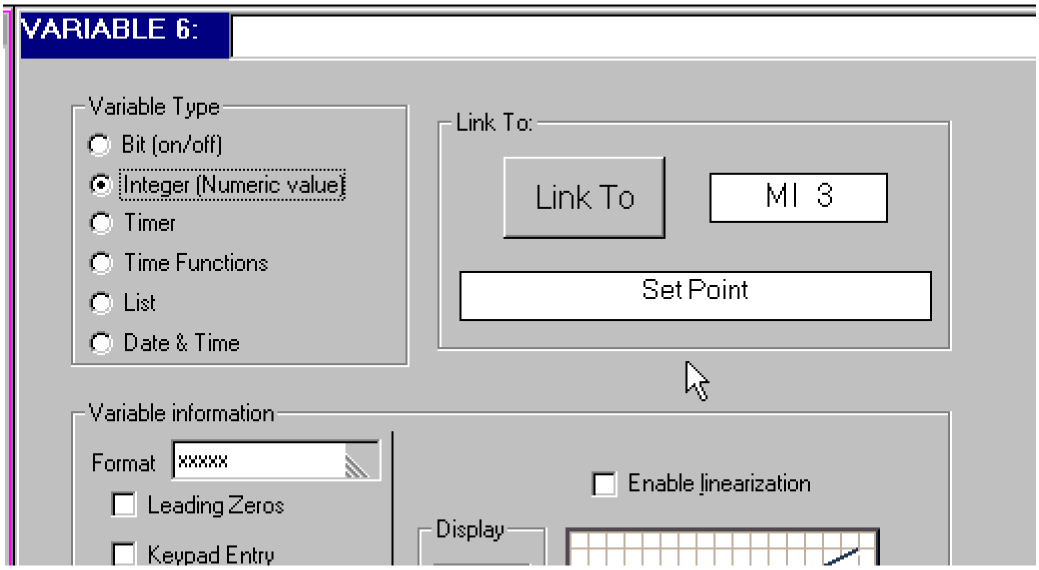
4. Select the Operand type.



5. Enter the Operand Address and Symbol.



6. The new Variable appears with the appropriate link in the Variable Editor.



Showing an MI value on the controller's LCD

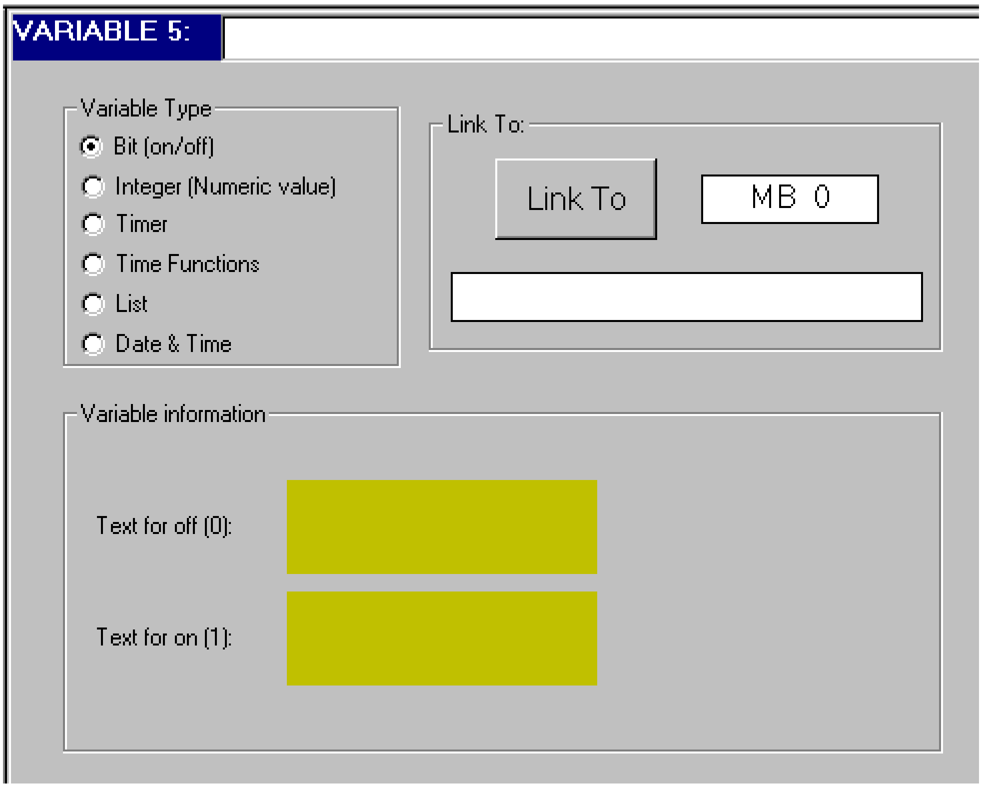
To display an MI value on the controller display:

1. **Create a Variable**

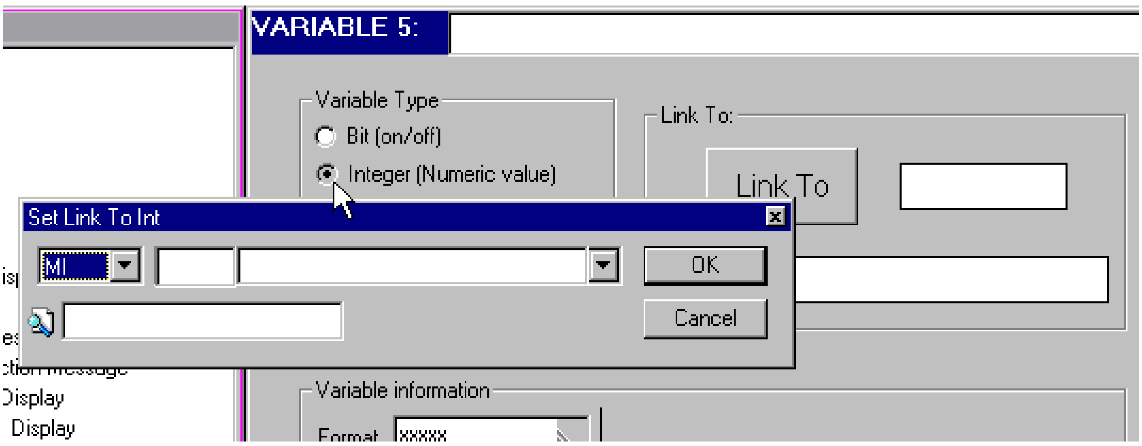
   To create a new Variable:

   1.Click the Add New Variable icon on the HMI toolbar.

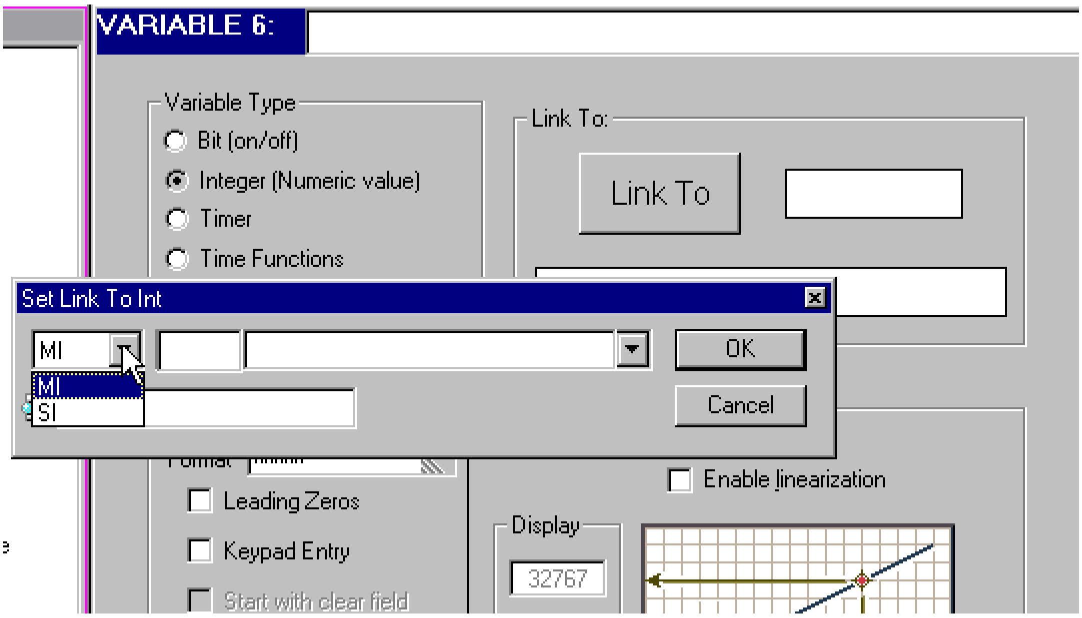
   2.A new Variable opens in the Variable Editor.



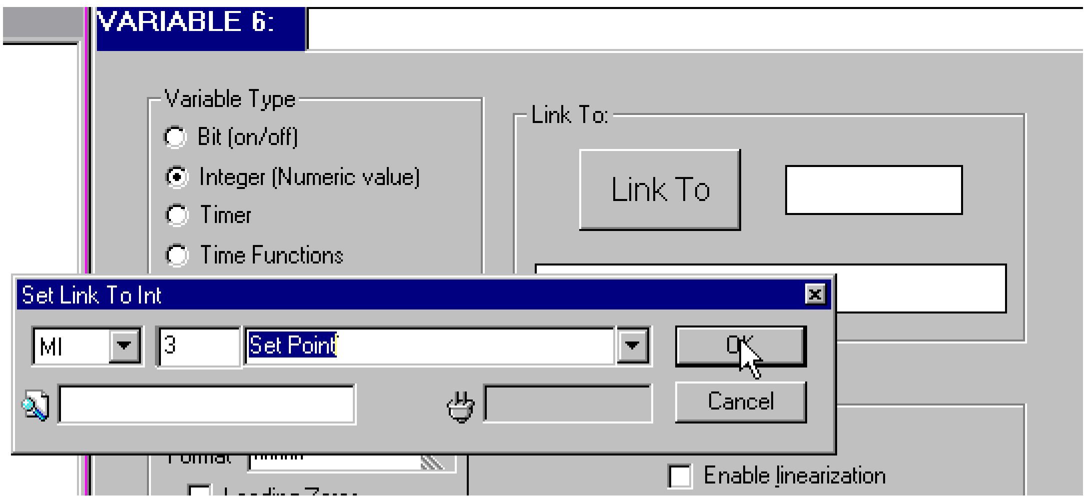
   3.Select the desired Variable Type.



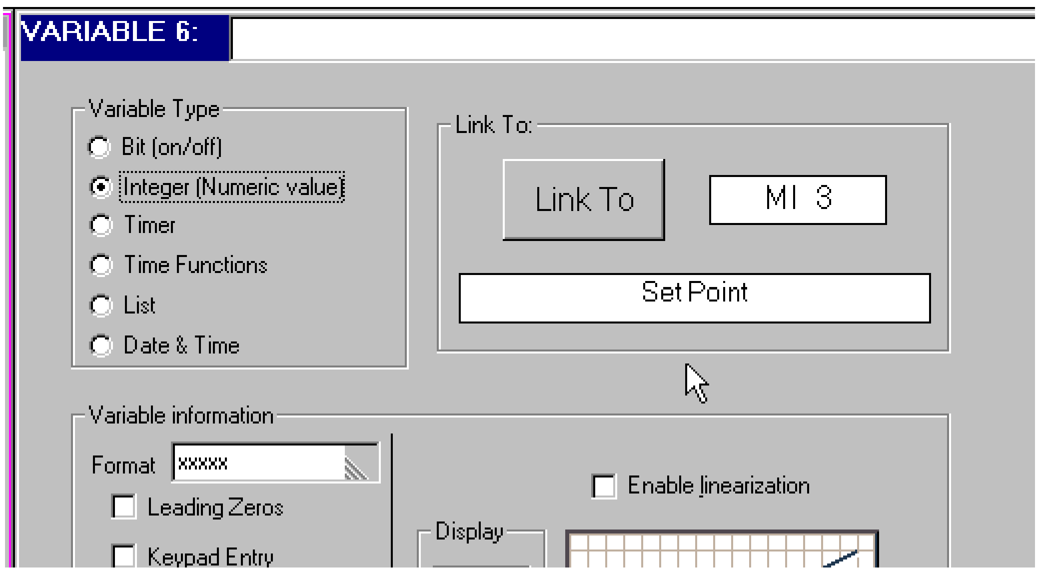
4. Select the Operand type.



5. Enter the Operand Address and Symbol.



6. The new Variable appears with the appropriate link in the Variable Editor.



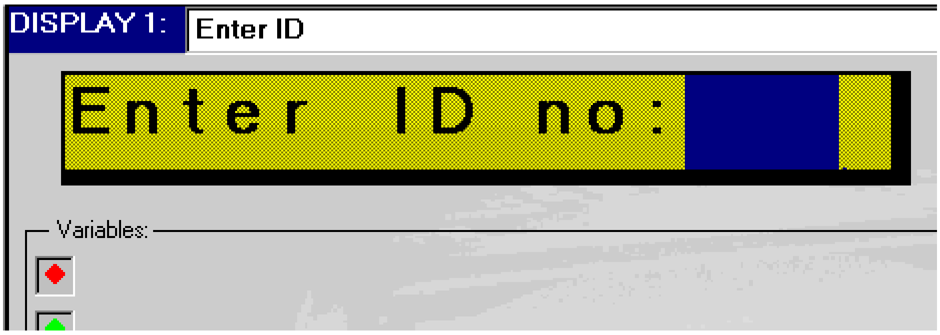
2. **Create a Variable Field in a Display** and attach it to the Variable.

Click your cursor in the display. This is the starting point of the field.

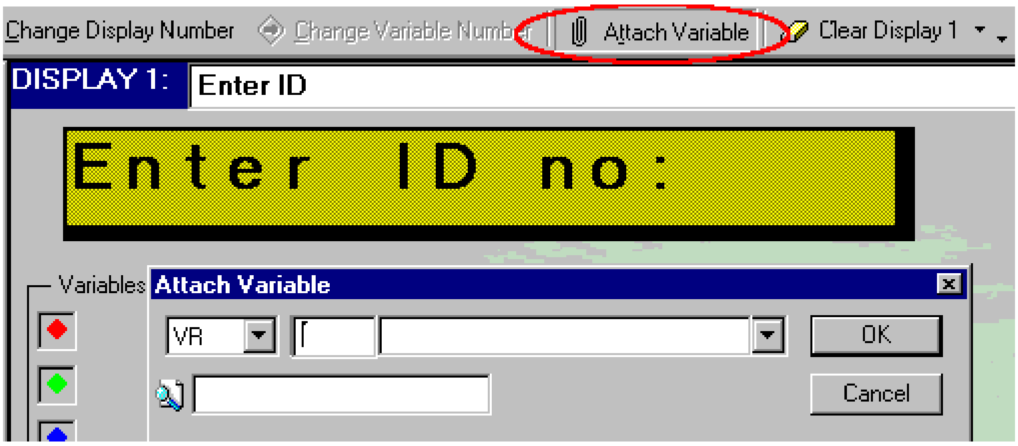
1. To create the field, either:
2. Drag the cursor across the display. The field you create is automatically highlighted in blue.

   OR
3. Hold the SHIFT key down, and press the right-pointing arrow key. Each time you press the arrow key, a space is automatically highlighted in blue.

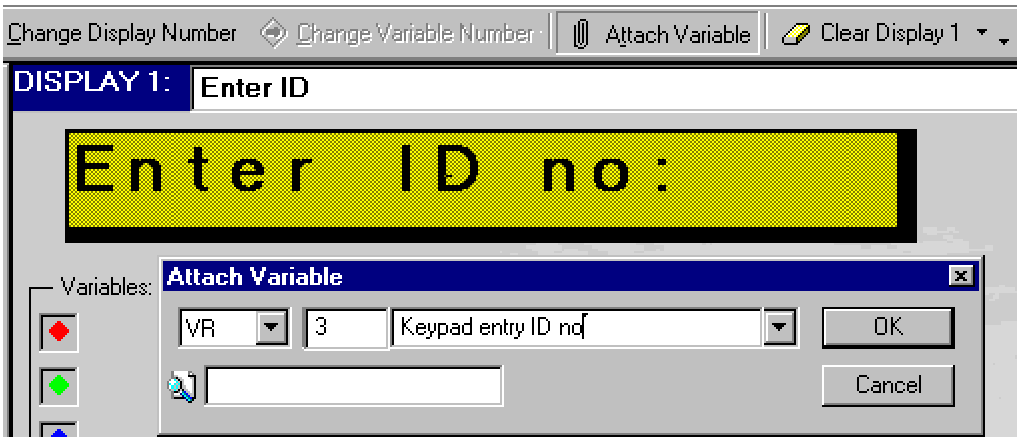
In the figure below, the display contains a field two spaces long.



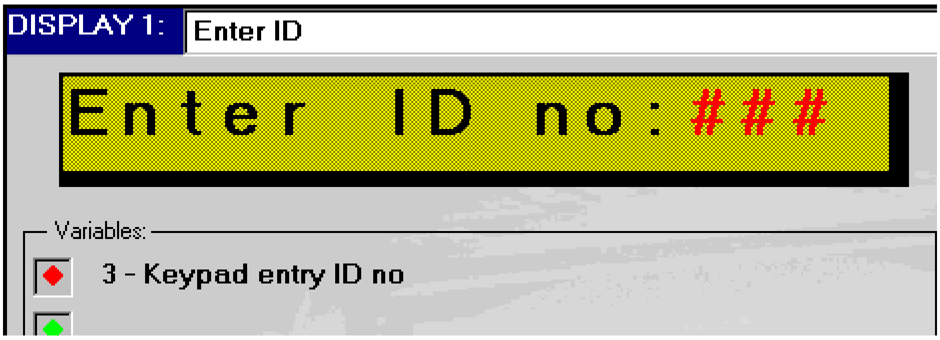
Click Attach Variable on the HMI toolbar. The Attach Variable dialog box opens as shown below.



4. Enter the number of the desired variable as shown below and press OK. If you do not enter a variable number, the program assigns a default variable.



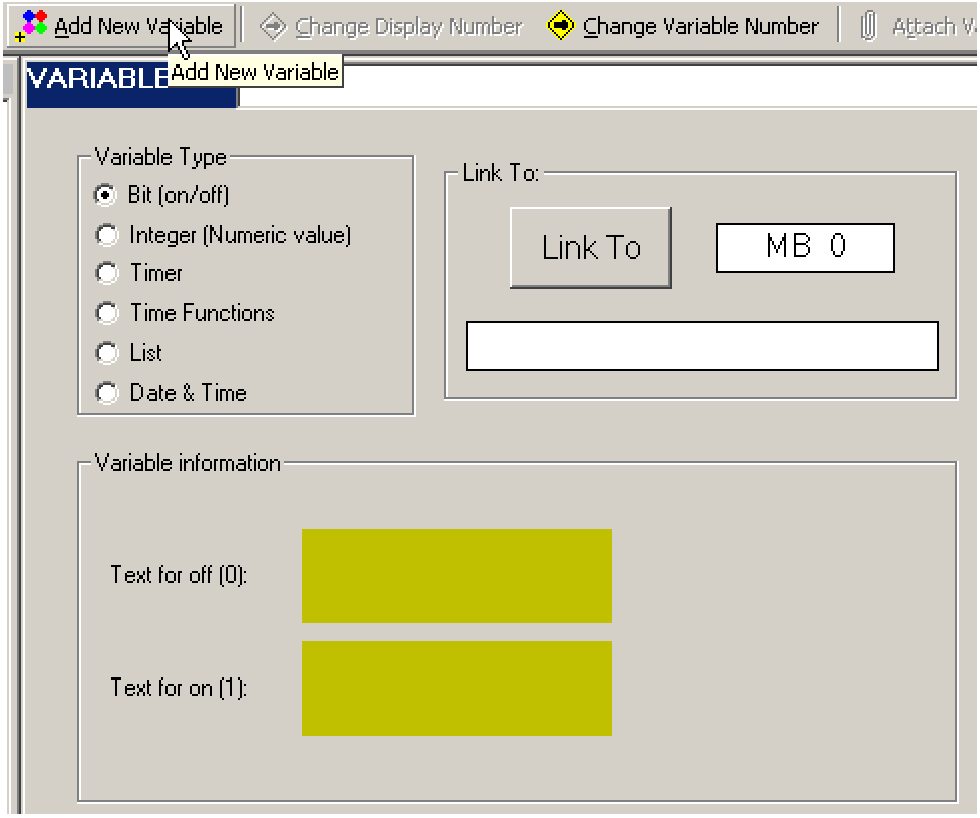
5. The variable-linked spaces now appear as red pound signs, and the variable itself appears in the Variable pane of this Display as shown below.



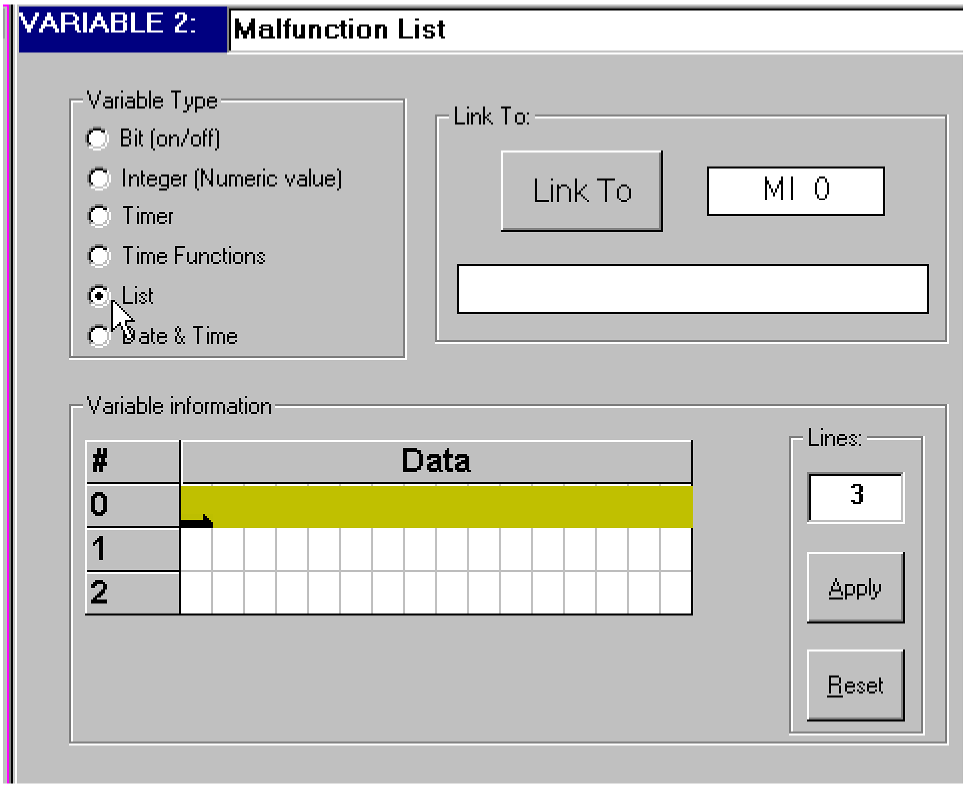
List Variable: Display text according to a changing MI value

To display different texts for different values of the same MI:

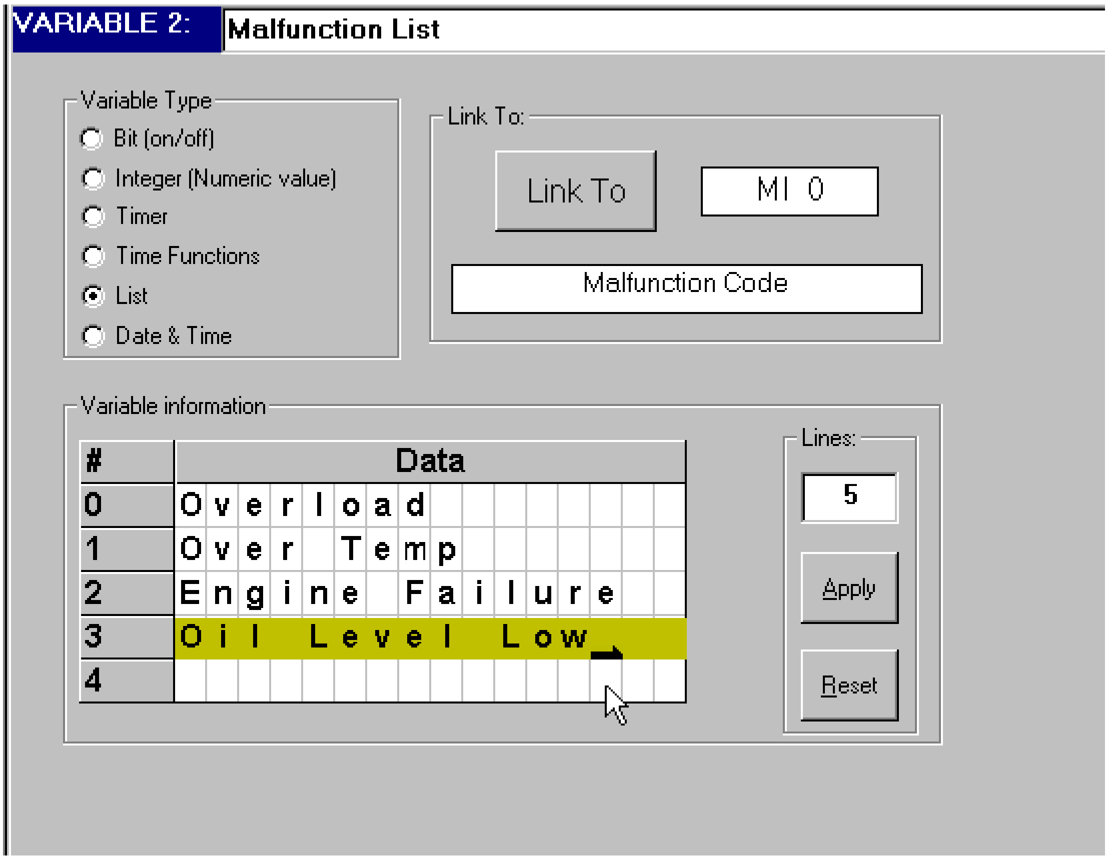
1. Create a new Variable.



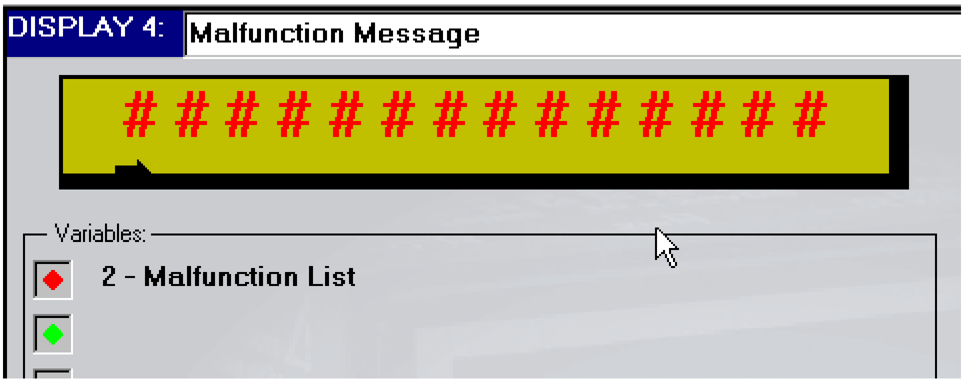
2. Select **List** Variable type.



3. Enter the desired text for each possible value of the linked MI.



4. Attach the Variable to a Display field.



The text on the Display will be determined by the value written into MI 0 in the Ladder.

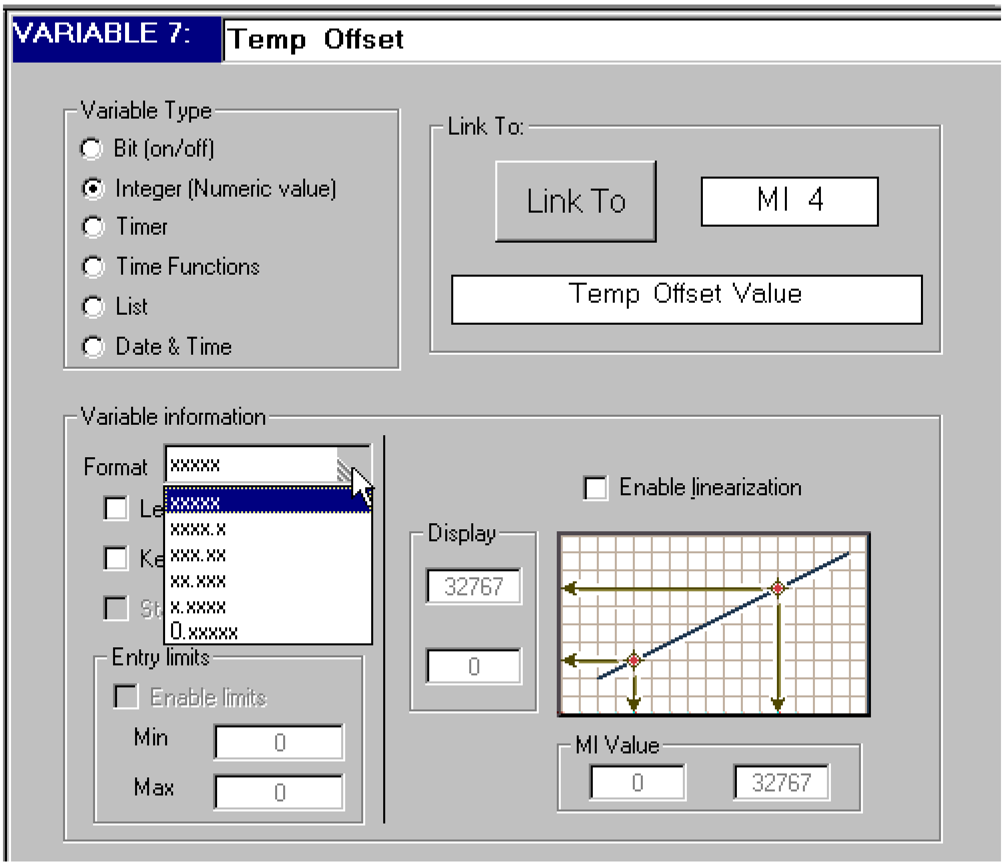
Example:

If MI 0 = 2, then the message will be **Engine Failure**.

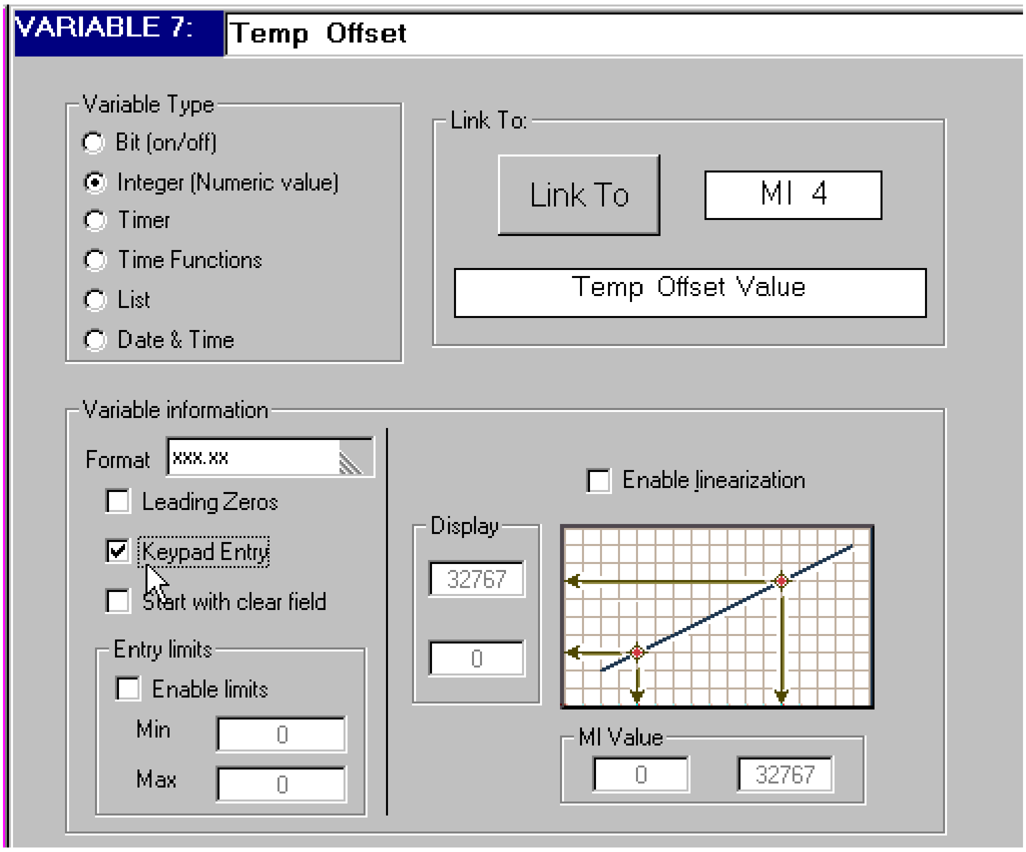
Keypad Entry values

To enter a decimal number into a MI from the keypad:

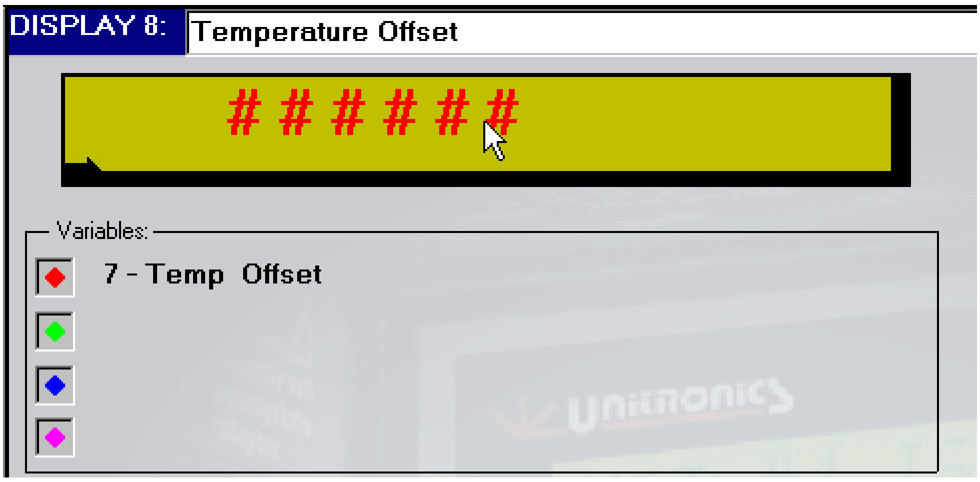
1. Select the desired decimal format from the Variable information box for the Integer Variable.



2. Select **Keypad Entry** from the Variable information box.



3. Attach the Variable to a field in the desired Display.



Note When an HMI keypad entry variable is active, and the Enter key is pressed on the controller keypad, SB 30 HMI Keypad Entries Complete turns ON. This can be used as a Jump condition.

In addition, note that a Display may contain a total of 4 variables. Each one has an SB:

- SB 31 HMI Var 1 Keypad entry completed
- SB 32 HMI Var 2 Keypad entry completed
- SB 33 HMI Var 3 Keypad entry completed
- SB 34 HMI Var 4 Keypad entry completed

The condition of these SBs may be used as Jump Conditions, or to drive calculations in your program.

How does the program know when a keypad entry is complete?

When a keypad entry is complete, there are special SBs that go to logic 1 for one system scan.

If there is more than one Variable on display, there is an HMI Var Keypad Entry Complete SB for each Variable.

The SBs are:

- SB 30 - HMI Keypad entries complete
- SB 31 - HMI Var 1 Keypad entry completed
- SB 32 - HMI Var 2 Keypad entry completed
- SB 33 - HMI Var 3 Keypad entry completed
- SB 34 - HMI Var 4 Keypad entry completed

You can use these special SBs in your Ladder project or Jump conditions to move from Display to Display when keypad entry is complete.

Force: HMI Keypad Entry Complete, SB 39

A flashing cursor on the LCD screen indicates that the controller is waiting for a keypad entry. You can turn off the flashing cursor by turning SB 39 ON.

This can enable you to use the same HMI screen to first enable keypad entry, and then to simply display the entered value.

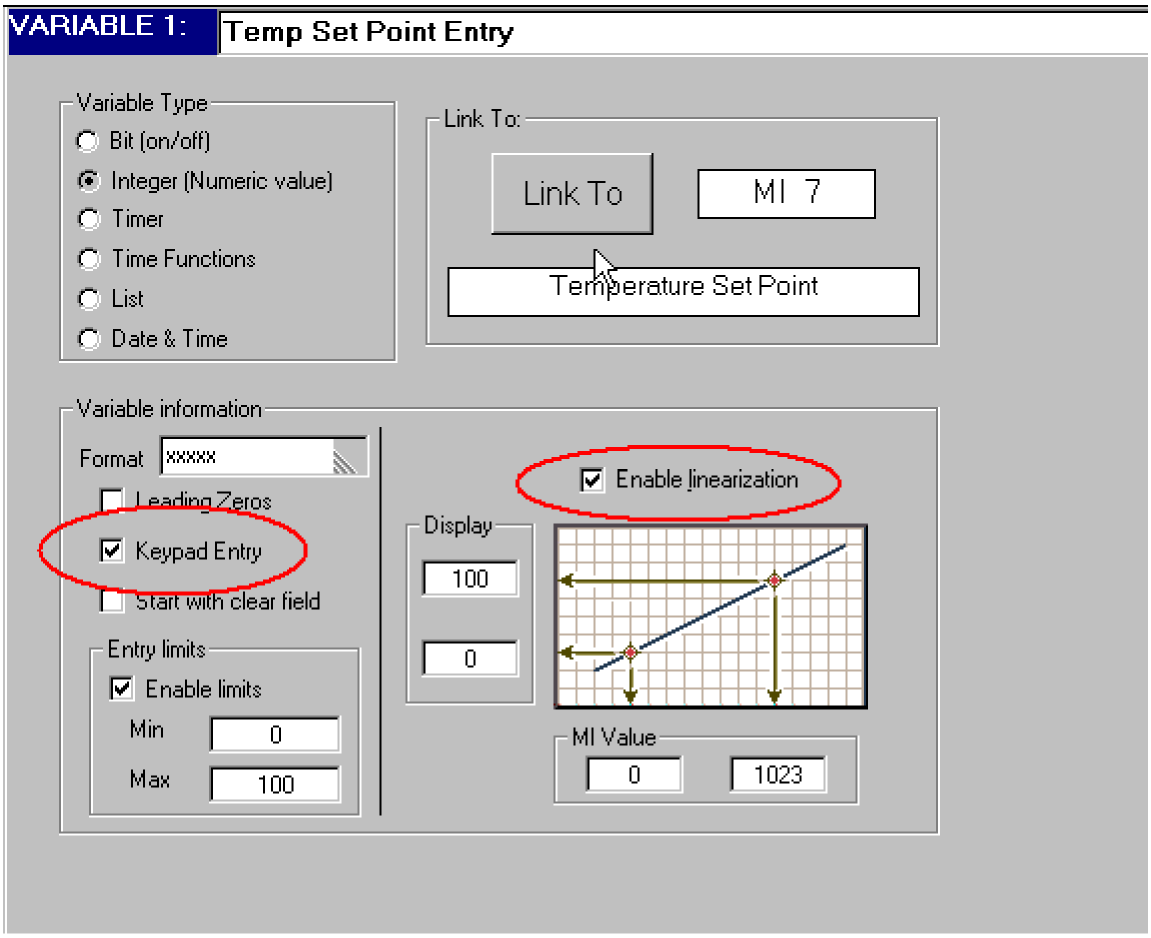
Converting Display values: Linearization

If you want to enter an Analog value, such as temperature, via the keypad and convert that value into a Digital value for comparison with a digital value from a temperature probe, you use the **Enable Linearization** feature in the linked Variable.

This conversion process is Reverse Linearization.

To enable Analog to Digital conversion:

1. Create a Display for entering the analog value.
2. Create an Integer Variable.
3. Select **keypad entry** and **enable linearization**.
4. Enter the linearization values for the x and y axes.



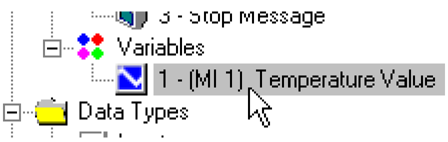
According to the above example:

- A temperature entry of 100^0 C will be converted to 1023 Digital value.
- A temperature entry of 50^0 C will be converted to 512 Digital value.

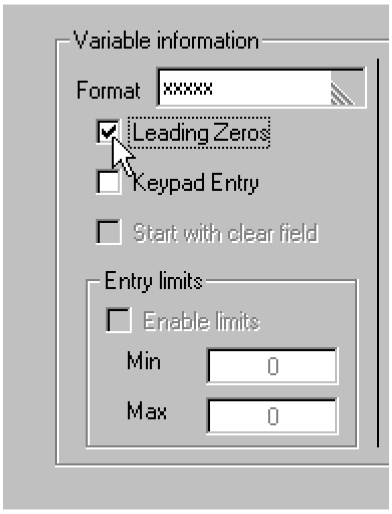
Displaying an MI value with a leading zero

To display an MI with a Leading Zero:

1. Select the desired Variable from the Navigator Window.



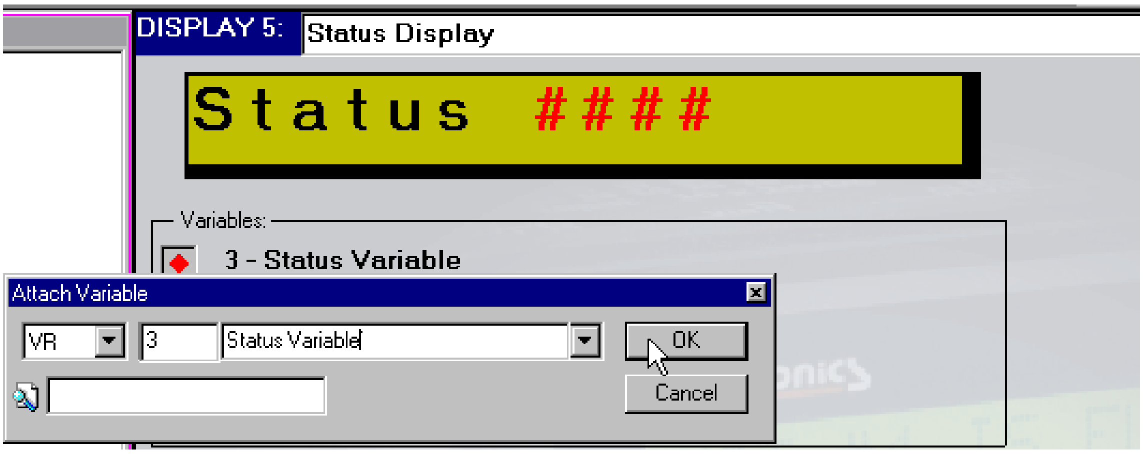
2. Select Leading Zeros from the Variable Information check box.



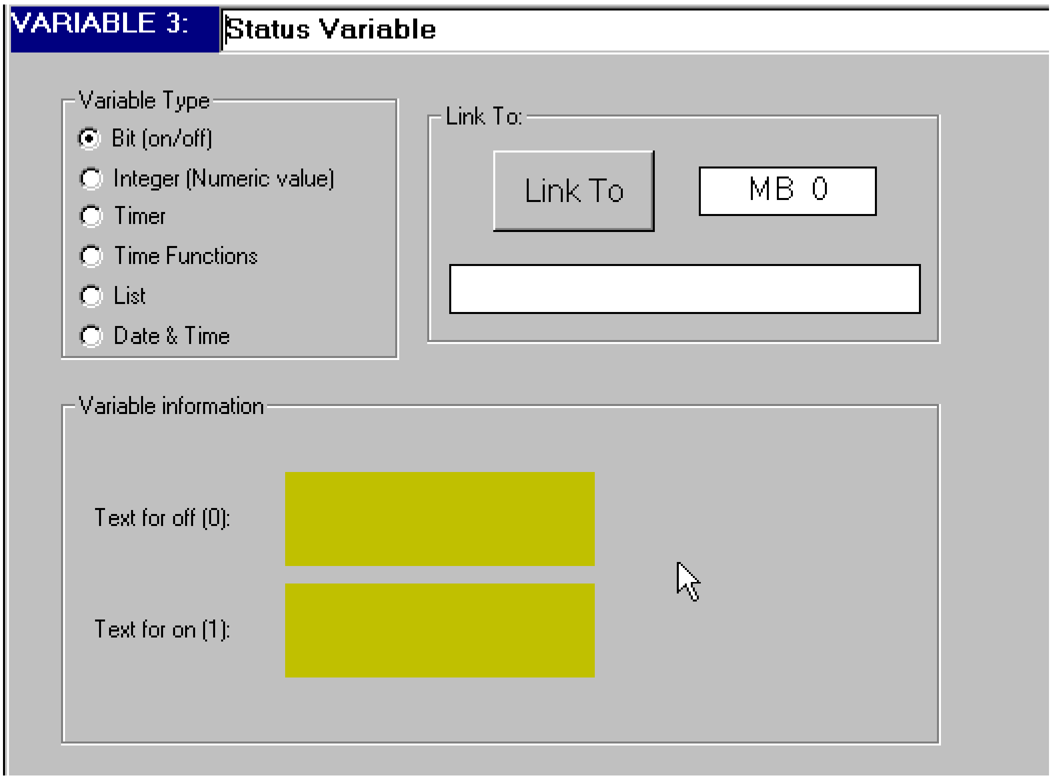
Displaying text according to the value of a MB or SB

To display a text according to the value of a MB or SB:

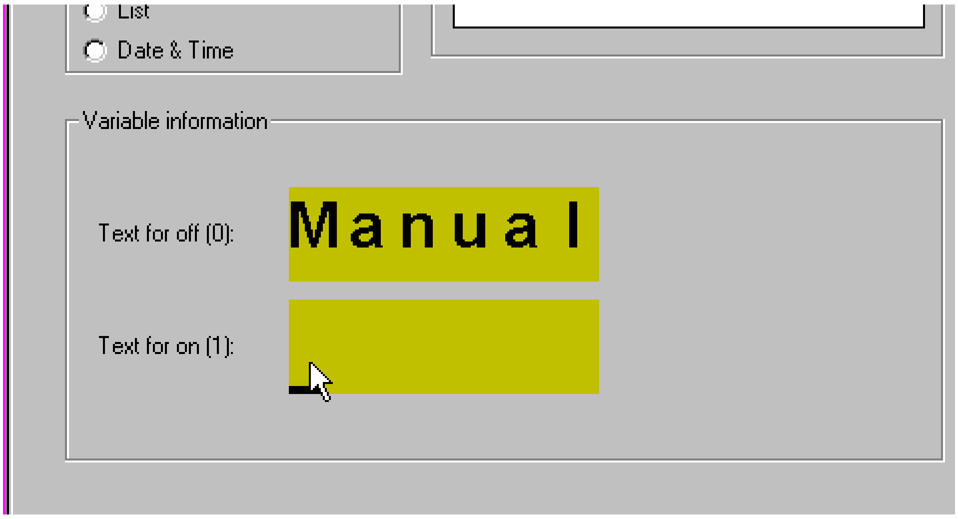
1. Create a Display and variable field.



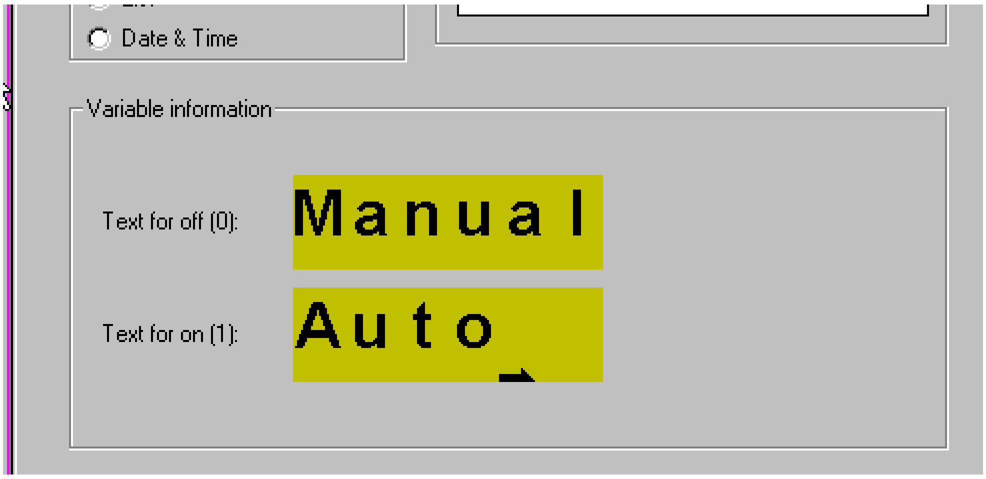
2. Create a **Bit** type variable attached to the field .



3. Enter a text Display for the "0" value of the MB / SB.



4. Enter a text Display for the "1" value of the MB / SB.



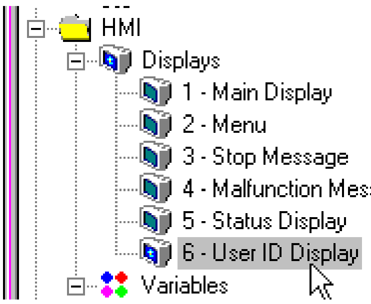
The text will be displayed according to the value of the MB / SB. Note that the Display field must be large enough for the defined text.

For the above example, the Display field must be 6 characters.

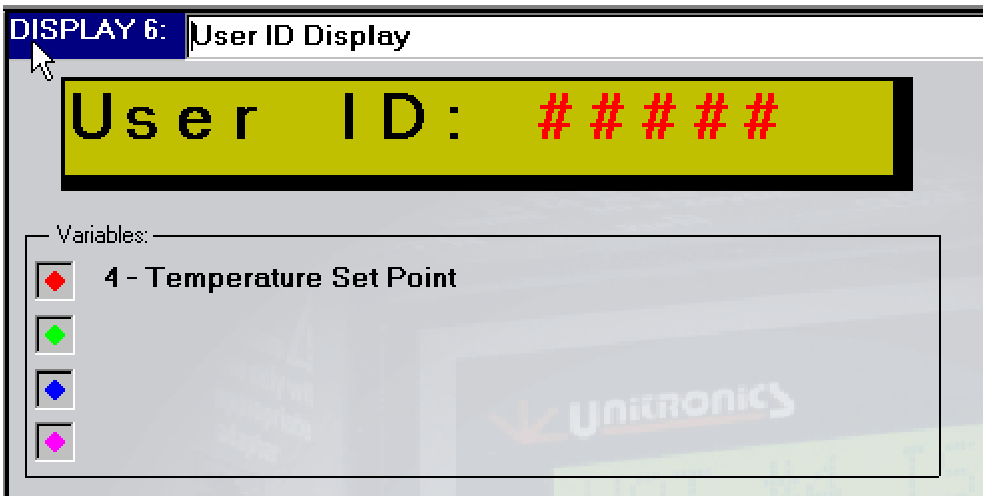
Opening a Variable from a Display

To move quickly from a Display to the Variable linked to the Display:

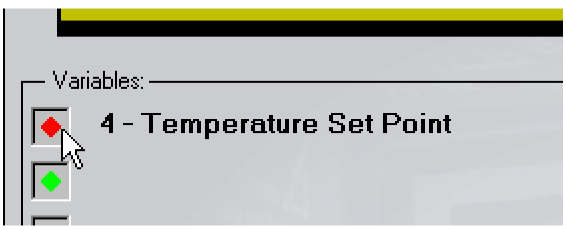
1. Select the desired Display from the Navigator window.



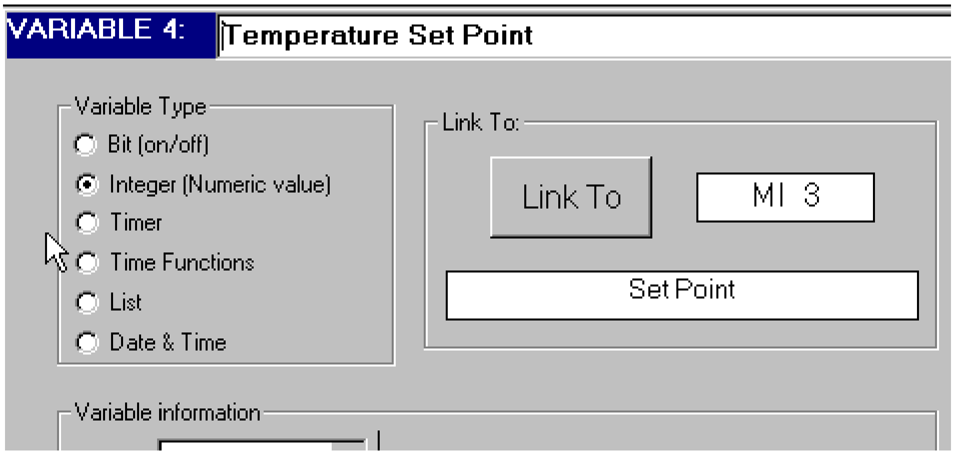
2. The Display opens in the Display Editor.



3. Select the Variable.

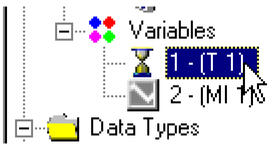


4. The Variable opens in the Variable Editor.

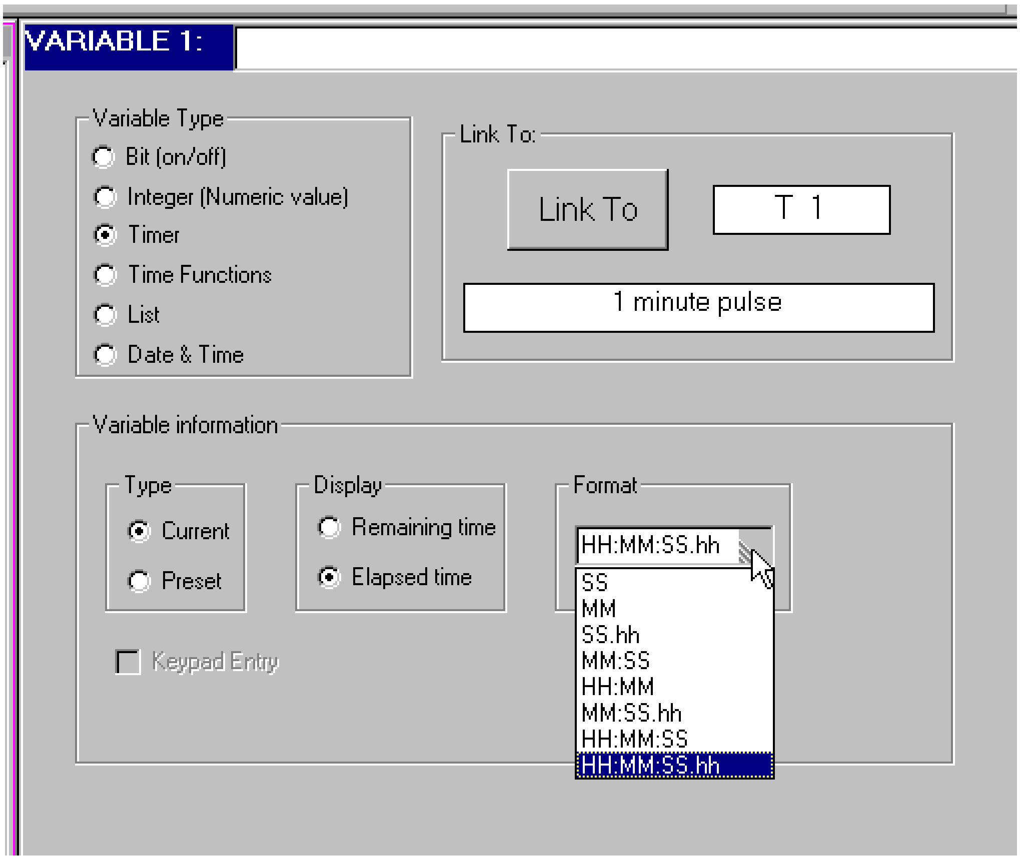


Selecting a Timer Display format

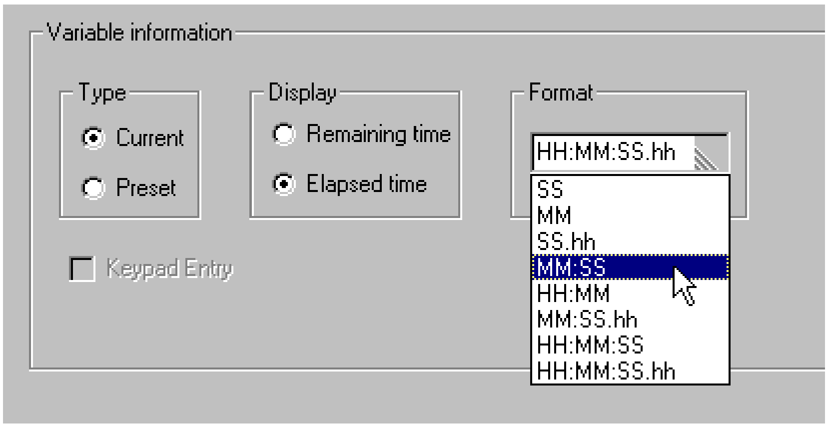
1. From the Navigator Window, create or choose an existing Timer Variable.



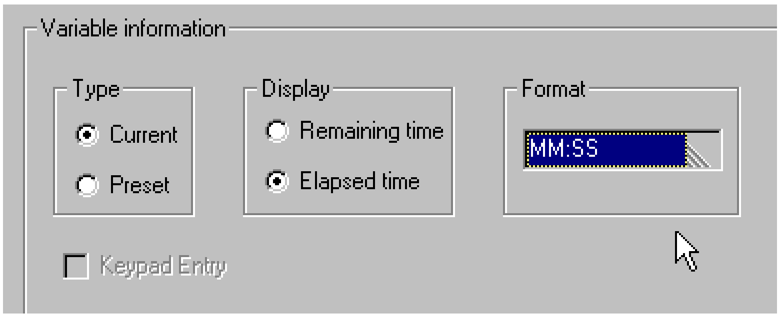
2. Open the Timer format drop-down menu in the Variable Editor.



3. Select the Timer format from the drop-down menu in the Variable Editor.



4. The selected format is displayed in the Format window.



Communications

About Communications

M90/91 controllers contain built-in serial communication ports. Certain M91 controllers offer serial ports that may be set to either RS232 or RS485.

Jazz controllers do not contain communication ports. Note that Jazz:

- Does not comprise integral COM ports. Ports may be added via Add-on Port modules. Such modules are plugged into the Jazz Jack. An example is MJ20-PRG RS232 Programming Add-On Port, which provides the serial interface for Application program download into the OPLC.
- Serial communications capabilities are determined by the type of Add-on Module. For example, the MJ20-PRG Programming Port may be used for RS232 communications with devices that supply active (RS232 positive voltage) DTR and RTS signals.
- Default COM settings and pin-outs are given in the technical specifications of the relevant Add-on Port.

You can use the RS232 port of your PLC for several purposes:

- Direct Communications
  This means that your PC is connected to a controller via the proprietary programming cable.
- Modem Communications
  A PC can connect to a remote controller via modem.
- RS232 communications
  Use the serial port to communicate with devices that use the RS232 standard, such as GSM modems for SMS messaging, or MODBUS.
- CANbus networking (M90/91 only)
  You use your PC to access the RS232 port of that controller is integrated into an M90 CANbus network. This M90 can act as an RS232-to-CANbus bridge; via this bridge, you can access any M90 in the network
- RS485 communications (M91 according to port settings, M90 via external adapter, and Jazz, according to add-on port module type).

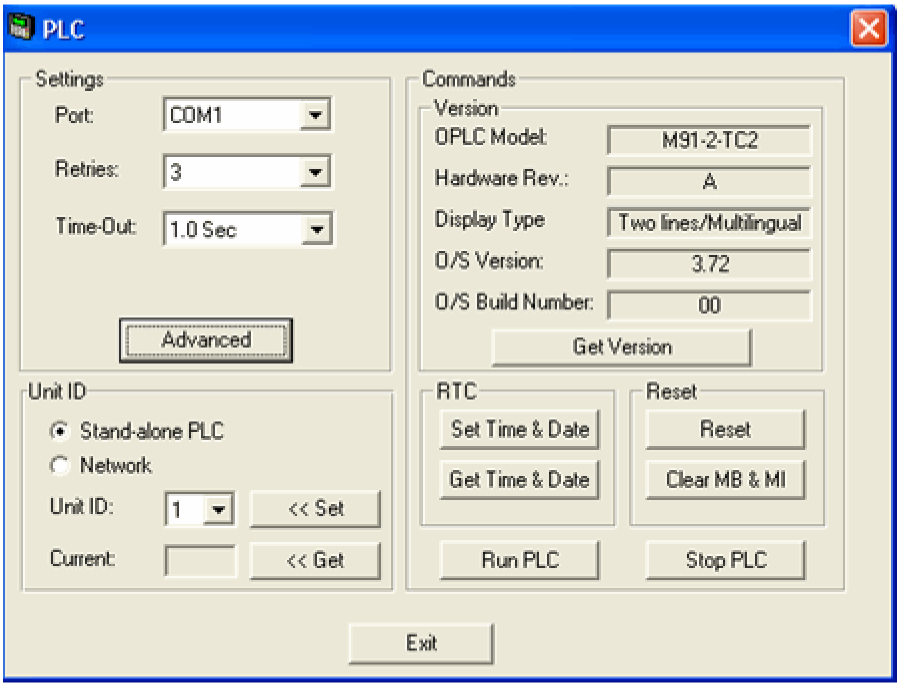
Note that a controller cannot use both SMS messaging and modem communications.

In addition, you cannot use Direct Communications and Modem Communications simultaneously. If your PC is connected directly with a controller and you dial a remote controller via modem, all communications are automatically diverted to the remote unit. You will not be able to access the directly connected controller until you 'hang up', terminating the call.

If you encounter problems, refer to the Troubleshooting Communications sections in this Help.

PLC Communication Settings

Display the current communication settings by selecting PLC from the Controller menu. The default communication settings are shown below.

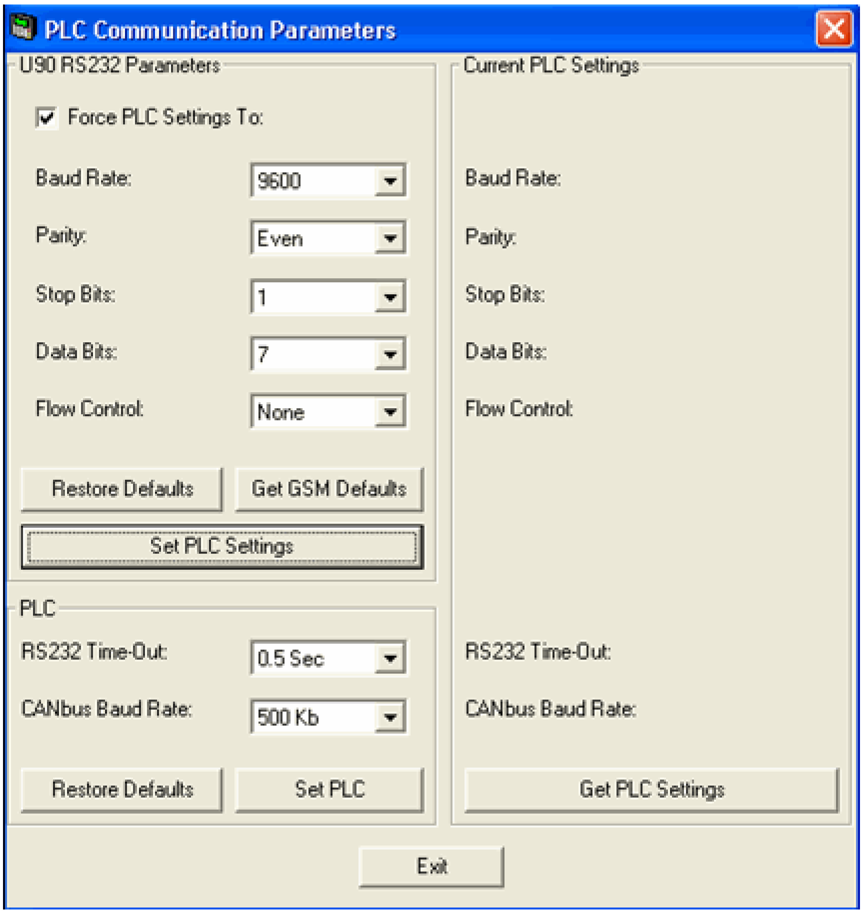


PLC Parameters

Settings	Port, Retries and Time-Out are the communication settings between U90 Ladder and the M90. Click the Advanced button to view the advanced RS232 parameters. The other settings in this box belong to your project, and relate to the M90.
Unit ID	Note that by default, projects are defined as 'Stand-alone'. If you want to integrate your PLC into a network, you must define the PLC as a member of a network and assign it an ID number. Click Get to retrieve the ID number of a directly connected M90. Click Set to change the ID number.
Commands	To display information about the PLC connected to your PC, whether directly connected or within a network, click Get Version. You can also view the current time and date settings within the PLC by clicking Get Time & Date, or import your PC's settings by clicking Set Time & Date. You can also click on Reset to initialize the PLC, and click on Clear MB & MI to initialize values.

Advanced Settings

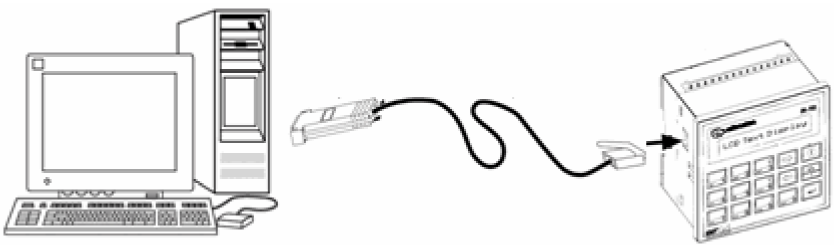
Click on Advanced. The PLC Communication Parameters box opens as shown below.



U90 RS232 Parameters	These settings are part of your U90 project. If you need to modify the default settings, click on the arrows to reveal the options. If this project is defined to 'Use Modem', we recommend that you change these settings to match the settings of the modem. If this project is defined as 'Use SMS', we recommend that you enter the settings of the GSM modem.
Force PLC Settings To:	This is checked by default, making the settings that you have selected become part of your U90 Ladder project. These settings will be installed in the M90/91 whenever communications are activated, overwriting the previous settings. Note that this does not write settings to Jazz controllers.
Restore Defaults	Click this to restore defaults
Get GSM Defaults	Click this to enter the settings used to communicate with standard GSM modems.
Set PLC Settings	Click here to write your selected settings into the M90/91. Note that this does not write settings to Jazz controllers.
Advanced	RS232 Time-Out settings may be edited. Make sure that the CANbus baud rate is the same for all networked M90 units.
Current PLC Settings	Click to retrieve the settings of the PLC to which you are directly connected. Note that this option does not work if you have defined the project as a network project.

Direct Communications- PC to PLC

Direct Communications: when your PC is connected to a PLC by the proprietary programming cable as shown below. Note that M90/91 PLCs comprise serial ports.

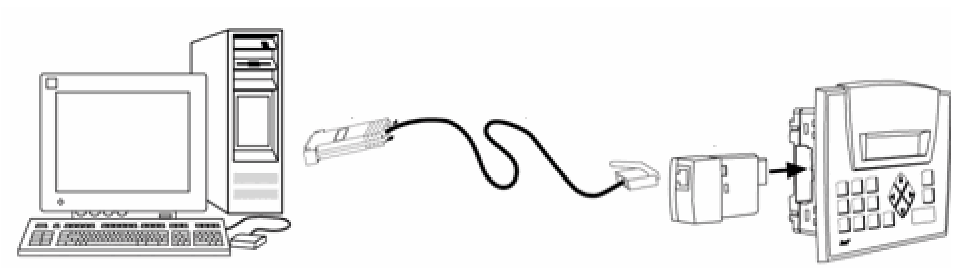


M90/91 4-wire Programming Cable Pin-out

PC Adapter MJ10-22-CS25			PLC programming port		
PC signals	**D-Type 9 pin, female**	**RJ11**	**RJ11**	**Controller signals**	
DTR (out)	4	1	6	DSR (in)	Unused
GND	5	2	5	GND	
TXD (out)	3	3	4	RXD (in)	
RXD (in)	2	4	3	TXD (out)	
GND	5	5	2	GND	
DSR (in)	6	6	1	DTR (out)	Unused

Note • The 4-wire programming cable supplied with the controller connects pins 2,3,4,5 to pins 5,4,3,2 correspondingly.

Jazz PLCs must be installed with an add-on port module, available by separate order, in order to provide a connection point for the programming cable. An example of such modules is the MJ20-PRG, which is included in the Jazz Programming kit JZ-PRG.



Jazz 6-wire Programming Cable Pin-out

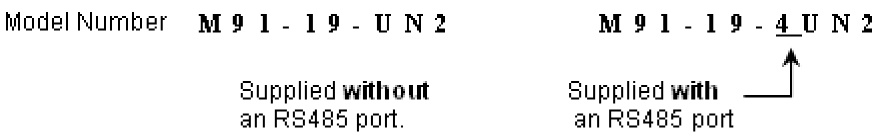
PC Adapter MJ10-22-CS10			Jazz programming port MJ20-PRG	
PC signals	**D-Type 9 pin, female**	**RJ11**	**RJ11**	**Controller signals**
DTR(out)	4	1	6	PWR (in)
GND	5	2	5	GND
TXD(out)	3	3	4	RXD (in)
RXD (in)	2	4	3	TXD (out)
GND	5	5	2	GND
RTS (out)	7	6	1	PWR (in)

Note • The 6-wire programming cable, MJ20-CB200, supplied with the programming kit JZ-PRG connects pins1,2,3,4,5,6 to pins 6,5,4,3,2,1 respectively.

COM Port Mode: RS232/RS485 (M91 only)

Certain OPLCs can be ordered with an RS485 port. Within the controller, the jumper settings determine the COM port function according to RS232 or RS485; RS485 termination settings are also determined via jumper.

To check if your controller was supplied with an installed RS485 port, check the device's model number.



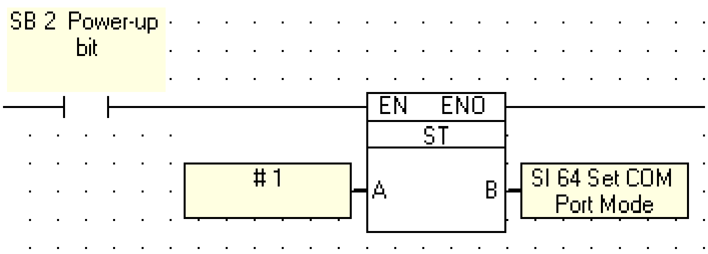
For more information regarding hardware COM settings, check the documentation M91 RS485 Port Settings.

Setting the COM Port Mode

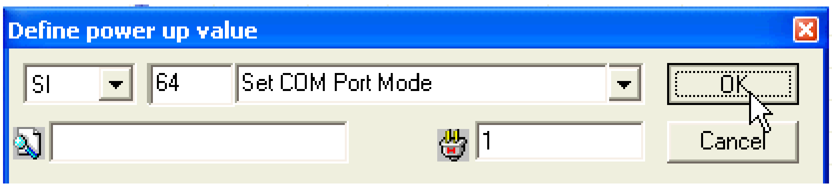
The value of SI 64, Set COM Port Mode, determines if the port will function according to RS232 or RS485. When SI 64 contains 0, the port is set to RS232, when SI 64 contains 1, the port is set to RS485.

The value in SI can only be changed via Power-up, whether via the Ladder application or by setting a Power-up value for SI 64.

Changing Mode via Ladder



Changing Mode via Power-up Value



Note • In order to change the mode, **Power-up must take place**; as for example if the power cable is temporarily disconnected.

- By factory default, SI 64 contains 0.
- When a port is set to RS485, both RS232 and RS485 can be used simultaneously if flow control signals DTR and DSR are not used.

Modems

About Modems

You can use the controller with either a PSTN modem or a cellular modem. When you use a cellular GSM modem, you can also program the controller to both send and receive SMS messages from a GSM cellular phone.

Before you can use modems in your application, you must use Modem Services to initialize both PC and PLC-side modems.

Modem services

Modem Services is located on the Connections menu.

To use Modem Services, connect the modem to a PC, using the **cable supplied by the modem manufacturer**. You can then initialize the modem.

Once you have connected initialized modems to your PC and PLC, you can use Modem Services to establish communications with a remote PLC and perform tasks, just as you would if the PLC were directly connected to your PC. For example, you can:

- Dial a remote modem via Modem services.
- Download, upload, and edit the controller program via the modem connection.
- Run Online test mode.
- Use OnLine test and Information Mode to troubleshoot problems in remote controllers and applications.
- Read and write data to/from controllers via Remote Access or Unitronics' communication .dll utilities.
- Receive and send SMS messages via SMS options.

Modem Tips

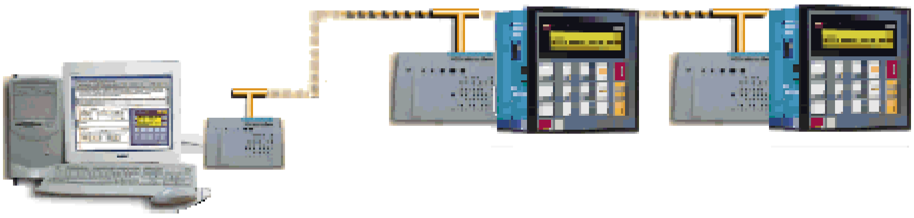
To avoid compatibility problems, use modems produced by the **same** manufacturer and of the **same** model. This is due to lack of standardization between modem manufacturers, which may result in communication conflicts.

Note

- The PC-modem cable is not the same type of cable used to connect between the controller and the modem. Ensure that the cable used to connect the PC to the modem provides connection points for all of the modem's pins.
- **Jazz Controllers**
  - Jazz controllers do not comprise an integral serial port. A Jazz controller cannot be connected to a modem unless it has been installed with an appropriate add-on port module.
  - Serial communications capabilities are determined by the type of Add-on Module.
  - Default COM settings and pin-outs are given in the technical specifications of the relevant Add-on Port.
  - The MJ20-PRG Programming Port may be used for RS232 communications with devices that supply active (RS232 positive voltage) DTR and RTS signals, such as most modems. Note that modems require an appropriate adapter.
- If calls are routed via a switchboard, note that the switchboard settings may interfere with communications. Consult with your switchboard provider
- If, within the modem initialization strings, the parameter S7 is too short to permit the PLC's modem to answer, an error will result.
  For example, if this parameter is set as S7=30, the PC modem will wait for 3 seconds to

receive an answer from the PLC's modem. If the PLC modem does not answer before the 3 seconds have elapsed, the S7=30 parameter is exceeded, and the PC modem will return the No Carrier error.

- PC/PLC modem communications: **Both** PC and controller must use the same type of modem: either **landline** or, **GSM**.



- Known compatibility issue: Sony Ericsson Modems.

  Unitronics products are compatible with the following Sony Ericsson Modems:
  - - Model GT47 R5xxxx and higher
  - - Model GM29 R6xxxx and higher

  This means, for example, that Unitronics cannot guarantee compatibility with a Sony Ericsson Modem model GM29 R4xxxx.

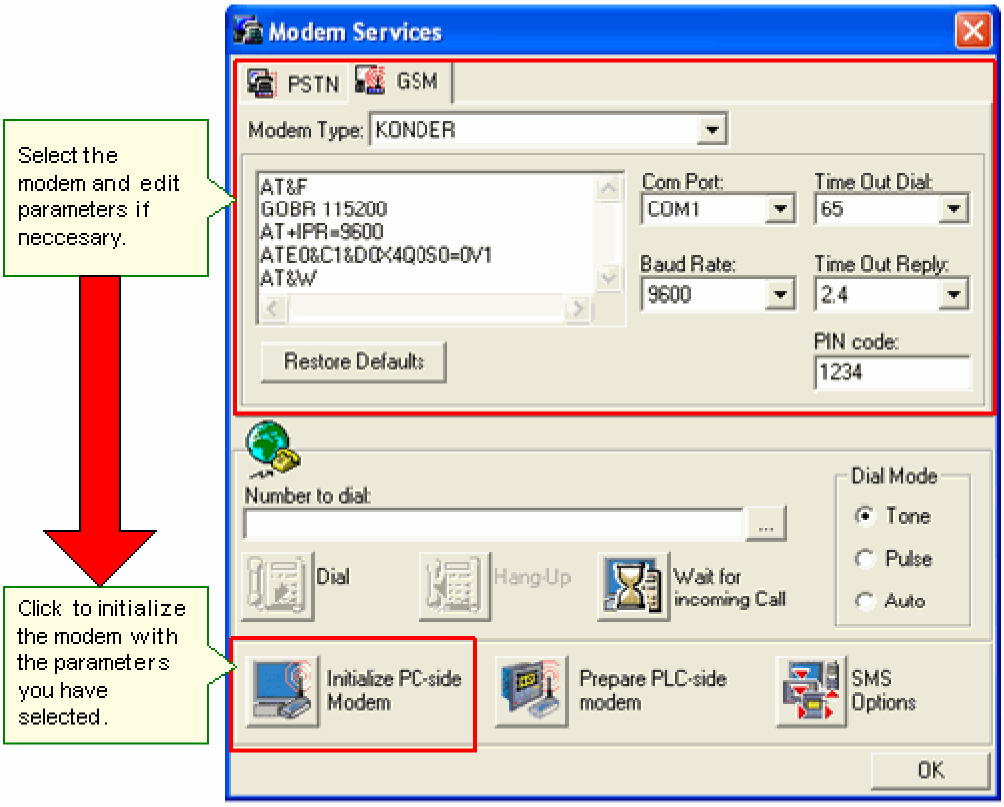
For advanced users, check: How the PLC works with a modem.

PC-Side Modems (Modem Services)

Before integrating modems into your applications, check the section Modems-Tips & Cautions.

Initialize PC-side Modem

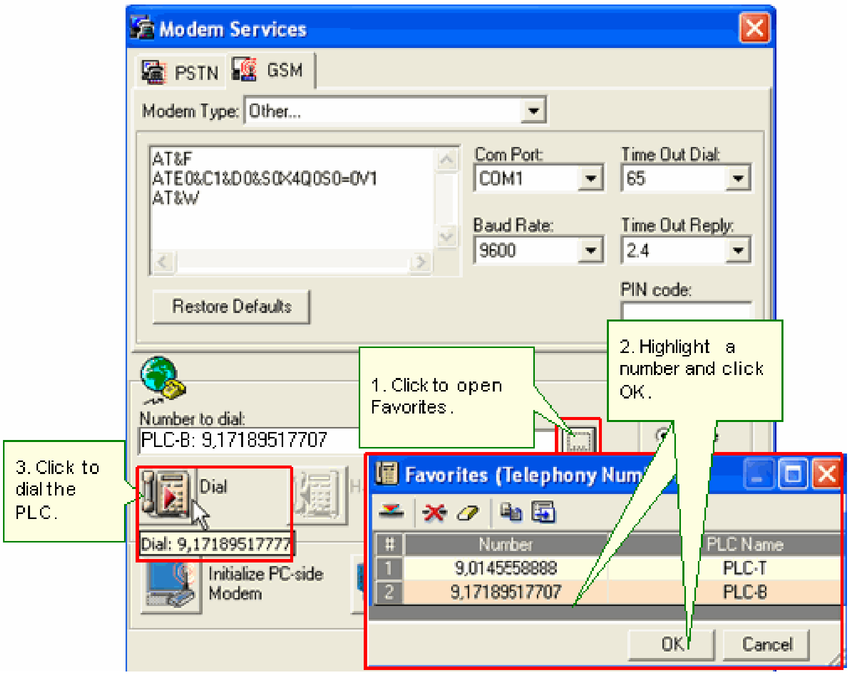
1. Connect the modem to a PC, using the cable supplied by the modem manufacturer.
2. Open Modem Services from the Connection menu.
3. Select and enter the modem parameters:
   1. At the top of Modem Services, select a tab; the Modem Type selection box shows the options.
   2. Select the PC modem type; the initialization strings change accordingly.
   3. If required, you can edit other parameters:
      - Initialization commands: click in the field and enter text.
      - Com Port, baud rate, Time Out, and Time-Out Reply: use the drop down boxes
      - PIN code: click to enter the number.
   4. When all parameters are set, click the Initialize PC Modem button; the PC establishes communication with the modem and initializes it.



How to use the PC modem to access a PLC

1. Prepare and connect the PLC-side modem as described in the topic PLC-side Modems, in the section Enabling a Controller to Communicate via Modem.
2. Dial the PLC to establish the communication link:
    1. Click the button to the right of the Number to Dial field to open Favorites and select a number, **Favorites** (Telephony)You can keep a list of frequently-used numbers in Favorites.

- Click a line to enter or select a number and description. To access outside lines, enter the access number required, a comma, then the phone number.
- Click Dial.



3.Enter OnLine (Debug) mode.

4.To break the data link, click Hang-Up.

Wait for Incoming Call

Click this button to place the PC modem in auto-answer mode.

Communication Log

When you dial a remote modem using U90 Ladder, a window opens up in the bottom of your screen. The log of events is quickly displayed in this window. This log is stored as a .txt file. You can view this log by navigating to the U90 folder and opening a file named U90ldxxx.txt.

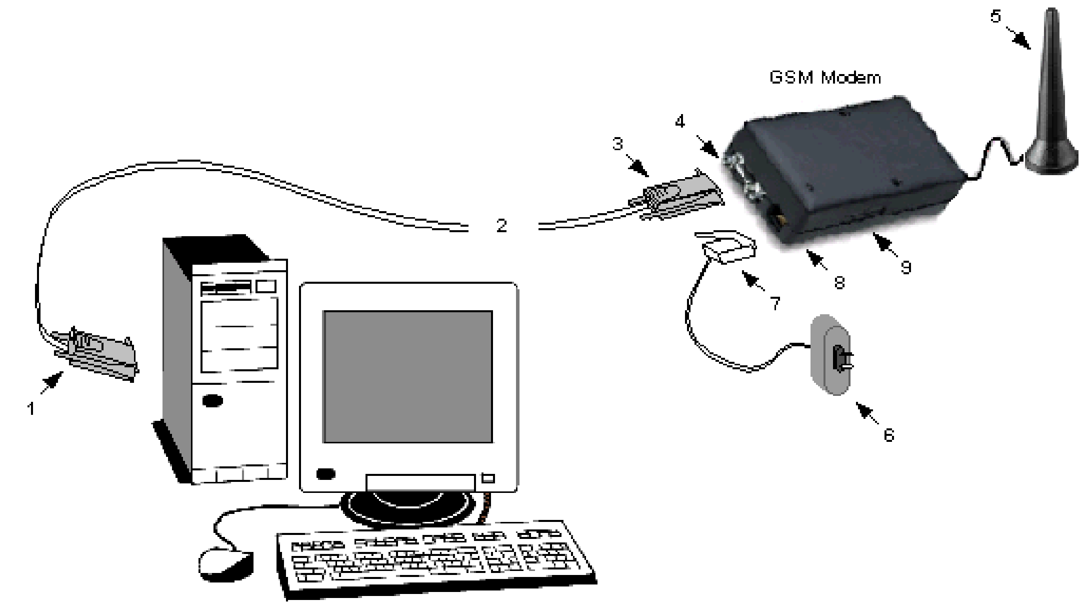
This log is stored as a .txt file. You can view this log by navigating to Unitronics\U90_Ladder\U90Ldxxx and opening a file named ComLog.txt.

In this file, the most recent log of events appears **last**.

Using a PC to access a PLC via GSM modem

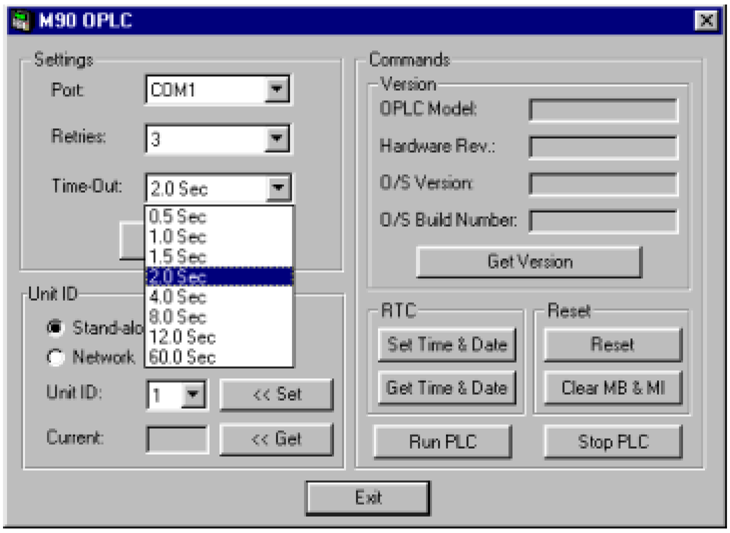
To use a PC running U90 Ladder to access a remote PLC for programming and maintenance via GSM networks:

1. Connect your PLC to the GSM modem according to the instructions supplied with the GSM Modem Kit.
2. Connect your **PC to the GSM modem**.
   If you have carried out the Prepare Modem procedure, you can skip steps 3 and 4.

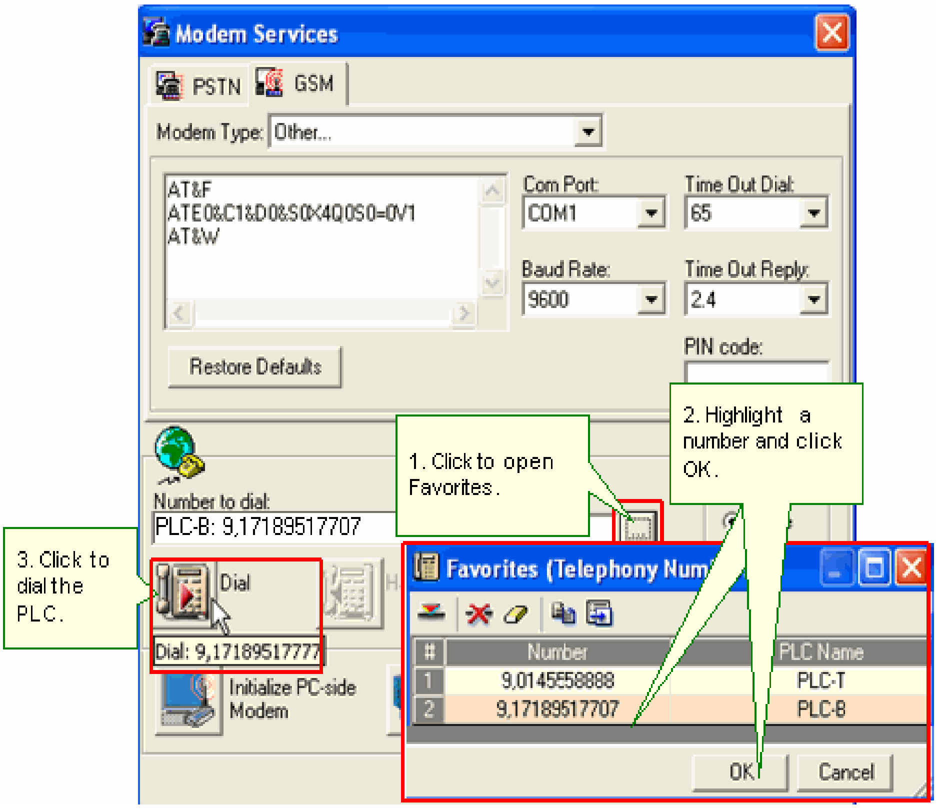


1	RS232 connector
2	RS232 cable MJ10-22-CS28 (available by separate order)
3	RS232 connector
4	GSM Modem serial port
5	GSM antenna
6	Power supply PS-GSM modem (available by separate order)
7	RJ11 connector
8	GSM modem power supply
9	SIM card drawer

3. Configure **U90 Ladder's modem initialization commands.**
   a. Open the PLC box by selecting PLC from the Controller menu.
   b. Set the PLC's Time-Out to 2 seconds as shown below. This should allow sufficient time for PC-to-PLC communications via the GSM modem.



2. Dial the **remote PLC modem from your PC.**



Note • Both GSM modems must contain SIM cards capable of data transfer. Check with your SIM card supplier to see if your SIM card is capable of data transfer.

• Note that only 3V SIM cards can be used with the GSM modem supplied with the Unitronics' GSM Modem Kits.

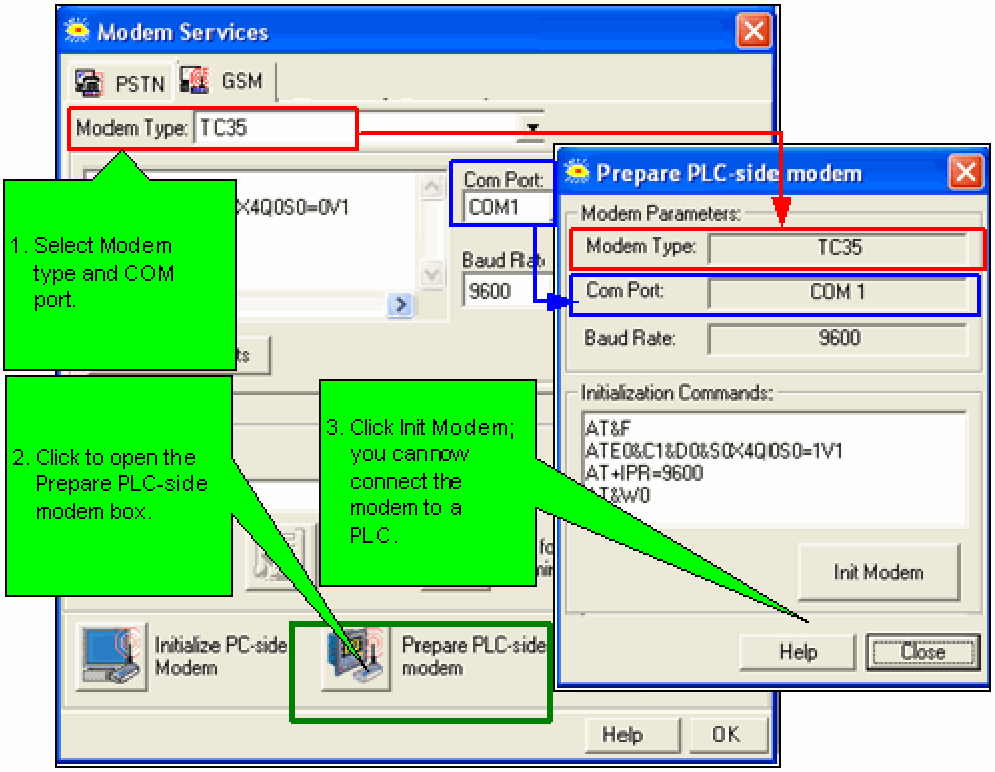
PLC-side Modems

The PLC can use a landline or GSM modem to send and receive calls. A programmer can also use a PC's modem to communicate with a remote PLC that is connected up to a modem.

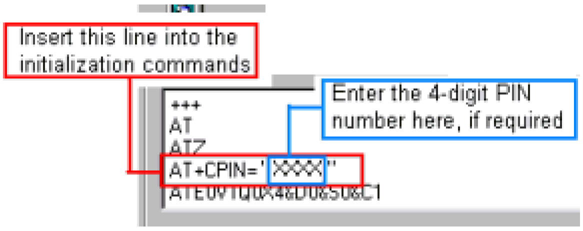
Before integrating modems into your applications, check the section Modems-Tips & Cautions.

Enabling a Controller to Communicate via Modem

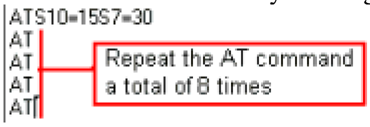
1. Connect the modem to a PC, using the **cable supplied by the modem manufacturer**.
2. **Prepare the PLC modem**.
   1. Open Connection>Modem Services, and select the modem type and COM port.
   2. Selecting a Modem
      - At the top of Modem Services, select a tab; the Modem Type selection box shows the options.
      - Select the PLC modem type; the initialization strings change accordingly.
      - To edit strings, click in the field and enter text.
      - Edit other options as required. If your GSM modem requires a PIN code, enter the number.
   3. Click the Prepare PLC-side Modem button; that dialog box opens.
   4. When all parameters are set, click the Init PC Modem button; the PC establishes communication with the modem and initializes it.



   5. If you are using a SIM card that has a PIN number, enter a new initialization command AT+CPIN="XXXX", where XXXX is the 4-digit PIN #.



6. End the list of commands by entering the AT command eight times as shown below.

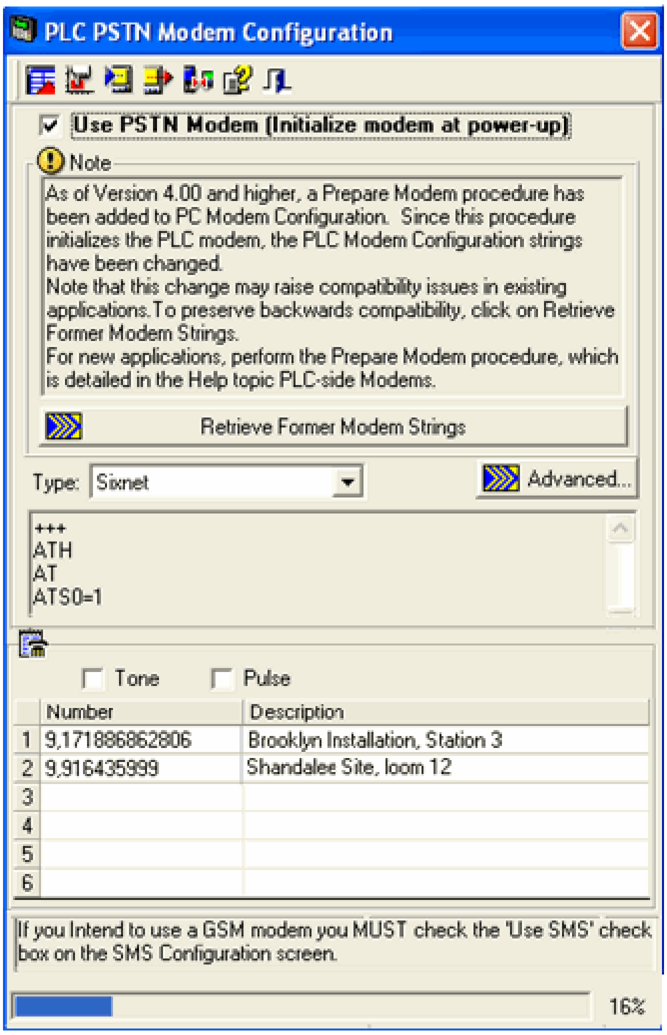


3. Ensure that the PLC port is initialized via either SB 72, Modem Initialization, or SB 180 Initialize GSM Modem for SMS.

PSTN Modems

1. Open the PLC Modem Configuration box by selecting Controller> PLC Modem Configuration.
2. Check the 'Use PTSN Modem' box shown below. This causes the PLC to automatically turn on SB 72, Initialize Modem, at power-up. Note that:

- If the Use Modem option is selected, at power-up the modem will be initialized with the customized strings and parameters that you selected during the Prepare PLC Modem procedure.
- If the Use Modem option is not selected, the default Modem strings and settings contained in PLC Modem Configuration, shown below, will be used to initialize the modem.

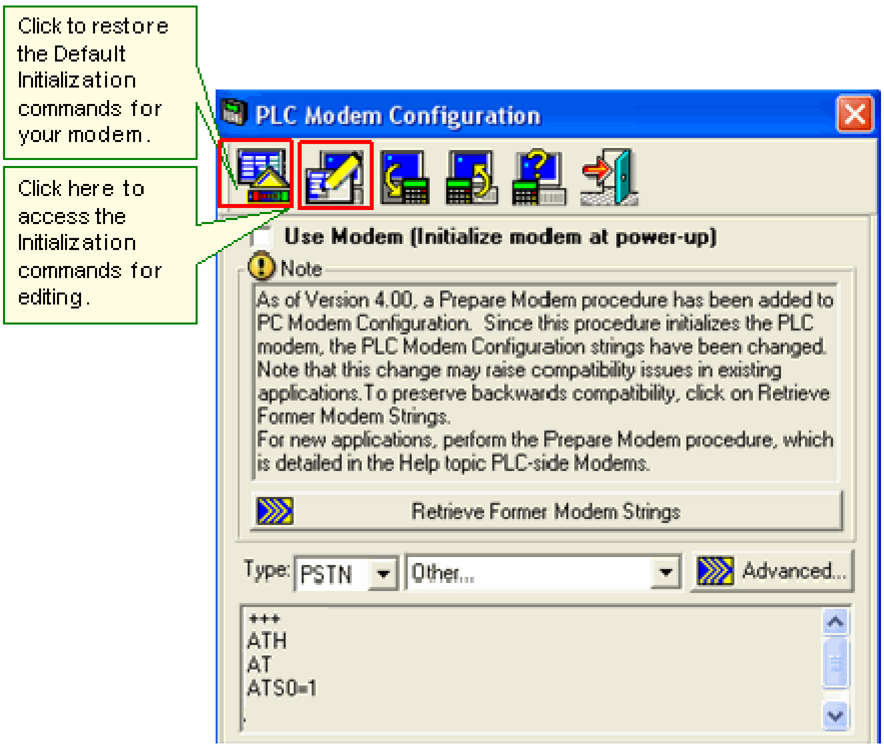


3. If your application requires, you can edit the **initialization commands**.

- To edit initialization commands, click on the Edit Initialization Commands button shown below.
  The window containing the commands turns white; you can now add, delete or edit commands.

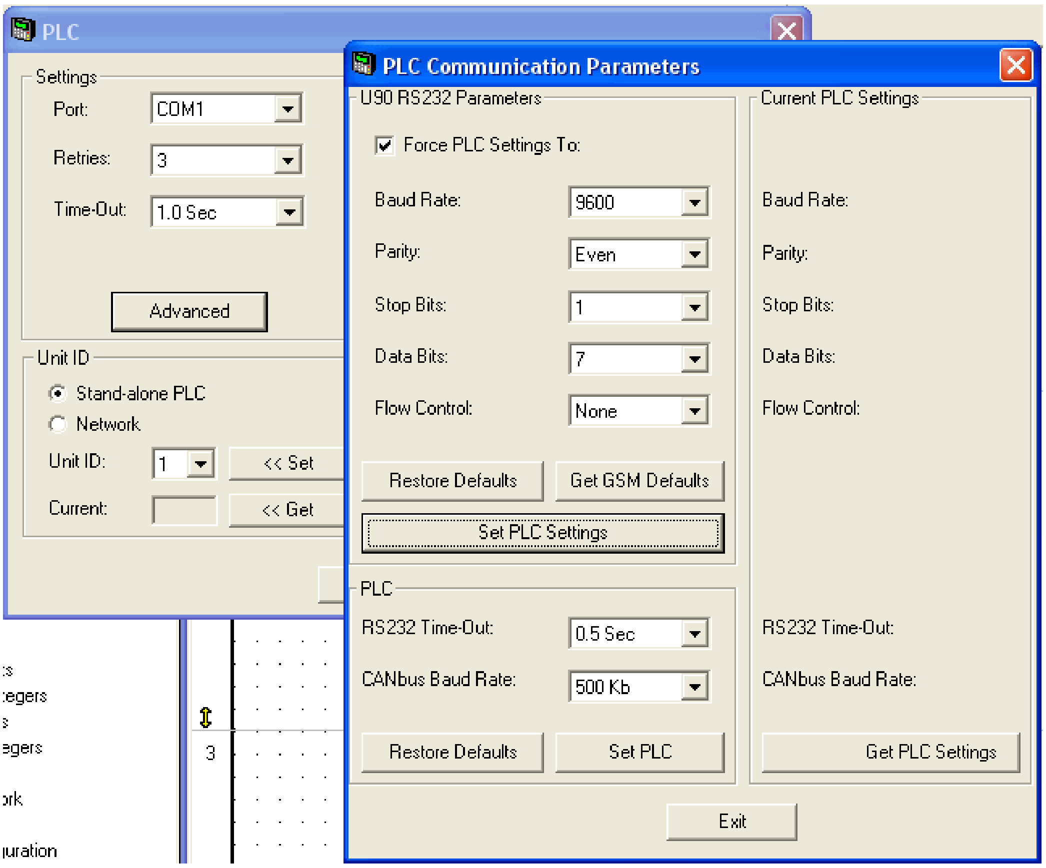
Note • Applications previous to U90 Ladder 4.0.

The Prepare Modem procedure was integrated into U90 Ladder starting with version 4.00. If you are working with an application created using an earlier version, you can restore the older, default modem commands by clicking the Retrieve Former Modem Strings button.

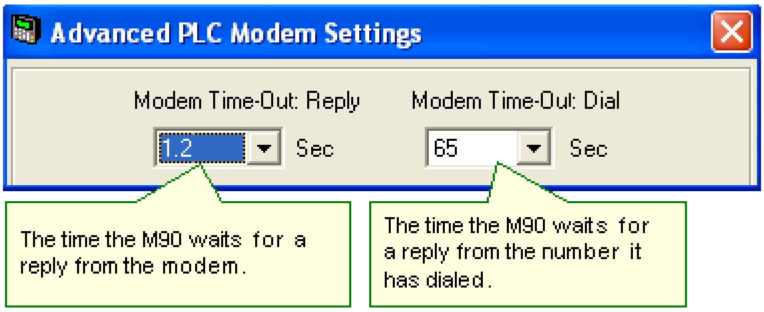


You can also enter a**wait command**.

4. The U90 Ladder default modem settings are: 9600, 8 data bits, no parity, 1 stop bit. If required, you can change the setting to match the **Prepare PLC Modem strings by clicking Controller> PLC> Advanced button to open PLC Communication Settings, and then changing the parameters and selecting Force PLC Settings.**



5. Select whether to use pulse or tone dialing, as is required by your system, by clicking on the appropriate box. You can also leave both blank (default).
6. You can also edit the **modem's time-out settings**.
   - Display the Modem Time-out settings by clicking the Advanced button. Set the appropriate times as shown below.



1. To enable the PLC to dial via modem, enter numbers in the **Phone Book**

   The Phone Book is where you define the list of numbers that the PLC can dial.

   You can enter up to six numbers. Each phone number is automatically linked to an index number. In your application, you store the index number of the phone number you want to dial into SI 71. Then, when SB 77, Dial, turns ON, the PLC dials that number.

   Each phone number can be up to 18 characters long. You can also add a description to identify the location or other details of the number to be dialed.

Entering numbers in the Phone Book

1.Click on an empty line in the Phone Book, then type in the number, **exactly** as you would dial from a standard phone, including area codes. To dial an outside line, enter the prefix number required and follow it with a comma as shown below.

This comma causes the short pause, or delay, that is required by many systems.

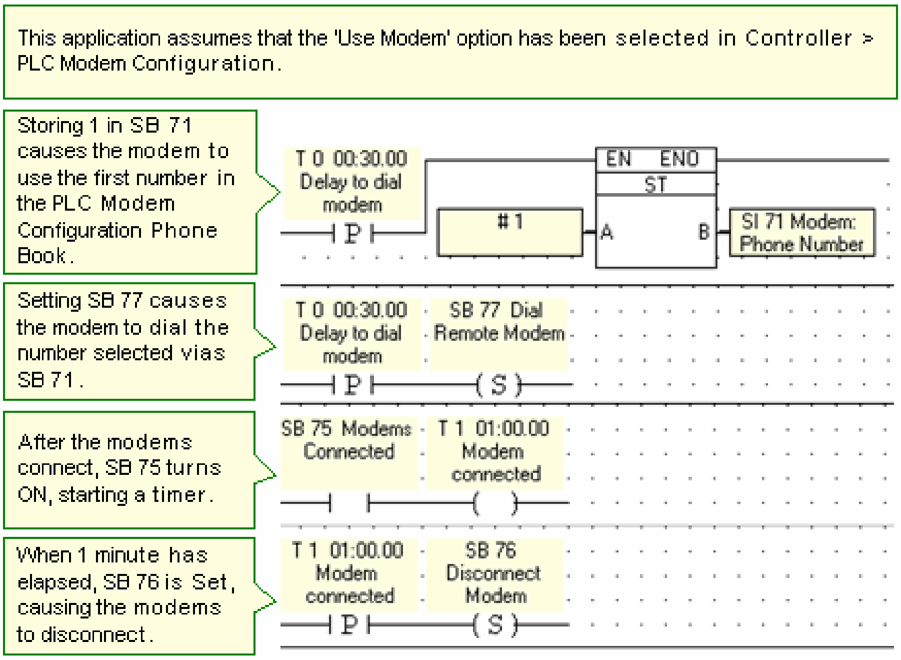
To edit the phone book, click in a number or description, then make your changes.

GSM Modems

1. Under Controller>SMS Configuration, select Use GSM Modem. This turns on SB 180 Initialize GSM Modem for SMS.

5. **Build a Ladder program containing the correct conditions and elements.**

Note • Communications cannot flow through the port during initialization. To avoid conflicts in your program, use the Modem Initialization SBs**.**



6. Download the application to the PLC.

7. Connect the modem to the PLC.

After the modem is enabled and successfully initialized by the PLC (SBs 72 & 73 turn ON), the controller can either be accessed via modem or can dial a remote modem to establish a data link.

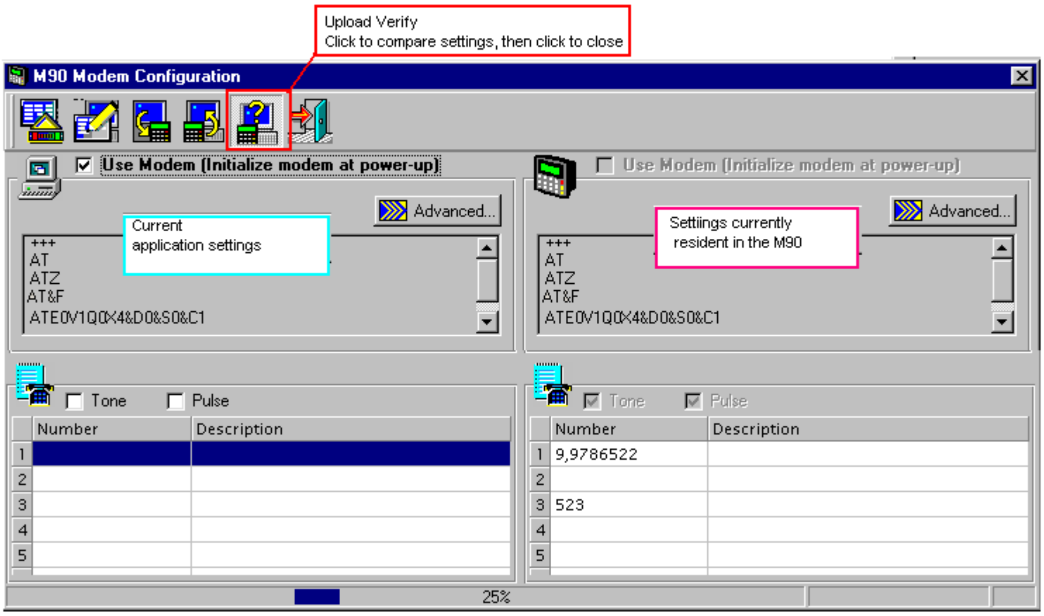
8. To terminate the call, turn SB 76 Disconnect Modem ON.

Downloading, uploading, and comparing settings

You download modem settings **to** the PLC by clicking the Download button on the tool bar. You can also upload settings **from** the PLC by clicking the Upload button. Note that downloading overwrites any settings that may already be in the PLC; uploading settings overwrites any settings that you have made in your application.

You can **compare** your application's modem settings to the settings that are already within the PLC--before downloading or uploading:

1. Display the settings for both your application and the PLC by clicking on the Upload Verify button.
2. Two windows open. The left window shows the settings you have set in your application; you can edit these settings. The right window shows the current settings within the PLC; these are read-only.



Note that an PLC cannot be configured for **both** SMS messaging and modem communications. If this is done, SMS messaging will override modem communications--the PLC will not be able to use the modem.

Modem Troubleshooting

Before integrating modems into your applications, check the section **Modems-Tips & Cautions.**

Modem commands

Note □ The modem must reply with either OK or READY to each command entered. If the modem fails to answer, the command has not been processed.

+++	Escape Sequence. This causes the modem to close connections and go back to command mode
AT	This command means Attention; and is used to begin a session
AT&F	Restores factory default settings
ATZ	Resets the modem. This command may take time to implement, so the response from the modem may be delayed
ATE0	No Echo
V1	Enable Verbose (long) response
Q0	Respond
X4	Detailed answers
&D0	Ignore DTR
&D2	Once DTR falls, disconnect and go to command mode
&D1	Once DTR falls, disconnect
&S0	DSR always ON.

	Since the DSR can be permanently set to ON, connecting it to the RTS causes the terminal always be ready to transmit\receive data
&S1	DSR OFF in command and test modes
&C1	Give the user a signal for the DCD
&C0	Don’t give the user a signal for the DCD (refers to LED indications where relevant)
ATS0=1	Auto-Answer after 1 ring
S0=0	Modem doesn't answer. Forces PLC to answer with ATA (pickup)
S10=15	Sets the time (in units of 0.1 sec) from the time when CD is not detected, until the string NO CARRIER is shown. If the value is 255, then the CD signal will not fall—even if the modems are no longer connected
S7=30	Time-out: If this time is exceeded, the modem notifies that dial has failed
S12	The modem register that defines the time interval during which the line must remain clear, before and after the +++ command.
&W	Burn the configuration into the modem’s non-volatile memory. **Note** □ This is part of the COM Init FB's modem default initialization strings.

PLC to modem connection and cable pin-out

PC-side modem, error messages

This deals with errors that may result from the PC's modem

Message	Cause
Com Port not open, or modem does not exist	The PC was unable to access the PC port. The port may: -Already be in use -Be damaged.
Modem not connected	The PC receives no reply from the modem following the 'AT' command. Check that: -The modem is connected to the same PC port you have defined in Modem Services. -The PC-modem cable is in proper order.
Modem not initialized	The modem was not successfully initialized. Check the topic: Using Hyperterminal for Modem Troubleshooting
The messages below describe the modem 's status if the PC dial attempt (ATD+ number) fails. Any one of these errors aborts the Dial process.	
Modem Busy	
Modem Error	
No Dial Tone	
No Carrier	**Note** □ This can occur if, within the modem initialization strings, the parameter S7 TimeOut, is to short to permit the PLC's modem to answer. For example, if this parameter is set as S7=30, the PC modem will wait for 3 seconds to receive an answer from the PLC's modem. If the PLC modem does not answer before the 3 seconds have elapsed, the S7=30 parameter is exceeded, and the PC modem will return the No Carrier error.
Dial time-out exceeded	No reply was received from the modem within the defined time.
The messages below only relate to unsuccessful GSM modem initialization.	
GSM SIM card blocked	
GSM SIM card does not exist	

Illegal GSM PIN code
GSM Network not found
Time-out exceeded

PLC-side modems

These errors may result from problems in the PLC-side modem

Message	Possible cause	Recommended action
Modem Busy	Modem is engaged, or is being initialized	Check that the line is free. Use the **SBs: Modem Initialization Status** listed above to check the COM port status; communications cannot flow through the port during initialization. For more information check the topic How the M90 works with a modem.
Handshake between modems complete ('CONNECT'), PLC does not reply	Modem adapter cable	Check the PLC-to-modem connection and pin-out, particularly that the DSR is connected to the RTS on the modem side.
Problem	**SB74**	**Possible Cause & Recommended Action**
Modem fails to initialize	ON	• PLC-to-modem cable: Make sure that the cable is securely connected. Check the modem connection and pin-out of the PLC-to-modem adapter cables. • Incompatible communication settings. Most modems automatically match the parameters of incoming data: baud rate, data bits, parity & stop bits. You may need to manually change your modem's communication settings via Hyperterminal.

These errors may result from problems in the PLC-side modem

PLC modem communication problems

If your PLC is transferring data via modem, you can begin troubleshooting by entering Information Mode. You can then check the status of relevant System Bits and Integers to help diagnose the problem.

To begin diagnosing the problem, check the error code contained in SI 70. Refer to the error code table in How the PLC works with a modem.

The tables below show the more common causes of modem communication problems.

Problem	SI 70 value	Possible Cause & Recommended Action
Modem fails to initialize	2: Modem Did Not Reply	PLC-to-modem cable: Make sure that the cable is securely connected. Check the PLC modem connection and pin-out of the PLC-to-modem adapter cables. Note that if you use cables comprising this pin-out, you must set the RS232 parameter Flow Control to N (none). Incompatible communication settings. Most modems automatically match the parameters of incoming data:

		baud rate, data bits, parity & stop bits. The PLC's embedded modem settings are: 9600, 8 data bits, no parity, 1 stop bit. You may need to manually change your modem's communication settings to match these via Hyperterminal.
	0: No Error	SB 72 OFF: In order to work with a modem, you must select 'Use modem' in the PLC Modem Configuration box . This causes SB 72 Initialize Modem to turn ON when the PLC powers up. Note that if the PLC has also been configured to use SMS messaging, that the PLC will not be able to connect to a modem because the SMS feature overrides the modem. Check too, that SB 72 is not disabled in your program.
	6: Modem Report Error	Check the modem initialization commands. Refer to Configuring the PLC to use a modem.

Other problems:

Problem	Possible cause	Recommended action
Modem is busy	Modem is engaged, or is being initialized	Check that the modem is free. Use the SBs: Modem Initialization Status listed above to check the COM port status; communications cannot flow through the port during initialization. For more information check the topic How the PLC works with a modem.
Handshake between modems complete ('CONNECT'), PLC does not reply	Modem adapter cable	Check the PLC-to-modem connection and pin-out, particularly that the DSR is connected to the RTS on the modem side, as shown in Modem Connections above.
PLC does not dial	Incorrect phone number	Check the PLC's phone book. Refer to Configuring the PLC to use a modem.

GSM modems

Problem	Possible Cause & Recommended Action
Cell phone does not receive message	Check the cell phone's SIM card; it may be full.

Check SMS System Bits and Integers for error messages

Using Hyperterminal for Modem Troubleshooting

You can use a standard Windows application called Hyperterminal to perform certain tasks, such as changing a modem’s communication rate.

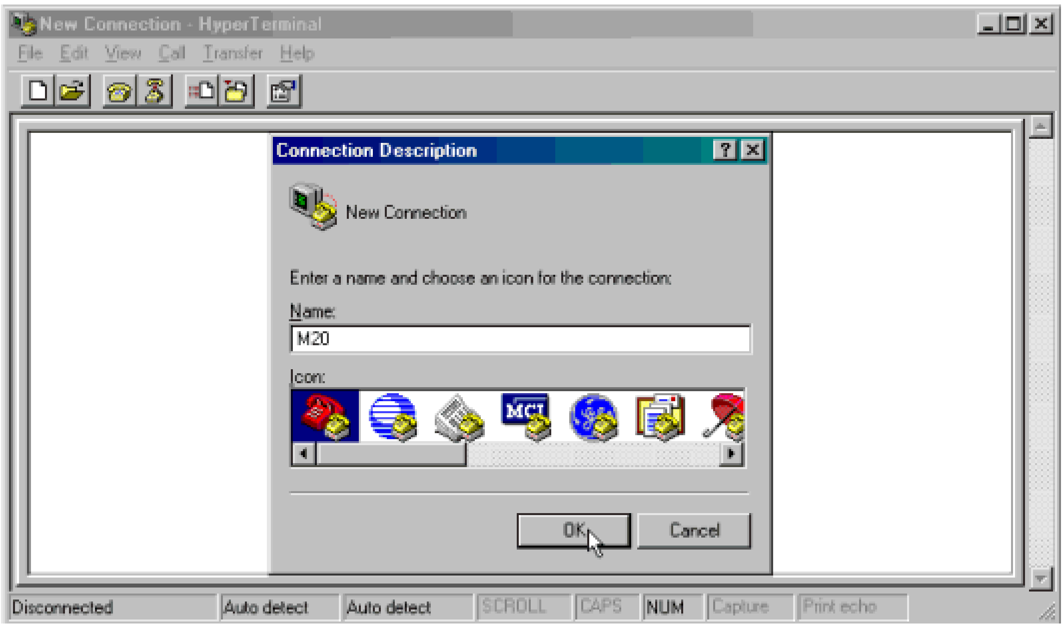
Note □ The modem driver does not need to be installed in order to access the modem via Hyperterminal.

Using Hyperterminal

1. Open Hyperterminal. The program can generally be located by clicking the Start button in the lower left corner of your screen, then selecting Programs>Accessories>Communications>Hyperterminal. The

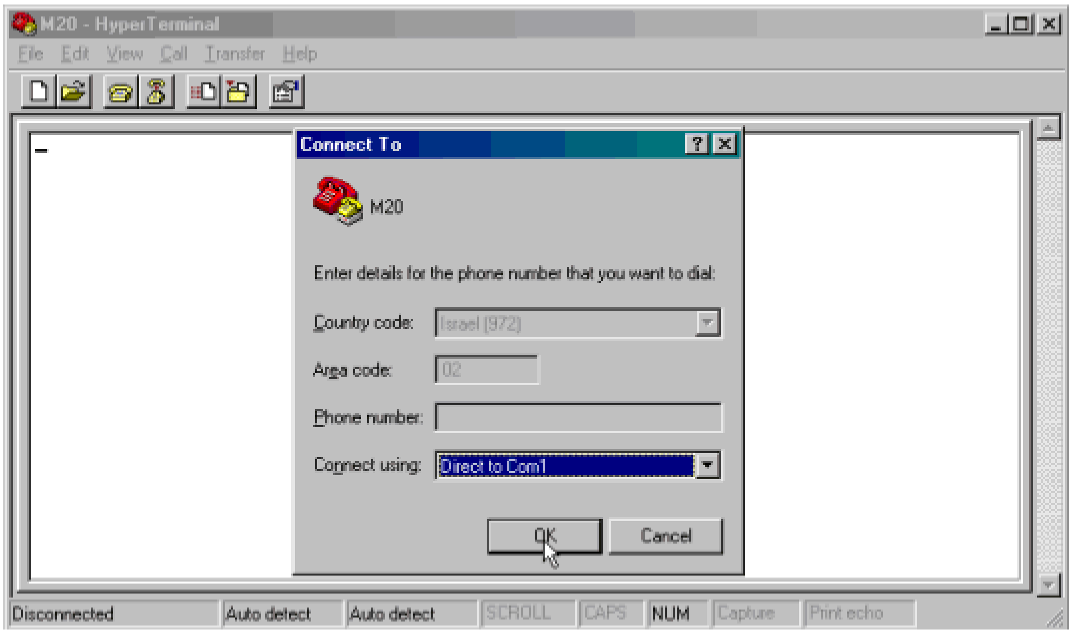
New Connection window opens as shown below.

Note □ Hyperterminal generally starts by pointing to the internal modem, if one is installed on the PC.

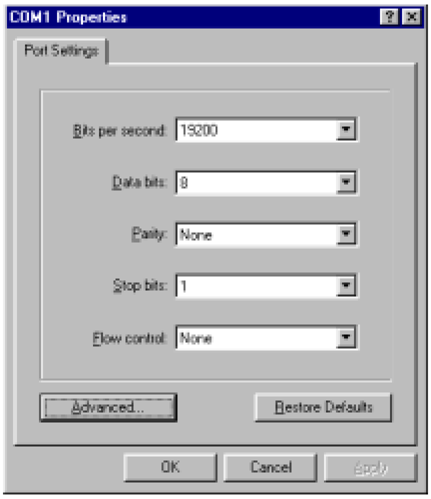


2. Enter a name for the new connection and select an icon, and then click OK. The Connect To box opens .

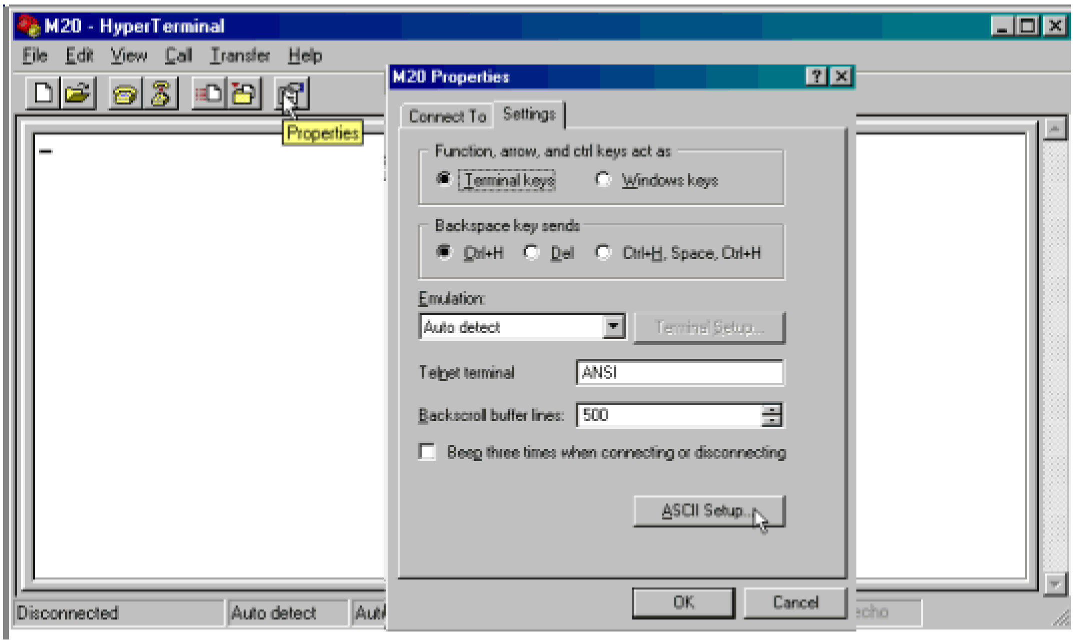
3. Select a COM port for the modem, and then click OK.



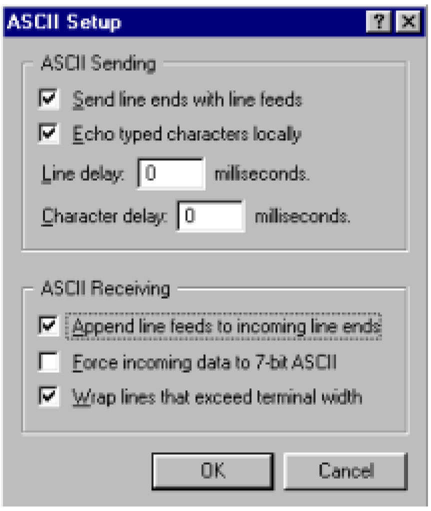
4. The Port Settings box opens as shown below. To enable your PC to communicate with the modem, set the COM port parameters to a BPS of either 9600 or 19200, Data bits=8, Parity=N, Stop bits=1, Flow control=None, and then click OK.



5.Open the modem's Properties box by clicking on the Properties button, then open ASCII Setup.



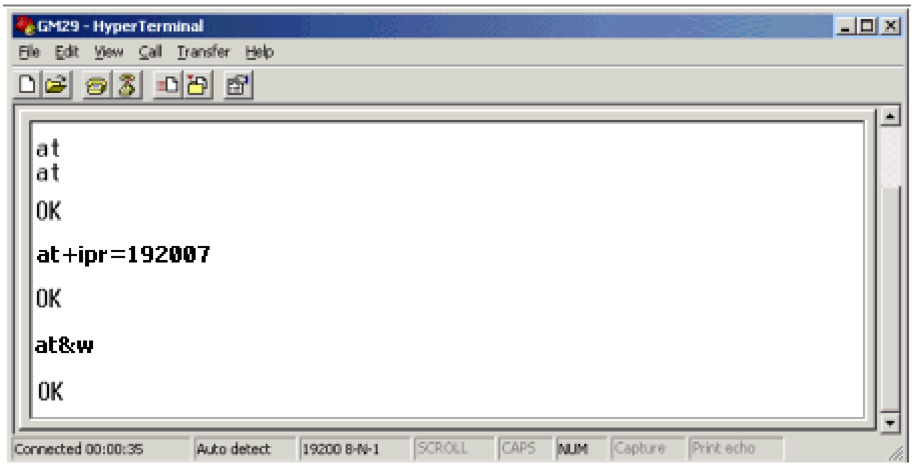
6.Select the options shown below, and then click OK.



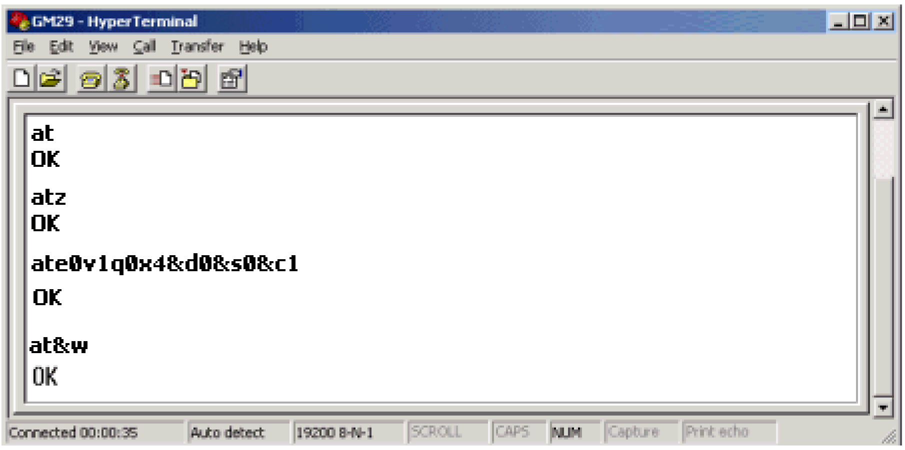
Hyperterminal is now connected to your PC via Com 1; the ASCII settings now enable you to enter commands via the PC keyboard and see the replies from the modem within the Hyperterminal window.

To test the connection, type AT; if the connection is valid the modem will respond 'OK'.

To change the modem’s baud rate, type AT+IPR=19200&W; the command '&W' burns the new baud rate into the modem's non-volatile memory.



Typical initialization strings used with an Siemens M20-type modem are shown below.



Modem Commands

Note □ The modem must reply with either OK or READY to each command entered. If the modem fails to answer, the command has not been processed.

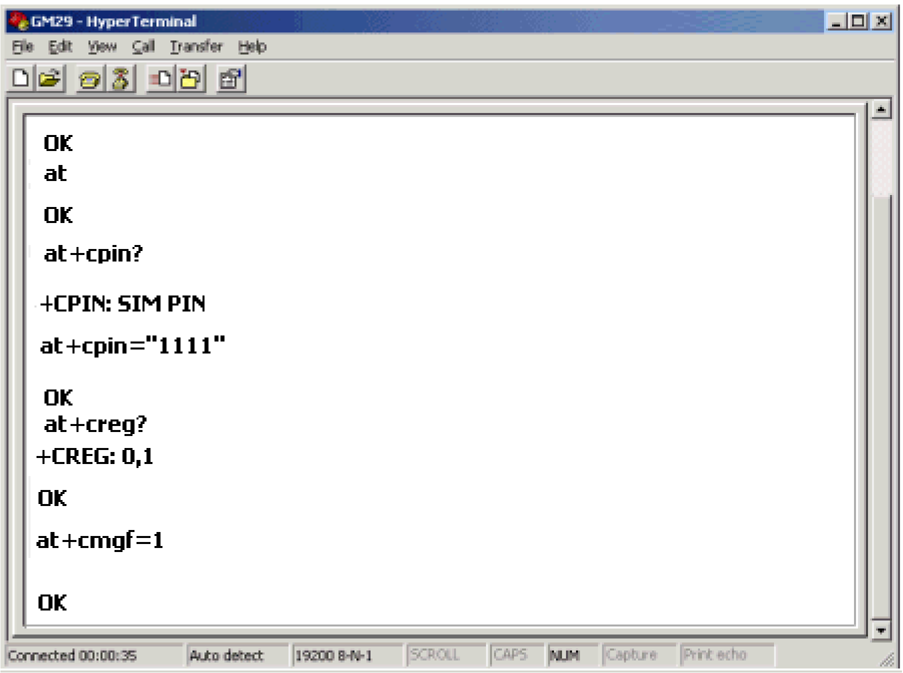
+++	Escape Sequence. This causes the modem to close connections and go back to command mode
AT	This command means Attention; and is used to begin a session
AT&F	Restores factory default settings
ATZ	Resets the modem. This command may take time to implement, so the response from the modem may be delayed
ATE0	No Echo
V1	Enable Verbose (long) response
Q0	Respond
X4	Detailed answers
&D0	Ignore DTR
&D2	Once DTR falls, disconnect and go to command mode
&D1	Once DTR falls, disconnect

&S0	DSR always ON. Since the DSR can be permanently set to ON, connecting it to the RTS causes the terminal always be ready to transmit\receive data
&S1	DSR OFF in command and test modes
&C1	Give the user a signal for the DCD
&C0	Don't give the user a signal for the DCD (refers to LED indications where relevant)
ATS0=1	Auto-Answer after 1 ring
S0=0	Modem doesn't answer. Forces PLC to answer with ATA (pickup)
S10=15	Sets the time (in units of 0.1 sec) from the time when CD is not detected, until the string NO CARRIER is shown. If the value is 255, then the CD signal will not fall—even if the modems are no longer connected
S7=30	TimeOut: If this time is exceeded, the modem notifies that dial has failed
S12	The modem register that defines the time interval during which the line must remain clear, before and after the +++ command. **Note** □ In the M90, this value is fixed on the M90 side and is not entered into the modem. If the controller cannot hang up, register S12 should be checked to ensure that the pause =1.2 sec
&W	Burn the configuration into the modem's non-volatile memory

Initializing the modem to SMS mode via Hyperterminal

Once the modem is successfully initialized, you can use Hyperterminal to initialize the modem to SMS mode.

Command	Description	Notes
at+cpin=?	Is a pin number required?	
at+pin="xxxx"	Is the pin number set in the application?	XXXX is the PIN number coming from the U90 application.
at+creg?	Has the SIM card been registered with the local cellular provider?	Should return one of two answers: • +CREG: 0,1 The SIM is registered with its local provider. • +CREG: 0,5 The SIM is in **roaming** mode.
at+cmgf=1	Go to text mode	



Notes • Commands including question marks are run for verification **twice**. If the command is not verified during the second attempt, the attempts stop.

- If the SIM requests the PUK number, the SIM must be taken out of the modem and installed into a phone to enable the number to be entered.
- If the SIM is full, the SIM must be taken out of the modem and installed into a phone to enable the SIM to be cleared.
- The modem must be able to support Text mode. P.D.U. mode is not supported.

When a controller sends an SMS text message

- The controller uses the Send command, containing the number to be called: AT+CMGS= ”phone number”.
- The controller then waits for the reply '>'.
- When the '>' is received, the controller sends the message, ending the line with CTRL_Z
- If the message is successfully sent, the controller will receive a message of confirmation,+CMGS:xx. When this message is received by the controller, SB 184 turns ON. The confirmation message is acknowledged by OK.
- If :
  the message of confirmation is not received within 15 seconds, or
  the '>' is not received within 3 seconds, SB 185 turns ON.

When the controller receives an SMS text message:

- It receives the command: +CMTI: “SM” ,xx. Xx is a number in the controller's memory, 1 to 20.
- When the message is received, the controller asks the modem for the text via the command AT+CMGR=xx
- The modem replies with +CMGR, including the phone number, status, text, and concluding with OK.

Note • When a Com port has been successfully initialized, the relevant bit turns ON: SB 80 , 82, 83 or 84.
If initialization fails, SB 81, 83, 85, or 87 will turn ON.

'The Sniffer'--Viewing communication strings

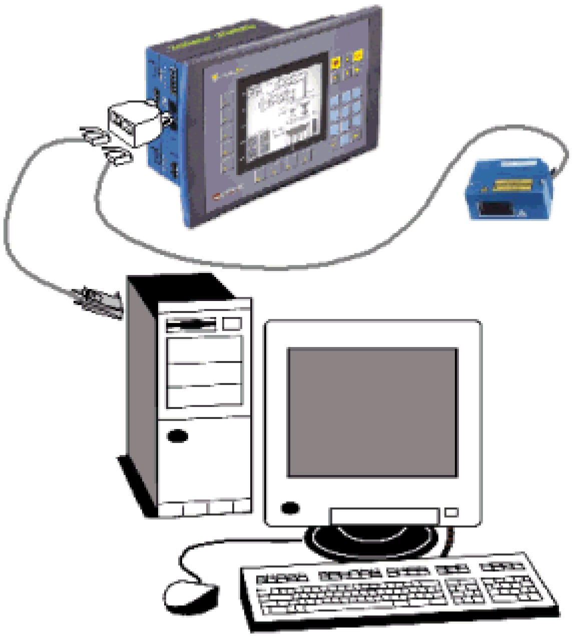
The instructions below show you how to construct a communications 'Sniffer'. This device enables you to use Hyperterminal to view communication strings flowing between a PLC and an external, connected device such as a bar code reader.

'Sniffer' is connected to the external device.

'COM' is connected to the PLC.

The completed Sniffer is connected to a PLC communication port, PC and external device.

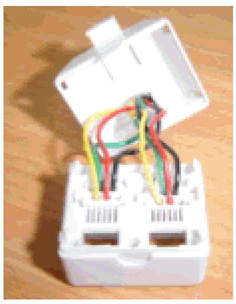
Note that communication cables are the programming cable provided by Unitronics.



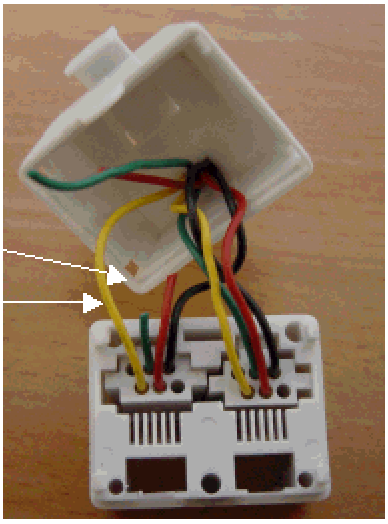
To make a Sniffer, you need:

- An adapter.
- Two 1N4148 or 1N914 diodes.

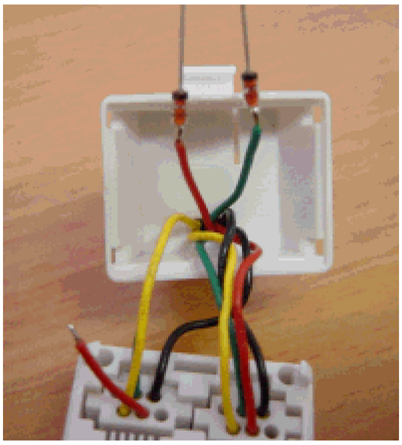
1. Open the adapter carefully via the 4 snaps in its sides.



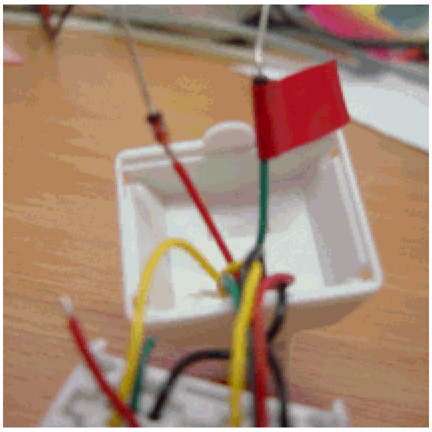
2. Cut the red and green wires as shown below.



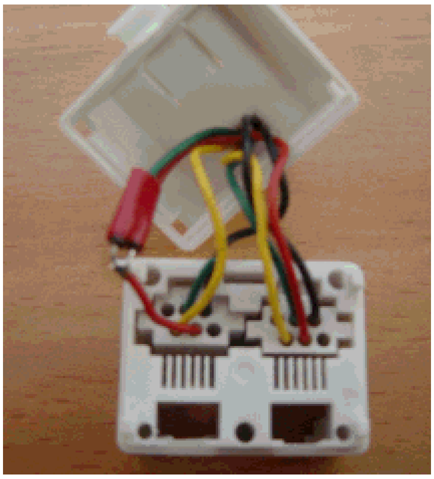
3. Solder one diode to the red wire, and one diode to the green wire.
   The soldered point provides the anode.



4. Put isolating material on the soldered points.



5. Solder both diodes' cathodes to the red wire.



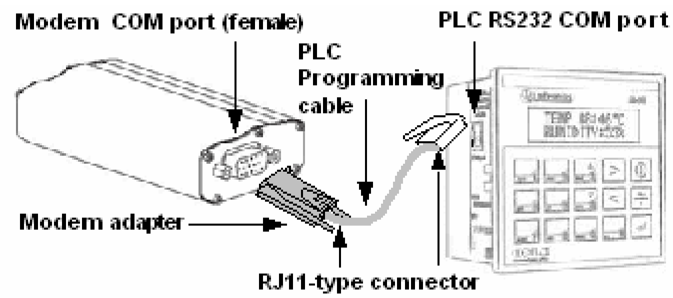
6. Put isolating material on the solder.
7. Close the Sniffer.
8. Label the connectors as shown.

Note □ In order to run view the strings in Hyperterminal, you must set the program to display ASCII strings as described above in Using Hyperterminal.

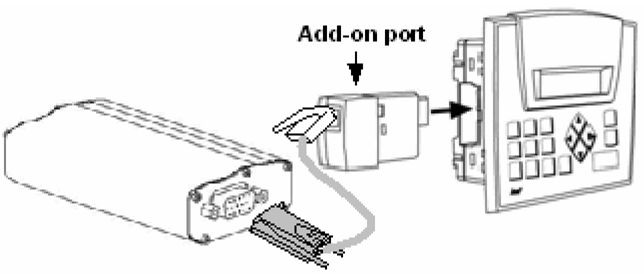
PLC to Modem Connections and Pin-outs

The next two figures show the basic elements you use to connect a controller to a modem.

M90/91



Jazz (Add-on Port Module required)



Note • M90/91 controllers
- Comprise an integral COM port
- Note that the M90/91 PLC programming cable is a **4-wire cable**. The cable is included with the M90/91 all-in-one kits.

• Jazz controllers
- Do not comprise COM ports. To provide Jazz with a port, install an add-on port module. These may be part of a kit, or ordered separately. An example of a port module is the MJ20-PRG, included in the Jazz Programming Kit JZ-PRG.
- Note that the Jazz PLC programming cable is a **6-wire cable**. The cable is also included in the JZ-PRG kit.

Connecting a Controller to a Modem

You can:

- Use a Unitronics' modem kit in conjunction with the appropriate Unitronics PLC programming cable, as shown in the two figures above. Kits contain a modem that is compatible with Unitronics controllers and related hardware. The Products section of the Unitronics web site contains kit descriptions and specifications.
- Use a modem you have purchased independently. In this case, you can use the appropriate Unitronics PLC programming cable to connect the PLC to a modem adapter. You can order modem adapters from Unitronics.
- Use a modem you have purchased independently, and construct your own D-type to D-type connector cable to connect the programming cable to the modem's serial port, according to the pin-outs provided below.

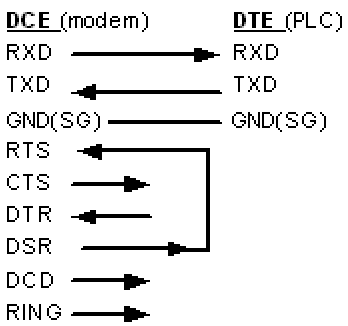
General Information: Modem to Controller Interface (DCE to DTE)

The next figures show the interface between the Data Communications Equipment (DCE; the modem) and the Data Terminal Equipment (DTE; the controller or PC). The arrows show the direction of data flow.

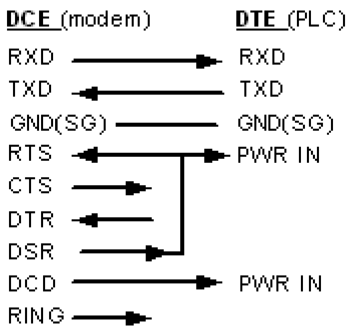
Note that:

- Transmitted data (TXD) is input to the modem, output from the PLC
- Received data (RXD) is input to the PLC, but output from the modem

M90/91



Jazz



Note □ Unitronics controllers do not support all the control lines.

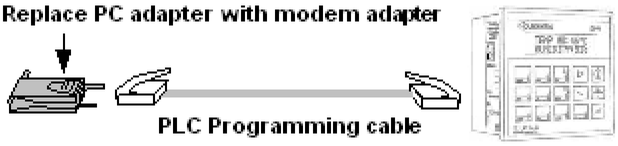
□ Modems should be initialized via the Modem Services> Prepare Modem procedure. This procedure:
- Turns the DSR signal ON
- Turns the DCD signal ON (Jazz only)
- Sets the appropriate PLC-modem communication parameters. These are:
  - M90/91: 19200 bps, 8 bit, no parity, 1 stop bit
  - Jazz: 9600 bps, 8 bit, no parity, 1 stop bit

□ Connecting DSR and RTS signals causes the modem to be always ready to transmit\receive data.

Using Modem Kits

Unitronics' kits contain all of the elements you need to connect a controller to a modem using the appropriate PLC programming cable, as shown in the first two figures at the beginning of this section.

Note that you must remove the PC adapter from the PLC programming cable and replace it with the modem adapter supplied in the kit.



In order to work with Unitronics controllers, you must initialize the modem via the procedure detailed in the Prepare PLC Modem topic.

The following list shows modem adapters supplied with the kits and their pin-outs. For updated information, consult your Unitronics distributor.

Standard Landline and Siemens GSM/GPRS modems

Modem Adapter MJ10-22-CS76		
Adapter signals	**D-Type 9 pin, male**	**RJ11**
DSR (out) + RTS (in)	6+7	1
GND	5	2
RXD (out)	2	3
TXD (in)	3	4
GND	5	5
DCD (out)	1	6

PLC Serial Port / Port Module	
RJ11	**Controller signals**
6	PWR (in) for Jazz DSR (in) for M90/M91
5	GND
4	RXD (in)
3	TXD (out)
2	GND
1	PWR (in) for Jazz DTR (out) for M90/M91

Note
- **M90/91**: The cable connects RJ11 pins 2,3,4,5 to pins 5,4,3,2 respectively.
- **Jazz**: The cable connects RJ11 pins 1,2,3,4,5,6 to pins 6,5,4,3,2,1 respectively

Sony Ericsson GM29 GSM/GPRS modems

Modem Adapter MJ10-22-CS72		
Adapter signals	**D-Type 9 pin, male**	**RJ11**
DSR (out)	6	1
GND	5	2
RXD (out)	2	3
TXD (in)	3	4
GND	5	5
DCD (out) + RTS (in)	1+7	6

PLC Serial Port / Port Module	
RJ11	**Controller signals**
6	PWR (in) for Jazz DSR (in) for M90/M91
5	GND
4	RXD (in)
3	TXD (out)
2	GND
1	PWR (in) for Jazz DTR (out) for

	M90/M91

Note □ **M90/91**: The cable connects RJ11 pins 2,3,4,5 to pins 5,4,3,2 respectively.
□ **Jazz**: The cable connects RJ11 pins 1,2,3,4,5,6 to pins 6,5,4,3,2,1 respectively.

Wavecom GSM/GPRS modems

Modem Adapter MJ10-22-CS79			PLC Serial Port / Port Module	
Adapter signals	**D-Type 15 pin, male**	**RJ11**	**RJ11**	**Controller signals**
DCD (out)	1	1	6	PWR (in) for Jazz DSR (in) for M90/M91
GND	9	2	5	GND
RXD (out)	6	3	4	RXD (in)
TXD (in)	2	4	3	TXD (out)
GND	9	5	2	GND
DSR (out) + RTS(in)	7+12	6	1	PWR (in) for Jazz DTR (out) for M90/M91

Note • **M90/91**: The cable connects RJ11 pins 2,3,4,5 to pins 5,4,3,2 respectively.
• **Jazz**: The cable connects RJ11 pins 1,2,3,4,5,6 to pins 6,5,4,3,2,1 respectively.

Note • Wavecom modem kits do not contain the PC to modem cable, MJ10-22-CS32, that is required for the Wavecom Prepare Modem procedure. This cable is available by separate order.

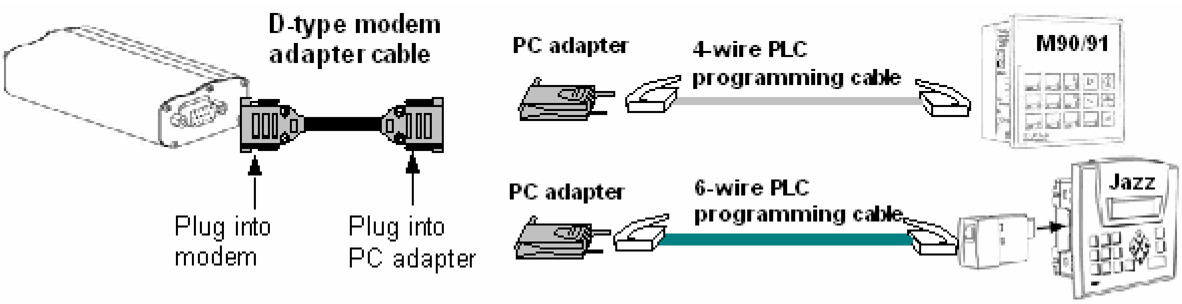
Using a Unitronics Adapter

If you are using a modem from an independent source, you can order one of the modem adapters described in the preceding section from Unitronics, and use this adapter to connect your modem to the PLC via the PLC programming cable.

Constructing Adapters

You can construct a D-type modem adapter yourself, using the appropriate pin-outs shown in the preceding section.

You can also construct a cable with 2 male D-type connectors, and then use it to connect a modem's serial port directly to the PC adapter on the PLC programming cable as shown in the next figure.



The tables below give the pin-outs of the programming cables, and show you an example of the pin connection you can use to construct a cable with 2 male D-type connectors to connect a PLC to a standard landline modem.

M90/91 4-wire Programming Cable

PC -side Adapter MJ10-22-CS25			PLC-side Programming port		
PC signals	**D-Type 9 pin, female**	**RJ11**	**RJ11**	**Controller signals**	
DTR (out)	4	1	6	DSR (in)	Unused
GND	5	2	5	GND	
TXD (out)	3	3	4	RXD (in)	
RXD (in)	2	4	3	TXD (out)	
GND	5	5	2	GND	
DSR (in)	6	6	1	DTR (out)	Unused

Note • The 4-wire programming cable supplied with the controller connects RJ11 pins 2,3,4,5 to pins 5,4,3,2 respectively.

Example: D-type modem adapter cable to connect a M90/91 controller to a standard landline modem

Modem-side (D-type 9-pin, male)		PLC-side (D-type 9-pin, male)	
DSR (out) + RTS (in)	6+7		
GND	5	5	GND
RXD (out)	2	3	RXD (in)
TXD (in)	3	2	TXD (out)
GND	5	5	GND

Jazz 6-wire Programming Cable

PC-side Adapter MJ10-22-CS10			PLC-side Jazz programming port MJ20-PRG	
PC signals	**D-Type 9 pin, female**	**RJ11**	**RJ11**	**Controller signals**
DTR(out)	4	1	6	PWR (in)
GND	5	2	5	GND
TXD(out)	3	3	4	RXD (in)
RXD (in)	2	4	3	TXD (out)
GND	5	5	2	GND
RTS (out)	7	6	1	PWR (in)

Note • The 6-wire programming cable, MJ20-CB200, supplied with the programming kit JZ-PRG connects pins 1,2,3,4,5,6 to pins 6,5,4,3,2,1 respectively.

Example: D-type modem adapter cable to connect a Jazz controller to a standard landline modem

Modem-side (D-type 9-pin, male)		PLC-side (D-type 9-pin, male)	
DSR (out) + RTS (in)	6+7	4	PWR (in)
GND	5	5	GND
RXD (out)	2	3	RXD (in)
TXD (in)	3	2	TXD (out)
GND	5	5	GND
DCD (out)	1	7	PWR (in)

Modem Communications-- System Bits and Integers

Relevant System Bits, System Integers, and Modem Error Messages are listed below.

Modems: General

System Bits

SB	Symbol	Description
72	Initialize Modem	Causes modem initialization. Remains ON until initialization is complete, then turns off. Note that: • This SB turns ON at power-up. You can disable this SB at power-up to avoid initializing the modem. • You may use this SB to initialize the modem at any point during your application.
73	Modem Initialization: Succeeded	Signals that modem has been initialized. When SB 73 is ON, PLC is ready to both make and receive calls.
74	Modem Initialization: Failed	Signals that modem initialization failed. SI 70 contains the error code.
75	Modems Connected	Turns ON when connection is established
76	Disconnect Modem	Ends call (hang-up)
77	Dial Remote Modem	Dials the phone number represented by the index number stored in SI 71

System Integers

SI	Symbol	Description
70	Modem: Error Code	Contains an error code resulting from a modem error. The list is shown below.
71	Modem: Phone Number	Contains the phone number to be dialed. You create a phone book when you configure the modem. Each phone number in the phone book is linked to an index number. Use the Store Direct function to place the index number of desired phone number in SI 71, then activate SB 77 to dial it.

Error Messages (SI 70)

Number	Error Message	Description
0	No Error	No error.
1	No Carrier	No carrier signal found--reason unknown. Check your communication cables.
2	Modem Did Not Reply	The modem referred to is the one on the PLC side.
3	No Dial Tone	No dial tone.
4	Line is Busy	The number dialed is engaged.
5	No Carrier While Dialing	Carrier signal was lost during dialing.
6	Modem Report Error	May be due to an incorrect number or unknown initialization commands.
7	Modem Report Unknown Message	An unrecognized message.
8	No Phone Number	SI 71 contains a number that is not linked to any phone number stored in the phone book.
9	RS232 Port Busy	The RS232 port is already in use.

SMS System Bits and Integers

Listed below are the System Bits, System Integers, and Error Messages that are used by the PLC in SMS messaging.

System Bits

SB	Symbol	Description
180	Initialize GSM Modem for SMS	Turn this ON to enable SMS messaging.
181	SMS: Initialization Succeeded	Signals that GSM modem has been initialized. The modem is now ready to send and receive SMS messages.
182	SMS: Initialization Failed	Signals that GSM modem has failed. SI 180 contains the error code.
183	Send SMS	Send the string that is represented by the index number stored in SI 182, to the phone number represented by the index number stored in SI 181.
184	SMS: Transmission succeeded	Signals that SMS has been successfully transmitted
185	SMS: Transmission Failed	Signals that SMS has failed. SI 180 contains the error code
186	SMS Received	Signals that a defined SMS has been received. SI 183 contains the index number identifying the origin of the SMS, if this number has been stored in the SMS phone book. If the number is not found, SI 183 equals 0. SI 184 contains the index number of the SMS string that has been received. Only messages that have been defined in the SMS messages list can be received by the PLC.
187	Error in Received	This bit signals one of the errors listed below. SI 180 contains the error code.

	SMS	
188	Ignore Received SMS	Allows the user to block reception of SMS messages
189	Print SMS message	This prints a message with CR (Carriage Return) & LF (Line Feed)
190	Print SMS message	This prints a message with LF (Line Feed)
191	Print SMS message	This prints a message without CR (Carriage Return) or LF (Line Feed)
192	Get GSM antenna signal quality	Get GSM antennae signal quality. The signal quality is contained in SI 185 GSM Signal Quality.
193	Delete SMS messages from SIM	Deletes SMS messages from the SIM card. When used alone, the default number of messages is 20. Using SB 193 in conjunction with SI 187, Number of SMS messages to be deleted, enables you to delete up to 30 SMS messages.
194	Print SMS message	This prints a message including STX and ETX.

System Integers

SI	Symbol	Description
180	SMS Error Code	Contains an error code resulting from a SMS error. The list is shown below
181	SMS: Send to Phone Number	Contains the index number of a phone number within the GSM phone book. Use the Store Direct function to place the index number of the desired phone number in SI 181. Storing the value '0' into SI 181 causes a message to be sent to the **last** number to which an SMS message was sent. When auto-acknowledge is selected, the number 7 will be automatically placed into S1 181 when the SMS is acknowledged.
182	SMS: String Number to Send	Contains the index number that represents the SMS string to be sent. Use the Store Direct function to place the index number of the desired SMS string in SI 182.
183	Origin of Received SMS	Contains the index number that represents the phone number from which the SMS was sent. If this number is not defined in the GSM phone book, SI 183 will contain 0.
184	Received SMS String	Contains the index number that represents the SMS that has been received. If this number is not defined in the SMS message list, SI 184 will contain 0.
185	GSM Signal Quality	GSM antenna signal quality. If this is less than 11, reposition the antenna. You can use SB 192, Get GSM antennae signal quality,together with this SI.
187	Number of SMS messages to be deleted	Using SB 193 in conjunction with the new SI 187, Number of SMS messages to be deleted, enables you to delete up to 30 SMS messages.

Error Messages (SI 180)

Number	Error Message	Description
0	No error	No error found
1	GSM Modem Not Initialized	The GSM modem was not initialized. Before using the SMS feature the modem must be initialized. Refer to relevant help sections.
2	GSM Modem Did	The GSM modem referred to is the one on the PLC side.

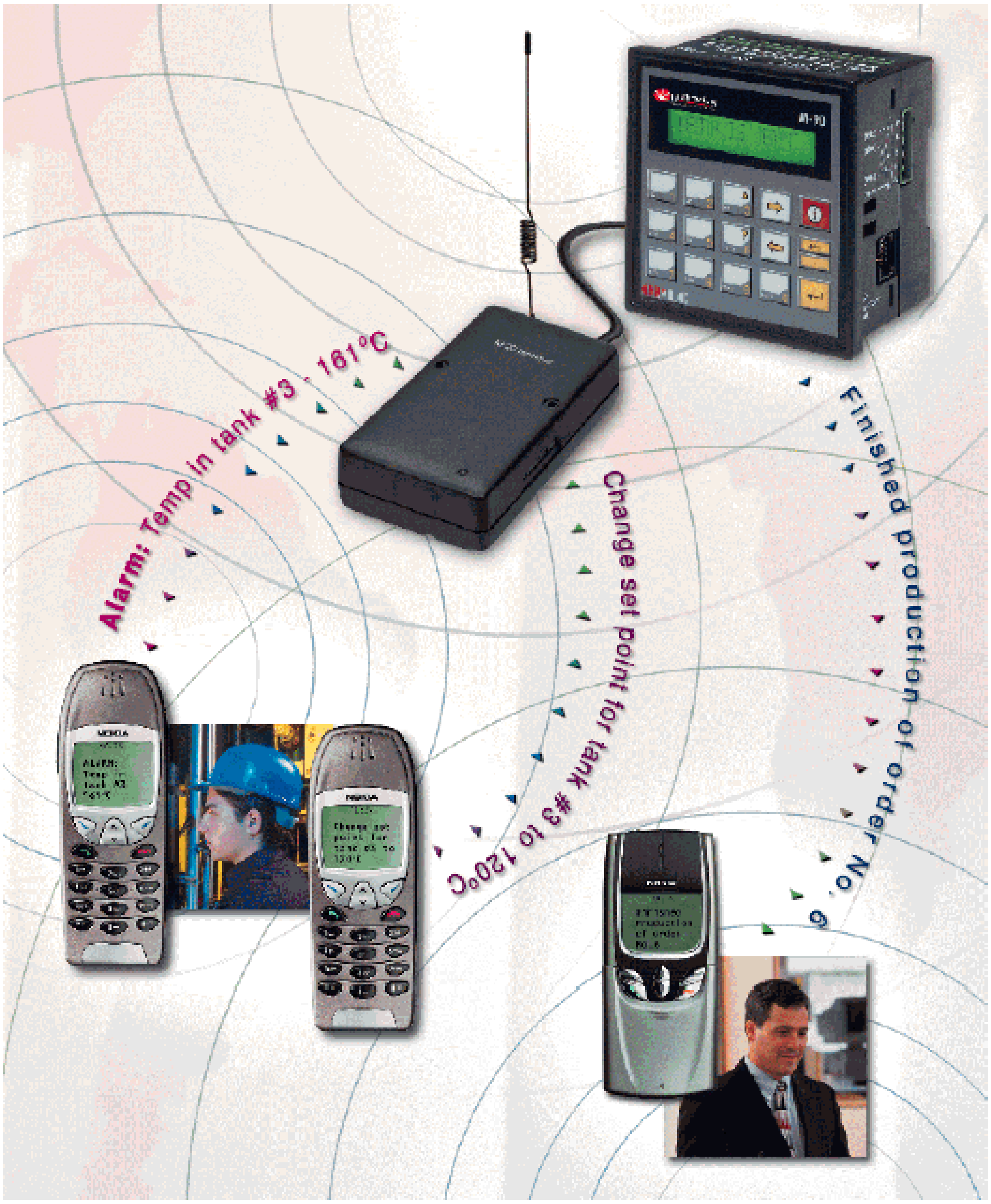
	Not Reply	
3	Modem Reports Unknown Message	Modem returns an unrecognized reply
5	Wrong PIN number	The Personal Identification Number that was given does not match that of the SIM card installed in the PLC's GSM modem.
6	Failed Registration	GSM modem did not register successfully, for example if no network was found, or if the modem antenna is not functioning.
7	No Phone Number	SI 181 contains a number that is not linked to any phone number stored in the GSM phone book.
8	Transmit: Undefined String number	SI 182 contains a string number that is not linked to any string number stored in the SMS Messages List.
9	Unauthorized Origin	This SMS string has been transmitted from an unauthorized phone number.
11	Illegal String Received	The string received is not linked to any string stored in the SMS Messages List. SI 184 will contain 0.
14	RS232 Port Busy	The RS232 port is already in use; for example, the modem is currently connected.
16	SMS not successfully sent to all numbers	The SMS message was not successfully sent to all the phone numbers for which it was configured.
17	PUK number needed	The SIM card is locked due to too many attempts to enter an incorrect PIN number.

SMS

About SMS messaging

SMS messaging is a feature of GSM-based cellular telephone services. SMS-enabled controllers can use SMS messaging to send and receive data to and from a cell phone. Both fixed text and variable data can be communicated. This feature can be used to transmit data and for remote diagnostics.

SMS messaging is featured in several sample applications; these may be found by selecting Sample U90 Projects from the Help Menu.



In order to use this feature, you must connect an SMS-enabled controller to a GSM modem, which is sometimes called a cellular IP modem. Other modems do not support connection to a cellular network.

SMS messaging is subject to all of the limitations of normal cellular network use, as for example network availability.

Note that SMS messages are limited to the English character set.

SMS Messaging Overview

To enable the PLC to use SMS messaging, you must:

1. Create the SMS phone book; the PLC can only send SMS messages to phone numbers listed in the phone book.
2. Create SMS messages.
3. Configure the SMS Message Properties for each SMS message.
4. Configure your SMS messaging features.
5. Download the project to the PLC.
6. Connect the PLC to a GSM modem

After you have performed the above procedures, you can use SMS messages in your application.

Once SMS messages have been created, configured, and downloaded to the PLC, the PLC can receive these messages from a GSM cell phone.

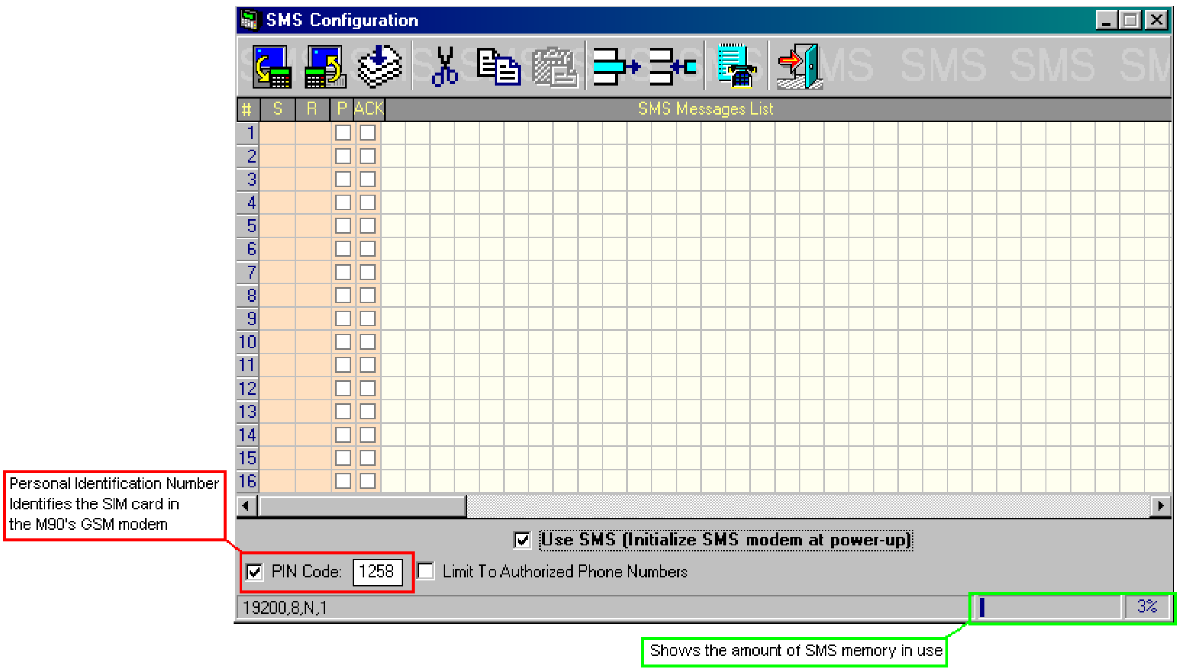
Note that you must use the English character set to write SMS messages.

Configuring SMS messaging features

In order to use the SMS feature, your controller must be connected to a GSM modem. To enable the controller to use the GSM modem, select the 'Use SMS Messaging' option shown below. This causes the controller to turn on SB 180, Initialize GSM Modem, at power-up.

M90/91 default GSM modem settings are: 19200, 8 data bits, no parity, 1 stop bit. You may need to manually change your modem's communication settings to match these parameters.

If your GSM modem requires a PIN code to connect to a GSM network, enter it as shown below.



Limit to Authorized Phone Numbers

Select this option to prevent the controller from receiving SMS messages from any number not listed in the SMS phone book.

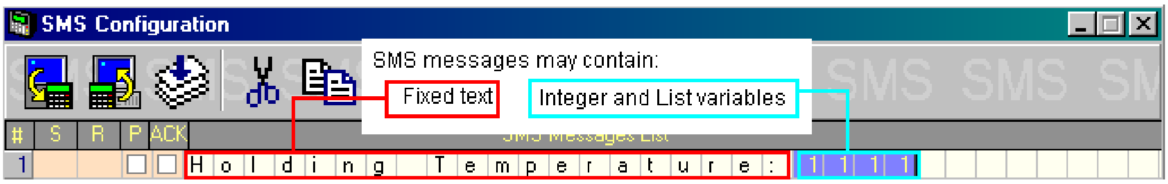
Creating SMS messages

You can create up to 99 SMS messages, or up to a total of 1k, whichever comes first. Each SMS message can contain up to 140 characters. SMS messages can include both fixed text and variable data.

Creating SMS text messages

Note that you must use the English character set to write SMS messages.

1. Open the SMS editor by selecting SMS Configuration from the Controller menu.
2. Enter fixed text by placing your cursor within a line and typing normally. You may use any keyboard symbols except for number symbols (#). These have a specific purpose which is described below.



1. Cut and copy messages by clicking on the Cut button. This removes all of the text and variables from a message, but does not delete the line.
2. Copy messages by clicking on the Copy button. This copies all of the text and variables.
3. Paste by clicking on the Paste button. You can paste over an existing message. This action erases any information in the line.
4. Use the Insert button to add a line **below** the line containing the cursor.
5. Use the Delete button to remove a line **below** the line containing the cursor.

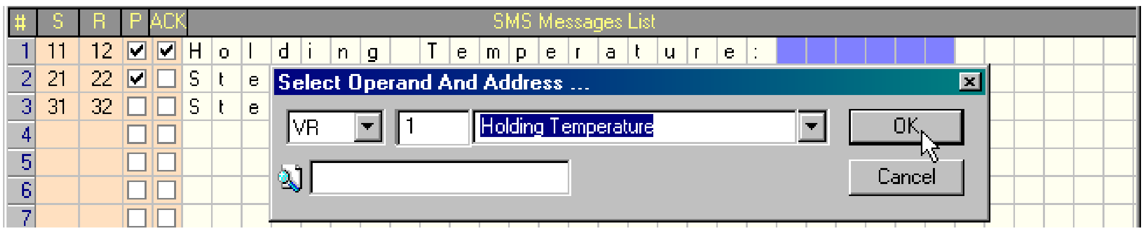
Attaching variables

You can attach up to 9 Integer or List Variables to an SMS message. Each variable can include up to 16 characters. Attaching variables to an SMS message is similar to attaching variables to an HMI display. However, the variable must already be in the variable list--you cannot link a variable before it has been created.

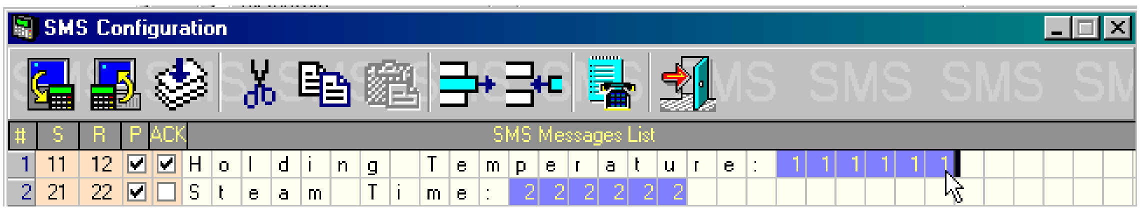
Integer variables can be sent and received with SMS messages. List variables can only be sent to a cell phone.

As with HMI variables, you must create a Display Field for the display of the variable's value.

1. Click your cursor where you want to locate the variable text.
2. Hold down the **Shift** key on your PC keyboard, while you press the right-pointing arrow key. A square is highlighted each time you press the arrow key. The first square displays the number of highlighted squares.
3. Release the **Shift** key. The Select Operand and Address box opens.
4. Enter the variable number and description, then click OK as shown below.



5. The SMS message now appears together with the variable field.



Deleting variables

1. Place your cursor in the highlighted Variable field.
2. Press the Backspace or Delete key until the entire field is erased.

Testing messages

1. To test your messages, click on the Compile button. If, for example, you have attached 'illegal' variables--not integer or list variables--the first illegal variable will be displayed.

Sending SMS messages from a GSM cell phone

To send SMS messages from your cell phone you must:

- Write and download SMS messages to the PLC as described in Creating SMS messages.
- Write an SMS message in your cell phone.
- Send the message to the controller s GSM modem

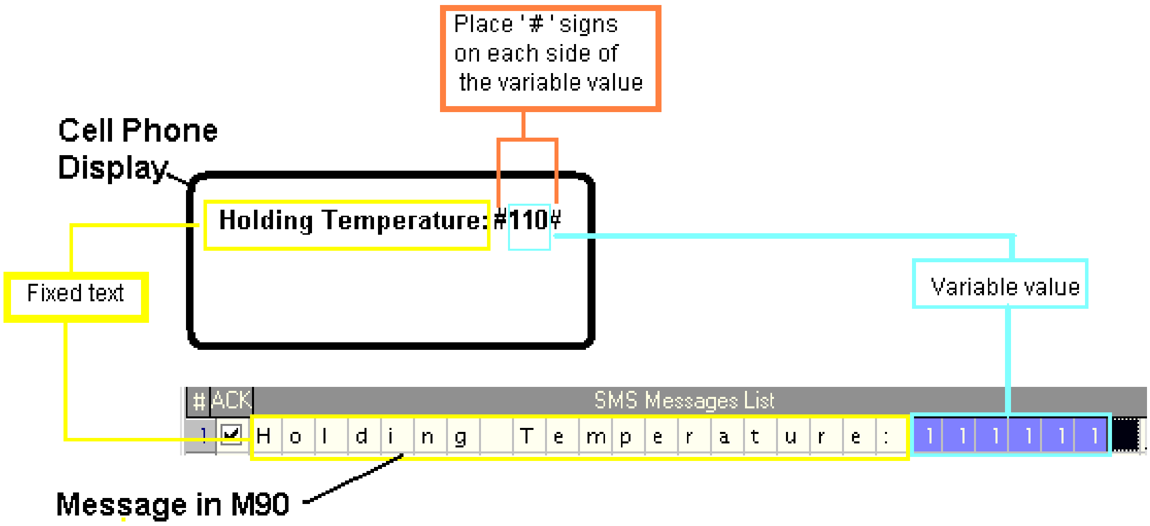
Note that you can only send messages that have already been set in the PLC. In addition, if a PLC is configured with the Limited to Authorized Phone Numbers option, you will not be able to send it SMS messages if your number is not in the list .

Writing SMS messages in your cell phone

You write an SMS message using your cell phone keypad. Make sure that:

- The fixed text in your cell phone is identical to the PLC's SMS message **in every detail**: spaces, characters--and note that characters are case-sensitive.
- You bracket variable values with number signs (#) as shown below. These signs '#' do not count as spaces.
- The variable field in the HMI Display is big enough to hold the value.

The figure below shows the same SMS message: as it appears on a cell phone display, and as it appears in the PLC's SMS Messages List.



When you send this message from your cell phone, the value 110 will be written into Variable 1 in the M90.

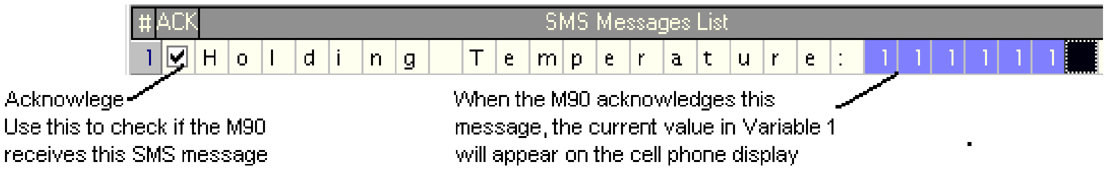
Sending the message to the PLC

1. Enter the number of the PLC's GSM modem exactly as you would enter any GSM cell phone number, then send the message.

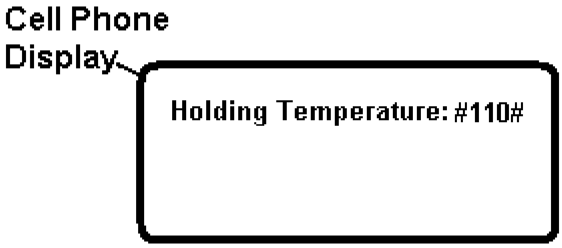
Checking that the PLC has received the SMS message

You can check if the PLC received your message by using the Acknowledge feature:

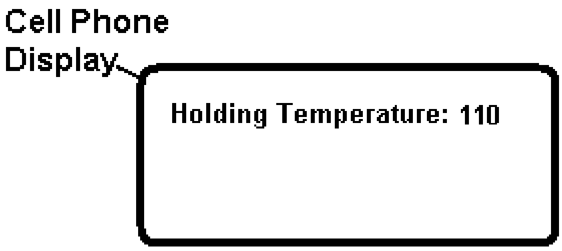
1. Select the **ACK** box as shown below.



2. Use your cell phone to send the message "**Holding Temperature:#110#"** to the PLC.



3. The PLC receives this SMS message.
4. The PLC immediately returns the message to your cell phone, together with the current variable value.
5. You can now view this SMS message on your cell phone display, together with changes in the variable value.



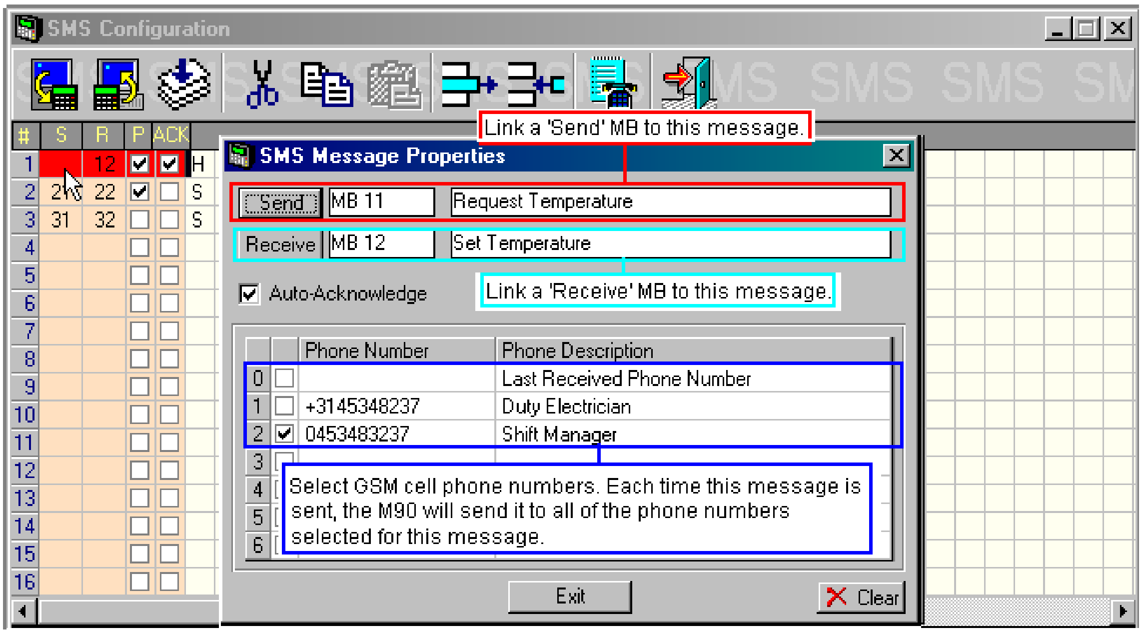
Variable Types

Although SMS messaging supports Integer and List variables, note that you cannot send List variables via cell phone.

SMS Message Properties

Before you can use an SMS message in your application, you must configure its properties.

1. Open the SMS Messages Properties box by clicking in the fields at the beginning of a message as shown below.

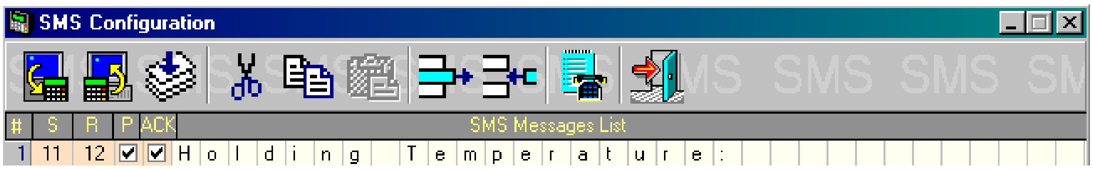


2. Link a Send MB to this message by clicking on the Send button. The Select Operand and Address box opens.
3. Select an MB, then press OK. The MB's number and description appear in the Send fields.
4. Repeat Steps 2 & 3 to link a Receive MB.

   Note that a message does not need to be linked to both a Send and Receive MB.
5. Link the GSM cell phone numbers to this message by checking the boxes of the desired numbers. You can also select Last Received Phone Number. This will cause this SMS message to be sent to the origin of the **last** SMS message received by the PLC.

   Note that you cannot edit the SMS phone book while you are configuring SMS Message
6. When you have finished, click Exit.

In the message below, the Send MB is 11, the Receive MB is 12, and the checked box under P means that phone numbers have been linked to this message. ACK has also been selected.



ACK-Acknowledge message

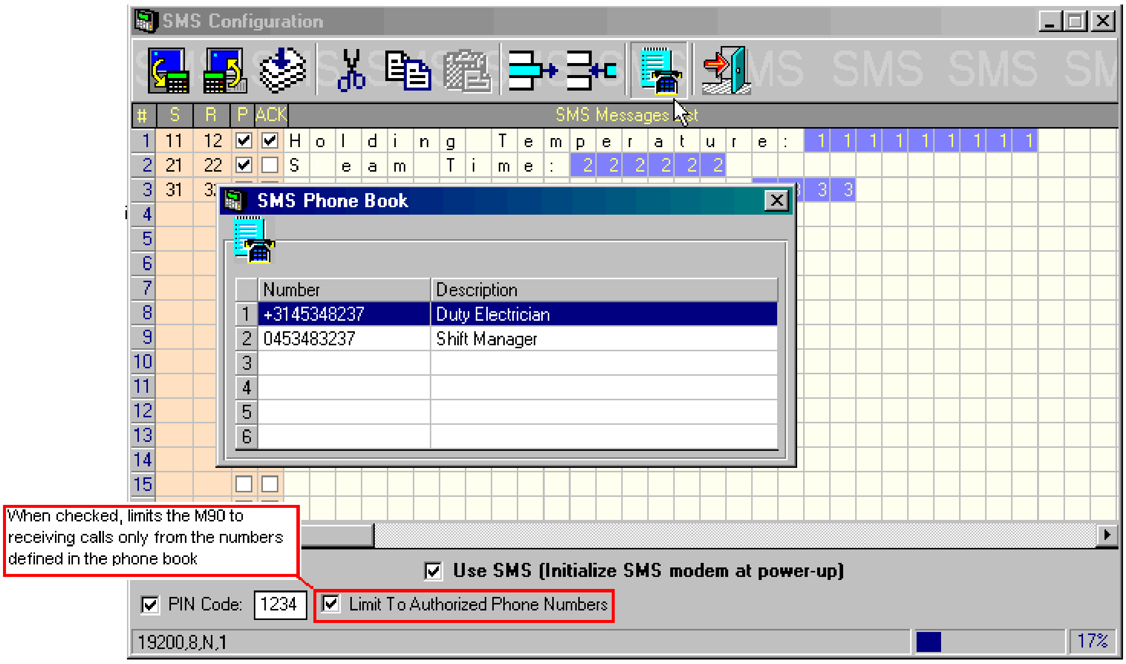
This feature allows a cell phone user to check if the PLC has received a particular message.

SMS phone book

The SMS phone book is where you define the list of GSM cell phone numbers that the PLC can use for SMS messaging. The phone book holds 6 numbers; however, you can dial more numbers by using an MI pointer. Each phone number can be up to 18 characters long. You can also add a description to identify who is being called. In addition, note that the number of the last received SMS is stored in SIs 188 to 192.

Entering numbers in the Phone Book

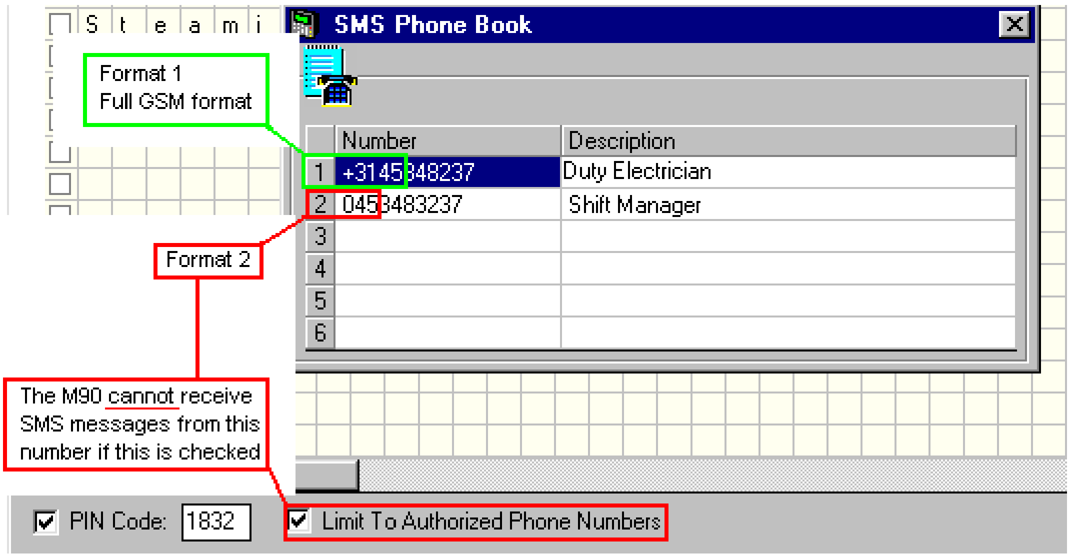
1. Open the Phone Book by clicking the button on the toolbar.
2. Click on an empty line in the Phone Book shown below, then type in the number.



Note that there are two formats for entering phone numbers shown below. If **Limit to Authorized Phone Numbers** is *not* selected, the PLC can send and receive SMS messages to/from any number in the Phone Book.

If **Limit to Authorized Phone Numbers** *is* selected:

- Format 1: The **PLC can** receive messages from this number. This is because the number is in full GSM format, including the '+' in front of the country code.
- Format 2: The **PLC cannot** receive messages from this number.



To edit the phone book, click in a number or description, then make your changes.

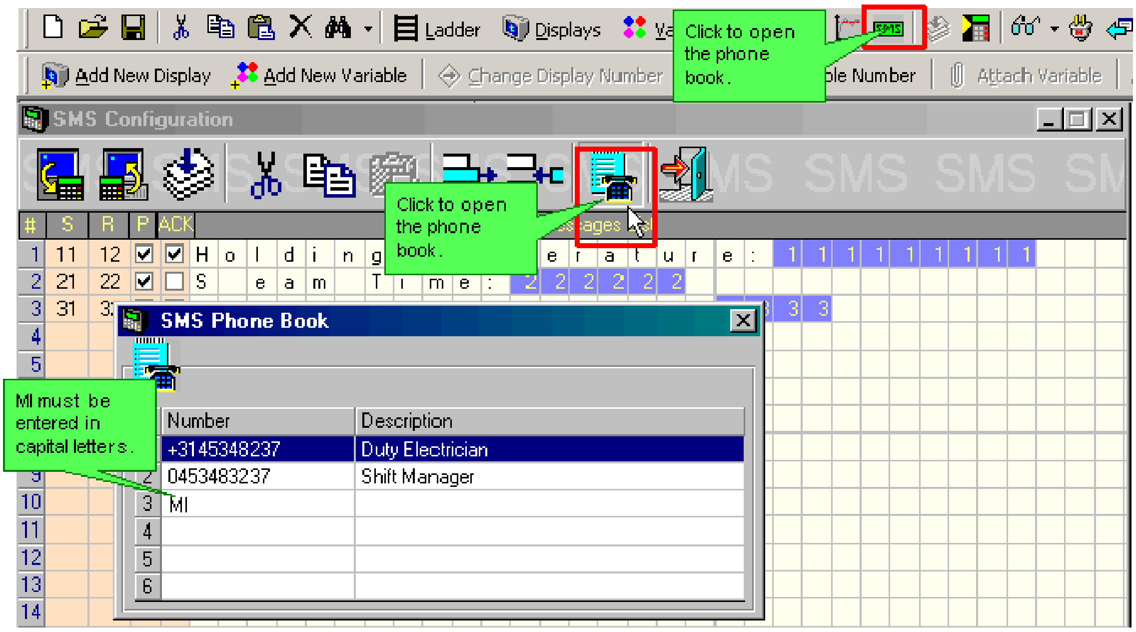
SMS Phone Number: via MI Pointer

Use this utility to use an MI vector as one of the phone numbers in the SMS phone book. This allows you to:

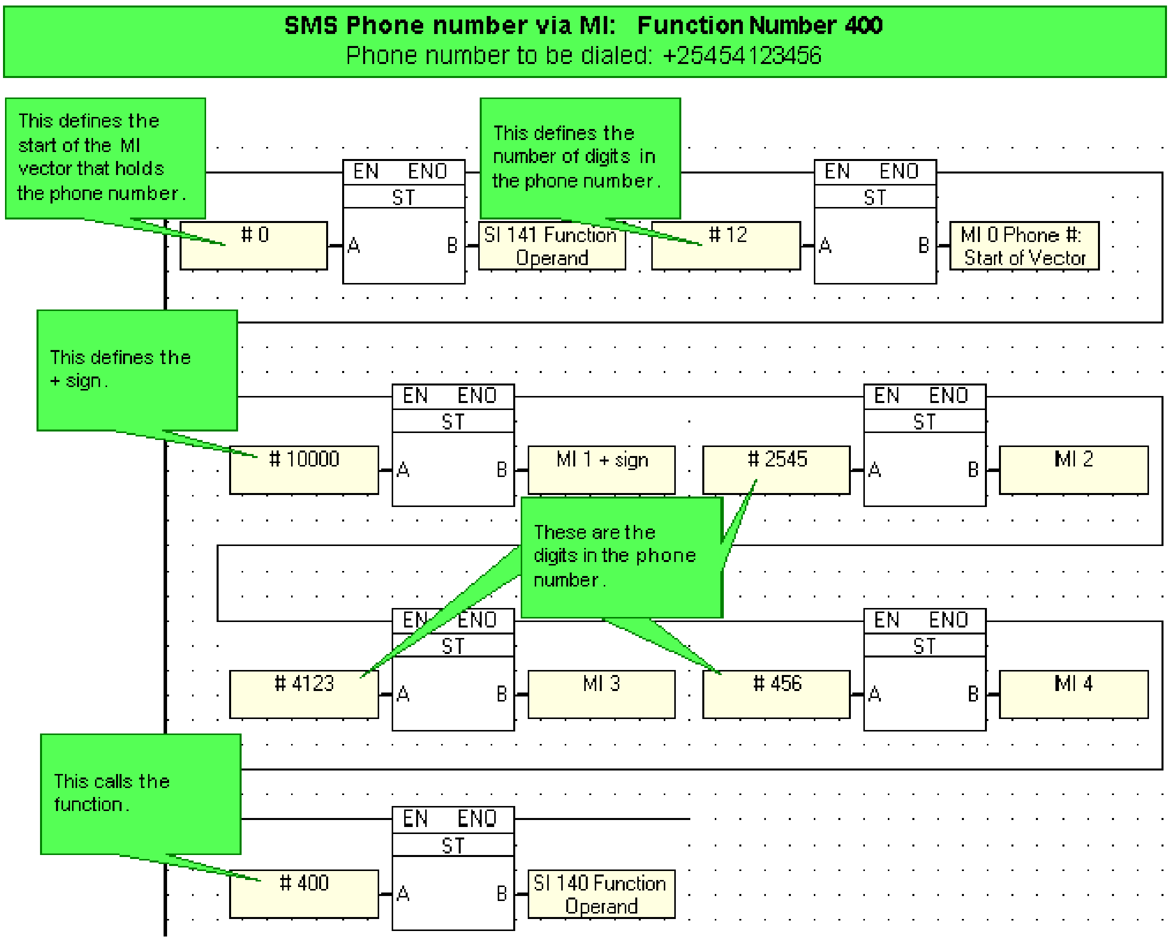
- Enable a number to be dialed via the PLC's keypad.
- Exceed the 6 number limit of the SMS phone book.

Note that since there is no Ladder element for this function; you perform it by:

- Storing the start address of the MI vector needed to contain the phone number into SI 141,
- Entering the character's MI, in capital letters, in the **SMS phone book**,



- Using the index number of that line to call the number, which enables the number in the MI vector to be called,
- Storing 400 into SI 140 to select the function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters. Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.



SMS System Bits, Integers, and Error Messages

System Bits

SB	Symbol	Description
180	Initialize GSM Modem for SMS	This is necessary to enable use of the SMS feature. Note that the modem must first be initialized using SB 72.
181	SMS: Initialization Succeeded	Signals that GSM modem has been initialized. The modem is now ready to send and receive SMS messages.
182	SMS: Initialization Failed	Signals that GSM modem has failed. SI 180 contains the error code.
183	Send SMS	Send the string that is represented by the index number stored in SI 182, to the phone number represented by the index number stored in SI 181.
184	SMS: Transmission succeeded	Signals that SMS has been successfully transmitted
185	SMS: Transmission Failed	Signals that SMS has failed. SI 180 contains the error code
186	SMS Received	Signals that a defined SMS has been received. SI 183 contains the index number identifying the origin of the SMS, if this number has been stored in the SMS phone book. If the number is not found, SI 183 equals 0. SI 184 contains the index number of the SMS string that has been received. Only messages that have been defined in the SMS messages list can be received by the M90.
187	Error in Received SMS	This bit signals one of the errors listed below. SI 180 contains the error code.
188	Ignore Received SMS	Allows the user to block reception of SMS messages
189	Print SMS message	This prints a message with CR (Carriage Return) & LF (Line Feed)
190	Print SMS message	This prints a message with LF (Line Feed)
191	Print SMS message	This prints a message without CR (Carriage Return) or LF (Line Feed)
192	Get GSM antenna signal quality	Get GSM antennae signal quality. The signal quality is contained in SI 185 GSM Signal Quality.
193	Delete SMS messages from SIM	Deletes all of the SMS messages from the SIM card
194	Print SMS message	This prints a message including STX and ETX.

System Integers

SI	Symbol	Description
180	SMS Error Code	Contains an error code resulting from a SMS error. The list is shown below
181	SMS: Send to Phone Number	Contains the index number of a phone number within the GSM phone book. Use the Store Direct function to place the index number of the desired phone number in SI 181. Storing the value '0' into SI 181 causes a message to be sent to the **last** number to which an SMS message was sent.

		When auto-acknowledge is selected, the number 7 will be automatically placed into S1 181 when the SMS is acknowledged.
182	SMS: String Number to Send	Contains the index number that represents the SMS string to be sent. Use the Store Direct function to place the index number of the desired SMS string in SI 182.
183	Origin of Received SMS	Contains the index number that represents the phone number from which the SMS was sent. If this number is not defined in the GSM phone book, SI 183 will contain 0.
184	Received SMS String	Contains the index number that represents the SMS that has been received. If this number is not defined in the SMS message list, SI 184 will contain 0.
185	GSM Signal Quality	GSM antenna signal quality. If this is less than 11, reposition the antenna. You can use SB 192, Get GSM antennae signal quality,together with this SI.
187	Number of SMS messages to be deleted	Using SB 193 in conjunction with SI 187 enables you to delete up to 30 SMS messages.

Error Messages (SI 180)

Number	Error Message	Description
0	No error	No error found
1	GSM Modem Not Initialized	The GSM modem was not initialized. Before using the SMS feature the modem must be initialized. Refer to relevant help sections.
2	GSM Modem Did Not Reply	The GSM modem referred to is the one on the M90 side.
3	Modem Reports Unknown Message	Modem returns an unrecognized reply
5	Wrong PIN number	The Personal Identification Number that was given does not match that of the SIM card installed in the M90's GSM modem.
6	Failed Registration	GSM modem did not register successfully, for example if no network was found, or if the modem antenna is not functioning.
7	No Phone Number	SI 181 contains a number that is not linked to any phone number stored in the GSM phone book.
8	Transmit: Undefined String number	SI 182 contains a string number that is not linked to any string number stored in the SMS Messages List.
9	Unauthorized Origin	This SMS string has been transmitted from an unauthorized phone number.
11	Illegal String Received	The string received is not linked to any string stored in the SMS Messages List. SI 184 will contain 0.
14	RS232 Port Busy	The RS232 port is already in use; for example, the modem is currently connected.
16	SMS not successfully sent to all numbers	The SMS message was not successfully sent to all the phone numbers for which it was configured.

17	PUK number needed	The SIM card is locked due to too many attempts to enter an incorrect PIN number.

GSM PIN Code via MI

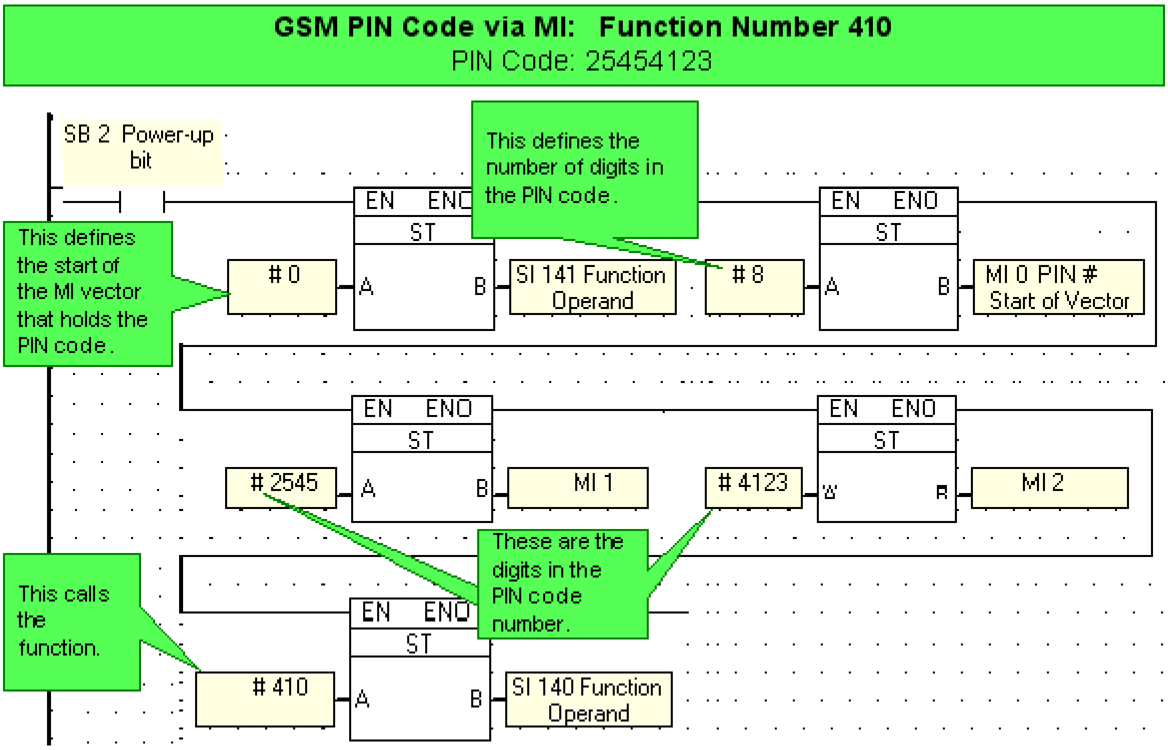
Use this utility to use an MI vector to supply a GSM modem PIN code. When you use this function, the controller will look for the number in the MIs, bypassing the PIN code in the SMS message dialog box.

Note that since there is no Ladder element for this function; you perform it by:

- Storing the start address of the MI vector needed to contain the PIN into SI 141,
- Storing 410 into SI 140 to select the function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters. Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

The PIN code should be called before the modem is initialized; the function should therefore be called as a power-up task.

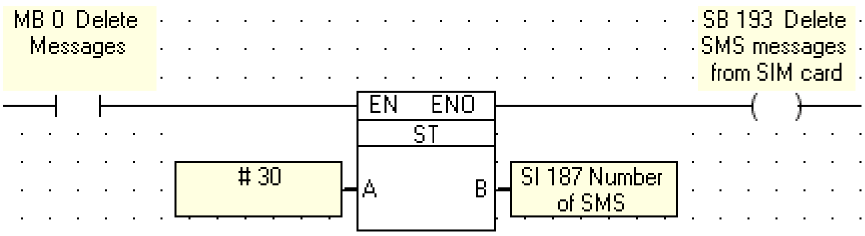
Note that if the MIs contain an incorrect PIN code format, the error will be indicated by Error message #18 in SI 180--Illegal PIN Format.



Deleting SMS messages

In order to delete SMS messages from a SIM card, turn SB 193, Delete SMS Messages, ON. When used alone, SB 193 will delete 20 messages from the SIM card.

Using SB 193 in conjunction with SI 187, Number of SMS messages to be deleted, enables you to delete up to 30 SMS messages.



Using SMS messages in your application

To cause the controller to send an SMS message, you use the Send MB which is linked to that message. In the figures below, the Send MB is 11. When MB 11 is turned ON in your application, this message will be sent. The Send MB is turned OFF automatically after the message has been sent.

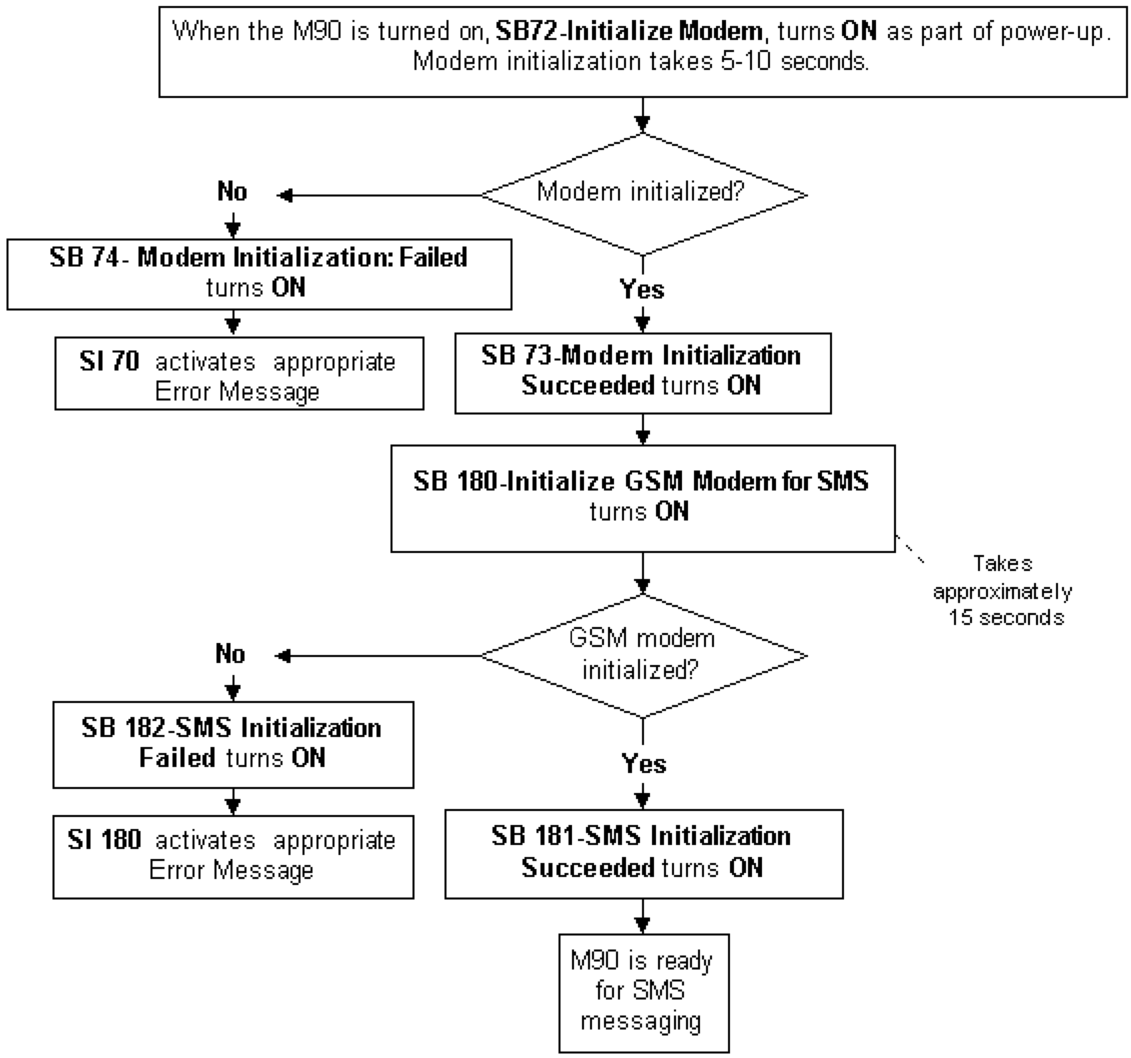
The Receive MB is 12. When this message is received by the controller, MB 12 will turn ON. You must turn the Receive MB OFF in your application in order to register the next time this message is received.

How the Controller works with SMS messaging

To allow the controller to use SMS messaging, you select 'Use SMS messaging' in the Controller>SMS SMS Configuration box.

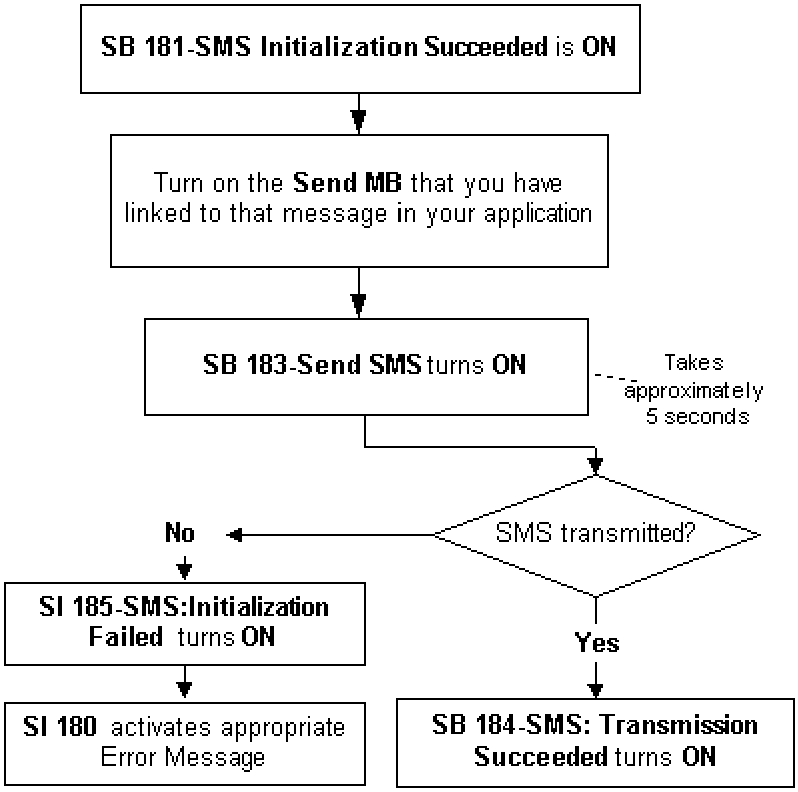
The charts below show the actual process--exactly how the controller initializes and works with a GSM modem. This information is provided for advanced users who may require it for a specific application, or for troubleshooting.

Initialization



After initialization, the M90 can send and receive SMS messages.

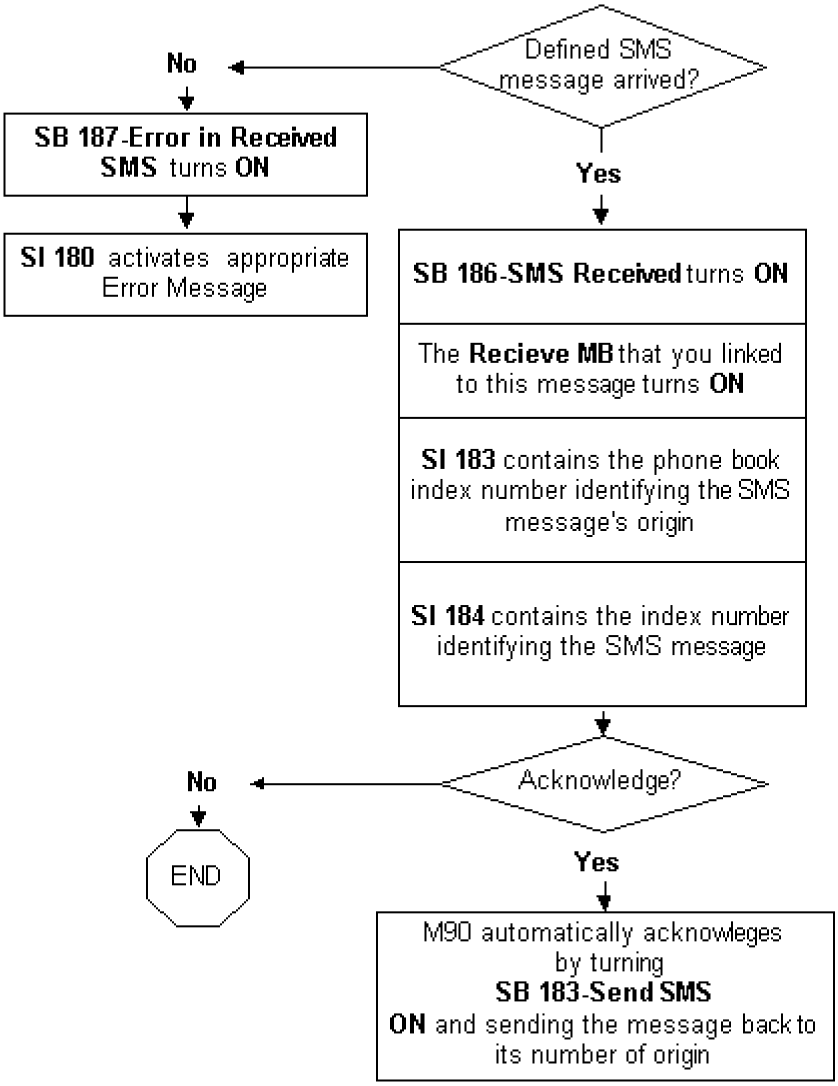
Sending Messages



Note that a cell phone will not be able to receive a message if its SIM card is full.

Receiving SMS messages

The chart below shows how the M90 receives SMS messages. It also shows what happens if the M90 receives an SMS message marked 'Acknowledge'.



SMS messaging problems

You can begin troubleshooting by entering Information Mode. You can then check the status of relevant System Bits and Integers to help diagnose the problem.

To begin diagnosing the problem, check the error codes contained in SI 70 and SI 180.

The tables below show the more common causes of SMS communication problems.

Problem	SI 70 value	Possible Cause & Recommended Action
Modem fails to initialize	2: Modem Did Not Reply	PLC-to-GSM modem cable: Make sure that the cable is securely connected. Check the pin-out of the PLC-to-modem adapter cables. Note that if you use cables comprising this pin-out, you must set the RS232 parameter Flow Control to N (none). Incompatible communication settings. Most modems automatically match the parameters of incoming data: baud rate, data bits, parity & stop bits. M90/91 embedded GSM modem settings are: 19200, 8 data bits, no parity, 1 stop bit. Jazz embedded GSM modem settings are: 9600, 8 data bits, no parity,

		1 stop bit You may need to manually change your modem's communication settings to match these.
	0: No Error	SB 72 / SB180: OFF In order to work with a GSM modem , you must select 'Use GSM modem' in the SMS configuration box . This causes SB 72 Initialize Modem and SB 180 Initialize GSM modem to turn ON when the PLC powers up. Check that these SBs are not disabled in your program.
	6: Modem Report Error	Check the modem initialization commands. Refer to the topic PLC-side Modems.

Other Common Problems:

Problem	**SI 180 value**	**Possible Cause & Recommended Action**
GSM modem not Initialized	1	Refer to table above
Wrong PIN number	5	Check the PIN number contained in the SMS Configuration box, leave it empty if your SIM card has no PIN number.
Failed Registration	6	GSM modem did not register successfully, for example if no network was found, or if the modem antenna is not functioning.
PUK number needed	17	The SIM card is locked due to too many attempts to enter an incorrect PIN number.
Cell phone does not receive message	No value	Check the cell phone's SIM card; it may be full. You can clear the SIM card using SB 193 Delete all SMS messages from SIM card.

Networks

About M90/91 Networks

You can create a decentralized control network of up to 63 controllers using CANbus-enabled M90 models. This is sometimes called a multi-master network. In an M90 network, CANbus enables inter-PLC data exchange. Technical specifications and wiring diagrams are given in the M90 User Guide.

Using your PC, you can access a networked M90 unit via its RS232 port. You can then view, read, and write data into any unit. This feature can also allow you to view your network via a SCADA program.

Assigning a Unit ID number

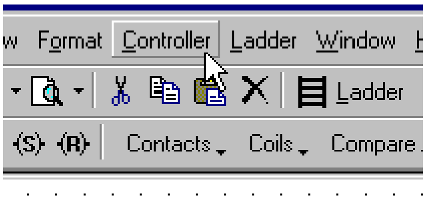
When you create an M90 network, you must assign a Unit ID number to each controller. A Unit ID number is unique. It **must** be used **only** once within a network.

You use this number for two purposes:

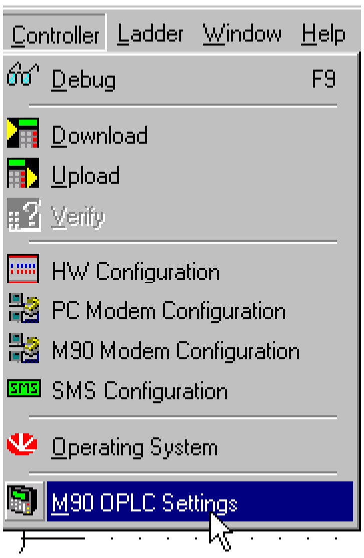
- To enable the M90 controllers to exchange data.
- To access a networked M90 via your PC.

To set a Unit ID number:

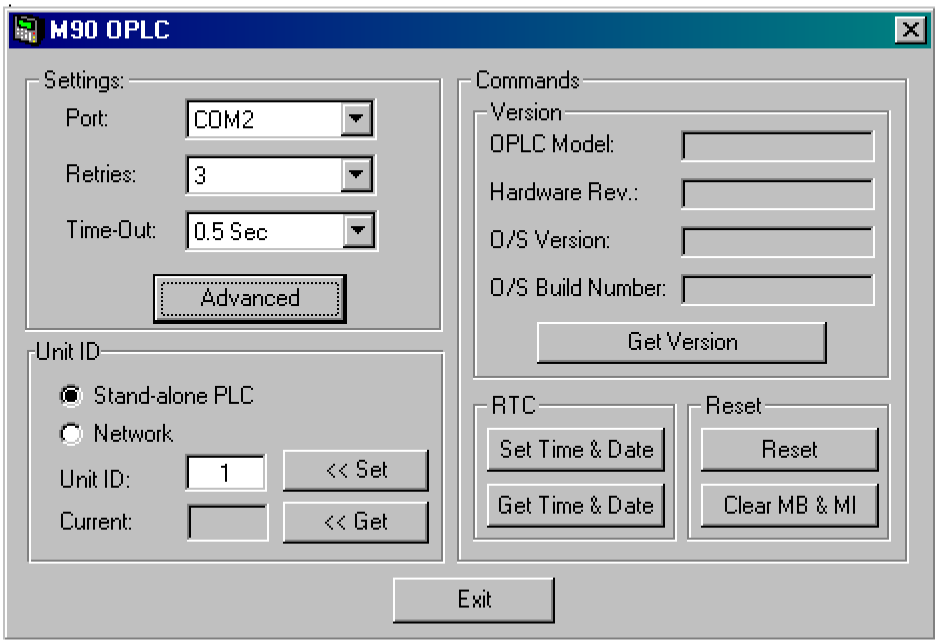
1. Click Controller on the Standard menu bar.



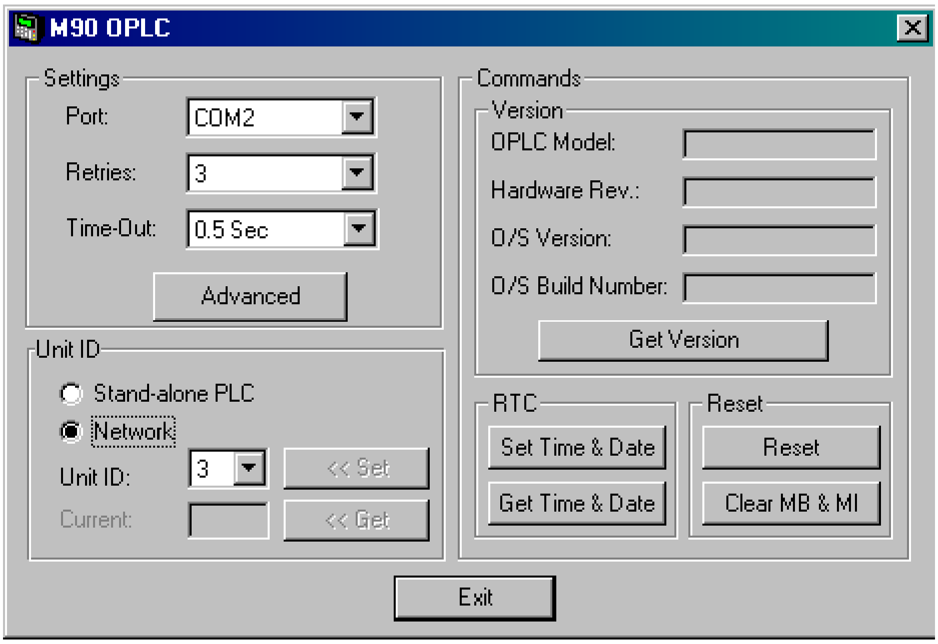
2. Select **OPLC Settings** from the Controller menu.



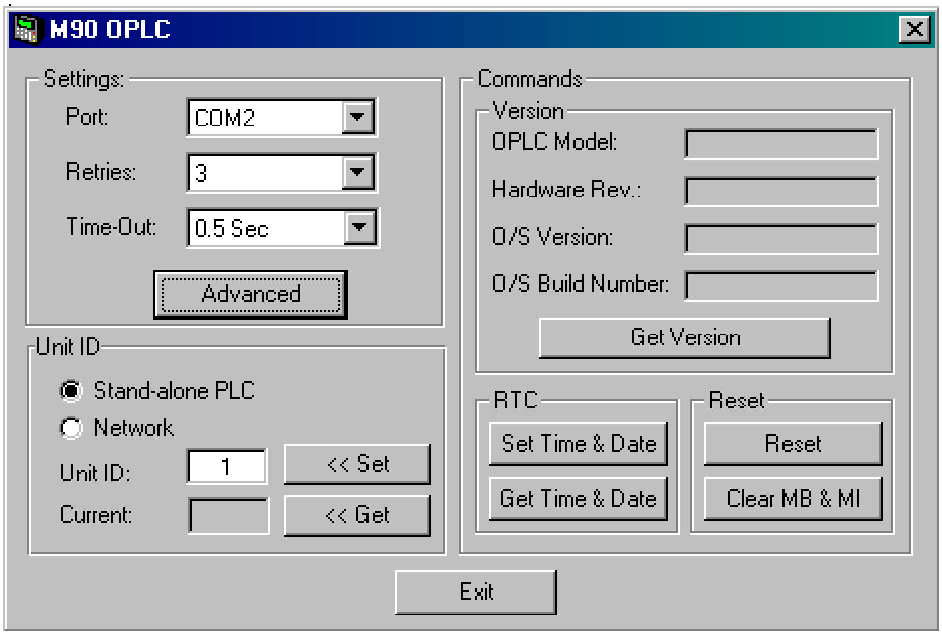
3. The **OPLC Settings** window opens.



4. Enter the new ID number in the Unit ID window.

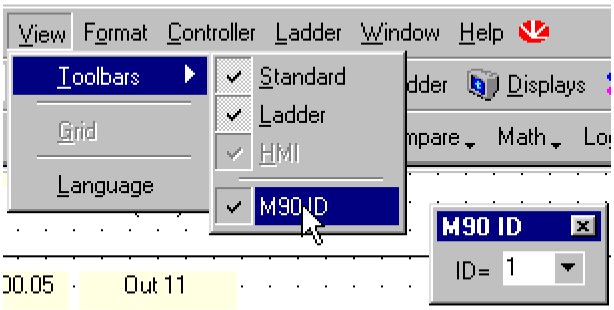


5. Click **<< Set** to enter the new IN number.



Displaying the Unit ID Tool Bar

1. Display the Unit ID by selecting ID from the Controller menu.
2. The Unit ID tool bar opens as shown below.



To download via an M90 bridge to a networked M90, you must select the unique ID of the networked M90. When you enter '0' as the Unit ID number, you communicate directly with the M90 that you are using as a bridge to the network.

CANbus Networking

CANbus enables inter-PLC data exchange.

CANbus Specifications

Power Requirements: 24VDC (±4%), 40mA max. per unit

Galvanic Isolation between CANbus and controller: Yes

Baud rate	Max. Network Cable Length:
1 Mbit/s	25 m
500 Kbit/s	100 m
250 Kbit/s	250 m
125 Kbit/s	500 m
100 Kbit/s	500 m

50 Kbit/s	1000 m
20 Kbit/s	1000 m

Note □ Cable lengths over 500 meters require an additional power supply.

Wiring Considerations

Use twisted-pair cable. DeviceNet® thick shielded twisted pair cable is recommended.

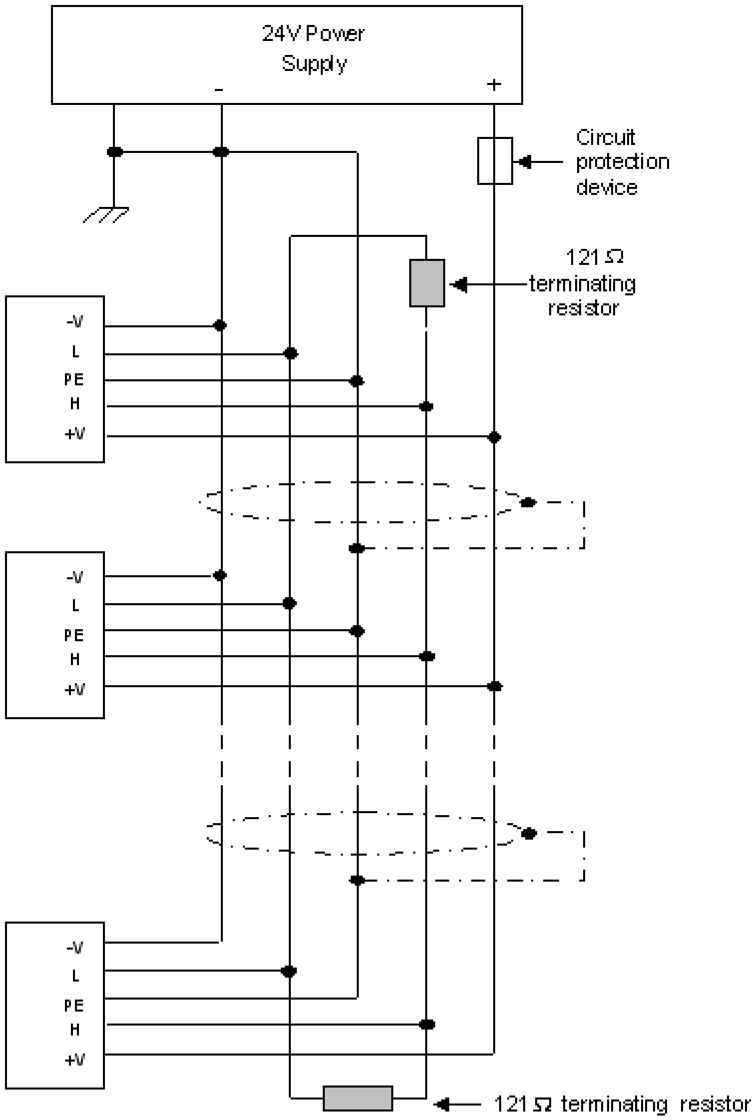
Network terminators: These are supplied with the controller. Place terminators at each end of the CANbus network. Resistance must be set to 1%, 121Ω, 1/4W.

Connect the ground signal to the earth at only one point, near the power supply.

The network power supply need not be at the end of the network.

Maximum number of controllers in a network: 63.

Wiring Diagram



When you create a CANbus network, you assign each controller a unique Unit ID number, 1 through 63.

You use these unique ID numbers when you write your network control program. You address operands using the unique ID number. This allows the M90 units to access data from other controllers, using special SIs and SBs in combination with the Unit ID number.

Each controller can read the information contained in **SI 200 & SI 201 and SB 200- SB 207 and 16 first Inputs I 0 - I 15 in other units**.

System Integers

Op	Addr	In Use	Power Up	Value	Symbol
SI	197	☐			
SI	198	☐			
SI	199	☐			
SI	200	☐			M90 Network Operand
SI	201	☐			M90 Network Operand
SI	202	☐			
SI	203	☐			
SI	204	☐			
SI	205	☐			

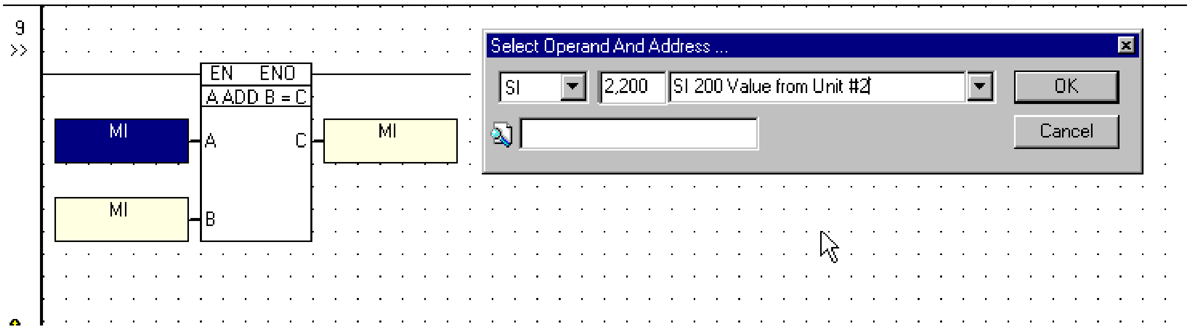
System Bits

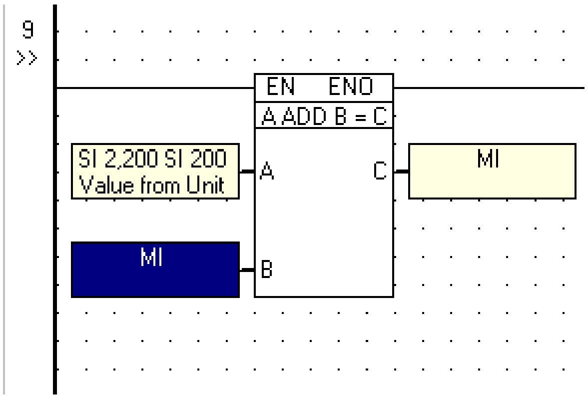
Op	Addr	In Use	Power Up	Value	Symbol
SB	197	☐			
SB	198	☐			
SB	199	☐			
SB	200	☐			M90 Network Operand
SB	201	☐			M90 Network Operand
SB	202	☐			M90 Network Operand
SB	203	☐			M90 Network Operand
SB	204	☐			M90 Network Operand
SB	205	☐			M90 Network Operand
SB	206	☐			M90 Network Operand
SB	207	☐			M90 Network Operand
SB	208	☐			M90 Network Operand
SB	209	☐			M90 Network Operand
SB	210	☐			M90 Network Operand
SB	211	☐			M90 Network Operand
SB	212	☐			M90 Network Operand
SB	213	☐			M90 Network Operand
SB	214	☐			M90 Network Operand
SB	215	☐			M90 Network Operand
SB	216	☐			

To read the information from a controller, the addressing to an SI or SB must be combined with the Unit ID number of the controller being read from.

Example:

We want to add the value in SI 200 in unit #2 with another MI.





CANbus networking is featured in several sample applications, check the application ' 8 PLCs + Alarm' .

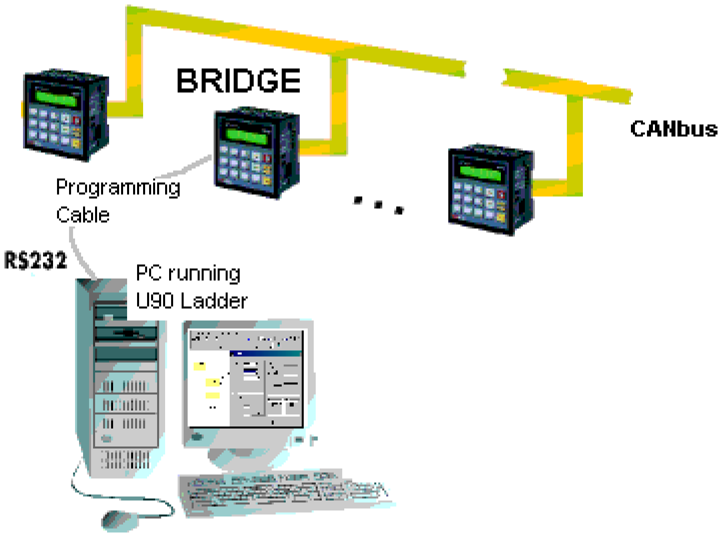
Note • Unitronics' CANbus control network is run by a separate isolated power supply that is not part of the network power supply.

• Note: You can connect up to **63** units in a CANbus network. Each controller can read information from up to **8** other controllers in the network.

Using your PC to access a network

You can use your PC to access any M90 unit within a network. To do this, you connect your PC to any M90 in the network using the programming cable supplied with the M90 controller as shown below. This M90 is your 'bridge' to the rest of the network.

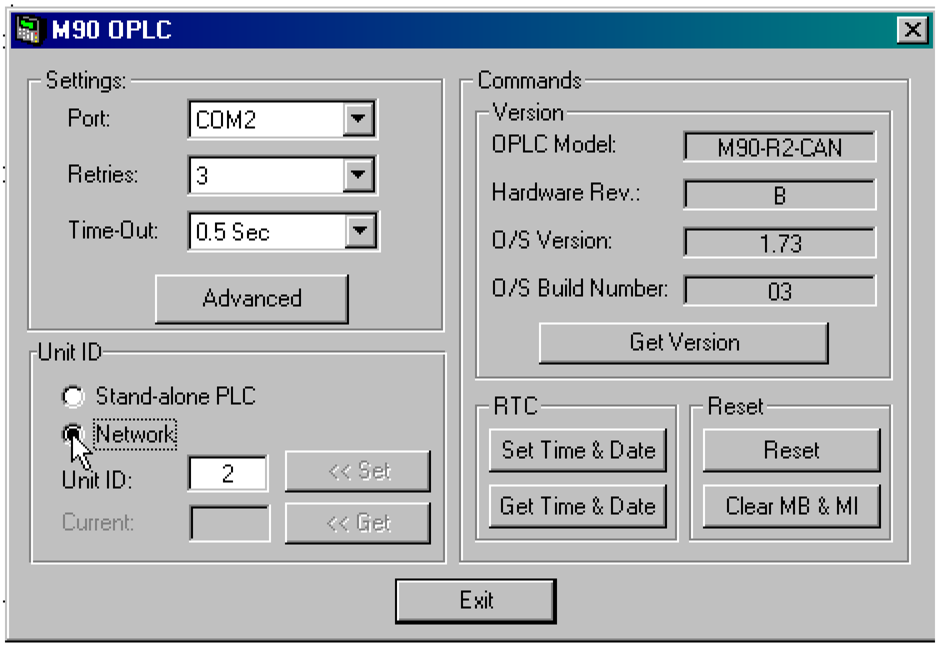
Via the bridge, you can download, upload, and edit programs--you can perform any action that can be performed via direct communications. You can also view runtime data. This does not affect the running of the control program.



Note that different PCs can access a network at the same time, using different M90 units as bridges. However, 2 different PCs cannot simultaneously access the same M90 unit.

To communicate with different M90 units via the bridge, you:

1. Select Network as shown below.
2. Select the M90 you wish to communicate with by entering its unique ID number.



According to the figure above, the PC would communicate with M90 number 2.

However, note that once your project is defined as a **Network** project, U90 Ladder **cannot** automatically detect the bridges' communication settings. In order to communicate via the bridge, your current communication settings must be **identical** with those of the bridge. Note too, that the bridge's RS232 baud rate cannot be set below 9600.

Ladder

Ladder Logic

You use Ladder Logic to write your project application. U90 Ladder is based on Boolean principals and follows IEC 1131-3 conventions.

Ladder Diagrams are composed of different types of contact, coil and function block elements. In U90 Ladder, these elements are placed on nets.

In any Ladder Diagram, the contacts represent input conditions. They lead power from the left rail to the right rail. Coils represent output instructions. In order for output coils to be activated, the logical state of the contacts must allow the power to flow through the net to the coil.

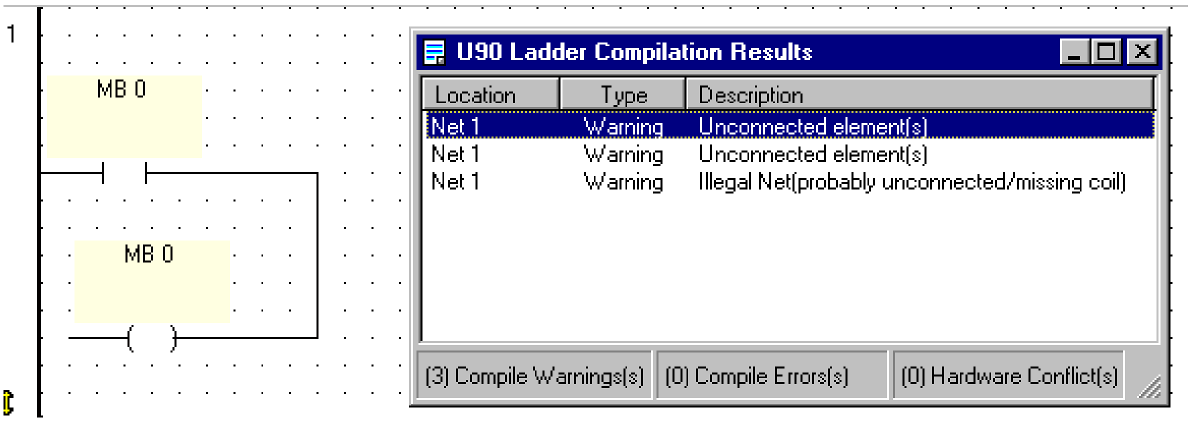
Ladder Net

A U90 Ladder net is the smallest division of a ladder diagram in Unitronics' U90 Ladder software.

Your first ladder element on the left must be connected to the left side of the ladder in each net. You do **not** need to connect the last element on the right to the right side of the ladder in each net.

You should place only one ladder rung on a Ladder net.

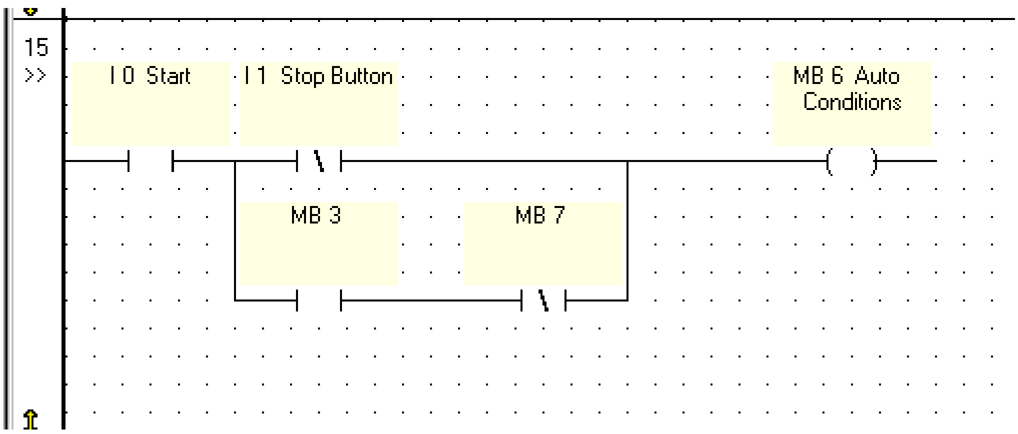
Power flows through the ladder elements in a net from left to right. If you build a net that would result in reverse power flow (right to left) the following error message occurs:



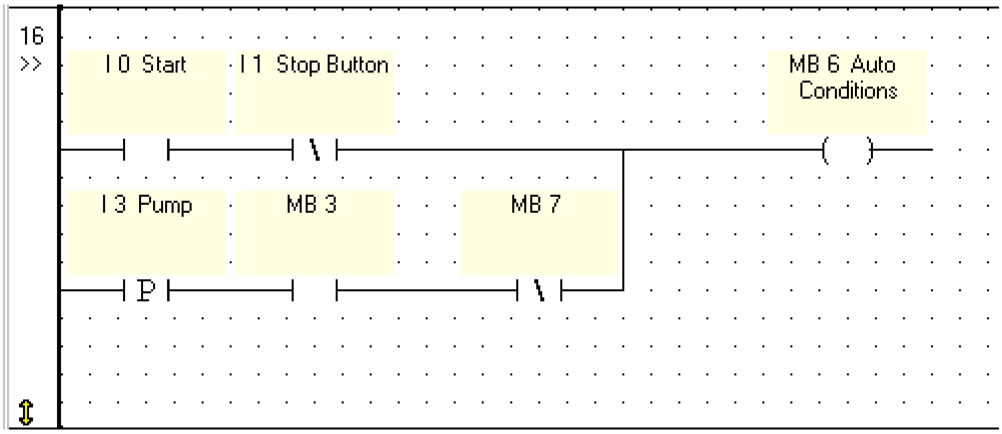
Placing more than one rung in a net may cause compiler problems in your project.

Examples:

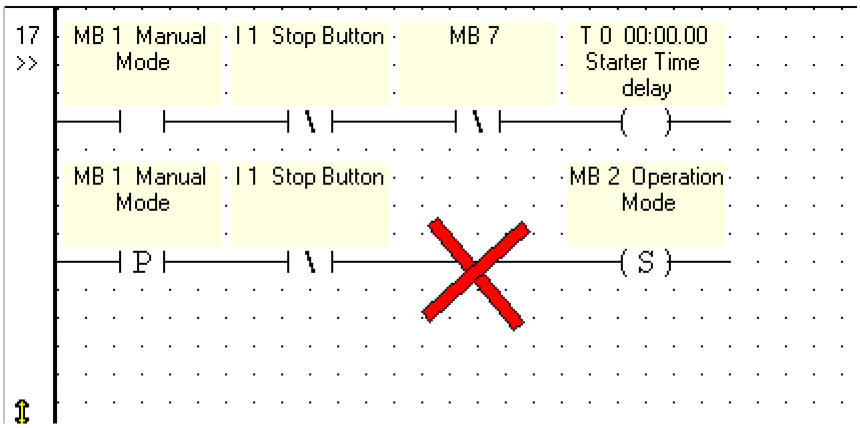
This net is constructed properly.



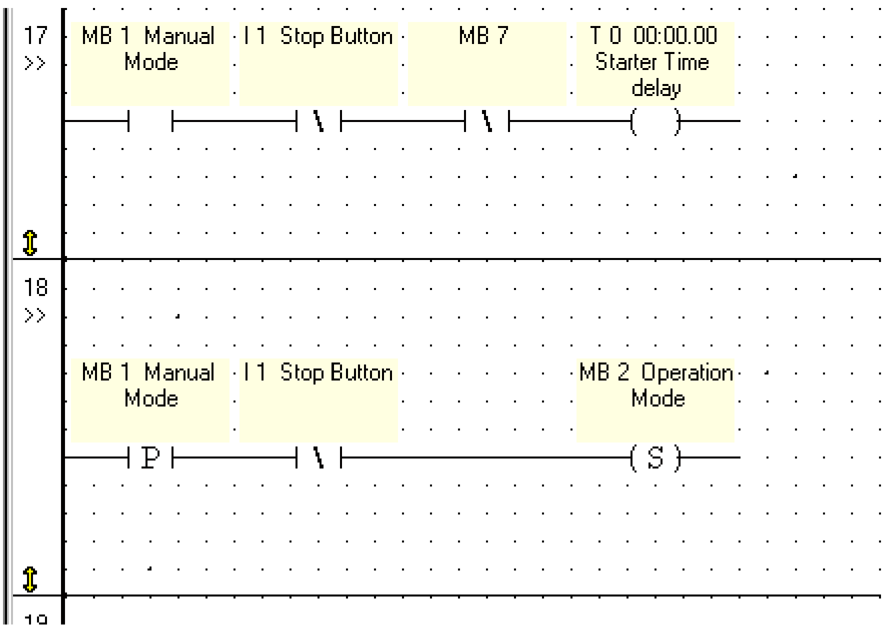
This net is constructed properly.



This net is improperly constructed and contains two rungs.



The rungs in the net below should be placed in two nets as shown below.:

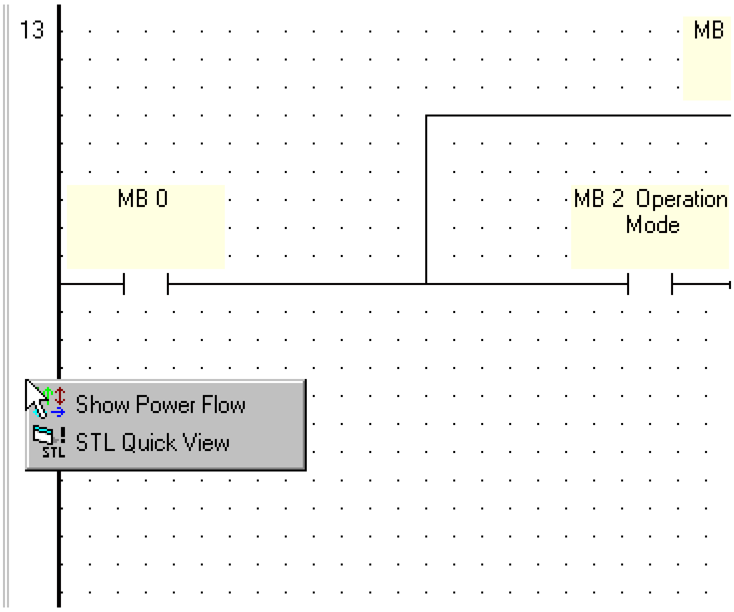


Viewing Logic Power Flow in a net

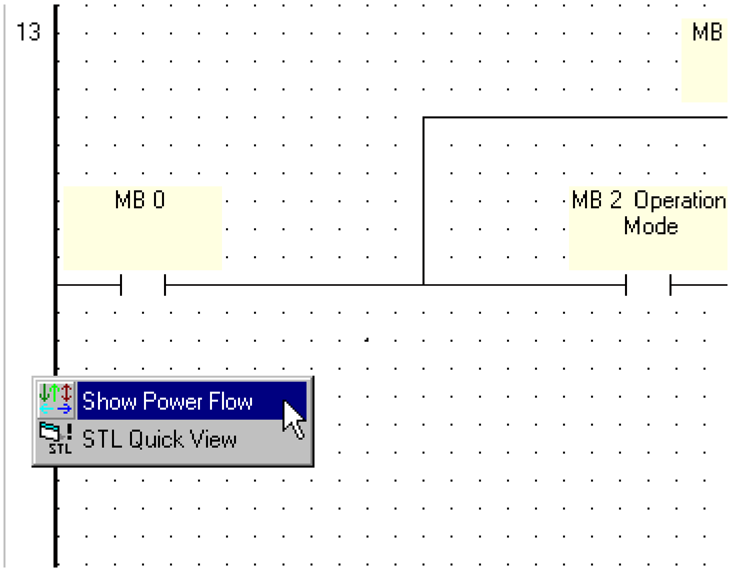
The **Show Power Flow** feature enables you to check the logic of a net you create.

You can see the Power Flow directions and, from these, how the net will work in the project.

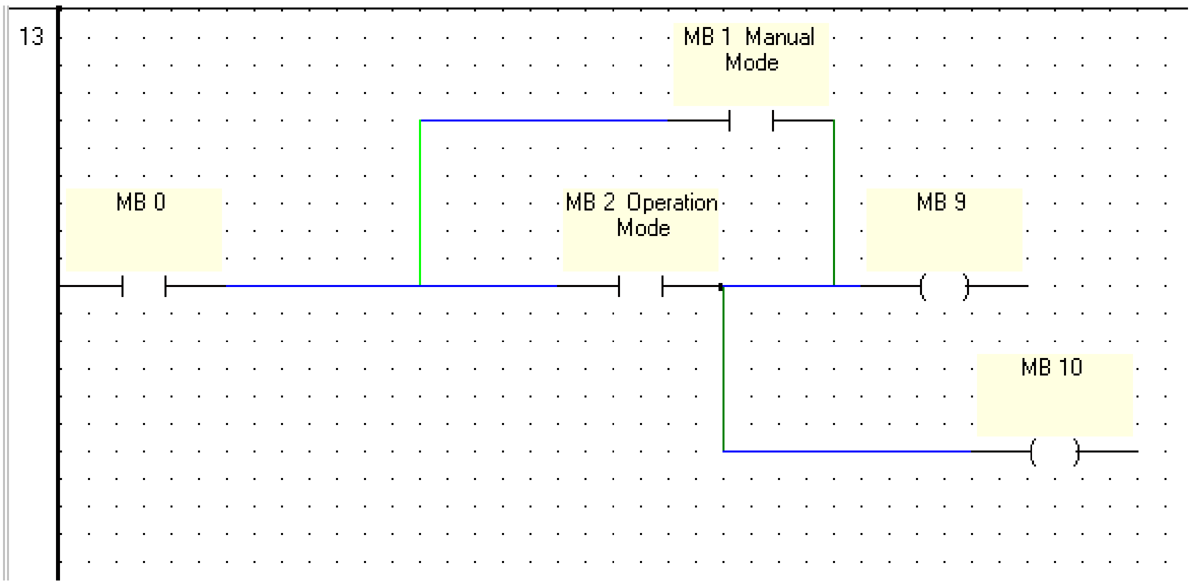
1. Right-click on the left Ladder bar. The Compiler Results menu appears.



2. Select Show Power Flow.



3. The net lines change color according to the power flow direction.



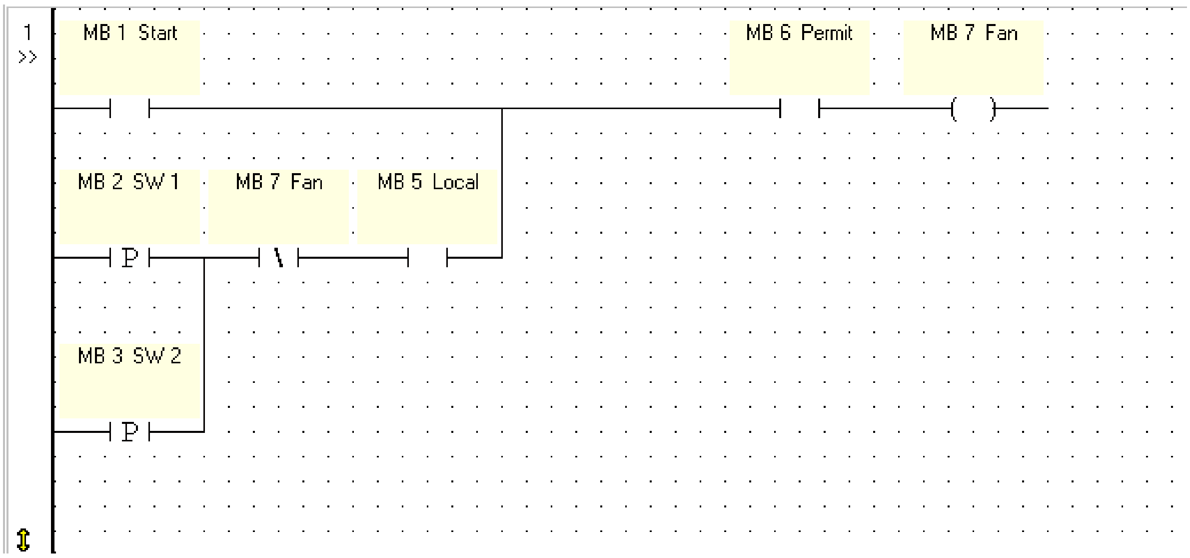
Each color represents a different direction of power flow.

Line Color	Power Direction
Dark Green	Down
Light Green	Up
Dark Blue	Left to Right
Light Blue	Right to Left
Red	Up or Down

Ladder Nets with Feedbacks

According to IEC 1131 - 3, it is possible to create Ladder Diagram nets that contain feedback loops, i.e. where an element is used as both contact(s) and coil(s) in the same net.

In Ladder Diagram, all external input values such as those associated with contacts are gathered before each net is evaluated.



In the above example:

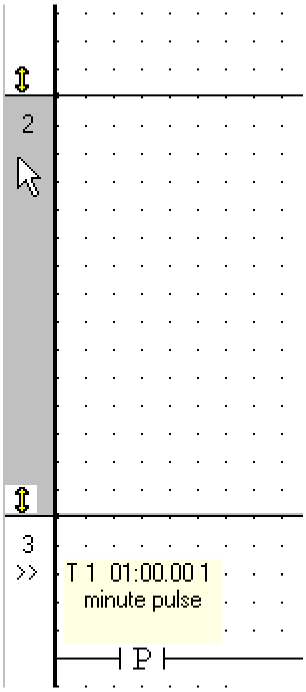
Where the net uses the state of its own output, the value of FAN (MB 7) coil associated with an inverted contact of MB 7 is always the value resulting from the previous evaluation.

However, if the value of FAN (MB 7) is used in any following nets, the latest evaluated state is used.

Deleting Nets

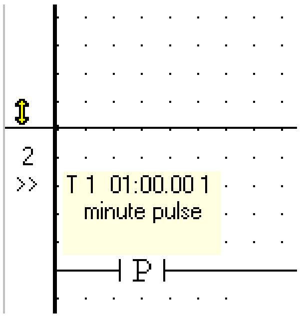
To delete a single net

1.Click in the net number space to select the net. (The white space to the left of the net.)



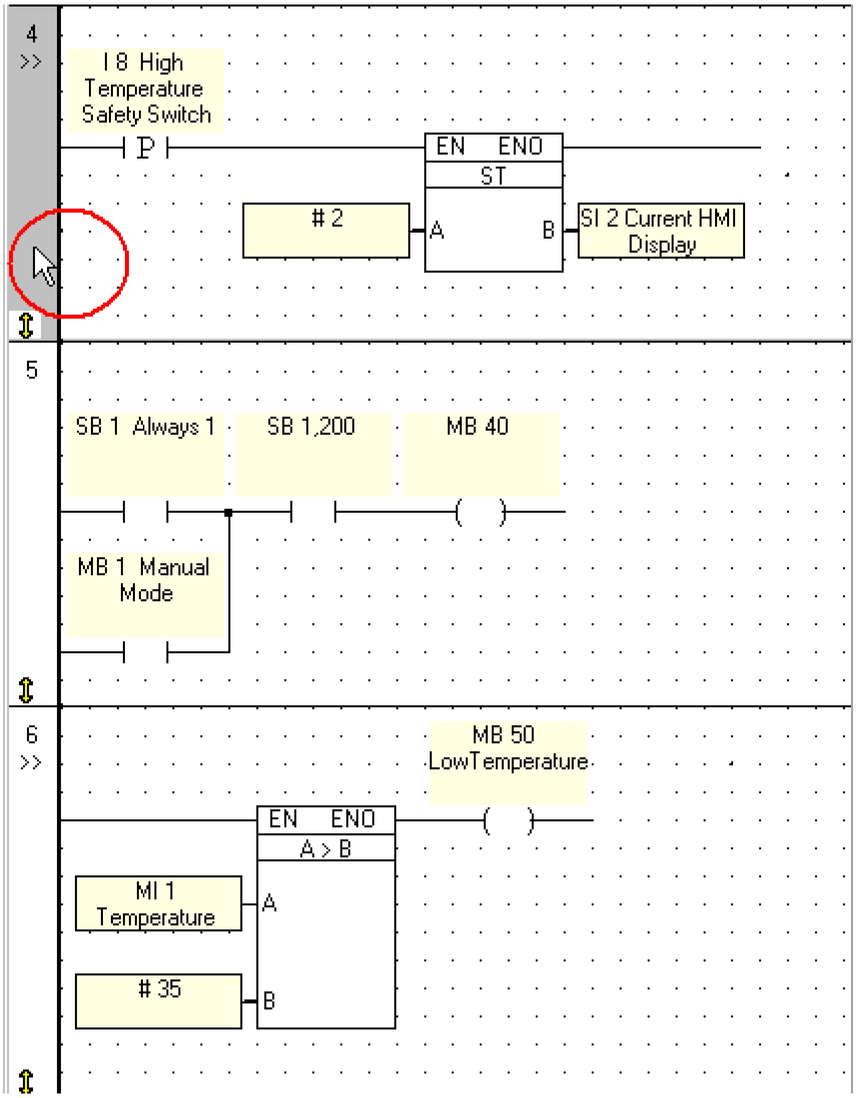
2. Select delete . A dialog box will prompt you to confirm the delete action.

3. The net will be deleted.

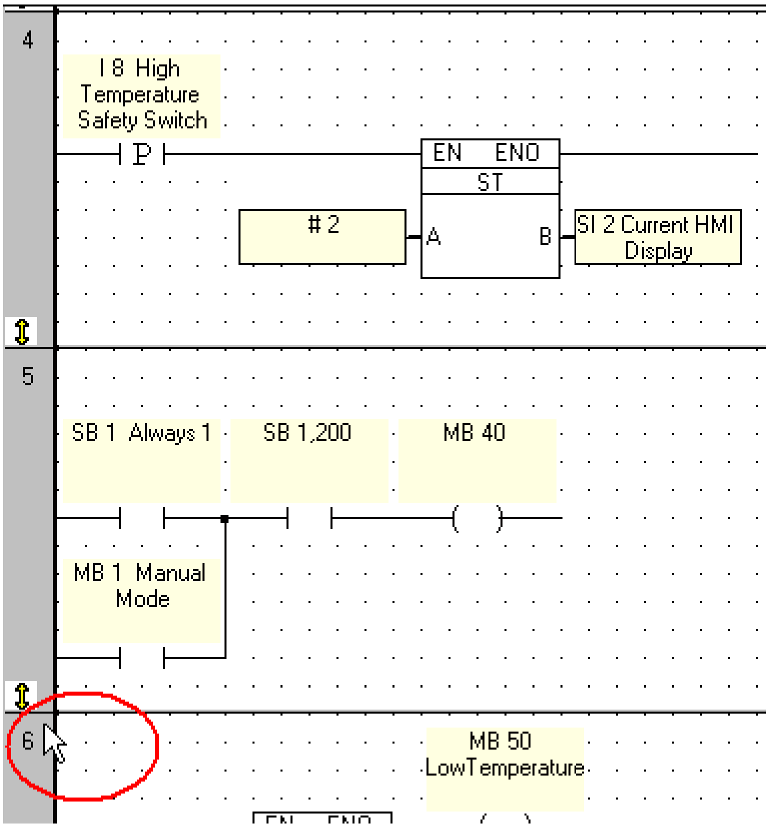


To delete more than one net

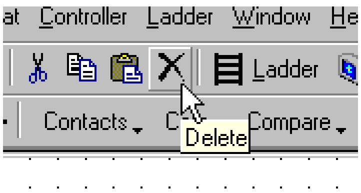
1. Select the first net by clicking on the left net bar.



2.Hold the **Shift** button and click on the last net in the range that you want to copy.



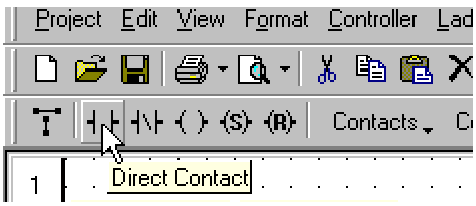
3.Click Delete on the Standard toolbar.



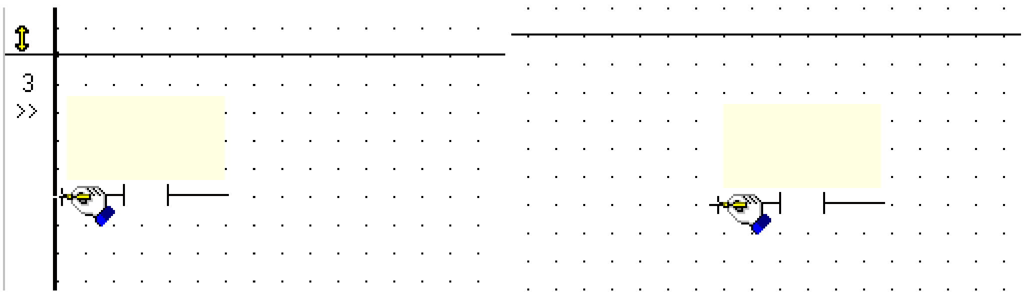
Placing Contacts & Coils

To place a Contact / Coil on a net:

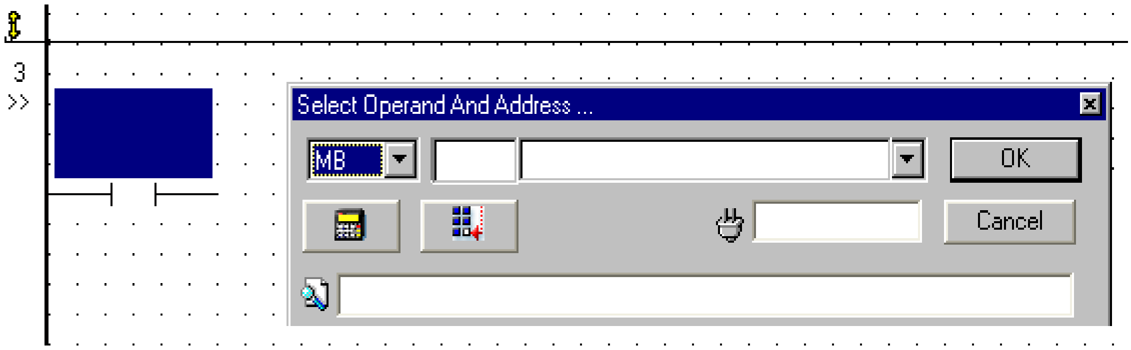
1. Click once to select the desired contact / coil.



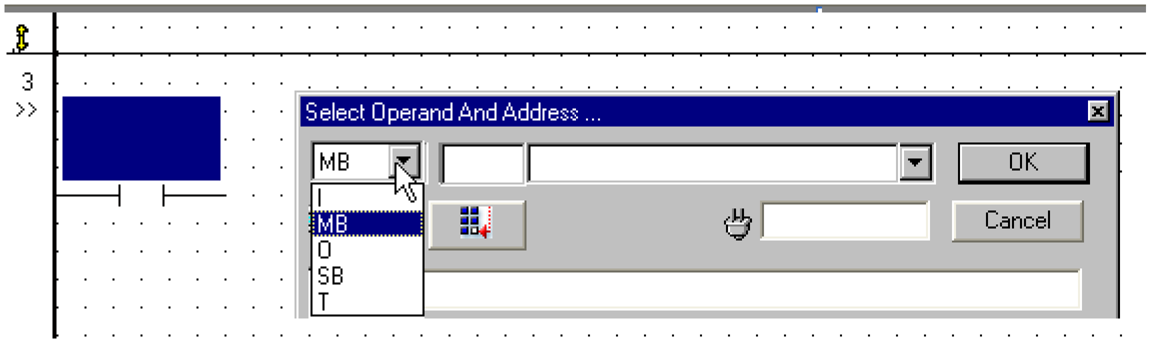
2. Move the element to the desired net position.



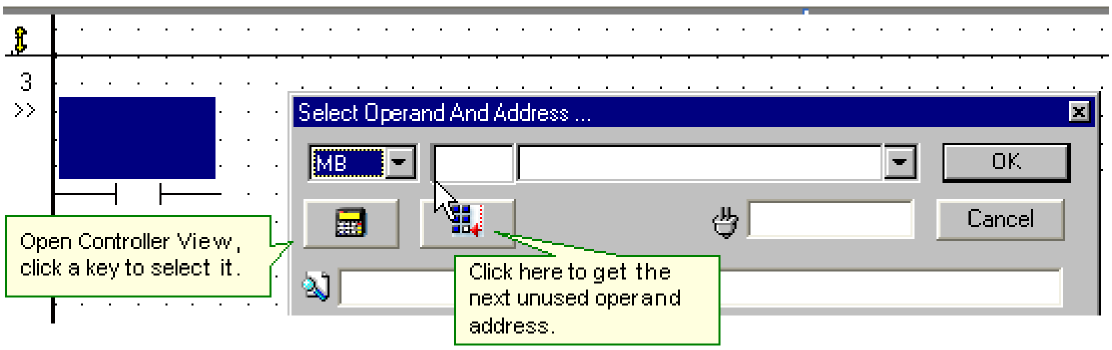
3. Click to place the element. The Operand and Address dialog box opens.



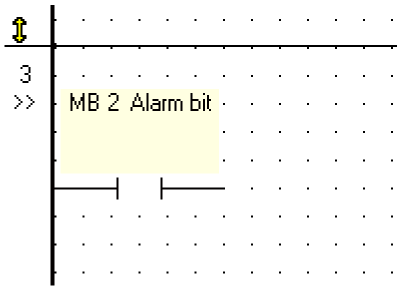
4. Select the Operand type from the drop - down menu.



5. Either type the Operand Address and symbol, open Controller View, or click Get Next Unused Operand. Click OK.



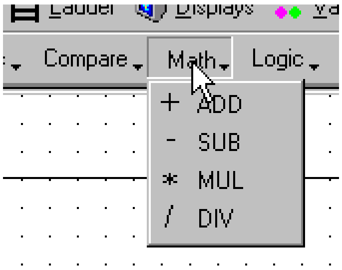
6. The element appears on the net with the selected Operand Address and symbol



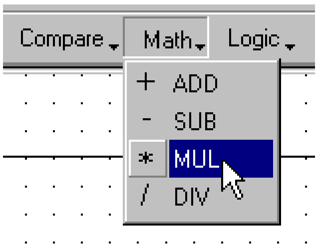
Placing a Function Block

To place a Compare / Math / Logic function block on a net:

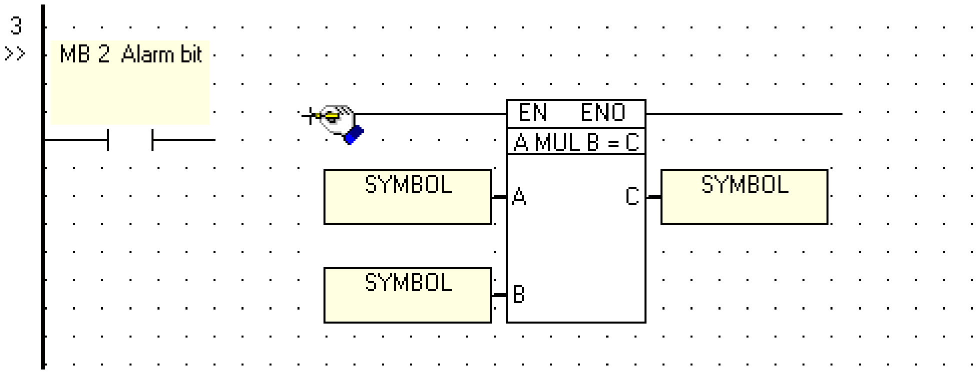
1. Click on the menu containing the desired type of function block,
   OR
   Right-click on a net to display the toolbar, then click on the desired menu; the menu opens.



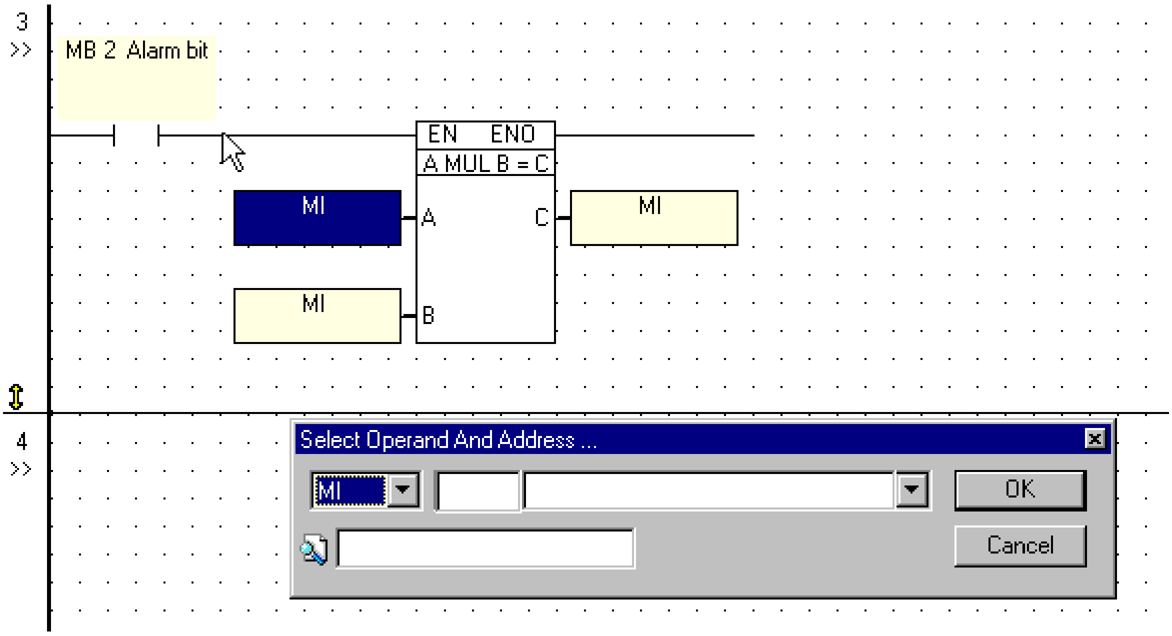
2. Select the desired operation.



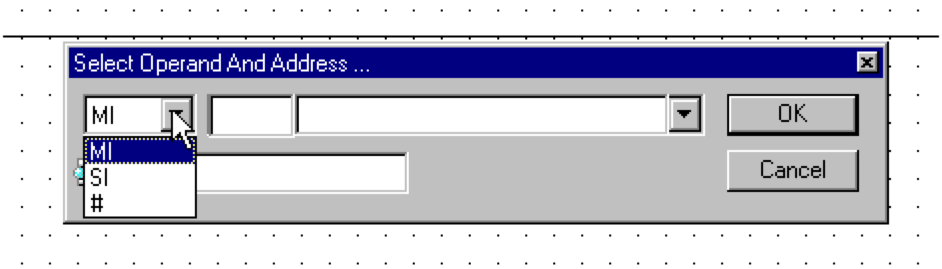
3. Move the function block to the desired net position.



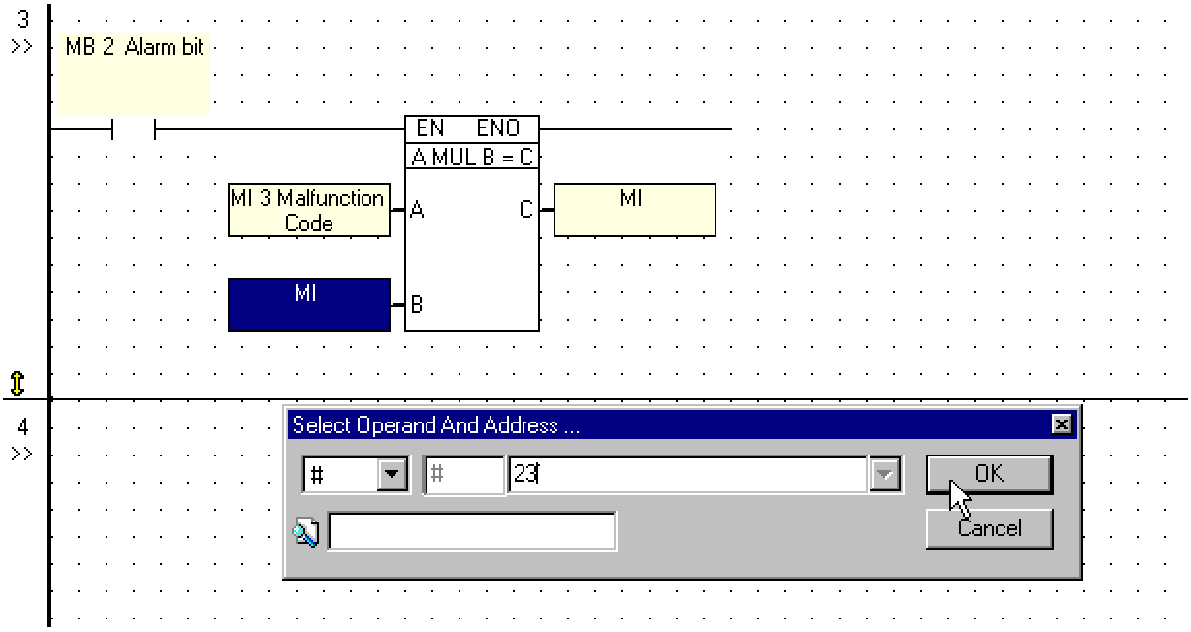
4. Click to place the element. The Operand Address and symbol dialog box opens.



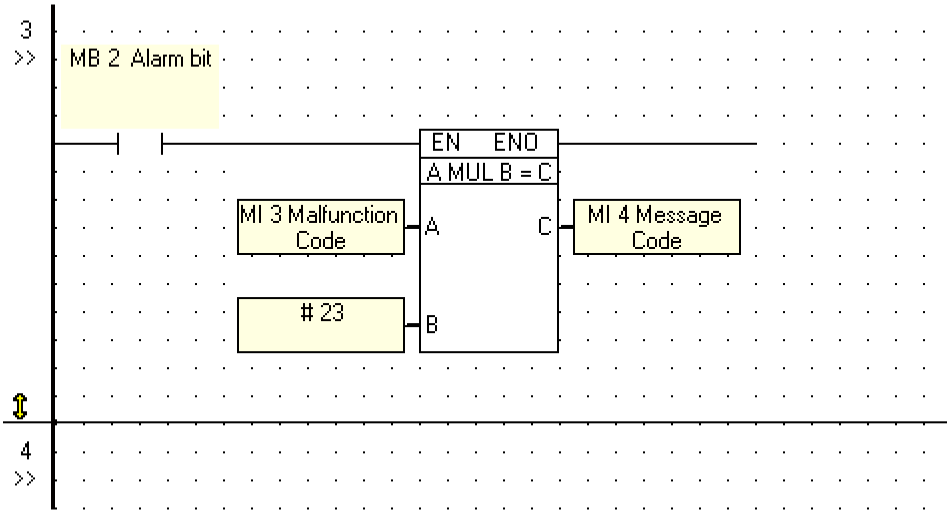
5. Select the desired Operand type.



6. Enter the Operand Address and symbol or constant value for each block variable. Click OK

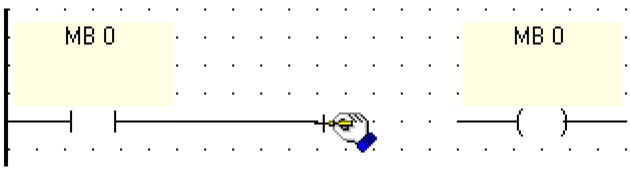


7. The function block appears on the net with the selected block variable values and symbols.

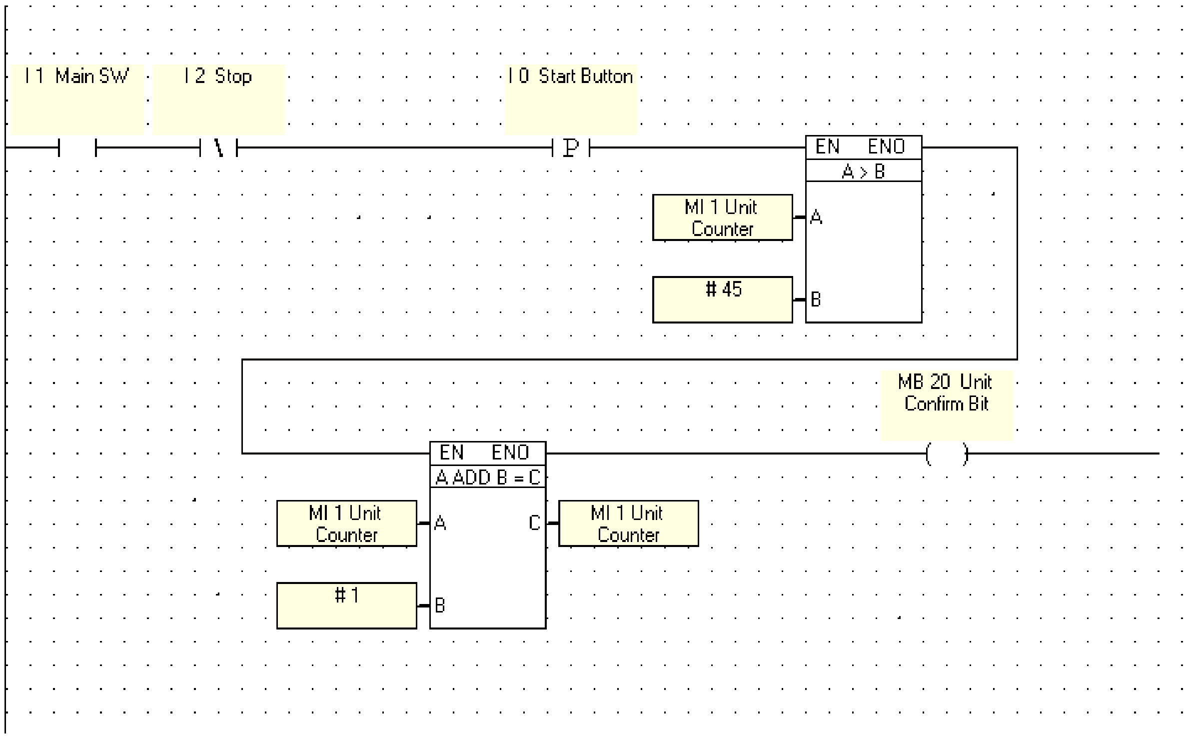


Connecting elements: Line Draw

Use the Line Draw tool to connect elements.

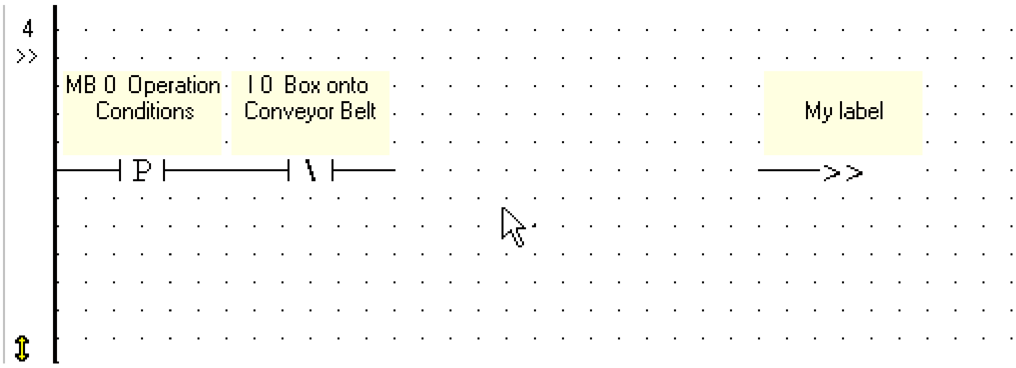


If you have a long series of elements in one net, you can use the Line Draw tool to extend the rung within the net.



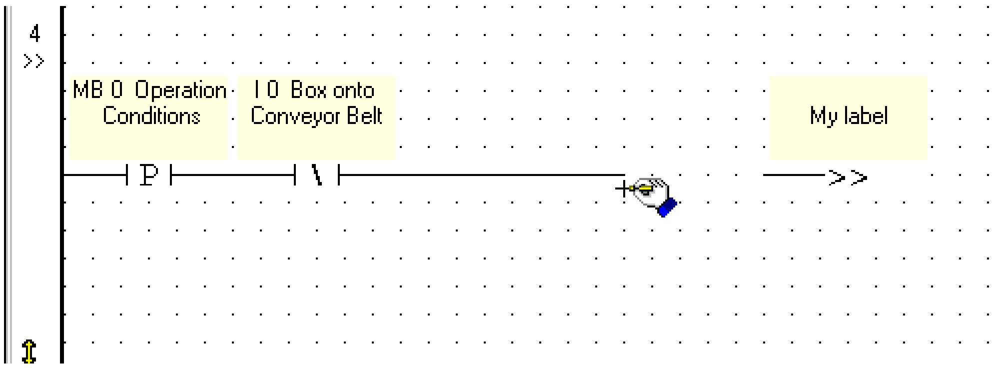
To use the Line Draw tool:

1. Place your cursor in the empty space in a net and double-click or click the Line Draw icon .



2. Your cursor changes into a drawing hand.

   Click and drag to draw the desired line to connect two elements in the net. Do not leave spaces between lines and elements. This may cause a compile error.

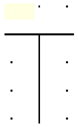


3.

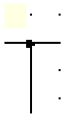
Intersecting lines: Junction

To check for junctions:

1. When you draw intersecting lines with the Line Draw tool, the line intersections are simply 90 degree angles.



2. After compiling the project, there will be a small circle at each junction. This circle shows you that the compiler recognized these line intersections as junctions.

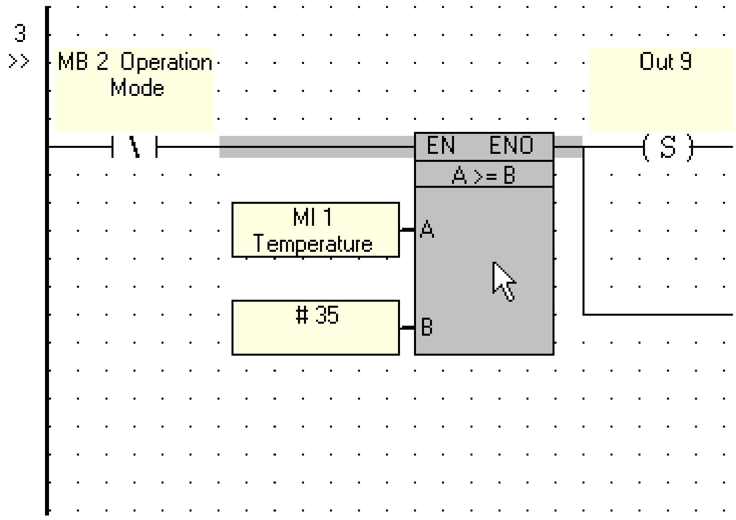


Copy and Paste Elements

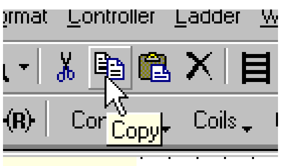
You can copy one or more elements from a net to paste into another net.

To Copy and Paste U90 Ladder elements in a net:

1. Select the element(s) you want to copy.

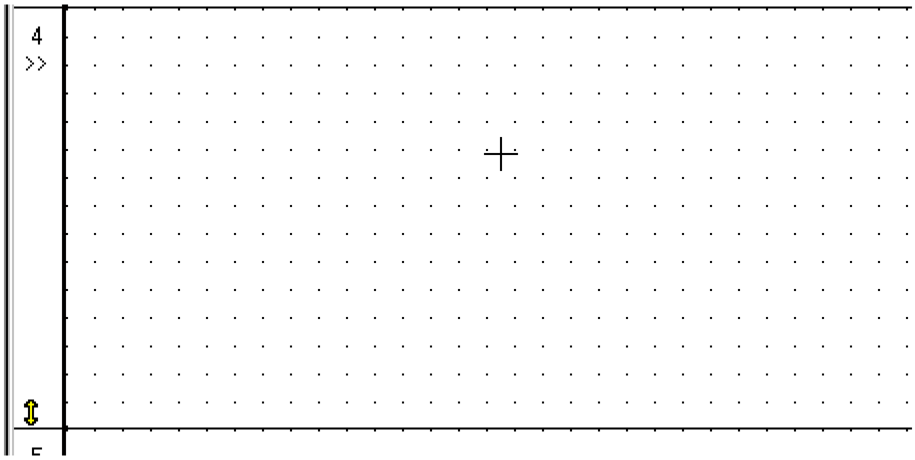


2. Select Copy.

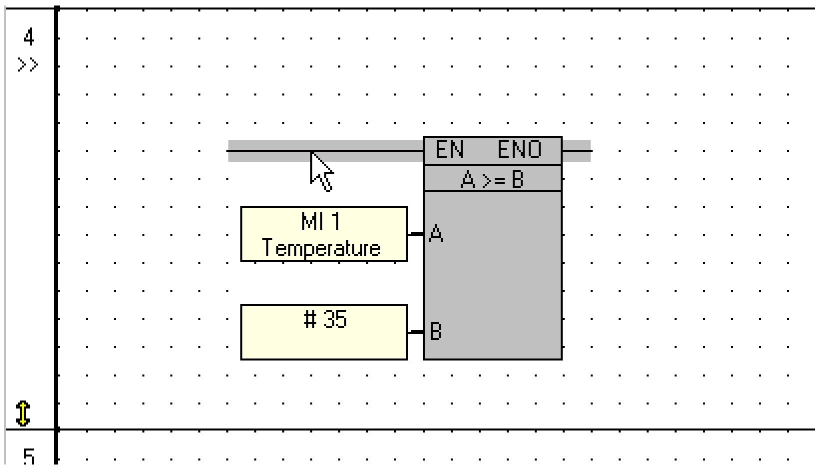


3. Select Paste.

4. Move the pointer to the net that you want to paste into



5. Click.

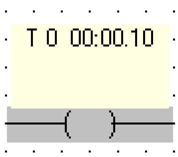


Note that the element(s) will appear in the same area in the new net as where they were in the copied net.

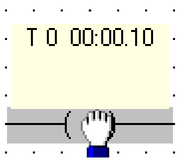
Moving Elements

To move an element within a net:

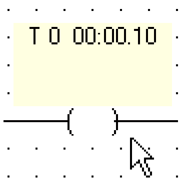
1. Select the element by single clicking on the element function (not the Operand and address area).



2. Hold the mouse button down. The cursor changes to a hand.



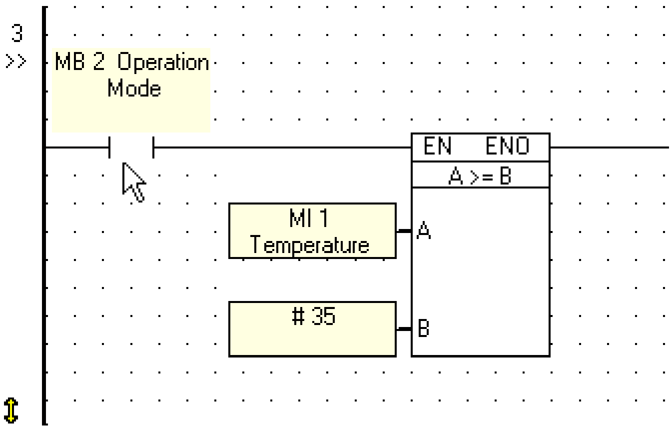
3. Move the mouse to re-position the element on the net. Release the mouse button.



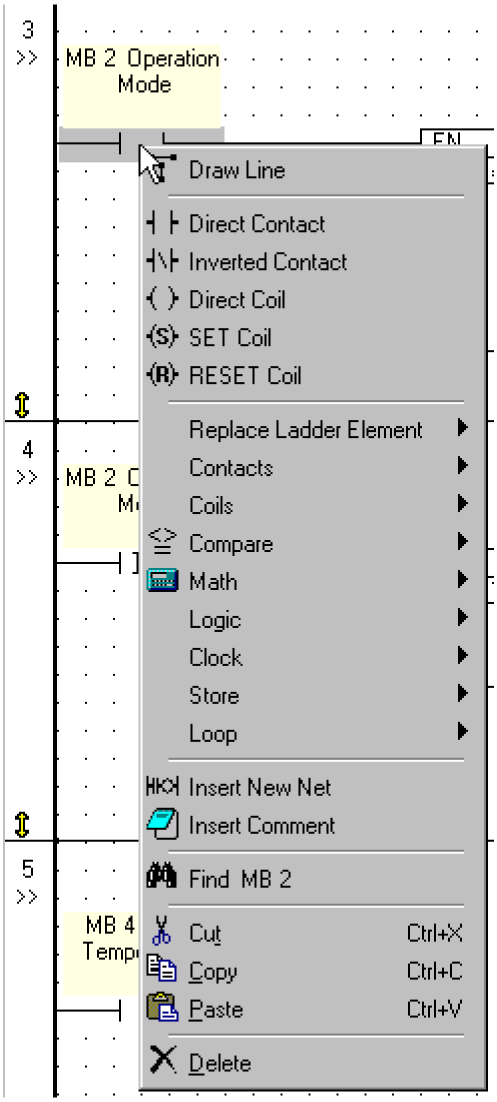
Replacing Ladder elements

To exchange one element for another within the same element family:

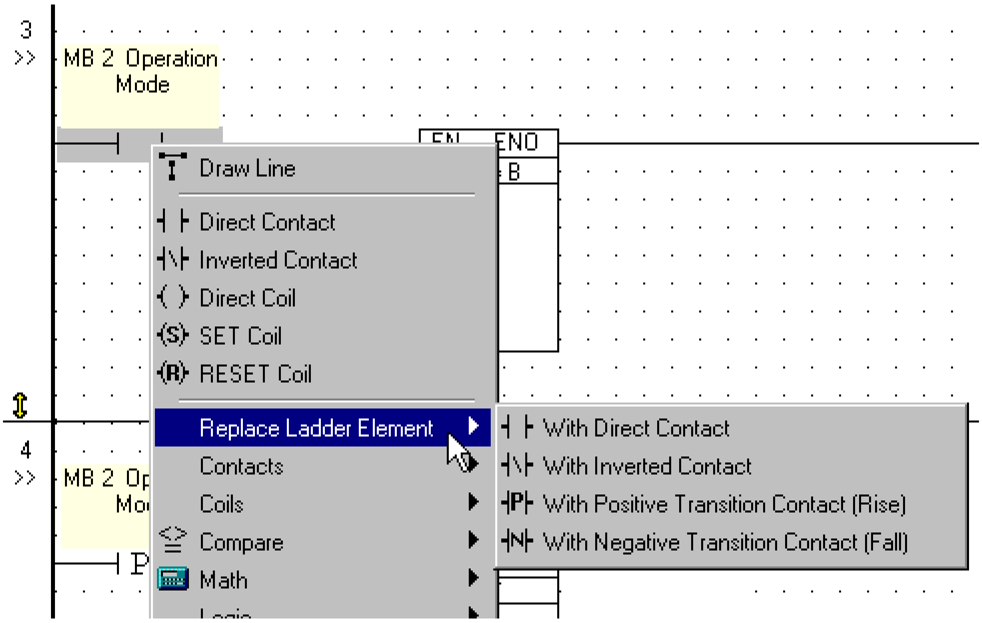
1. Select the element that you want to exchange.



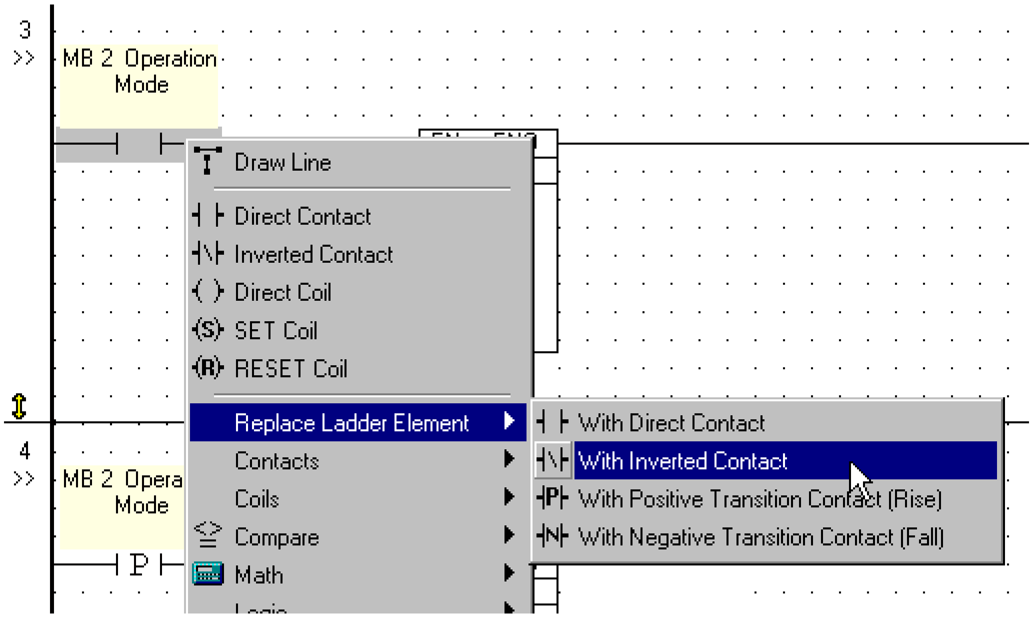
2. Right click to open the pop-up menu.



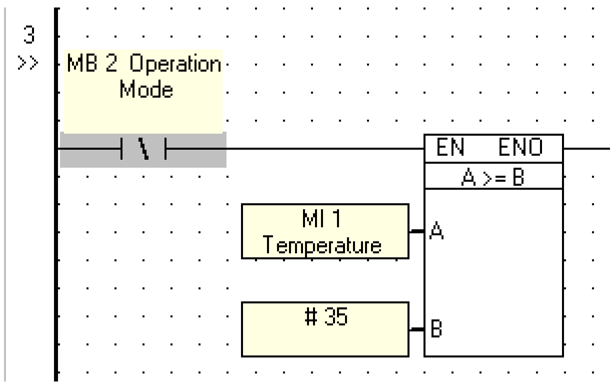
3. Select **Replace Ladder Element** option.



4. Select the desired replacement element type.



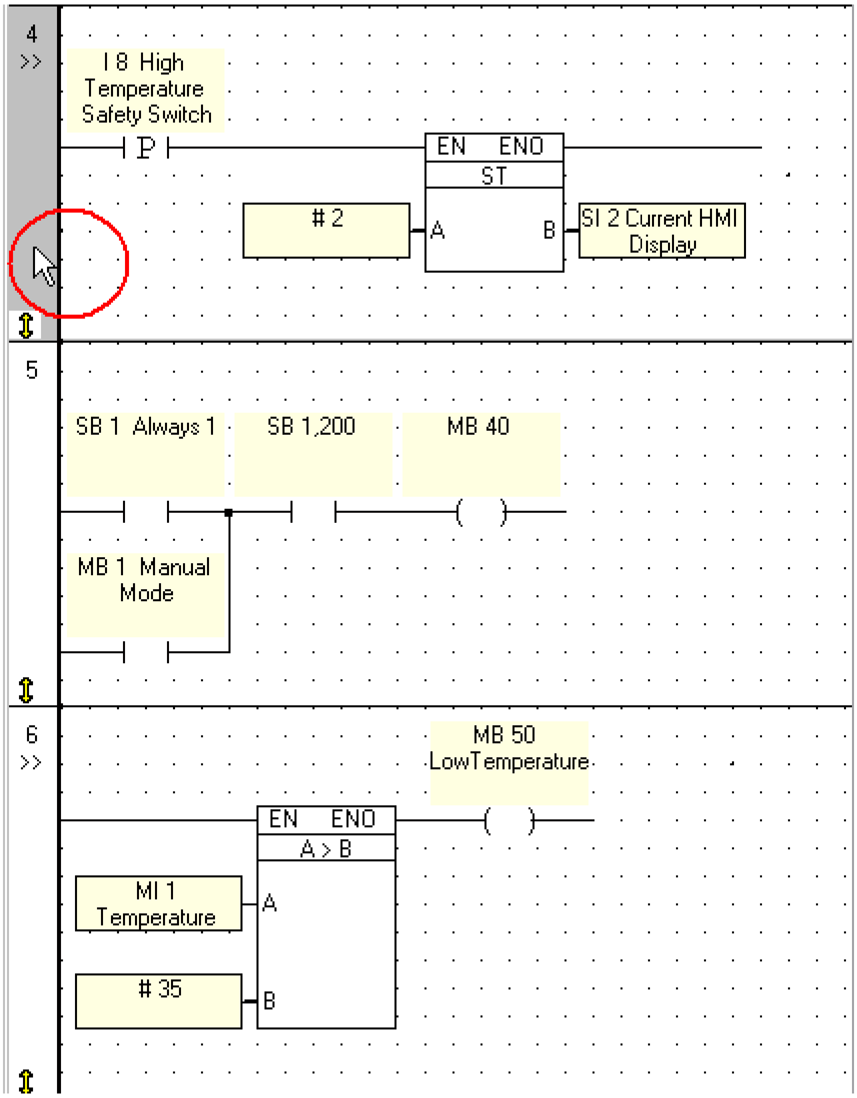
5. The element appears with the new element type.



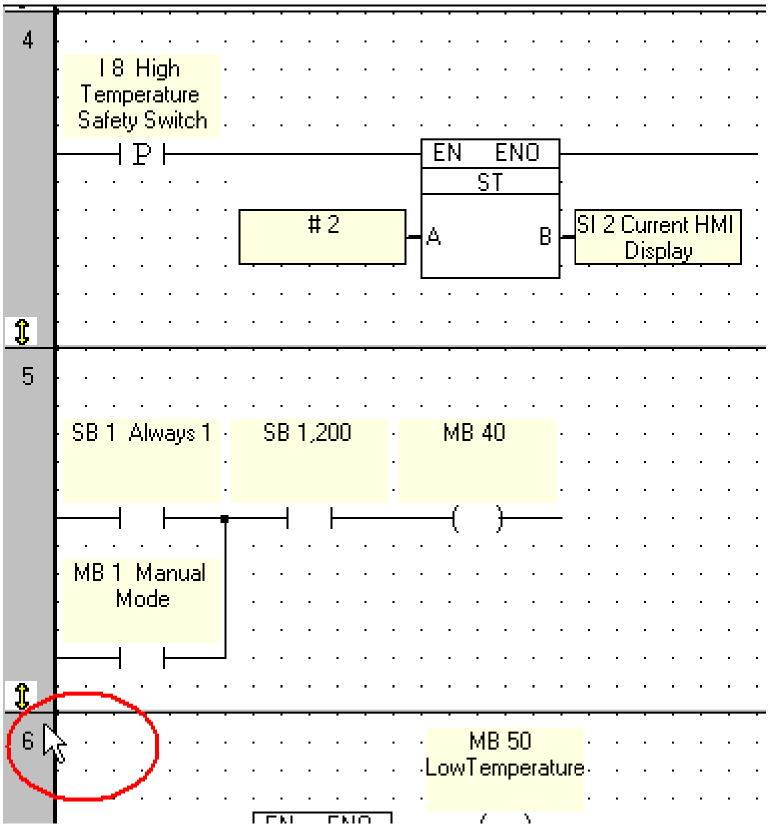
Copying multiple nets

To copy more than one net:

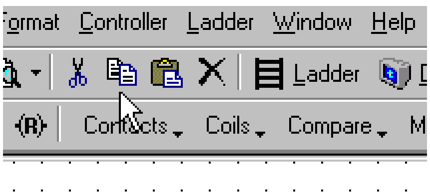
1. Select the first net by clicking on the left net bar.



2. Hold the **Shift** button and click on the last net in the range that you want to copy.



3. Click Copy on the Standard toolbar.



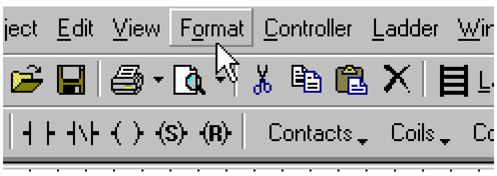
Displaying an Operand Symbol in the Ladder Diagram

In the Ladder Editor, you can view an element description as:

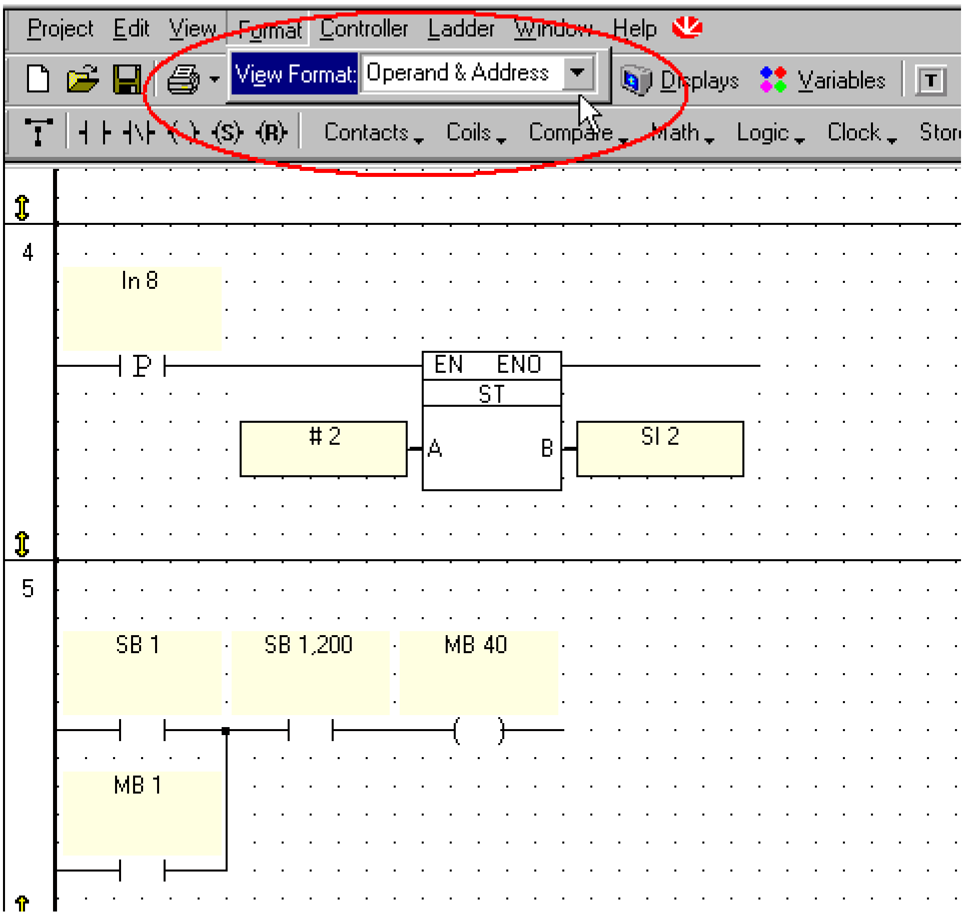
- An Operand and Address
- A Symbol
- Operand, Address and Symbol

To change the element description view format:

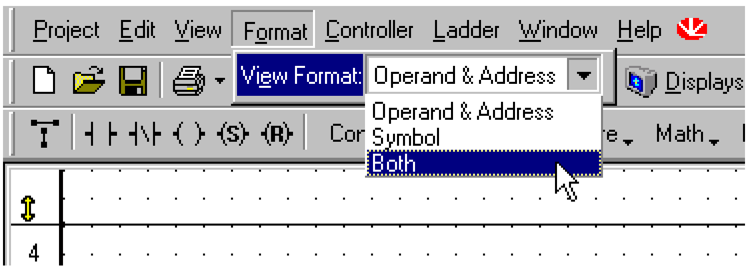
1. Click **Format** on the Standard menu bar.



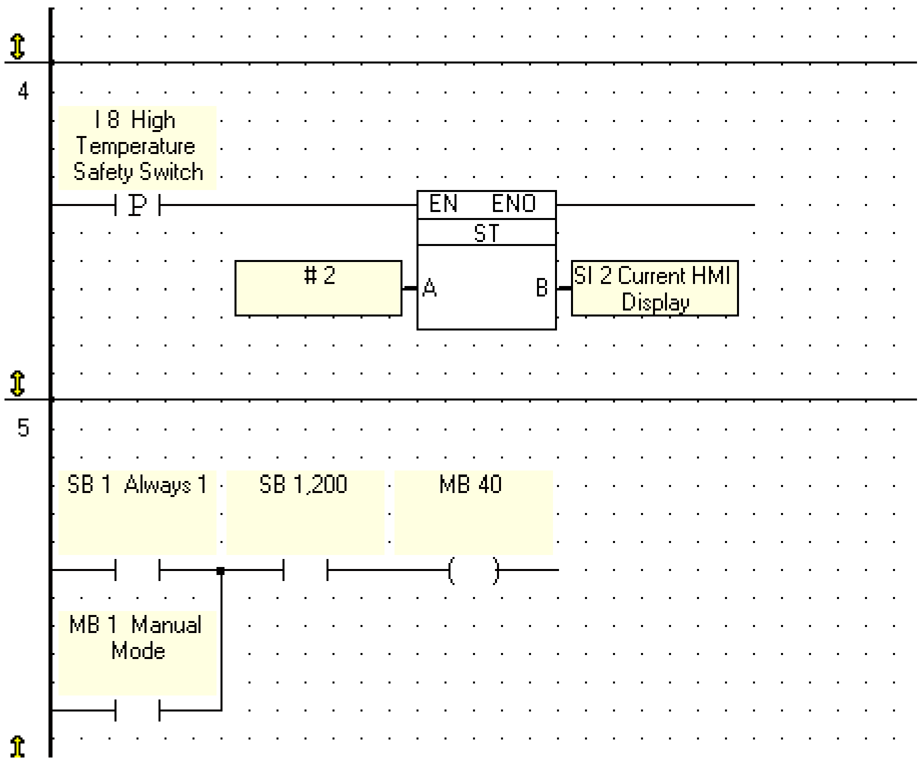
2. The **View Format** menu opens.



3. Select the desired view format.



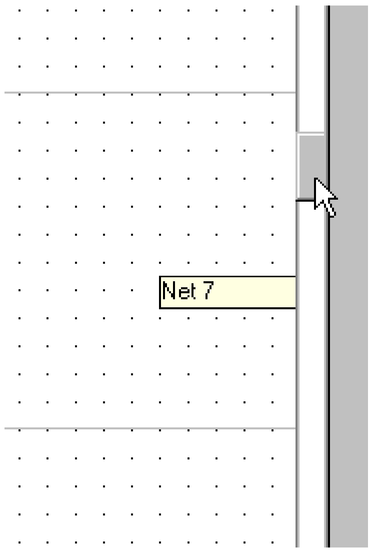
4. All of the Ladder elements appear with the selected view format.



Scrolling between nets

To move quickly between nets:

1. Click on the scroll box.
2. Holding the mouse button down, drag the scroll box up or down to the desired net number.



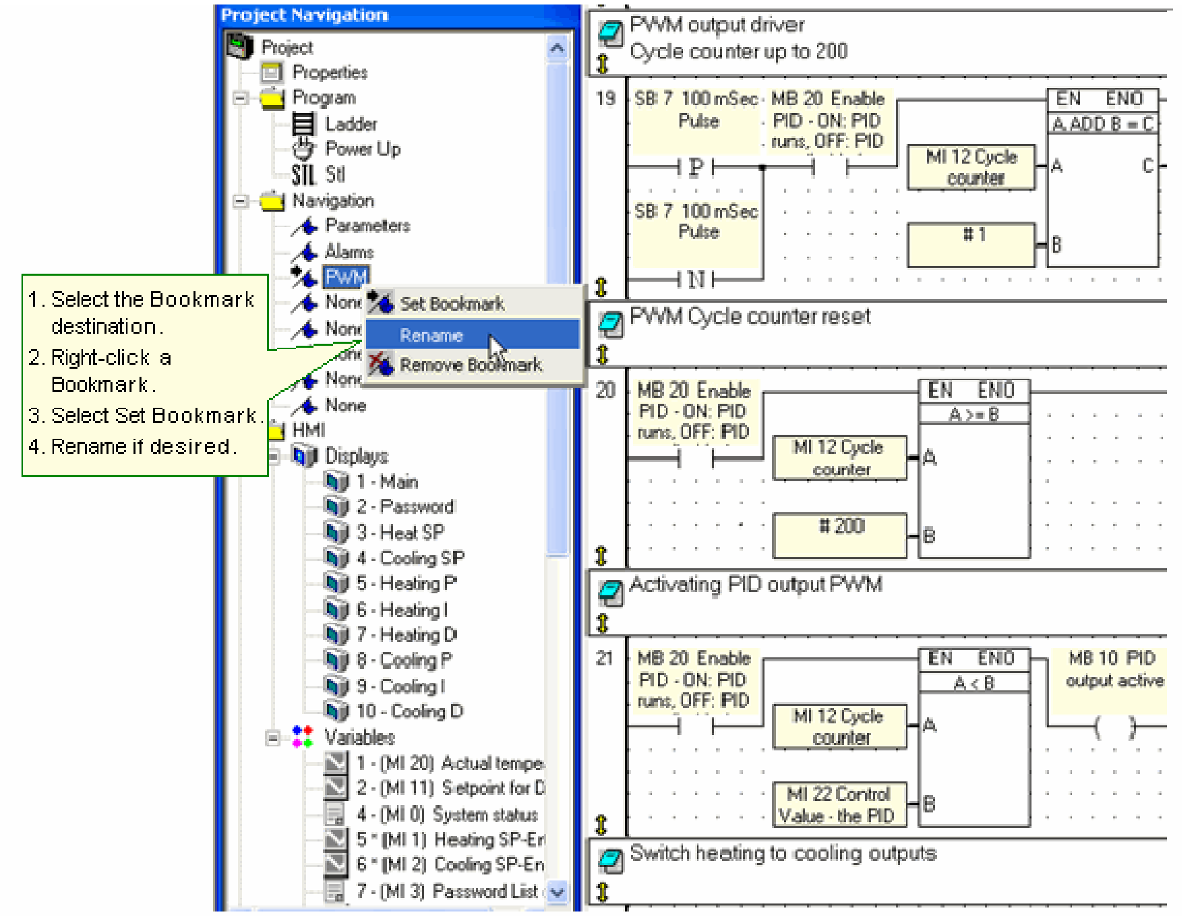
Bookmarks

Bookmarks can be linked to different points in your Ladder application. Bookmarks appear in the Project Navigation Window, under Navigation.

When you set a Bookmark, it 'remembers' the view that was on the screen when it was set. After you set a Bookmark location, you can rename it. No matter where you are in the application, clicking a Bookmark will jump to display the view that was on your screen when you set the Bookmark.

Using Bookmarks

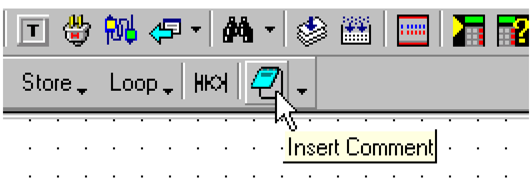
1. Select the Bookmark destination by scrolling through the Ladder application until you reach the desired point.
2. Right-click a Bookmark; the right-click menu opens.
3. Select Set Bookmark; the Bookmark location is set and a default name is assigned by the program.
4. If desired, rename the Bookmark by right-clicking it, and then selecting Rename Bookmark.



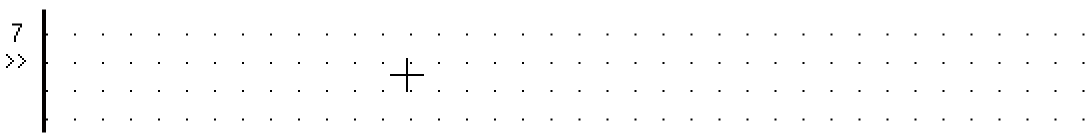
Comments

To insert comments:

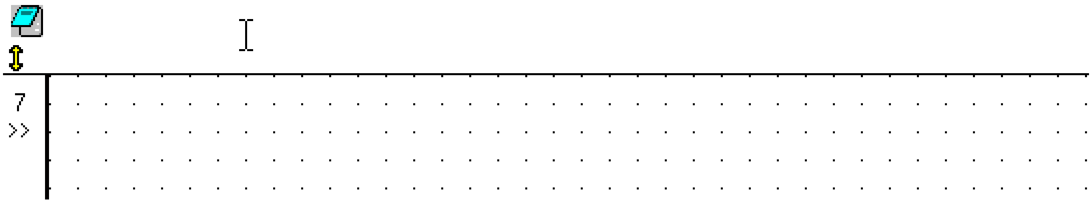
1. On the Ladder toolbar, click **Insert Comment** icon.



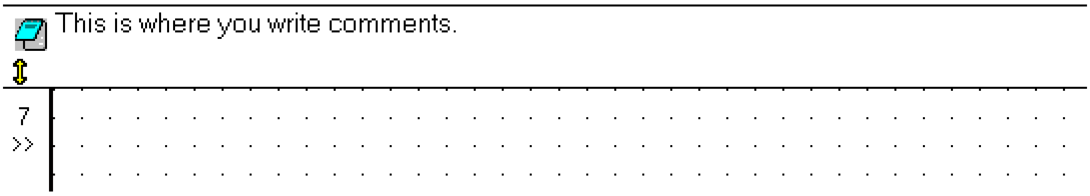
2. Move your cursor to the net in which you wish to insert a comment and click.



3. The Comment will appear above the net.



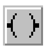
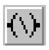
4. Type in your comments.



Elements

U90 Ladder Elements

Contacts	Icon
Direct Contact (NO)	
Inverted Contact (NC)	
Positive Transition (Rise)	
Negative Transition (Fall)	

Coils	Icon
Direct Coil	
Inverted (negated) Coil	
Set Coil	
Reset Coil	

Compare Functions	Icon
Greater Than	
Greater/Equal	
Equal	
Not Equal	

Less/Equal	<=
Less Than	<

Math Functions	Icon
Add	+
Subtract	-
Multiply	*
Divide	/

Logic Functions
AND
OR
XOR

Clock Functions	Icon
Time	
Day Of Week	
Day Of Month	
Month	
Year	

Contacts

A contact represents an action or condition. A contact can be:

- Input
- Output
- Memory Bit
- System Bit
- Timer

Each contact condition in a net is loaded into the bit accumulator and evaluated to determine the coil (output or expression) condition. There are 4 types of contacts:

- Direct Contact
- Inverted Contact
- Positive Transition Contact (Rise or One Shot)
- Negative Transition Contact (Fall)

Contacts can be connected in both series and parallel on a U90 Ladder net.

To insert a Contact from the Ladder toolbar onto a Ladder net:

1. Click once to select the desired contact.
2. Move your mouse to the desired net position.
3. Click again.

There is no need to click and hold after selecting a contact.

Direct Contacts

A Direct Contact is a normally open contact condition. A Direct Contact condition can be:

- Input
- Output
- Memory Bit
- System Bit
- Timer

A Direct Contact condition can be an external input device (for example: a push button) or an internal input system element (for example: SB 50 Key **+/-** is pressed).

A door buzzer contains an example of a Direct Contact. When you push the buzzer, the buzzer sounds. When you release the buzzer, the sound stops.

During the system scan, the processor evaluates the program elements net by net.

If the Direct Contact address (the door buzzer) is OFF (logic 0): power will not flow through the Direct Contact. The door buzzer is silent.

If the Direct Contact address (the door buzzer) is ON (logic 1): power will flow through the Direct Contact. The door buzzer sounds.

Inverted Contacts

An Inverted Contact represents a normally closed contact condition. An Inverted Contact can be:

- Input
- Output
- Memory Bit
- System Bit
- Timer

An Inverted Contact condition can be from an external input device (for example: a push button) or from an internal input system element (for example: SB 50 Key **+/-** is pressed).

An emergency light contains an example of an Inverted Contact.

- Normally there is power flow through the emergency light's Inverted Coil and the light stays off.
- During an electric power outage, the power flow through the Inverted Coil stops and the emergency light comes on.

During the system scan, the processor evaluates the program elements net by net.

If the Inverted Contact address (power supply) is ON (logic 1): power will flow through the Inverted Contact. The emergency light will stay off.

If the Inverted Contact address (power supply) is OFF (logic 0): power will not flow through the Inverted Contact. The emergency light comes on.

If the power outage ends and power flow is returned to the Inverted Contact, it will close again and the emergency light will go off again.

Negative Transition Contact

A Negative Transition Contact gives a single one-shot pulse when its reference address falls from ON (logic 1) to OFF (logic 0). A Negative Transition Contact is registering the **fall** in status from ON to OFF.

A Negative Transition Contact condition can be:

- Input
- Output
- Memory Bit
- System Bit
- Timer

A computer ON/OFF button is an example of a Negative Transition Contact. The computer is ON.

If you push the ON/OFF button in without releasing it - the computer will not shut off. Only when you release the button will the system register a change in status from ON to OFF and the computer will shut OFF.

During the system scan, a Negative Transition Contact address is evaluated for a transition from ON to OFF. A transition allows power to flow through the Negative Transition Contact for one scan.

At the end of the one scan, the Negative Transition Contact is reset to OFF (logic 0). Only after the triggering signal turns from OFF to ON again is there the possibility for the Negative Transition Contact to be re-activated by the next falling transition from ON to OFF.

Positive Transition Contact

A Positive Transition Contact gives a single one shot pulse when its address reference rises from OFF (logic 0) to ON (logic 1). A Positive Transition Contact is registering the **change** in status from OFF to ON. The length of the ON status is not relevant.

A Positive Transition Contact condition can be:

- Input
- Output
- Memory Bit
- System Bit
- Timer

A cellular phone keypad key is an example of a Positive Transition Contact. When you push a key a number is displayed on the screen. It does not matter if you push the key quickly or hold it down for several seconds. The number will only appear once on the screen.

The cellular phone registers the transition from no key pressed to a key pressed. The **length** of time the key is pressed is not relevant. You must release the key and press it again to repeat the number on the cellular phone screen.

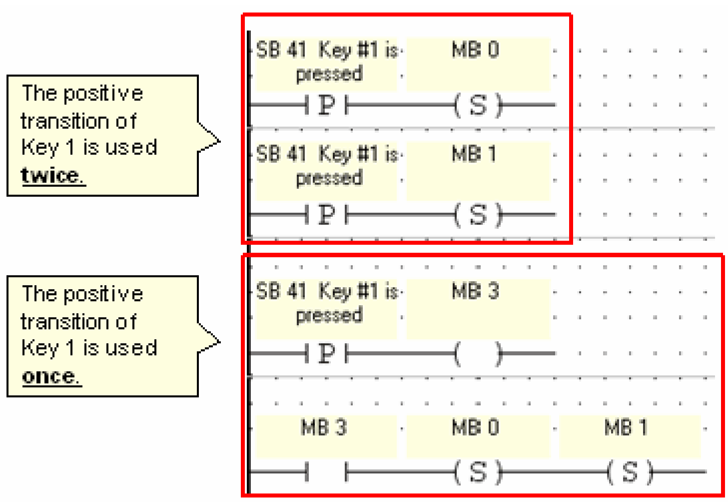
During the system scan, a Positive Transition Contact address is evaluated for a transition from OFF to ON. A transition allows power to flow through the Positive Transition Contact for one scan.

At the end of the one scan the Positive Transition Contact is reset to OFF (logic 0) even if the triggering signal stays on. Only **afte**r the triggering signal turns from ON back to OFF is there the possibility for the Positive Transition Contact to be activated again with a rise from OFF to ON.

Note • Execution time for Positive and Negative Transition contacts is considerably greater than the execution time for direct and indirect contacts. However, you can decrease the amount of transitional contacts in your program.

Decreasing the Number of Transitional Contacts

You can use the coil of a bit operand to save the positive transition of a contact, and then use the direct contact of the operand in your program.



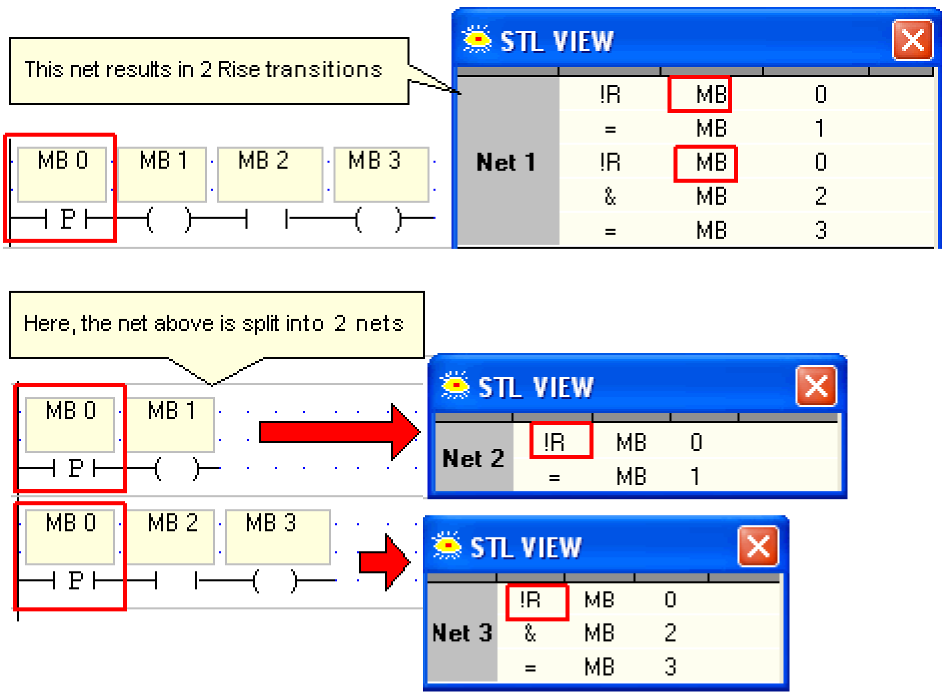
Rise/Fall Usage Summary

A **maximum of 255** Rise/Fall elements is allowed in a project. To ascertain how many elements of each type are in the project, use the Rise/Fall utility on the View menu. The **sum** of the results must not exceed 255.

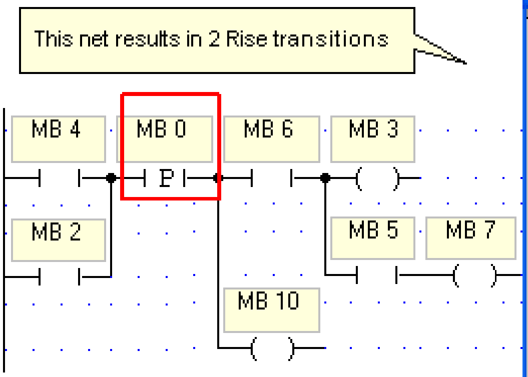
If a program exceeds this number, Error 2653 results.

However, in certain cases, the **actual** compiled number of Rise/Fall elements is **greater than** the total that is shown in the Summary. Examples are shown below.

Example 1

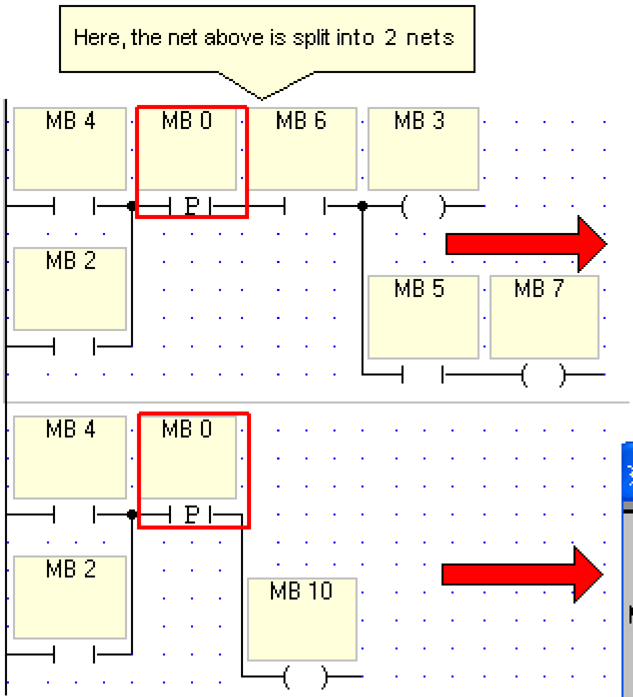


Example 2



STL VIEW

Net 1	!	MB	4
	/	MB	2
	=	LB	0
	!	LB	0
	&R	MB	0
	=	MB	10
	!	LB	0
	&R	MB	0
	&	MB	6
	=	LB	1
	!	LB	1
	=	MB	3
	!	LB	1
	&	MB	5
	=	MB	7



STL VIEW

Net 2	!	MB	4
	/	MB	2
	=	LB	0
	!	LB	0
	&R	MB	0
	&	MB	6
	=	LB	1
	!	LB	1
	=	MB	3
	!	LB	1
	&	MB	5
	=	MB	7

STL VIEW

Net 3	!	MB	4
	/	MB	2
	=	LB	0
	!	LB	0
	&R	MB	0
	=	MB	10

Coils

A coil represents a result or expression of an action. A coil can be:

- Memory Bit
- System Bit
- Output
- Timer

Each contact condition is evaluated in a net to determine the coil (result or expression) condition. There are 4 types of coils:

- Direct Coil
- Inverted Coil
- Set Coil
- Reset Coil

Recommended: Do not energize a coil more than once in a program.

To insert a Coil from the Ladder toolbar onto a Ladder net:

1. Click once to select the desired coil.
2. Move your mouse to the desired net position.
3. Click again.

There is no need to click and hold after selecting a coil. Note that, while the Direct, Set and Reset Coils are available on every menu, the Inverted Coil is not.

Direct Coil

A Direct Coil represents a direct result instruction of the conditions (contacts and/or function blocks) on the Ladder net before the Direct Coil. A Direct Coil instruction can be:

- Output
- Memory Bit
- System Bit
- Timer

The coil result can go to an external output device (for example: a light) or an internal system element (for example: SB 2 Power Up Bit).

A door buzzer contains an example of a Direct Coil. When the door buzzer button (Direct Contact) is pushed the door buzzer (Direct Coil) sounds. When you release the buzzer the sound stops.

During the system scan, the processor evaluates all of the program elements on the Ladder net before the Direct Coil for power flow continuity.

If no power flow continuity exists in the net (the door buzzer button is not pushed): the Direct Coil address instruction is OFF (logic 0). The door buzzer does not sound.

If power flow continuity exists in the net (the door buzzer button is pressed): the Direct Coil address instruction is ON (logic 1). The door buzzer sounds.

Inverted Coil

An Inverted Coil represents the opposite result instruction of the conditions (contacts and/or function blocks) on the Ladder net before the Inverted Coil. An Inverted Coil instruction can be:

- Output
- Memory Bit
- System Bit

The result instruction can be to an external output device (for example: alarm bell) or to an internal system element (for example: SB 80 activate linearization).

During the system scan, the processor evaluates all of the program elements on the Ladder net before the Inverted Coil for power flow continuity.

If no power flow continuity exists in the net: the Inverted Coil address instruction is ON (logic 1).

If power flow continuity exists in the net: the Inverted Coil address is OFF (logic 0).

Set Coil

A set coil separates the coil from the action or condition that energized the coil. Once energized, a set coil's result is no longer dependant on the action that energized it. A set coil stays energized (latched) until its condition is reset (unlatched) by a reset coil.

A set coil can be:

- Memory Bit
- System Bit
- Output

An example of a set coil is an overhead light. When we turn on a light it stays lit until we turn it off (reset or unlatch it) or the light bulb burns out. Luckily, you do not have to hold the light switch to keep the light on.

An example of a coil that you do **not** want to be set (latched) is a car horn. You expect it to toot only when you press on the horn button and you expect it to stop when you stop pressing on the horn button.

Use set and reset coils to preserve a condition in a program.

Reset Coil

A reset coil turns off (unlatches) a set coil, provided that there is logic continuity to the reset coil. Once a set coil is energized it stays energized, **independent** of the original set condition, until a reset coil with the same address resets (unlatches) the coil condition.

A reset coil can be:

- Memory Bit
- System Bit
- Output

Do not use a set coil without a reset coil in a program.

Operands

An element's Operand is the form in which information is stored and operated on in the U90 Ladder program.

Operand lists are organized in categories, according to operand type:

- Input: **I** (according to model and expansion)
- Output: **O** (according to model and expansion)
- Memory Bit: **MB** (0 - 255)
- Memory Integer: **MI** (0 - 255)
- System Bit: **SB** (0 - 255)
- System Integer: **SI** (0 - 255)
- Timer:**T** (0 - 63)

Every Operand has an Address and a Symbol.

Symbols appear together with the operand every time the operand and address are used in the program. There are two types of symbols: preset and user-created.

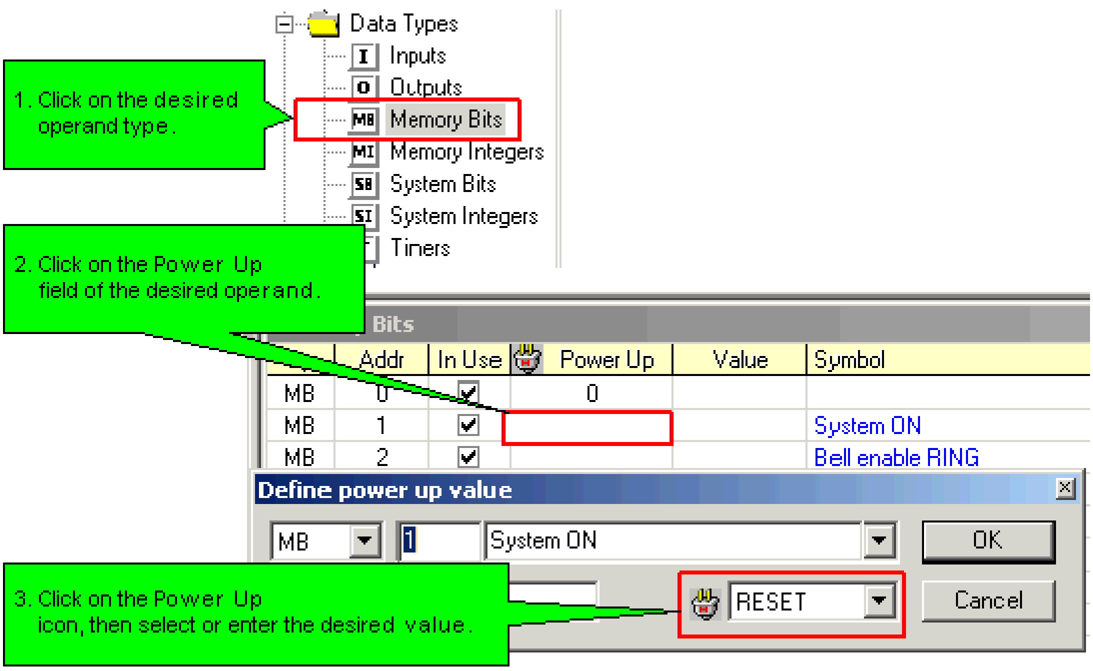
- Preset symbols are descriptions that are connected to System Bits and System Integers.
- User-created symbols are descriptions that are written by the user for a specific project application. The user assigns a particular description to a particular operand.

Power-up

You can assign Power Up values to most Data Types. These values are written into the operand by the program when the controller is turned on. Outputs, MBs, SBs can be set or reset; integer values can be written into MIs and SIs.

You can assign Power Up values when you place an element into a net, or by opening a Data Type list as shown below.

Note • If an operand has been assigned a Power-up value, it is a referenced operand and will not appear in the Unreferenced Operand list.

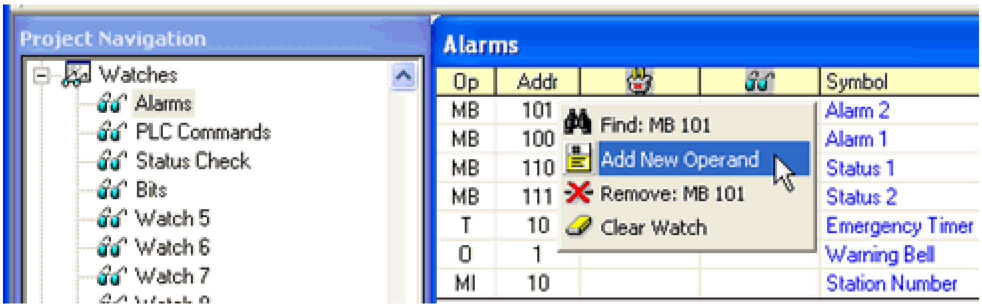


Watch Folders

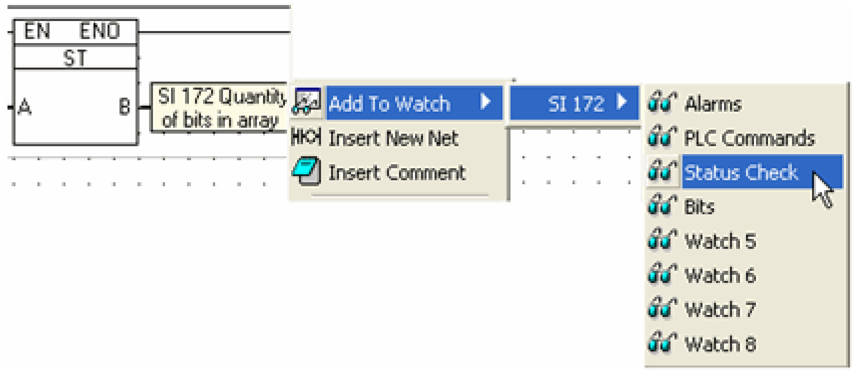
Watch Folders enable you to:

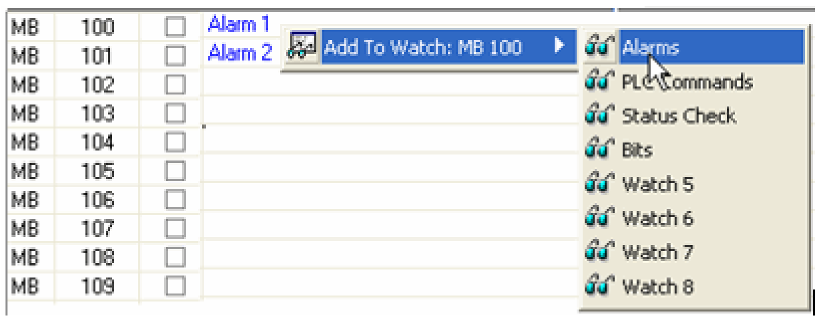
- Arrange related groups of operands in folders.
- Name the folders.
- View these operands in the Output Window at the bottom of the screen.

To view a Watch folder, click it in the Program Navigation window. Edit the folder by right-clicking a line, then selecting the appropriate function.



To add a single operand to a Watch folder, **right-click it in the Ladder or in the Operand Output Window.**





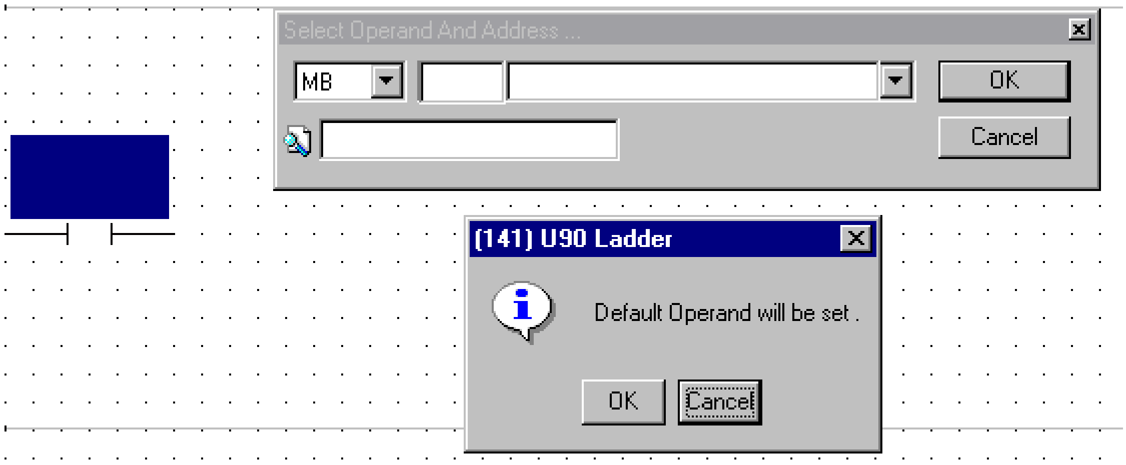
Operand Addressing

An Operand Address is the physical location in the PLC memory where the element information is stored.

For example:

- MB 10 - "10" is the address of the MB Operand
- MI 35 - "35" is the address of the MI Operand
- T 12 - "12" is the address of the Timer Operand

U90 Ladder allows you to create your own symbols before you write your program. This feature can help you to organize your project properly from the very beginning. You can also create symbols as you write your program. Symbols can be edited after you create them. Note that there is a default address setting for each operand type. The Default message box will appear if you do not specify an address:



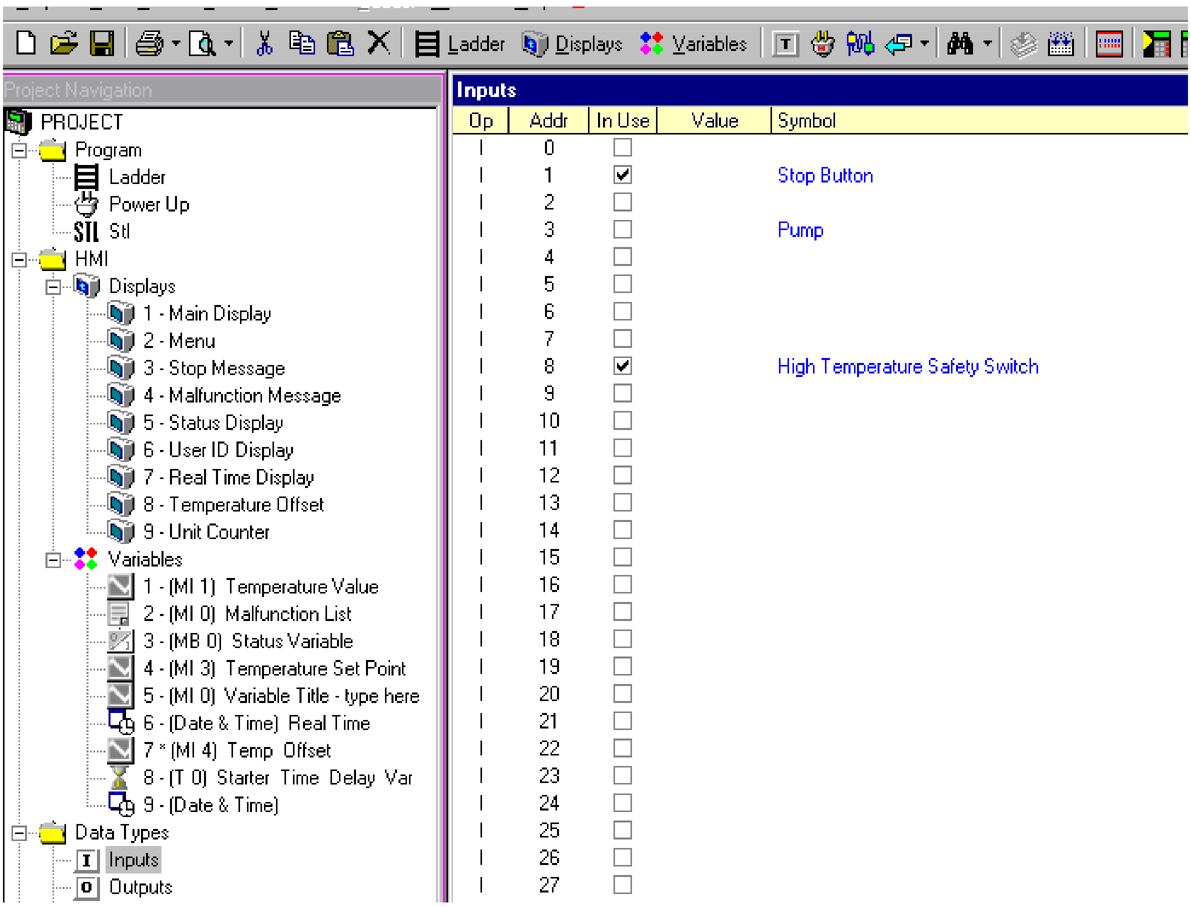
Inputs (I)

Inputs are one Operand type available for writing a project application.

The number of Inputs varies according to the PLC model and any I/O Expansion Modules that may be integrated into the project.

An Input is an actual hardwired input connection into the controller.

Click on the Inputs folder in the Program Navigation pane to display the complete list of Inputs. Scroll down to view the complete list



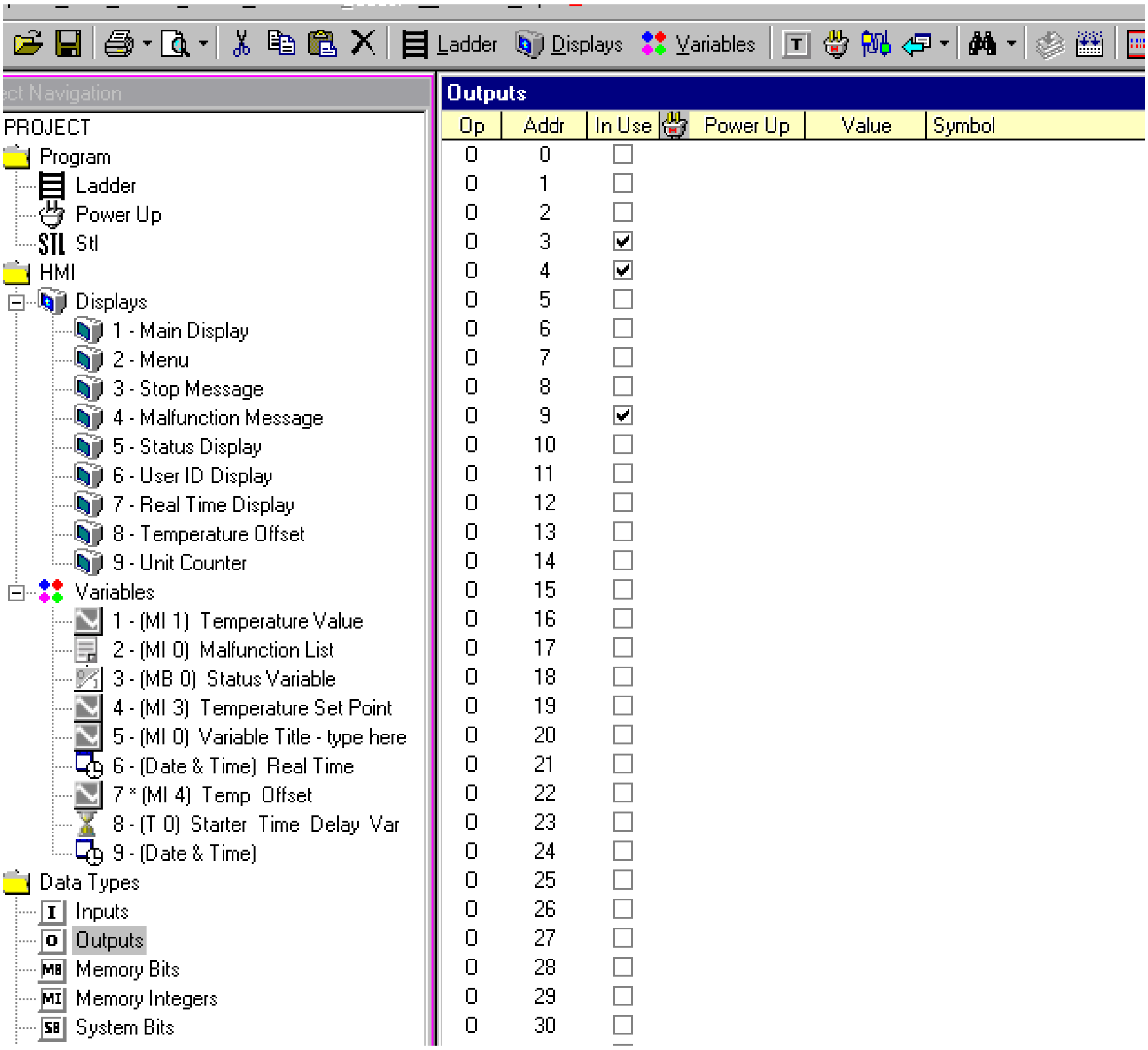
Outputs (O)

Outputs are one Operand type available for writing a project application.

The number of Outputs varies according to the PLC model and any I/O Expansion Module integrated into the project.

An Output is an actual hardwired output connection from the controller.

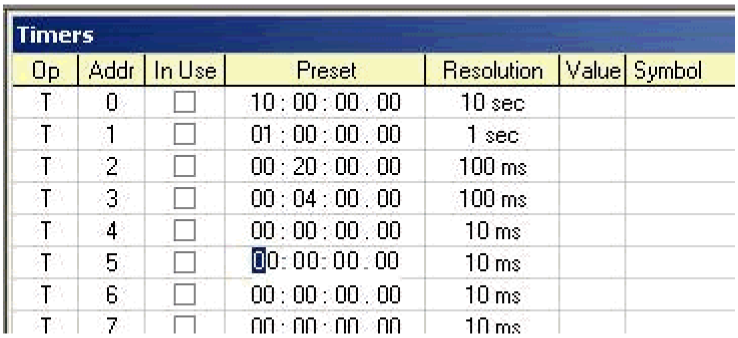
Click on the Outputs folder in the Program Navigation pane to display the complete list of Outputs. Scroll down to view the complete list



Timers (T)

U90 Ladder offers 64 On Delay Timers. Timers have a preset value, a current value, and a bit value. Timers always count **down** from the Preset Value. The timer value is 14 bits.

Click on the Timers folder in the Program Navigation pane to display the complete list of Timers. Scroll down to view the complete list.



Timers

Op	Addr	In Use	Preset	Resolution	Value	Symbol
T	0	☐	10 : 00 : 00 . 00	10 sec		
T	1	☐	01 : 00 : 00 . 00	1 sec		
T	2	☐	00 : 20 : 00 . 00	100 ms		
T	3	☐	00 : 04 : 00 . 00	100 ms		
T	4	☐	00 : 00 : 00 . 00	10 ms		
T	5	☐	00: 00: 00. 00	10 ms		
T	6	☐	00 : 00 : 00 . 00	10 ms		
T	7	☐	00 : 00 : 00 . 00	10 ms		

To place a Timer in your program, place a direct coil in a net, and select T.

Timer resolutions

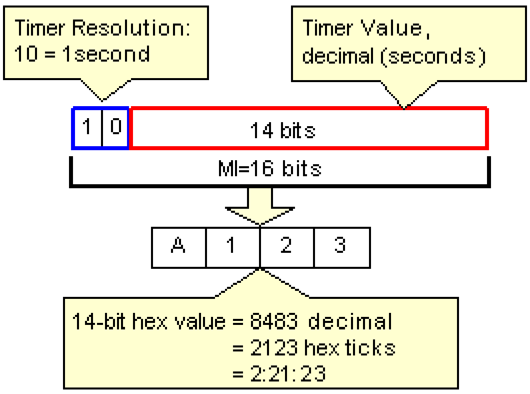
10mS (0.01S)(from 00:00:00.01 to 00:02:43.83)

100mS (0.1S)(from 00:00:00.10 to 00:27:18.30)

1000mS (1.0S)(from 00:00:01.00 to 04:33:03.00)

10000mS (10.0S)(from 00:00:10.00 to 45:30:30.00)

The first 14 bits (from the LSB) of the Timer register contains the value. The two most significant bits contain the Timer resolution.



Note that:

- A Timer value can be displayed in a Display as a current or elapsed value/
- The Resolution field is Read-only. The resolution is a function of the Timer Preset Value.
- You cannot change the **resolution** of a timer when the application is running.
- A timer's **current value** can be changed at any time, including when the timer is active. The new value can be either greater or smaller than the previous value; storing 0 into a timer's current value stops it immediately.
- A change of Timer Preset value without changing the resolution will take effect when the timer restarts.
- Changing the resolution of the timer's preset value does not affect the current resolution; it is therefore recommended that the resolution not be changed while the timer is active.
- During Stop mode, timers continue to run.

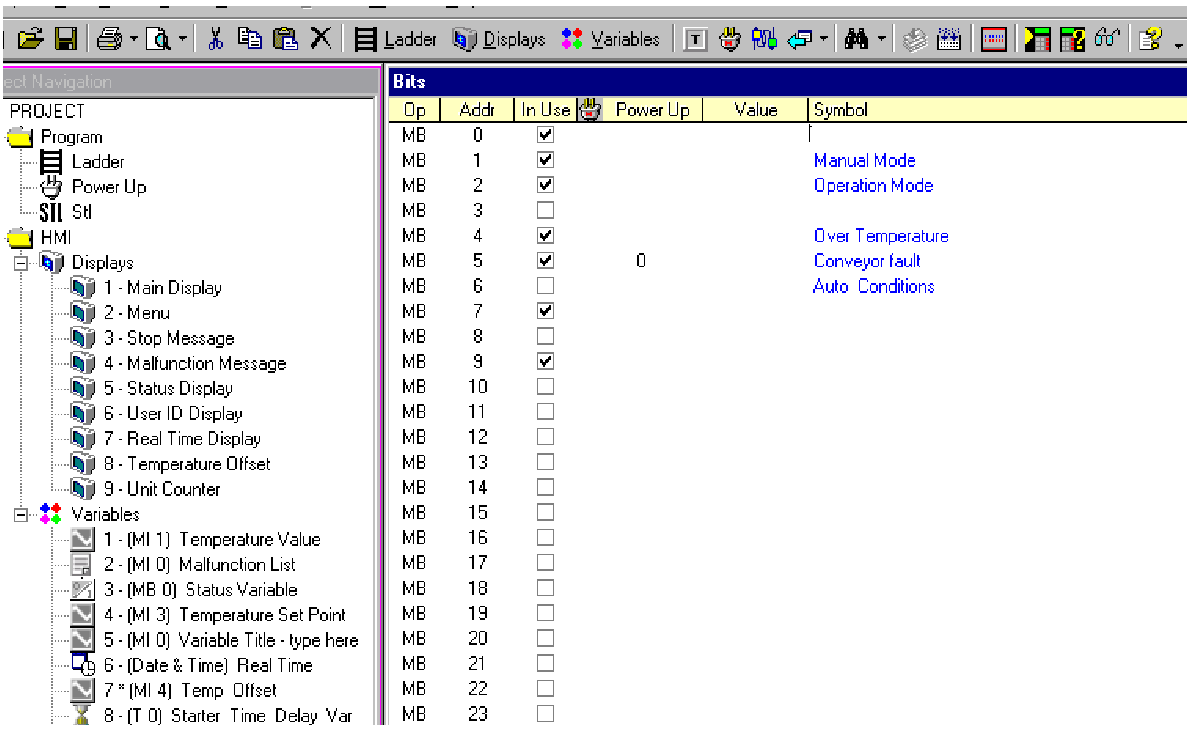
Memory Bits (MB)

Memory Bits are one Operand type available for writing a project application.

There are 256 MBs (Address MB 0 - MB 255).

Memory Bits hold a bit value (0 or 1).

Click on the Memory Bits folder in the Program Navigation pane to display the complete list of Memory Bits. Scroll down to view the complete list



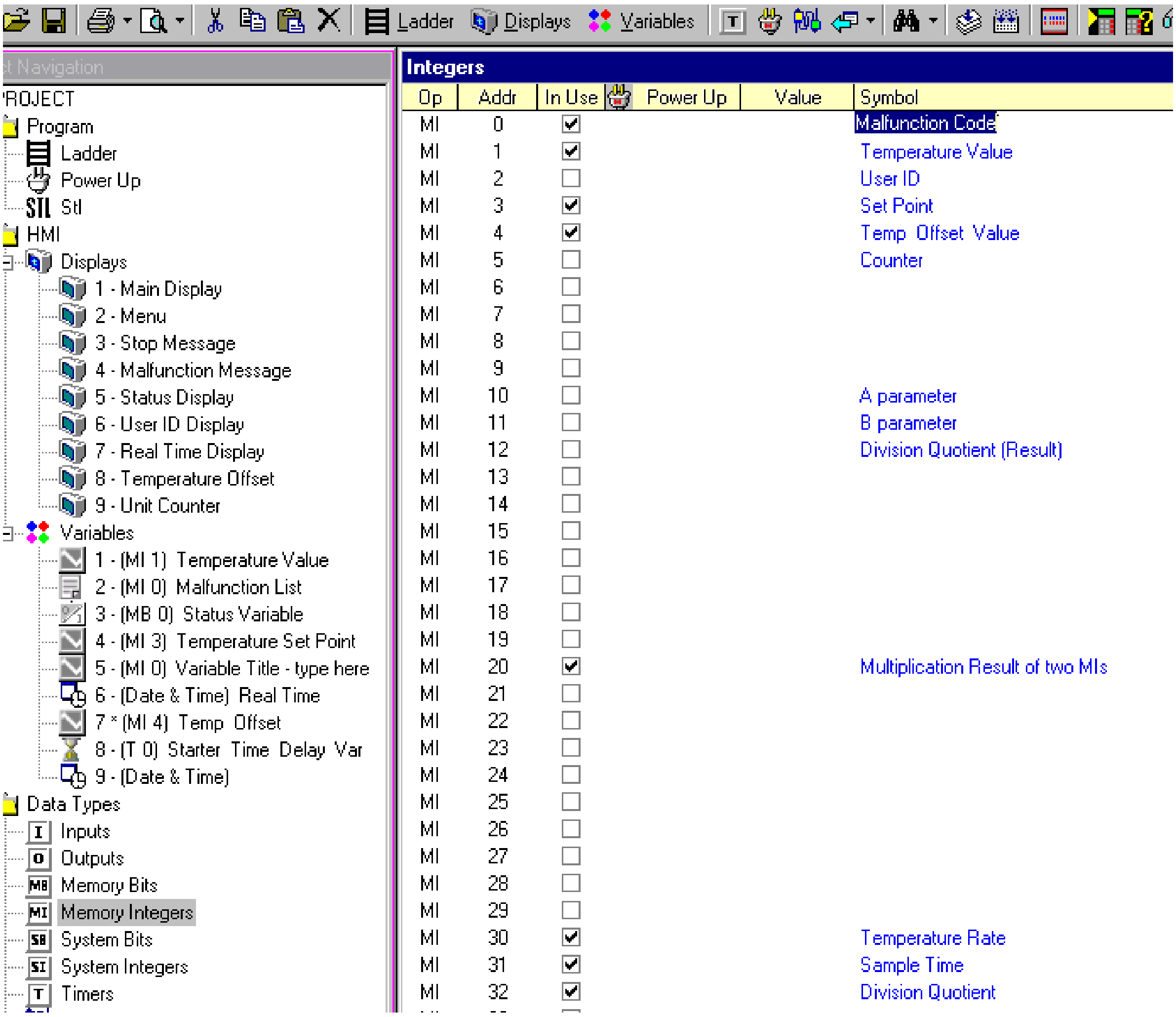
Memory Integers (MI)

Memory Integers are one Operand type available for writing a project application.

There are 256 MIs (Address MI 0 - MI 255).

Memory Integers hold an integer value (-32768 to +32767).

Click on the Memory Integers folder in the Program Navigation pane to display the complete list of Memory Integers. Scroll down to view the complete list



System Bits

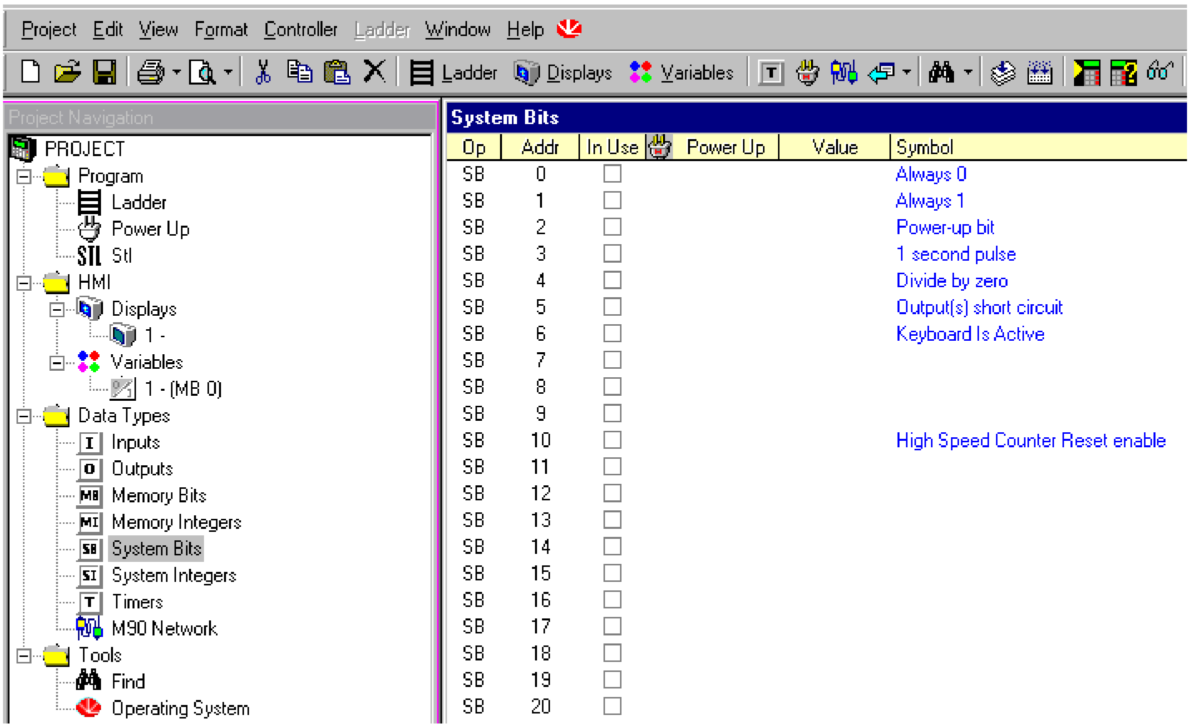
System Bits are the Operating System interface to the user writing the application. System Bits are reserved by the Operating System for particular functions. Some System Bits, for example, are connected to the PLC's keypad keys.

There are 256 SBs (Address SB 0 - SB 255).

Only certain SBs may be written into by the programmer:

- SB 80: Activate Linearization
- SB 200 -SB 215: M90 Network Operand

Click on the System Bits folder in the Program Navigation pane to display the complete list of System Bits. Scroll down to view the complete list



System Integers (SI)

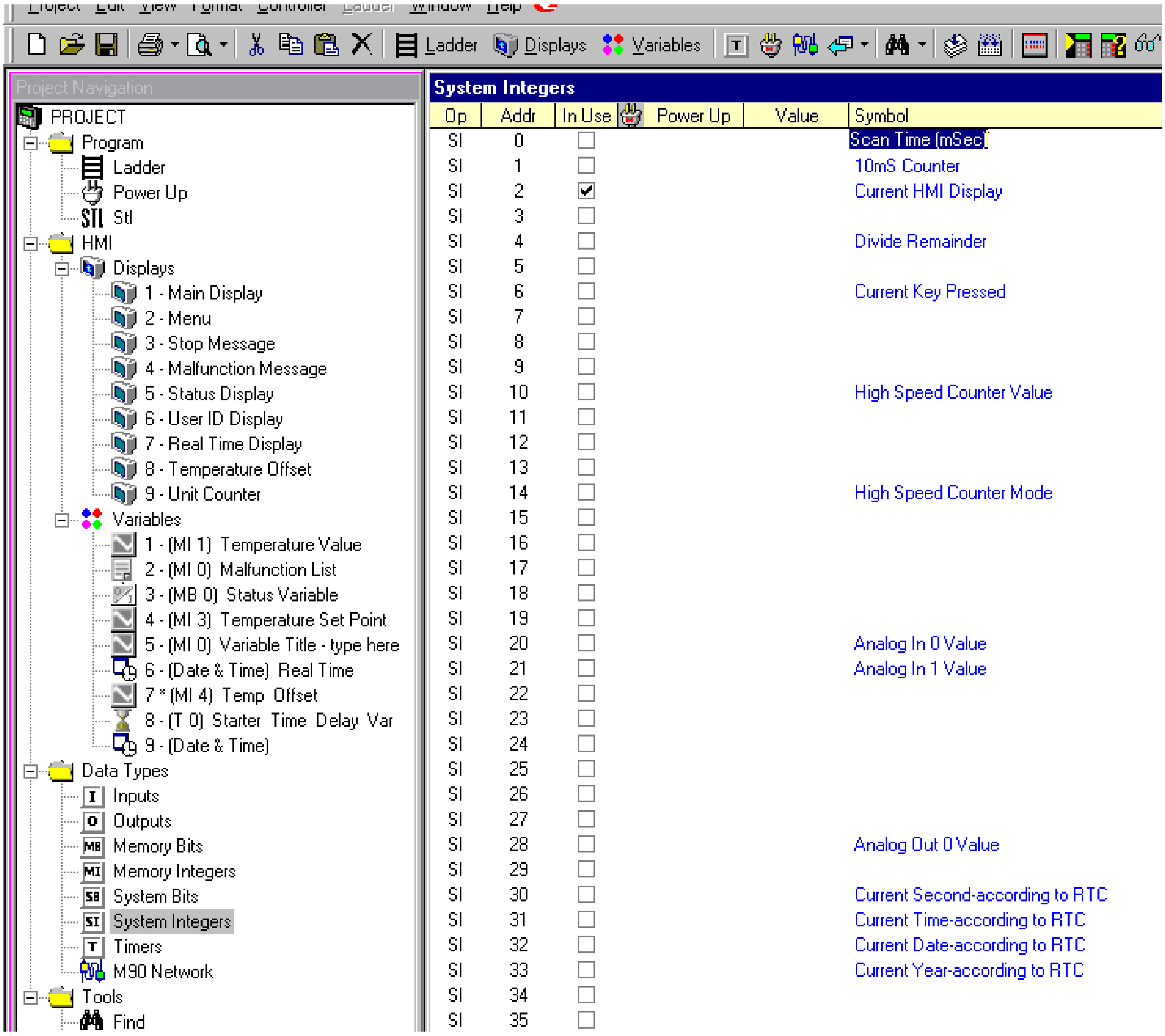
System Integers are the Operating System interface to the user writing the application. System Integers are reserved by the Operating System for particular functions. Specific System Integers, for example, are connected to the M90's high speed counter/shaft-encoder.

There are 256 SIs (Address SI 0 - SI 255).

Only certain SIs may be written into by the programmer:

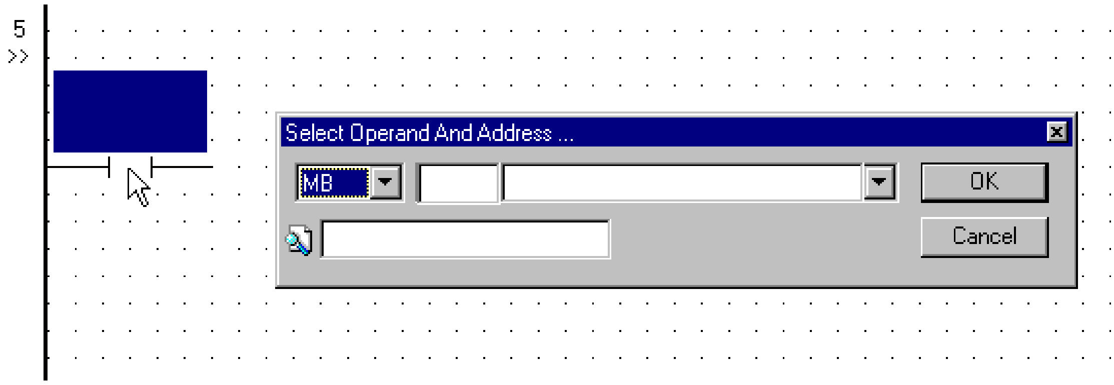
- SI 2: Current HMI Display
- SI 80 - SI 84: Linearization Parameters
- SI 200 , SI 201: M90 Network Operand

Click on the System Integers folder in the Program Navigation pane to display the complete list of System Integers. Scroll down to view the complete list

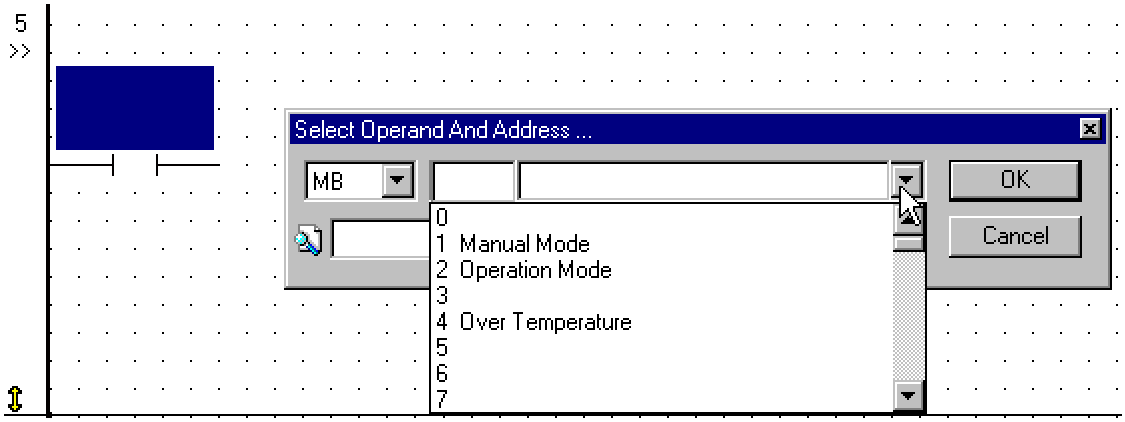


Assigning an Operand Address by Symbol

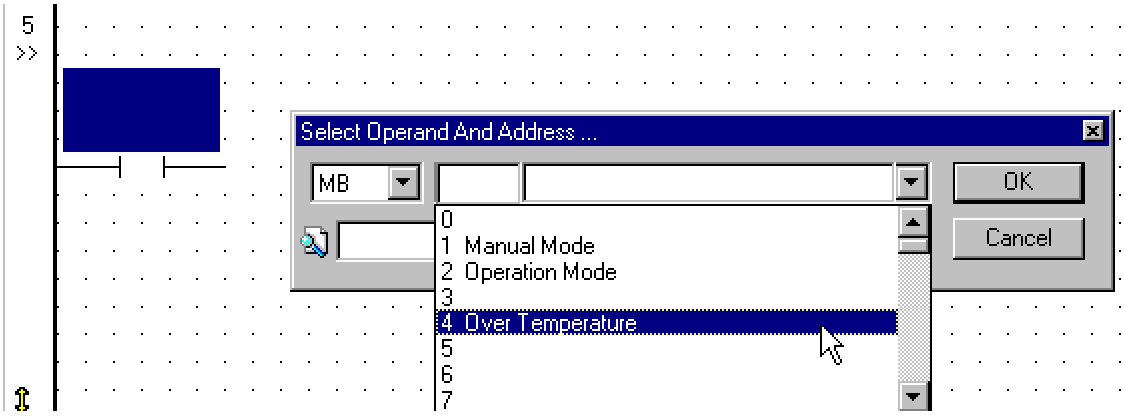
1. After placing the element on the net, the Select Operand and Address dialog box opens.



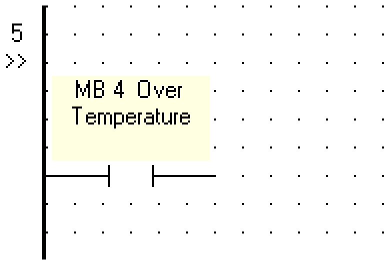
2. Click on the Symbol drop-down menu.



3. Select the desired Address.



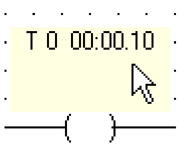
4. The element appears with the selected Address and Symbol.



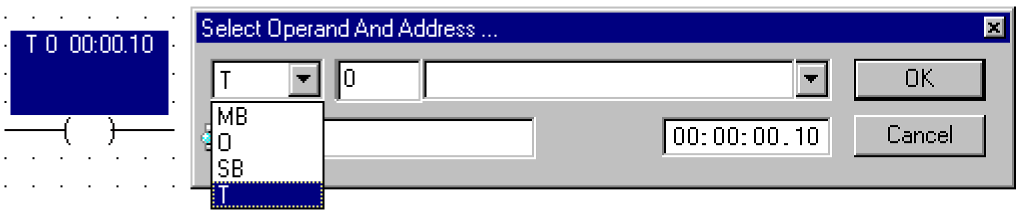
Changing an Operand type

To change an Operand type:

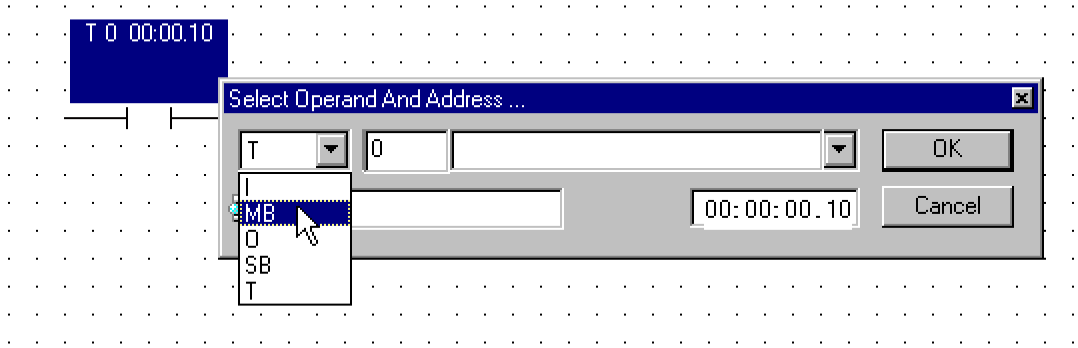
1. Double click on the element's Operand.



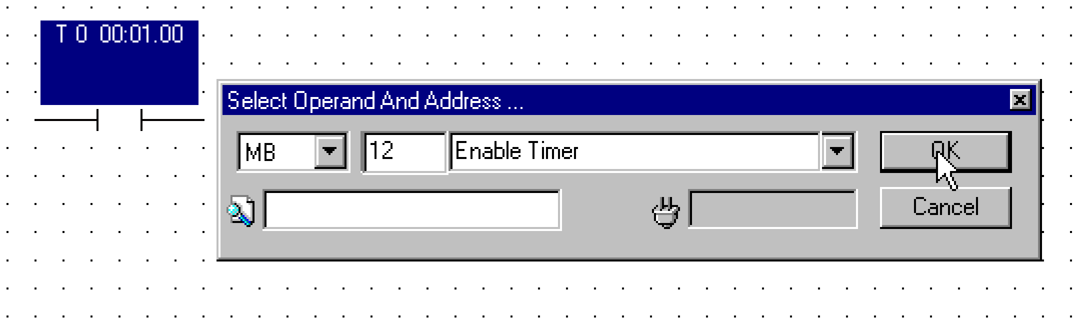
2. The Operand and Address dialog box opens.



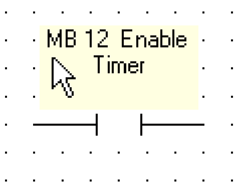
3. Select the new Operand type.



4. Enter the new Operand Address and symbol.



5. Click OK. The element appears on the net with the new Operand, Address and symbol.

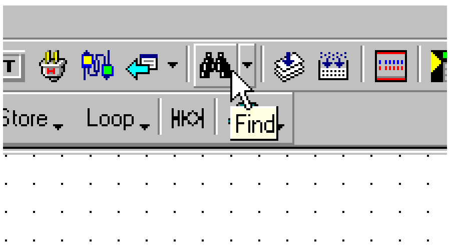


Operand Locations List

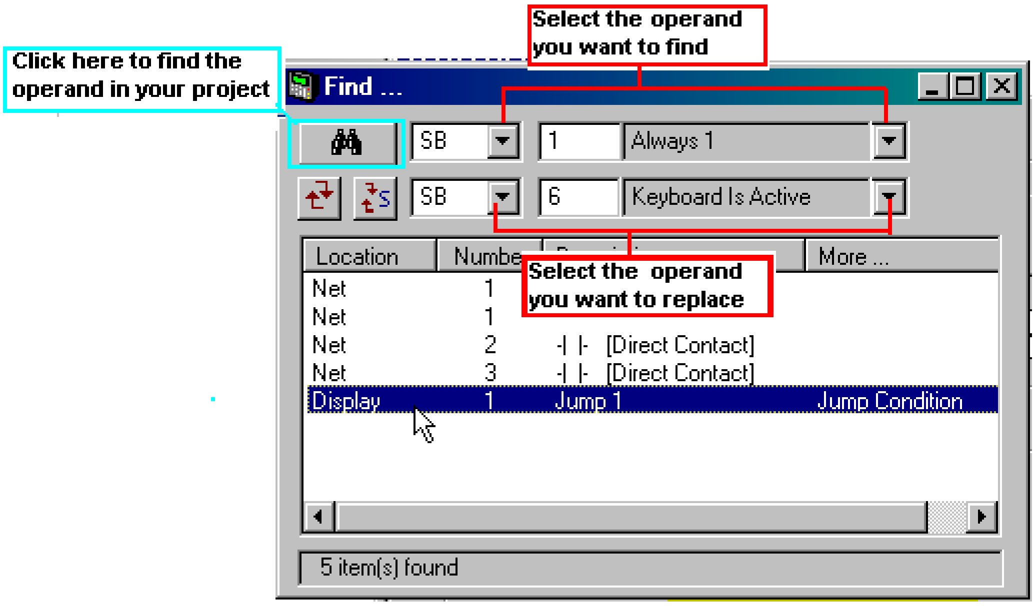
To get a list of Operand locations:

If you already have one location where you know the Operand exists, you can select the Operand and then open the Find dialog box. A list of all locations of the selected Operand will appear.

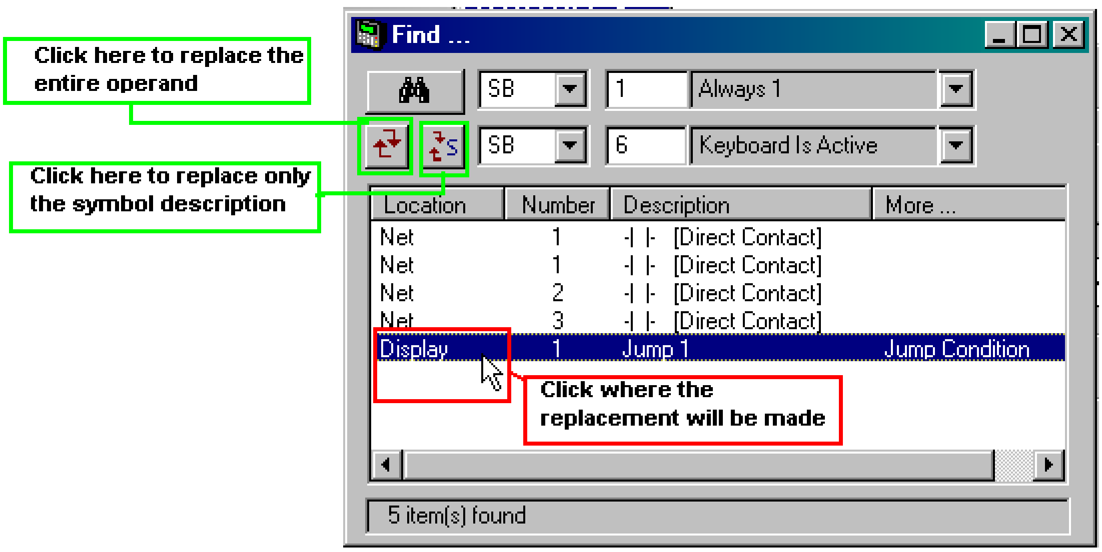
1. Click on the **Find** icon in the Standard toolbar.



2. The Find function opens.
3. Select the name and address of the operand you wish to find.
4. Click the Find button shown below; a list appears showing every time that operand is used in the project.
5. Select the name and address of the operand you wish to replace as shown below.



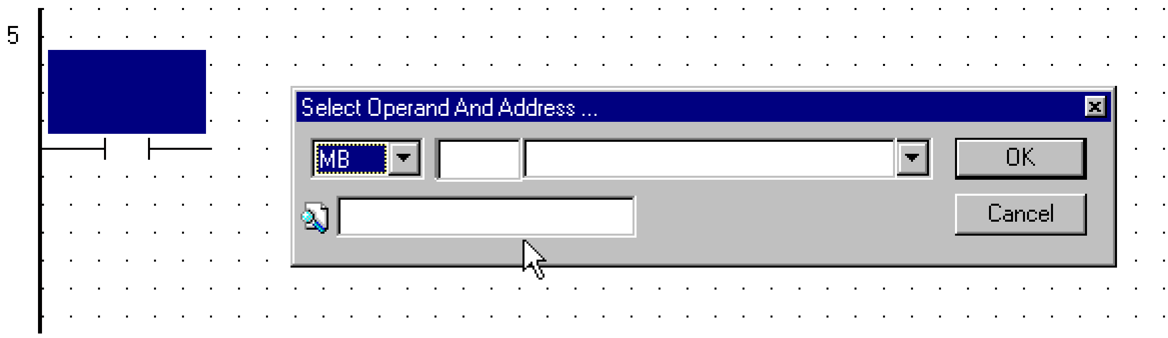
6. Select the location of the operand or description you wish to replace by clicking it within the list.
7. Replace operands or their descriptions by clicking the buttons shown below.



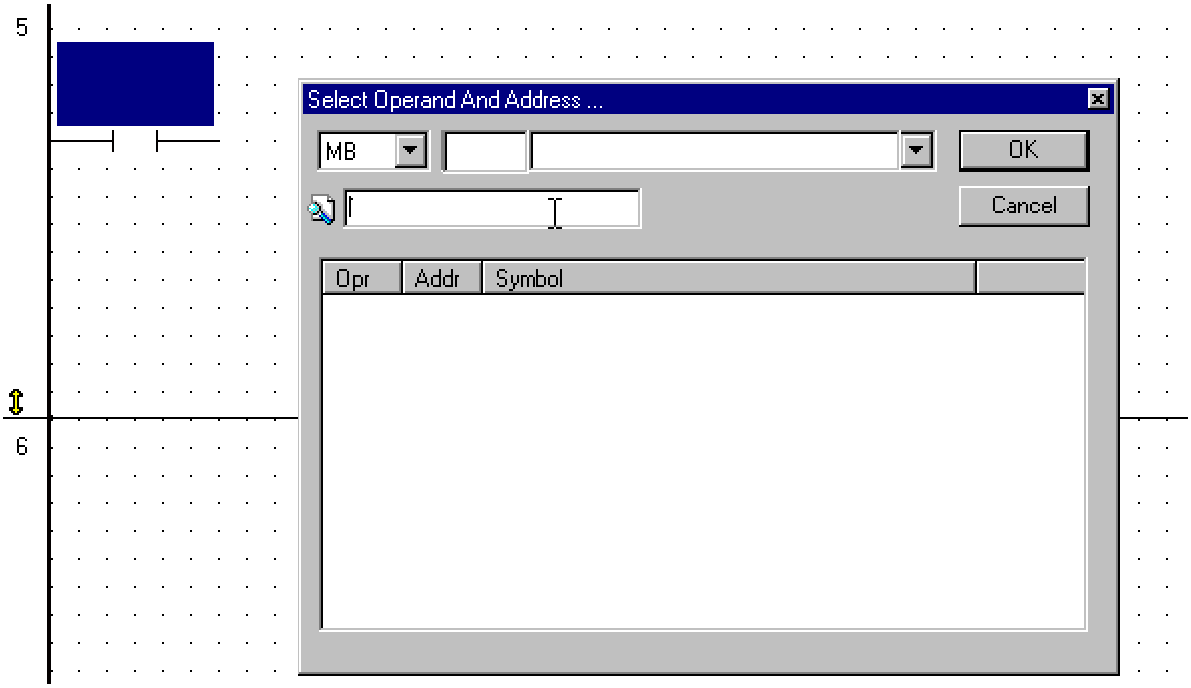
Finding an Operand by symbol

To find an Operand by its symbol when placing an element on a net:

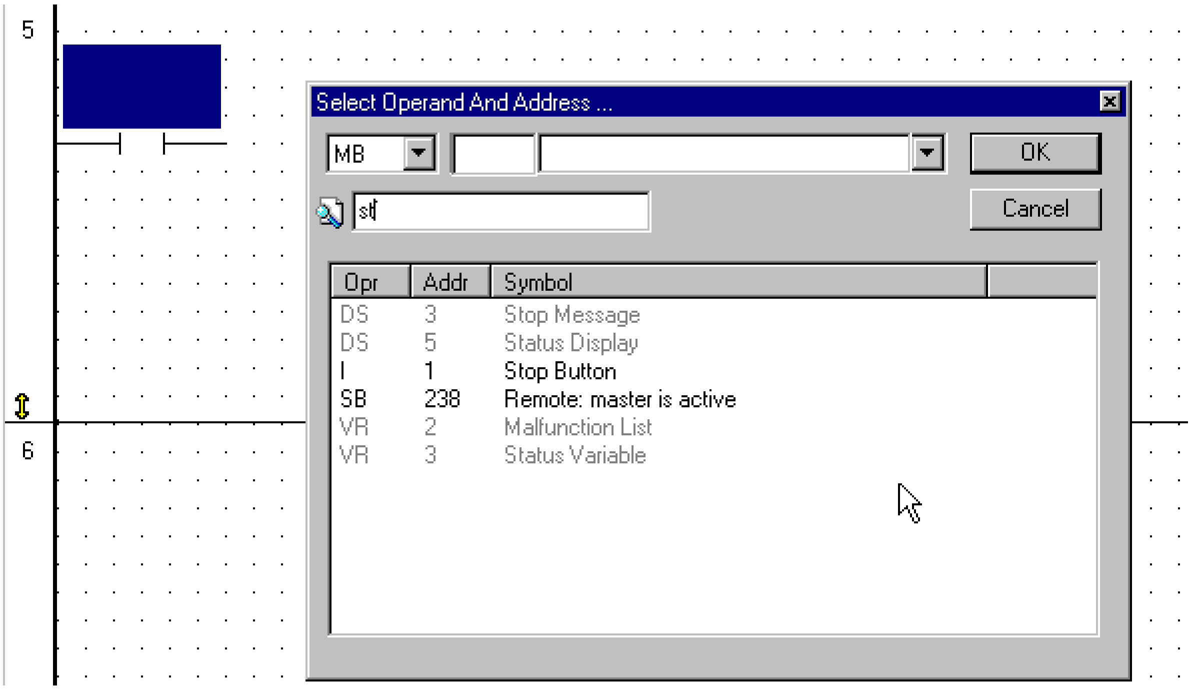
1. Click in the **Symbol Search** box in the Select Operand and Address dialog box.



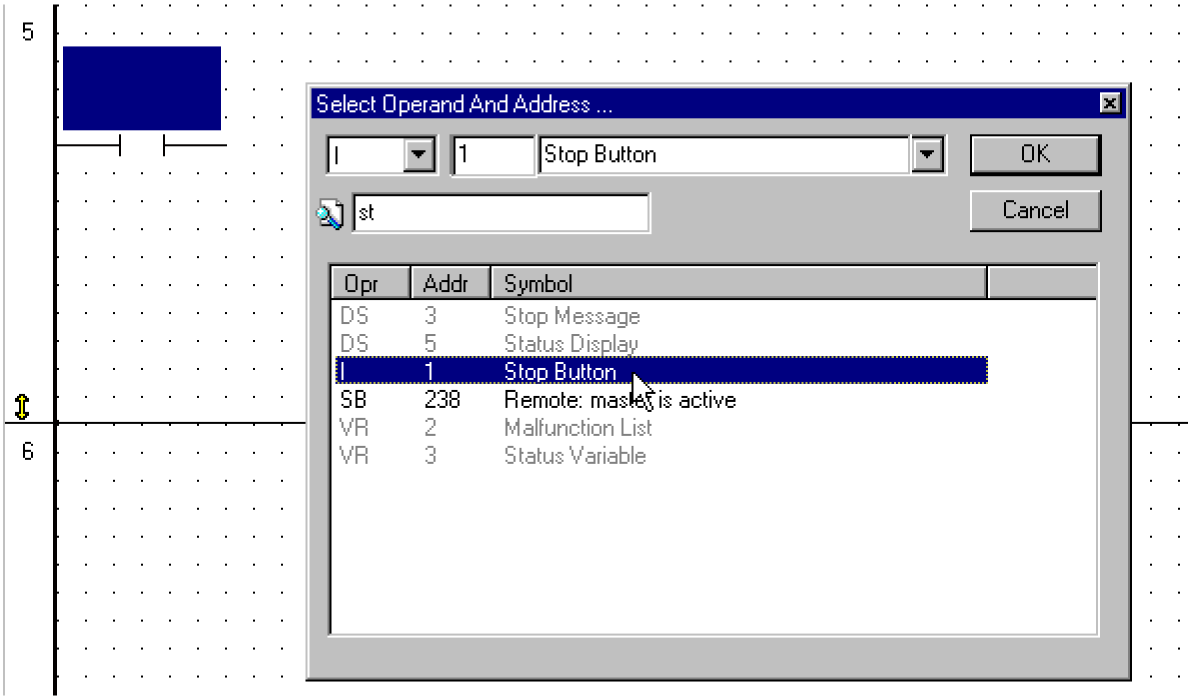
2. The **Symbol Search** dialog box opens.



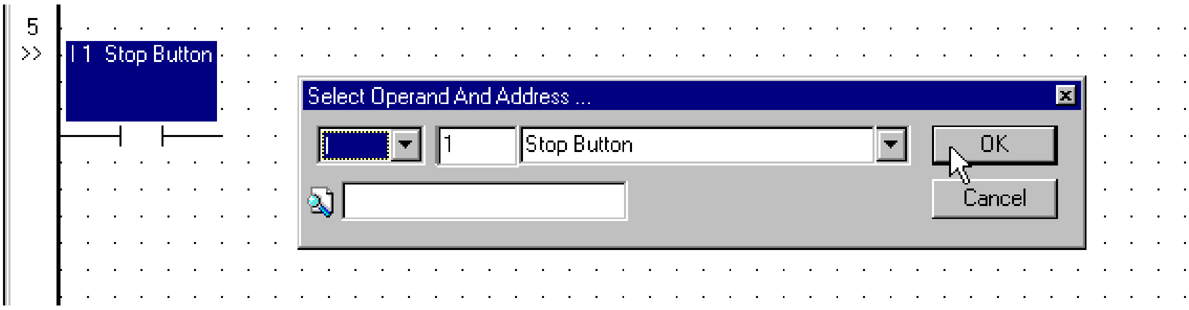
3. Begin entering the Symbol name for which you are searching. The list will become more specific the more letters you enter.



4. Select the desired Operand from the Symbol Search list.

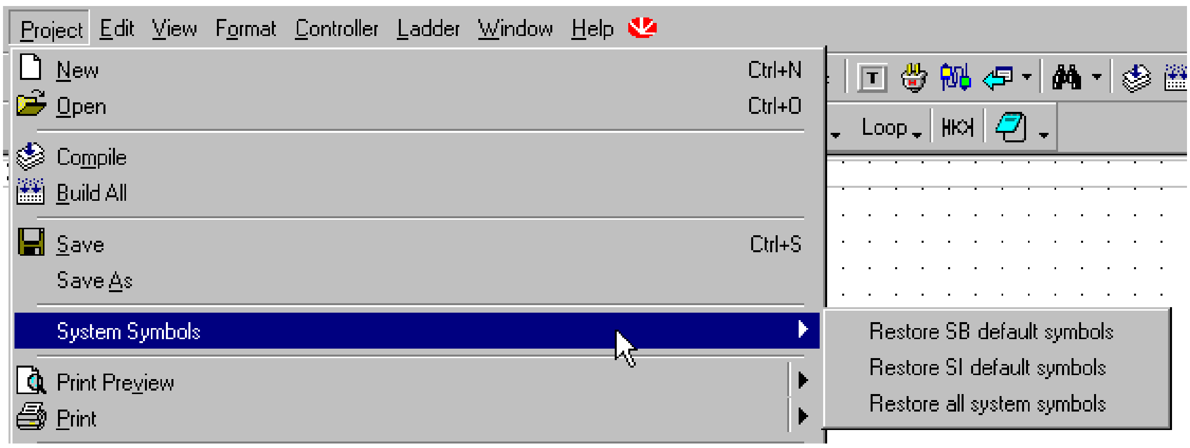


5. Click OK. The selected element appears on the net with the desired Operand and Address.



Restoring System Symbols

To restore System Symbol values:



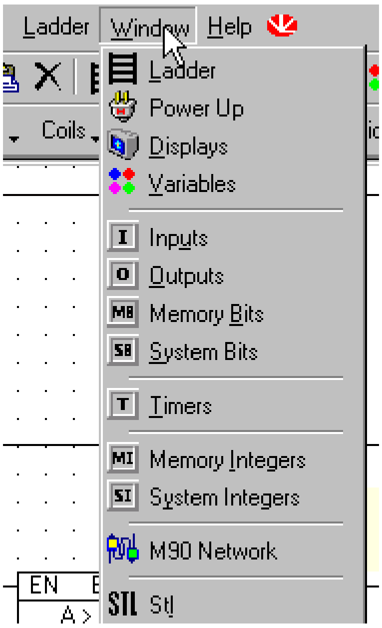
Keep in mind that there are SBs and SIs reserved for use by the system, such as SB 4 Divide by Zero or SI 4 Divide Remainder. Those SBs and SIs cannot be written into. If you accidentally write into them, you can recover their symbols.

Note that SBs and SIs are for system use. Even those currently 'blank' may be assigned a function in a later controller model. Writing into System Bits and System Integers is solely at the discretion of the programmer and the programmer is solely responsible for any problems that may arise as a result.

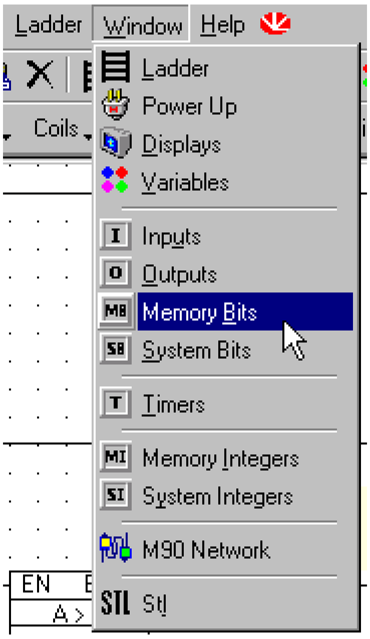
Operands in use

To check what Operands are being used in a project:

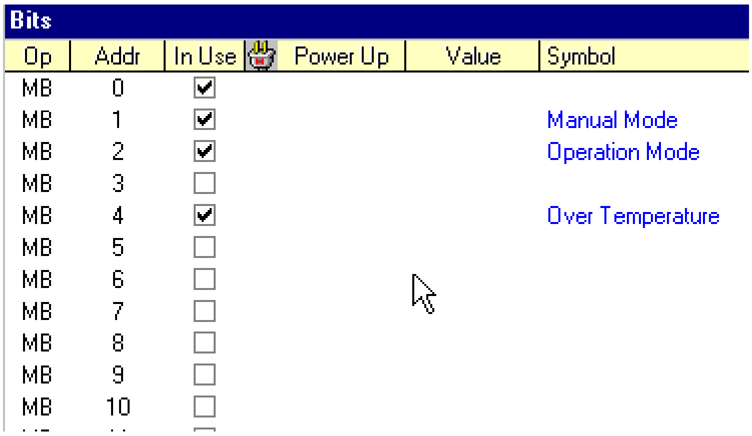
1. Open the Window Menu on the Main menu bar.



2. Select the Operand type you wish to check.



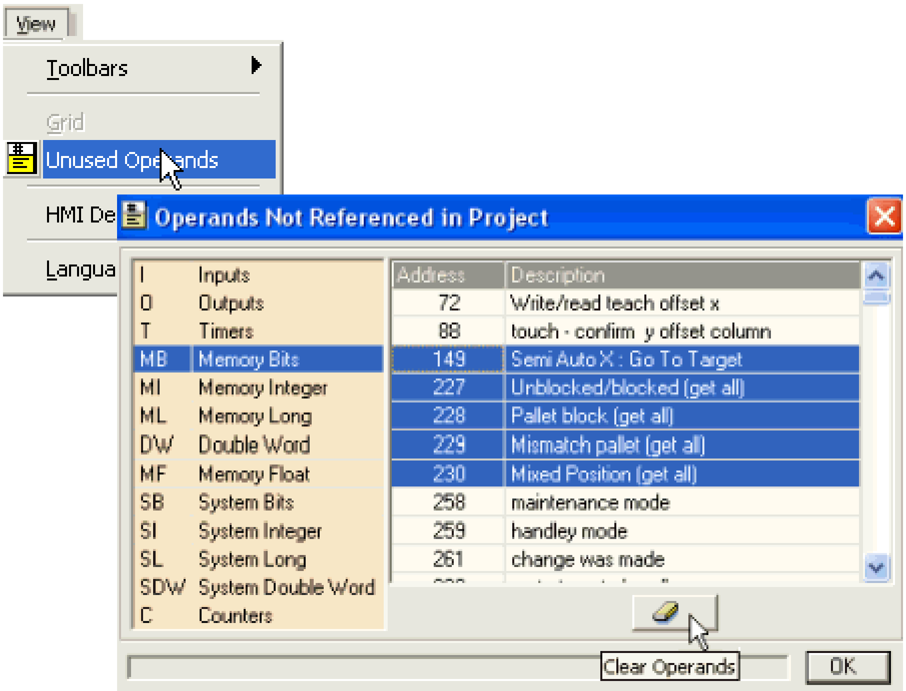
3. The Operand List window opens. The Operands in use are marked with a check mark in the **In Use** box.



Deleted Unreferenced Operands

To help manage your project, you can delete unreferenced operands. The utility searches through the entire application, including Hardware Configuration, SMS, and PID.

Note • If an operand has been assigned a Power-up value, it is a referenced operand and will not appear in this list.



Operand Values:

Operand	Address	Value
MB	0-255	Logic 0 or Logic 1
SB		
I		
O		
MI	0-255	16 bit integer
SI		
Timer	0-63	0 – 45:30:30:00

The integer value range is $2^{16} - 1$: that is +32767 to -32768.

Keep this integer range in mind when creating function blocks.

For example: MI 75 + #50 = MI 76

If MI 75 goes beyond 32626, the integer value returned in MI 76 will be a **negative** number!

Functions

Functions

The following types of Function Blocks can be used in your program:

- Compare Functions
- Logic Functions
- Math Functions
- Store functions
- Clock Functions
- Loops: Jump to Label

Special Functions: without Ladder elements

VisiLogic contains special functions that are not represented by Ladder Elements. You can perform these functions by storing values into the System Integers listed here.

To see a list of functions, check the Special Functions list.

Compare Functions

A compare function represents a data manipulation instruction. U90 Ladder uses function blocks to operate compare functions. Each function block takes 2 inputs (MI, SI or a constant integer) and manipulates them according to the function block instruction.

If the function block instructions are true (logic 1): power flows through the block.

If the function block instructions are false (logic 0): power does not flow through the block.

There are 6 types of Compare Functions:

- Greater Than
- Greater Than or Equal To
- Equal To
- Not Equal To
- Less Than or Equal To
- Less Than

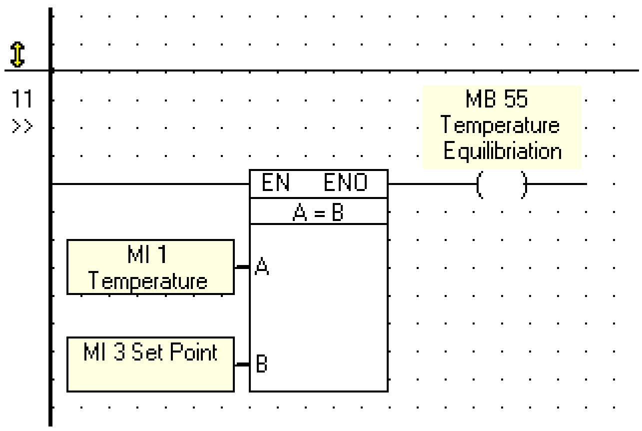
Equal

The Equal function block evaluates input A to see if its constant integer value is equal to input B.

If input A is equal to input B: power will flow through the function block.

If input A is not equal to input B: power will not flow through the function block.

Input Operands A & B must be integer values: MI, SI or # constant integer value.



According to the above example:

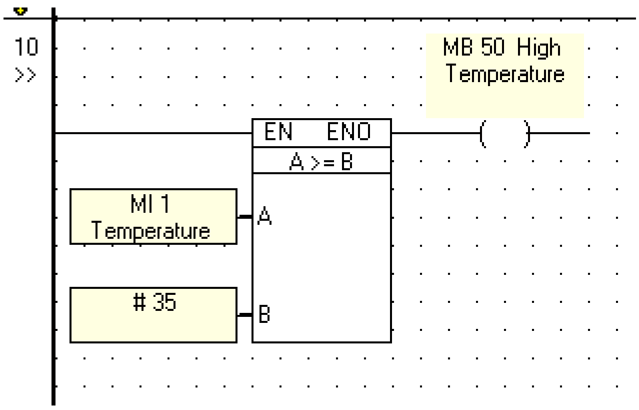
- If MI 1 is equal to MI 3; then MB 55 will go to logic "1" (ON).
- If MI 1 is not equal to MI 3; then MB 55 will go to logic "0" (OFF).

Greater or Equal

The Greater Than or Equal function block evaluates input A to see if its integer value is greater than or equal to input B.

If input A is greater than or equal to input B: power will flow through the function block.

If input A is not greater than or not equal to input B: power will not flow through the function block.



According to the above example:

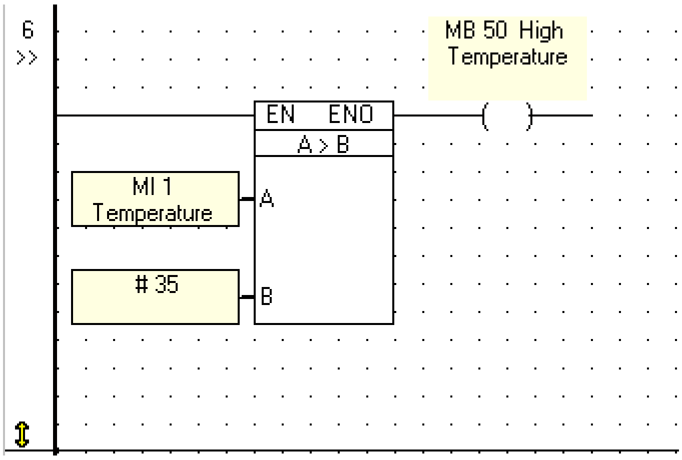
- If MI 1 value is greater or equal to constant integer 35; then MB 50 will go to logic "1" (ON).
- If MI 1 value is not greater or equal to constant integer 35; then MB 50 will go to logic "0" (OFF).

Greater Than 

The Greater Than function block evaluates input A to see if its current value is greater than input B.

If input A is greater than input B: power will flow through the function block.

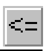
If input A is not greater than input B: power will not flow through the function block.



According to the above example:

- If MI 1 value is greater than 35; then MB 50 will go to logic "1" (ON).
- If MI 1 not greater than 35; MB 50 will go to logic "0".

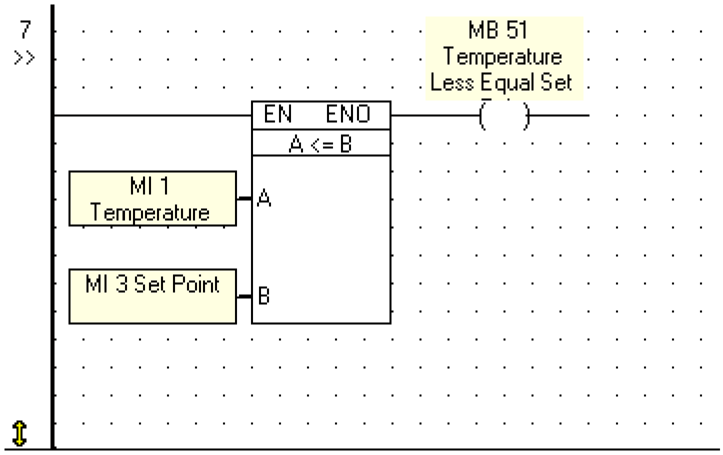
Care must be taken when using greater and less than function blocks. Do not create a program with instructions for Greater Than and Less Than but without an instruction block for how to proceed in a situation where input A equals input B.

Less or Equal 

The Less Than or Equal To function block evaluates input A to see if its current value is less than or equal to input B.

If input A is less than or equal to input B: power will flow through the function block.

If input A is not less than or equal to input B: power will not flow through the function block.



According to the above example:

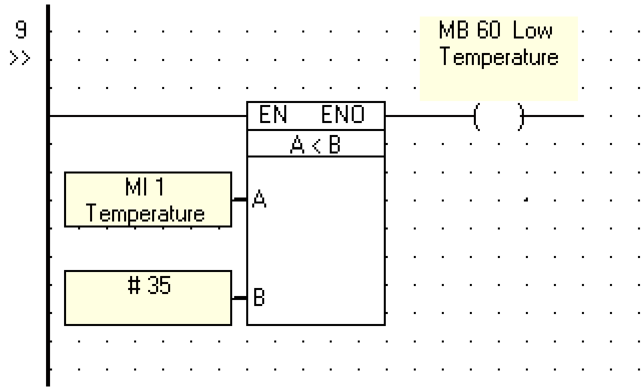
- If MI 1 value is greater than the MI 3 value; then MB 51 will go to logic "1" (ON).
- If MI 1 not greater than the MI 3 value; MB 51 will go to logic "0".

Less Than 

The Less Than function block evaluates input A to see if its integer value is less than input B.

If input A is less than input B: power will flow through the function block.

If input A is not less than input B: power will not flow through the function block.



According to the above example:

- If MI 1 value is less than constant integer 35; then MB 60 will go to logic "1" (ON).
- If MI 1 value is not less than constant integer 35; MB 60 will go to logic "0" (OFF).

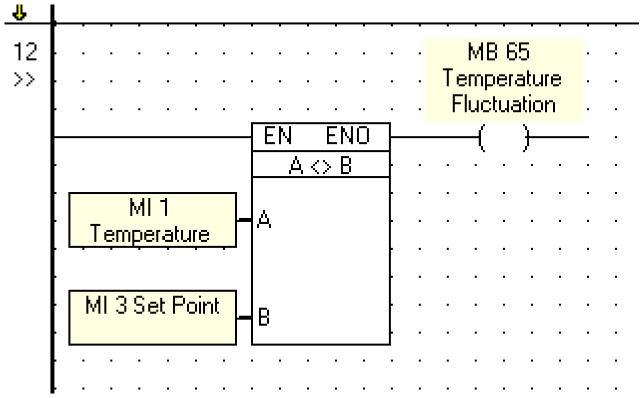
Not Equal 

The Not Equal function block evaluates input A to see if its integer value is not equal to input B.

If input A is not equal to input B: power will flow through the function block.

If input A is equal to input B: power will not flow through the function block.

Input Operands A & B must be integer values: MI, SI or # constant integer value.



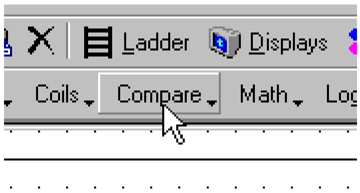
According to the above example:

- If MI 1 is not equal to MI 3; then MB 65 will go to logic "1" (ON).
- If MI 1 is equal to MI 3; then MB 65 will go to logic "0" (OFF).

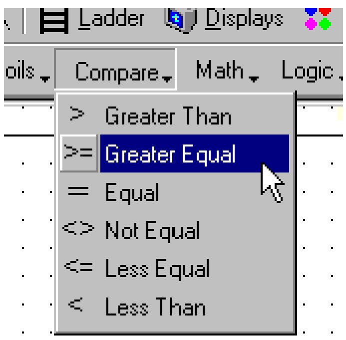
Using the Compare function

To use the Compare function:

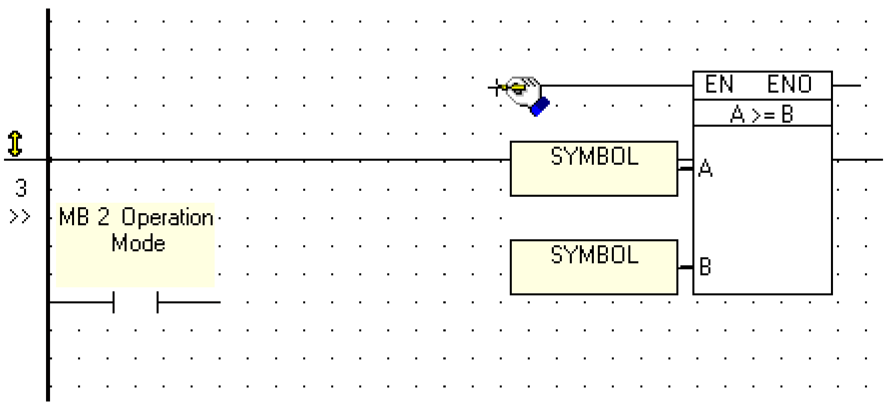
1. Click **Compare** on the Standard toolbar. The Compare function list opens.



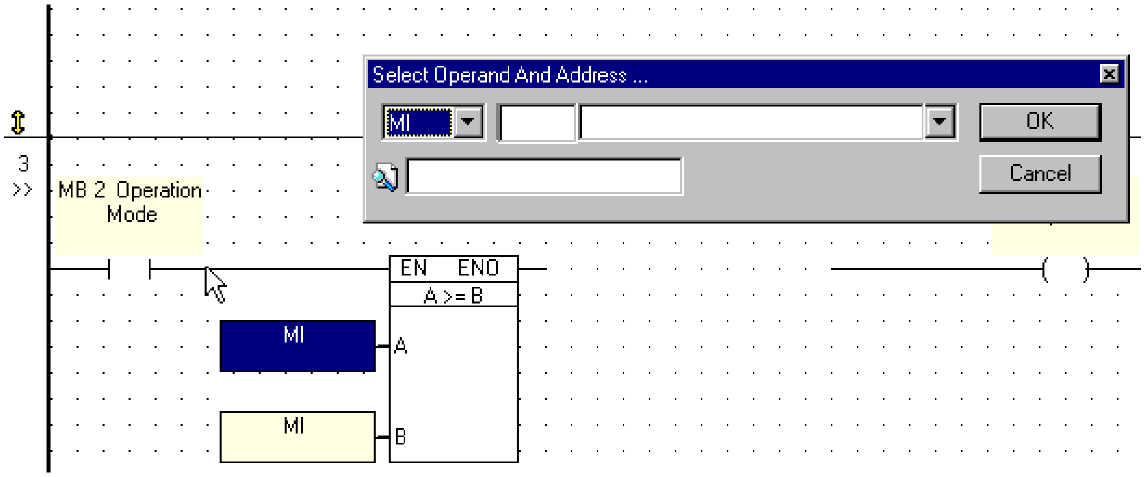
2. Select the desired Compare function.



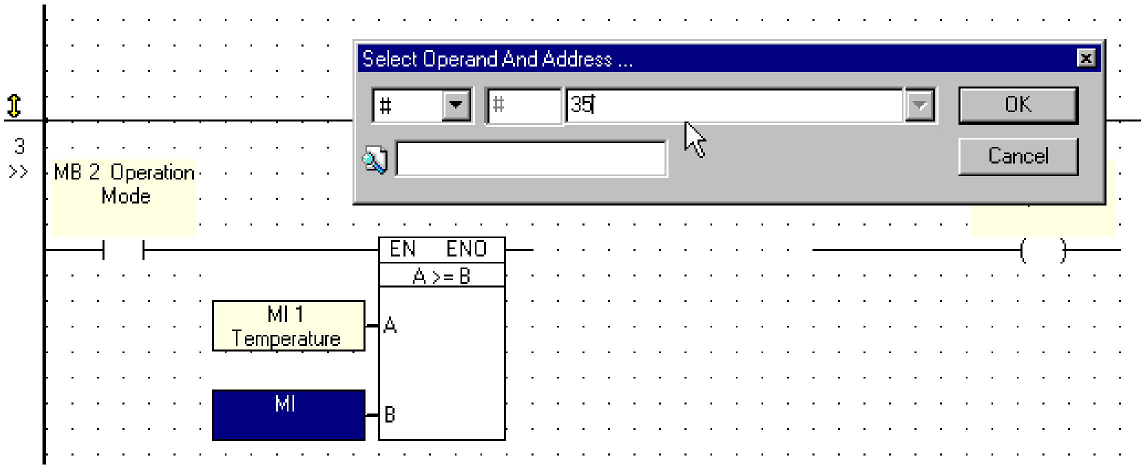
3. Move the function block that appears to the desired net location.



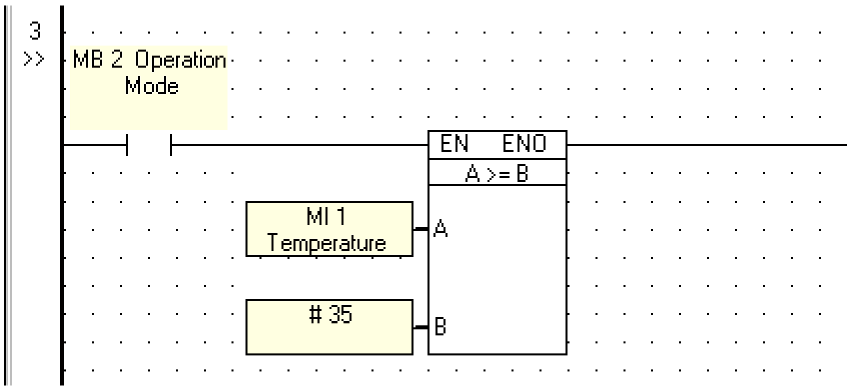
4. Click to place the function block. The Select Operand and Address dialog box opens.



5. Enter the Operands and Addresses in the dialog boxes and click OK.



6. The Compare function block appears with the selected Operands and Addresses.



Logic Functions

You perform logical functions in U90 Ladder by using logic function blocks. Function blocks are provided for:

- AND
- OR
- XOR

The internal operation of a function block is transparent to the user. You input the two operands. The result is automatically output by the function block

Input Operands A & B must be integer values: MI, SI or # constant integer value.

Output Operand C may be a Memory Integer or a System Integer.

AND

Example

The AND logic function block can evaluate the state of two integers. If a bit is true (logic 1) in both input A and B then the output C will be true (logic 1). If input A and B is false (logic 0) - the output C will be false (logic 0). If either input A or B is false (logic 0) - the output C will be false (logic 0).

AND Truth Table		
A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

Input Operands A & B must be integer values: MI , SI or # constant integer value.

Output Operand C may be an MI or a SI.

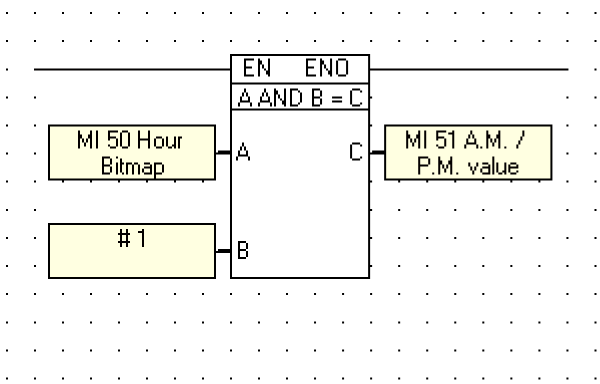
AND can be used to mask out certain bits of an input integer not relevant to a given function.

Example:

If a clock function block uses the first bit of a 16-bit word to decide if a given time is A.M. or P.M., you can mask out the other 15 bits. This will tell you if the current time is A.M. or P.M.

Bit Number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word	1	0	0	0	1	1	0	1	0	1	0	1	0	1	1	1
AND																
Mask	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Result	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1

All of the non-relevant bits will be turned off (logic 0) expect the A.M. / P.M. bit.

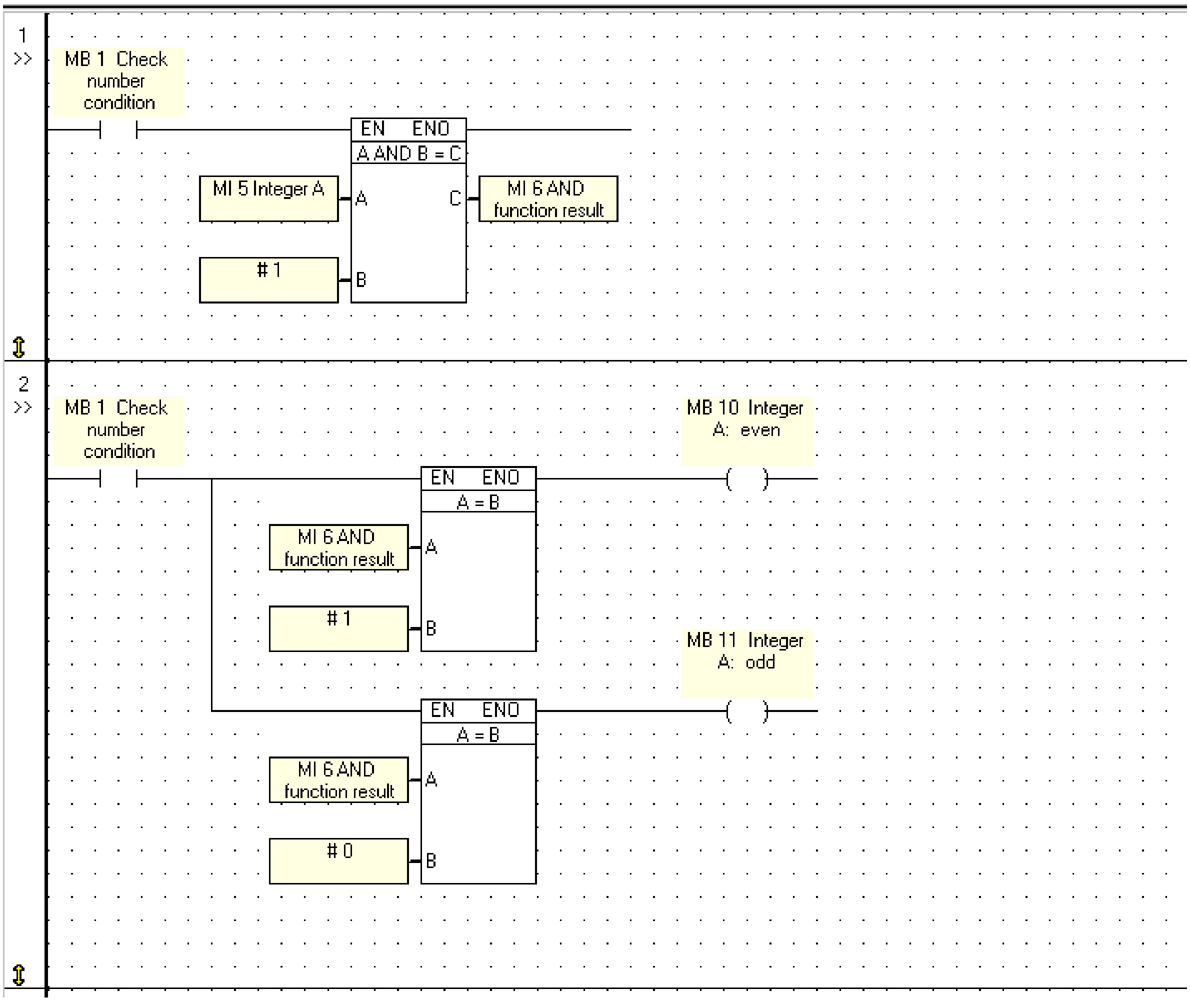


AND Example

You want to determine if an MI / SI value is an odd or an even number in your application.

An AND function between an integer A and #1:

- If integer A is an even number then the result of the AND operation = #1.
- If integer A is an odd number then the result of the AND operation = #0



OR

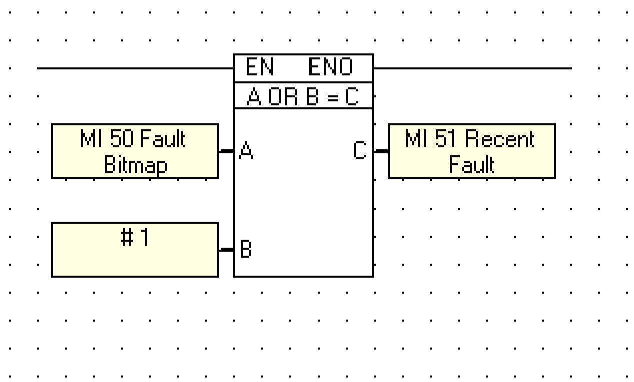
The OR logic function block can evaluate the state of two integers to see if either input A or B is true. If input A OR B is true - the output C will be true (logic 1). If both input A and B are true (logic 1) - the output C will also be true (logic 1).

OR Truth Table		
A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

Input Operands A & B must be integer values: MI , SI or # constant integer value.

Output Operand C may be a Memory Integer or a System Integer.

Bit Number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word	1	0	0	0	1	1	0	1	0	1	0	1	0	1	1	1
OR																
Compare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Result	1	0	0	0	1	1	0	1	0	1	0	1	0	1	1	1



XOR

The XOR logic function block can evaluate the state of two integers to see if input A and B are equal. If either input A OR B is true - the output C will be true (logic 1). If both input A and B are true (logic 1) - the output C will be false (logic 0). If both input A and B are false (logic 0) - the output C will be false (logic 0).

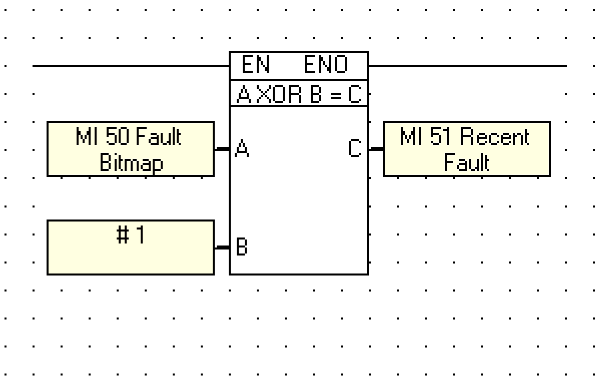
XOR Truth Table		
A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

Input Operands A & B must be integer values: MI, SI or # constant integer value.

Output Operand C may be a Memory Integer or a System Integer.

Use XOR to recognize changes in an integer to check for integer bit corruption. If 2 integers are equal: the result will return logic 0. If there has been bit corruption: the corrupted bit will return logic 1.

Bit Number	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Word	1	0	0	0	1	1	0	1	0	1	0	1	0	1	1	1
XOR																
Compare	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Result	1	0	0	0	1	1	0	1	0	1	0	1	0	1	1	0



Loops

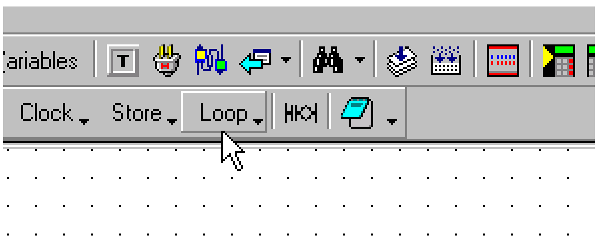
Loops: Jump to Label

Loops in a Ladder project cause the program to jump over certain net(s), according to specific logic conditions.

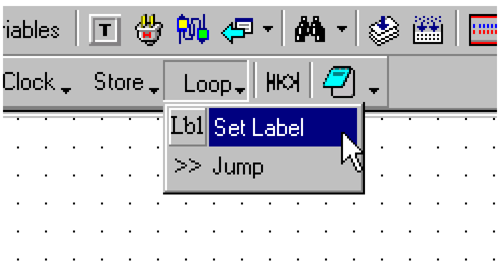
A Loop contains a Jump element and a Label. When the Jump condition(s) is true, the project jumps to the associated Label.

To create a Loop in your project:

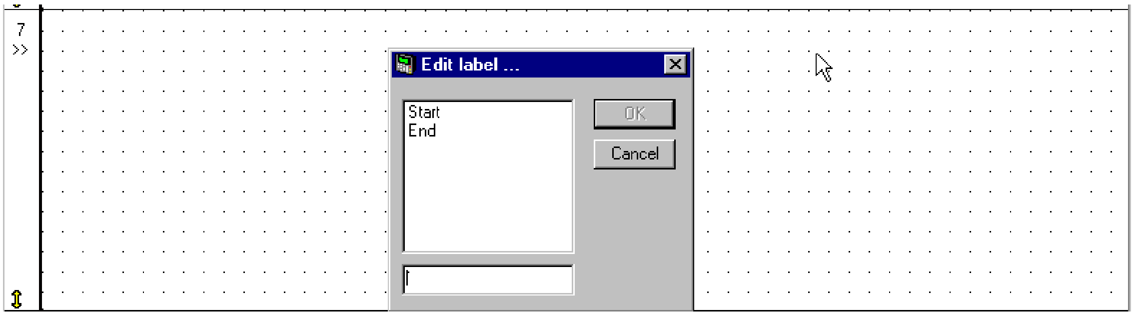
1. Click **Loop** on the Ladder toolbar.



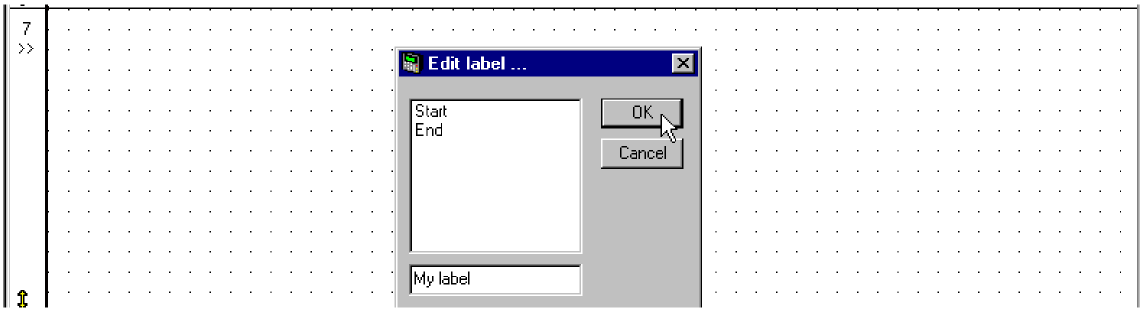
2. Select **Set Label** from the **Loop** menu. Place the cursor in the desired net and click.



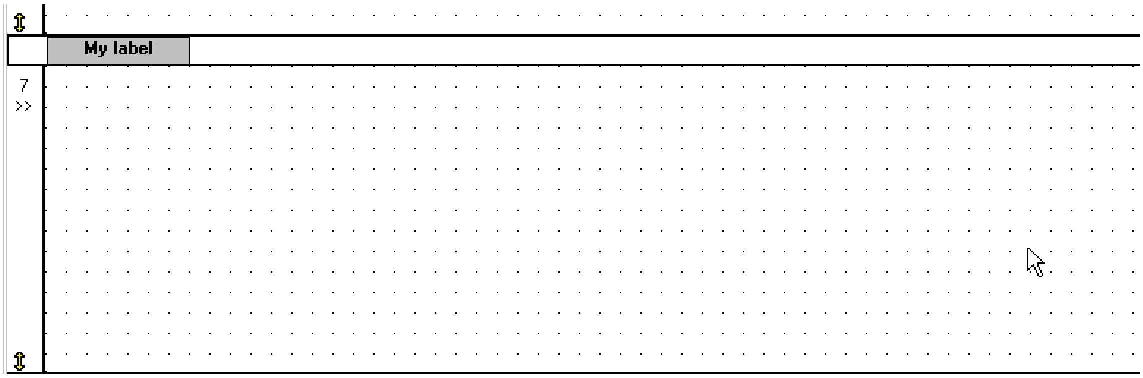
3. The **Edit Label** box opens.



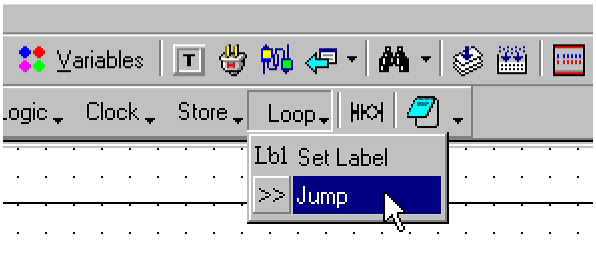
4. Enter a Label name of up to **eight** characters.



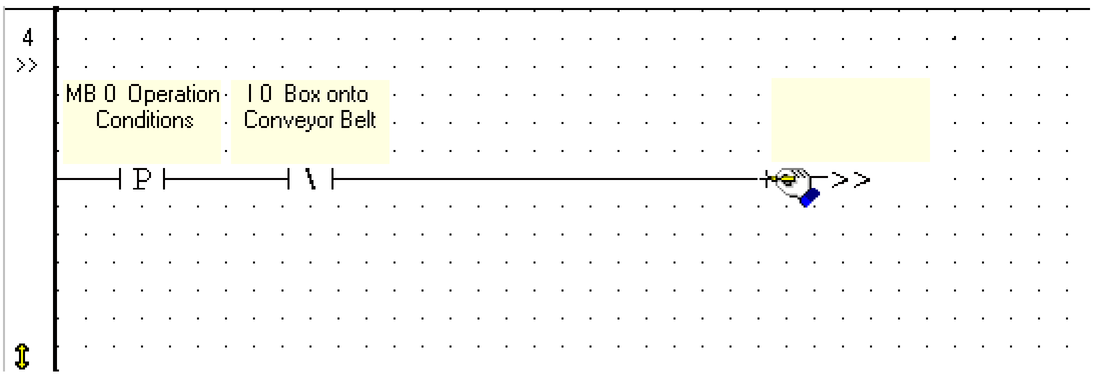
5. The Label appears above the net.



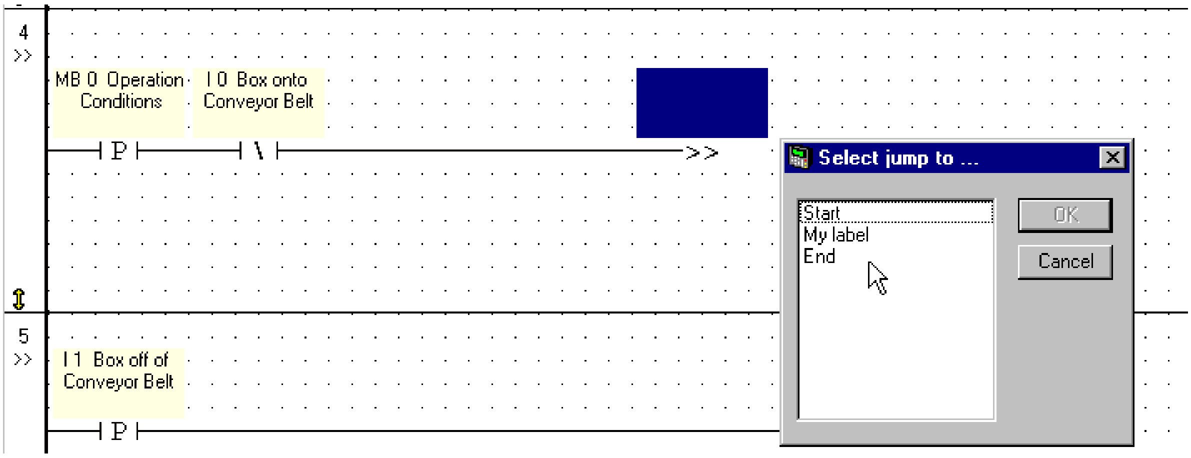
6. Select **Jump** from the Loop menu.



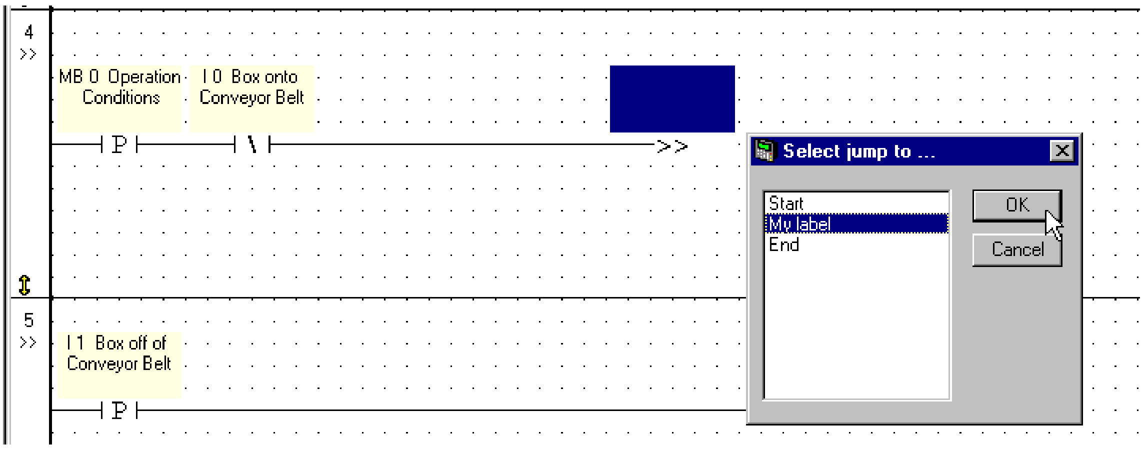
7. Place the Jump in the desired place on the desired net.



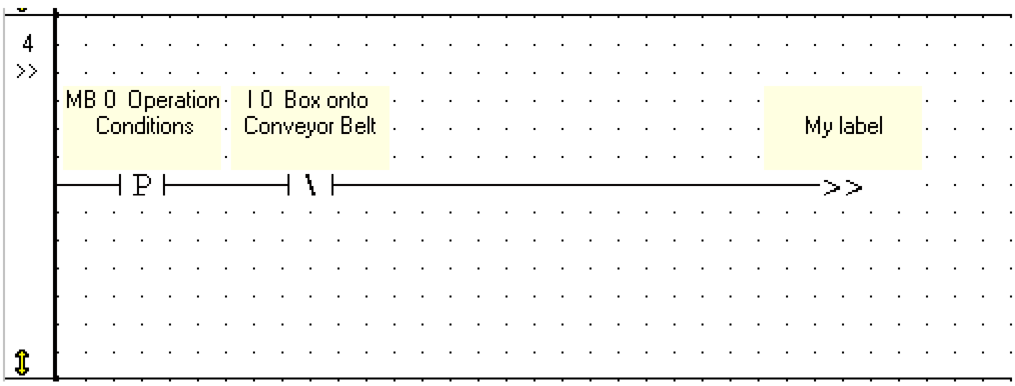
8. **Select Jump to...** window appears.



9. Select the desired Label name to which you want to jump. Click OK.



10. The Jump element appears with the selected Label name on the net.



According to the above example, if Ladder logic is true for net 4, the program will jump over nets 5 and 6 and continue from net 7.

Important note: You must take care when creating Loops not to create an endless Loop. While you can place Labels before a Jump condition and you can refer to a Label more than once, repeated referrals to a Label above a Jump element can create an endless loop which will cause the controller to stop with an error message "PROGRAM LOOP."

Loop functions are featured in the sample application, such as the applications ' Shortening scan time-jump'. This application may be found by selecting Sample U90 Projects from the Help Menu.

Math Functions

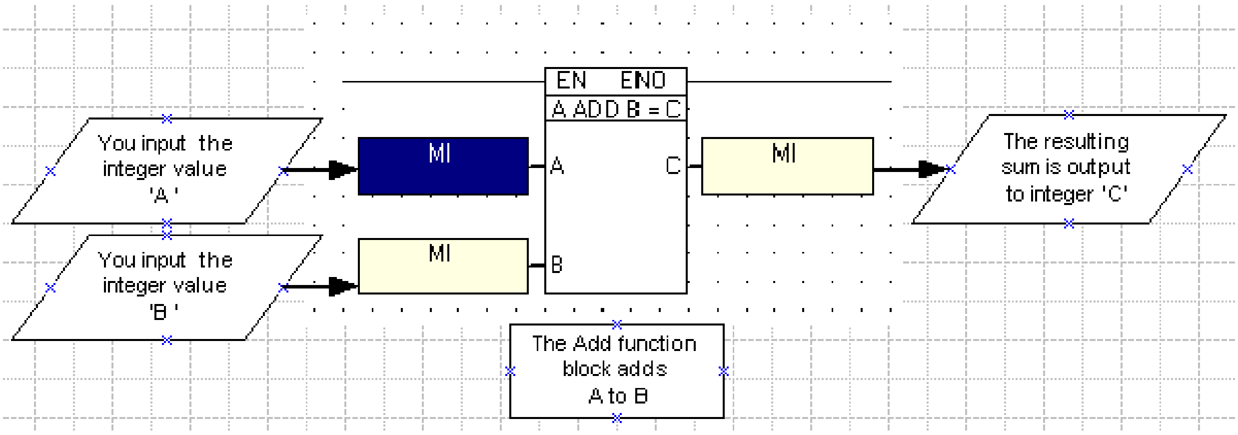
Math Functions

You perform mathematical functions in U90 Ladder by using math function blocks. Function blocks are provided for:

- Addition
- Subtraction
- Multiplication
- Division

The internal operation of a function block is transparent to the user. You simply input the two operands. The result is automatically output by the function block.

The example below shows the Add function block.



Input Operands A & B must be integer values: MI , SI or # constant integer value.

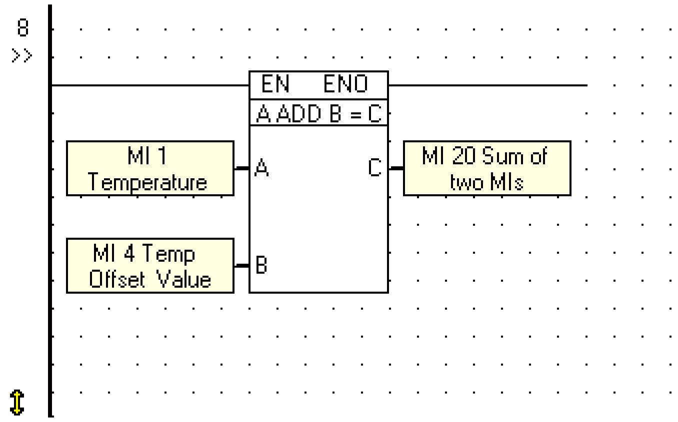
Output Operand C may be a Memory Integer or a System Integer.

You can use an Add function block to assign a real number value to an MI or SI.

Add +

Example

The math function add is executed by the Add function block shown below.

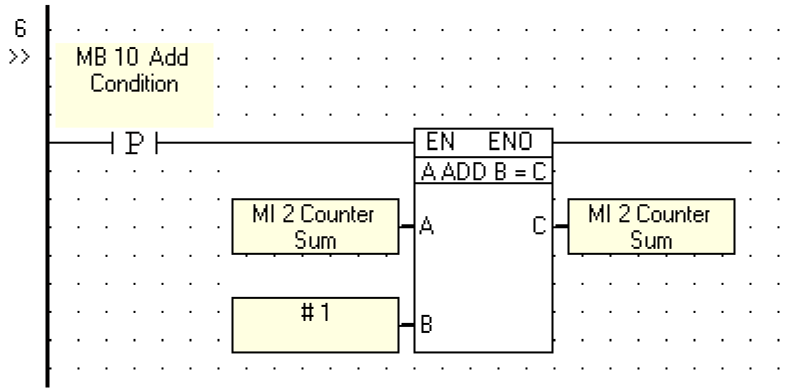


Input Operands A & B must be integer values: MI , SI or #constant integer value.

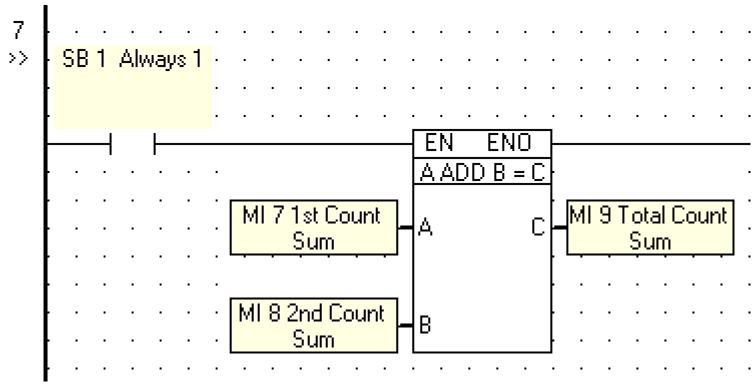
Output Operand C may be a Memory Integer or a System Integer.

Add Examples

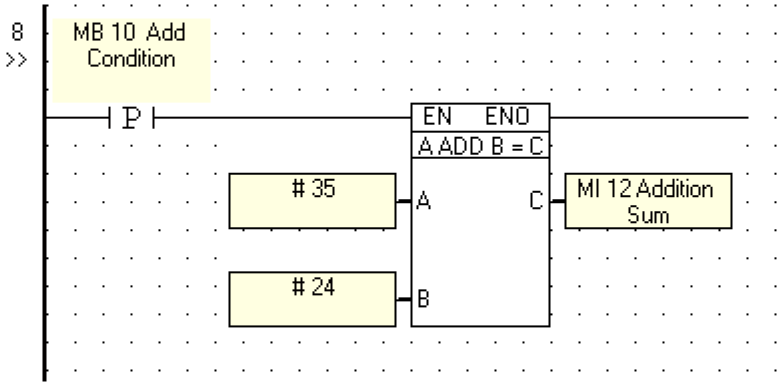
You can use the Add function to add an MI value to an integer value.



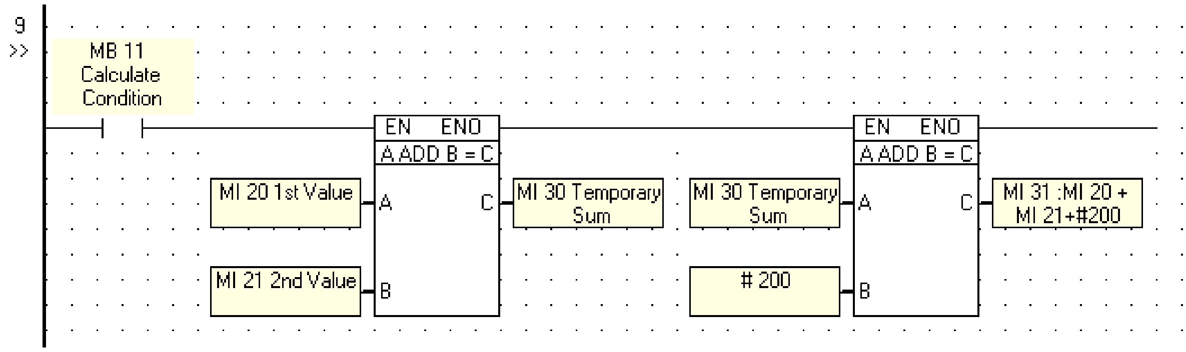
You can use the Add function to add two MI values.



You can use the Add function to add two integer values.



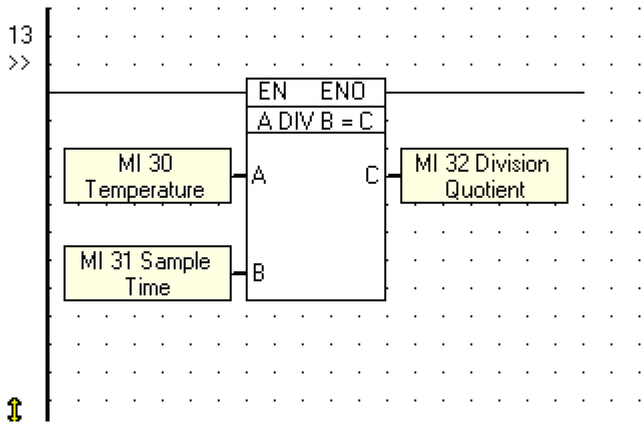
You can use Add function blocks in series.



Divide

Examples

The math function divide is executed by the Divide function block shown below.



Input Operands A & B must be integer values: MI , SI or #constant integer value.

Output Operand C may be a Memory Integer or a System Integer.

The Divide function can only return whole numbers. This function does not support floating point integers. Examples: 7.2 and 9.5.

Use System Integer 4 (**SI 4** - Divide Remainder) to find the exact integer value of a division function that may involve a remainder.

Note that you must use the remainder value in SI 4 immediately after the division function. SI 4 will be written over with the next division function and the specific remainder value will be lost.

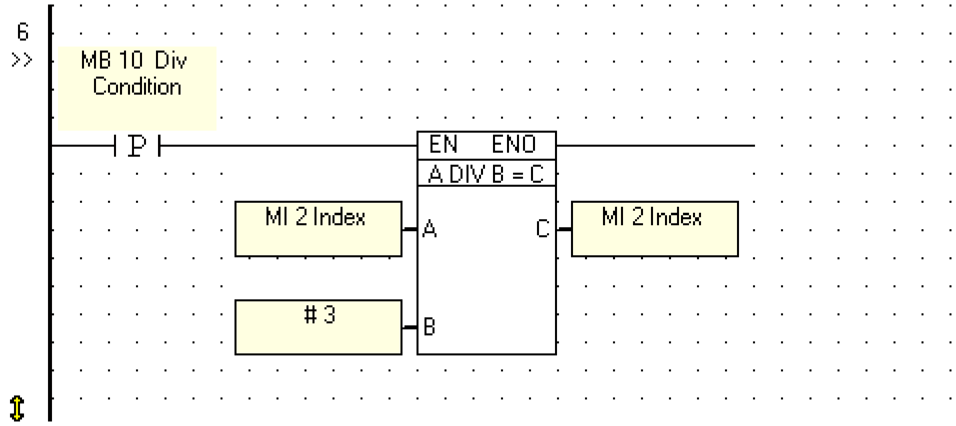
System Bit 4 (**SB 4** - Divide by Zero) will activate if the division operation will inadvertently result in a division by zero and return zero in Operand C.

Division Examples

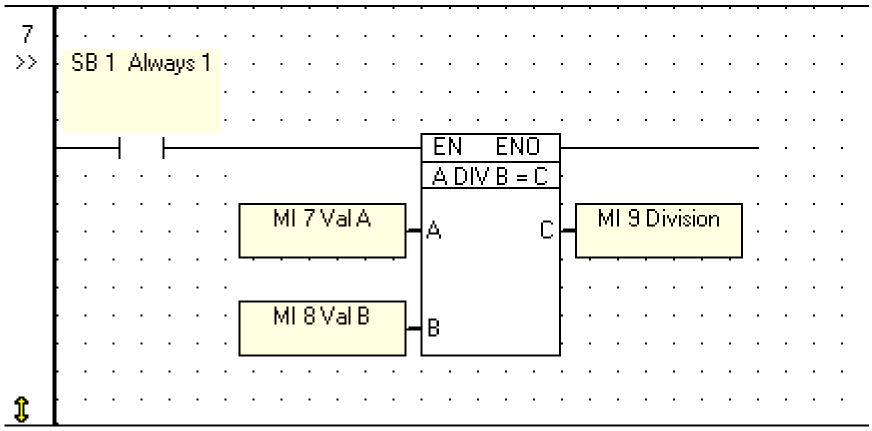
Remember that any remainder of a Division function will be written into **SI 4**. You must use any remainder value immediately after the Division function because **SI 4** will be written over with the next division function and the specific remainder value will be lost.

SB 4 (Divide by Zero) will activate if the division operation will inadvertently result in a division by zero and it will return zero in Operand C.

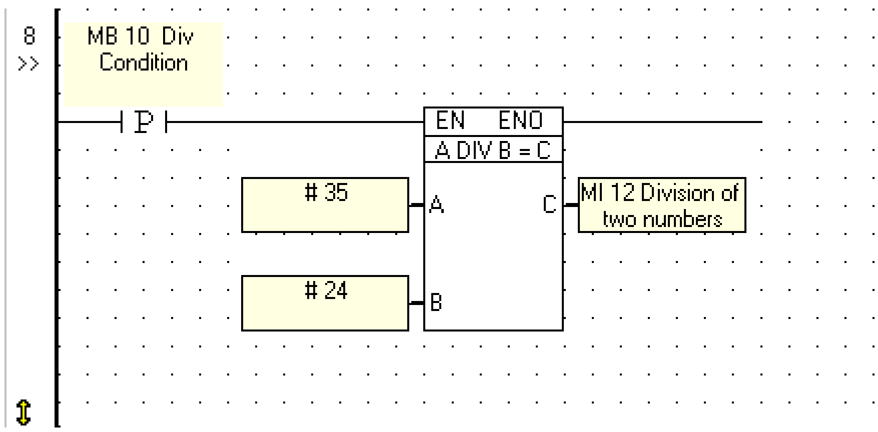
You can use the Division function to divide an MI value and integer value.



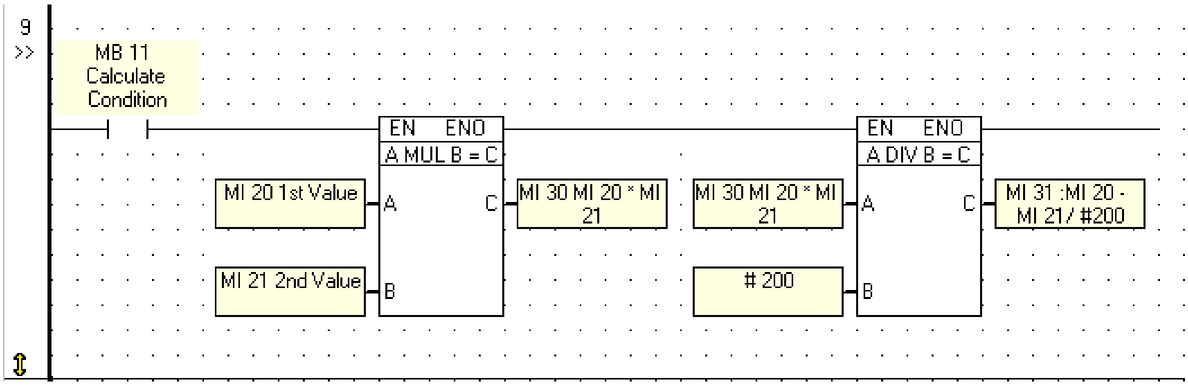
You can use the Division function to divide two MI values.



You can use the Division function to divide two integer values.



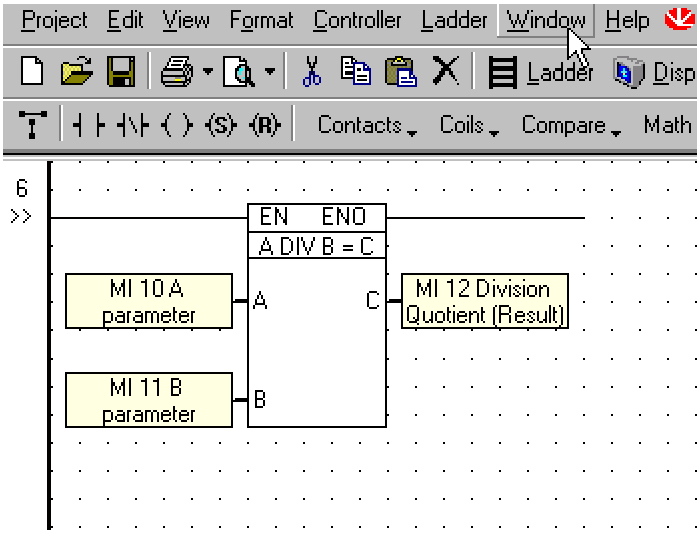
You can use Math function blocks in series.



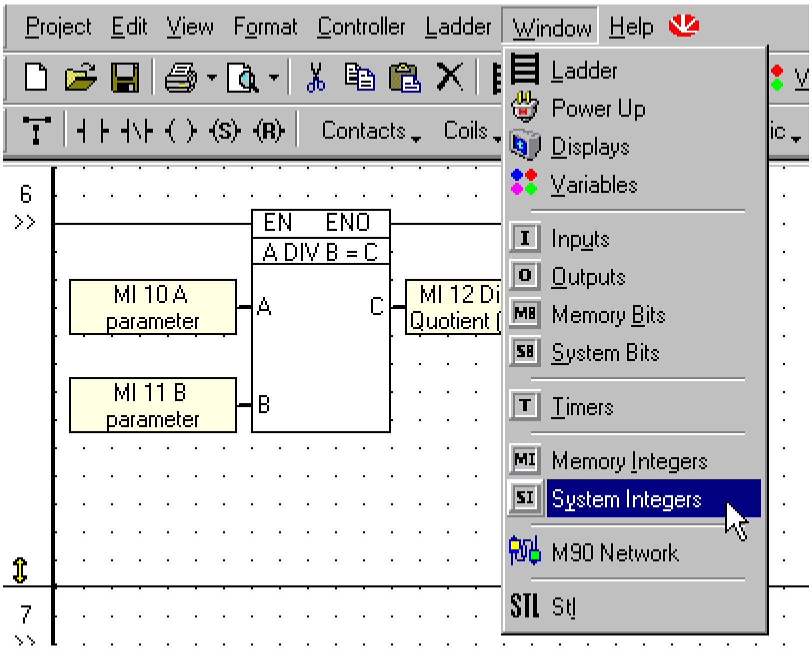
Division Function: Remainder values

To get the remainder value of a Division function:

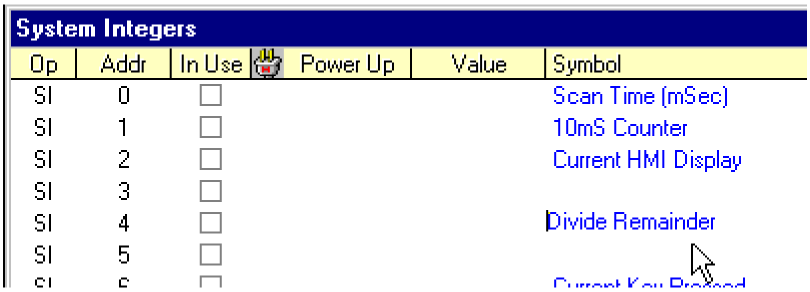
1. Enter the desired Operands into the Division function block.



2. Select **System Integers** from the Window Menu on the Standard Menu bar.



3. SI 4 holds the Remainder value for the most recent Division operation.



System Integers

Op	Addr	In Use	Power Up	Value	Symbol
SI	0	☐			Scan Time (mSec)
SI	1	☐			10mS Counter
SI	2	☐			Current HMI Display
SI	3	☐			
SI	4	☐			Divide Remainder
SI	5	☐			

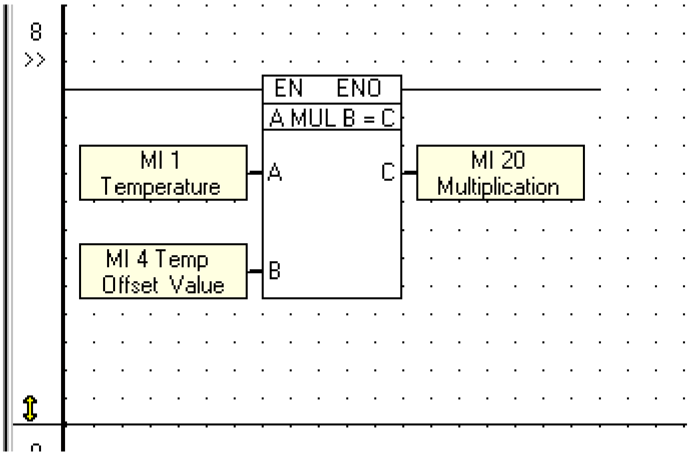
According to the above example:

If MI 10 = 7 and MI 11 = 2, then MI 12 = 3 and SI 4 = 1

Multiply *

Examples

The math function Multiply is executed by the Multiply function block shown below.

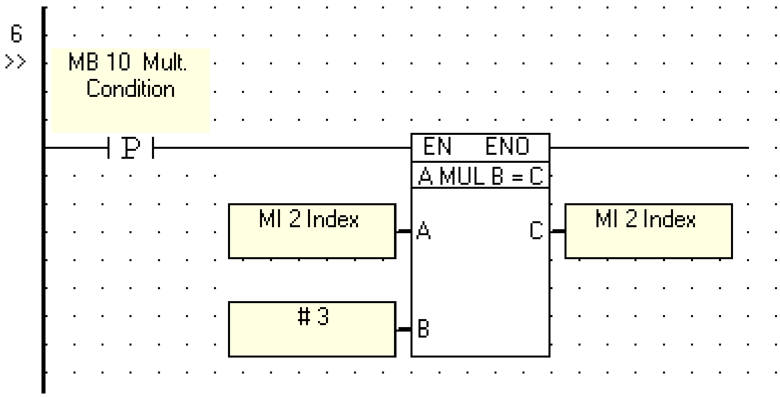


Input Operands A & B must be integer values: MI, SI or #.

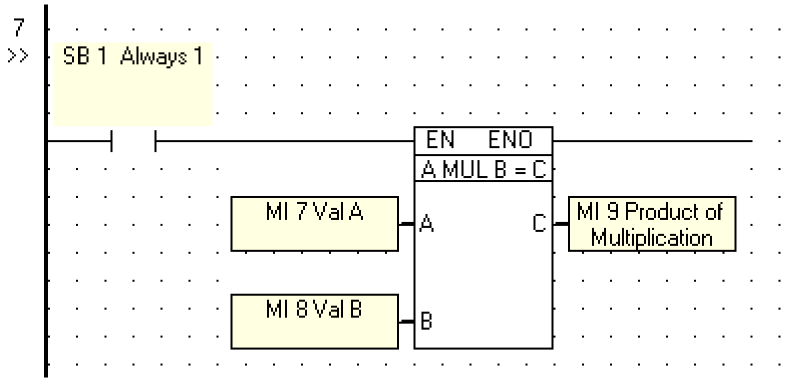
Output Operand C may be a Memory Integer or a System Integer.

Multiplication Examples

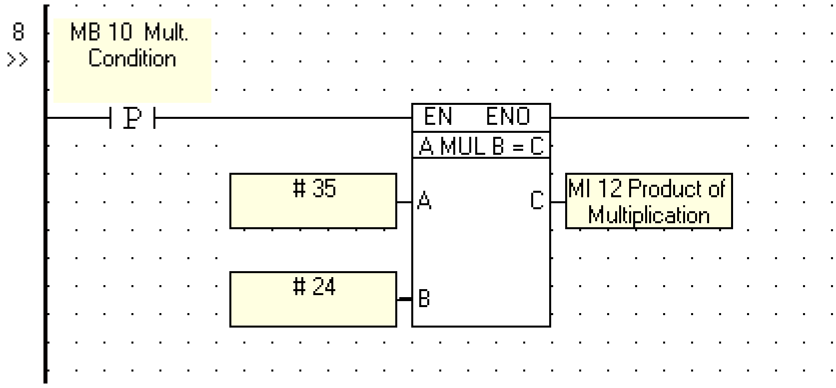
You can use the Multiplication function to multiply an MI with an integer value.



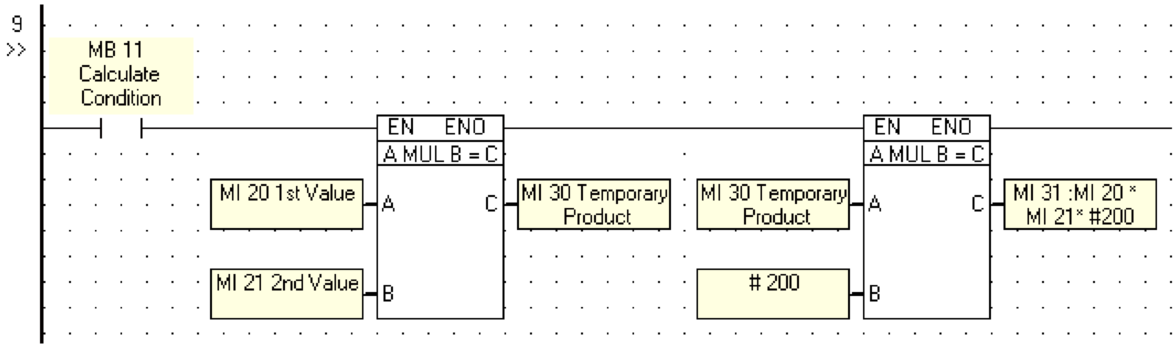
You can use the Multiplication function to multiply two MI values.



You can use the Multiplication function to multiply two integer values.



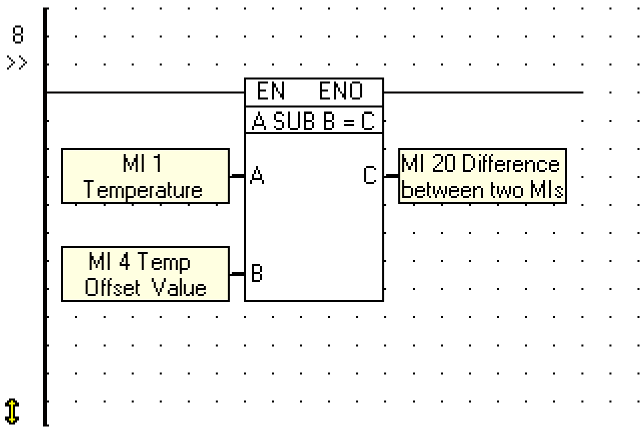
You can use Multiplication function blocks in series.



Subtract

Examples

The math function subtract is executed by the Sub function block shown below.

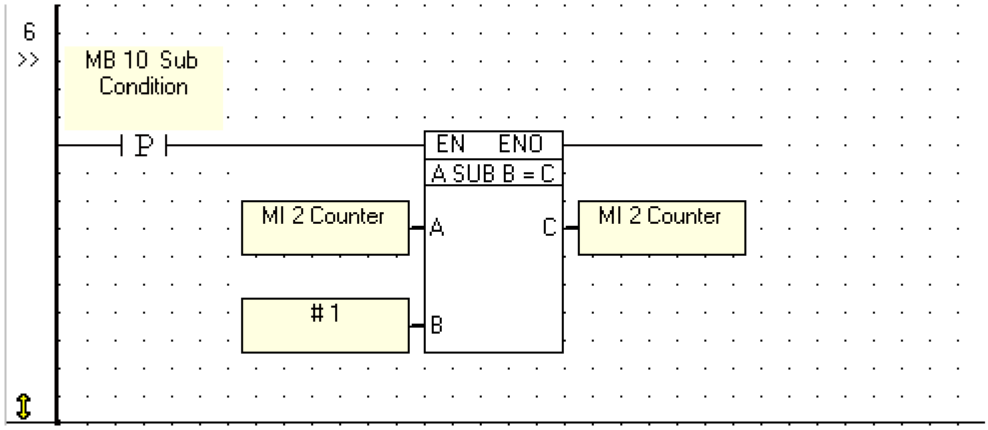


Input Operands A & B must be integer values: MI , SI or # constant integer value.

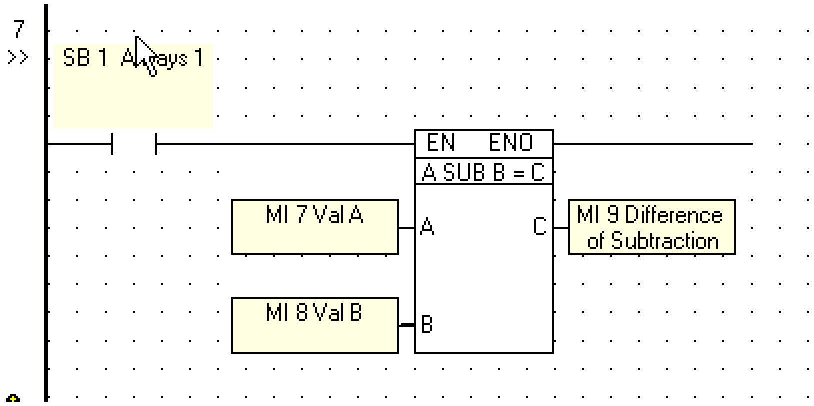
Output Operand C may be a Memory Integer or a System Integer.

Subtraction Examples

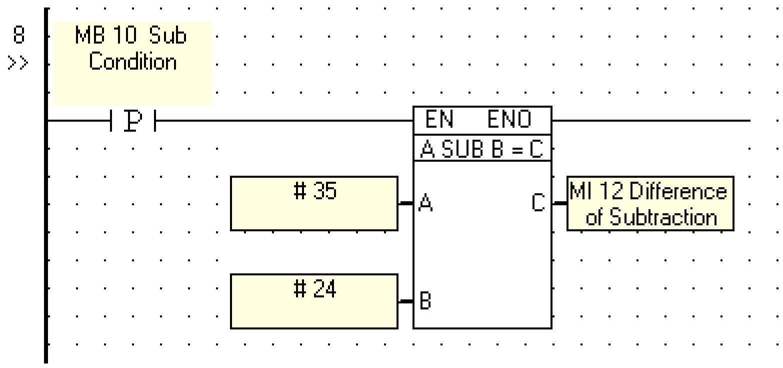
You can use the Subtraction function to subtract between an MI value and an integer value.



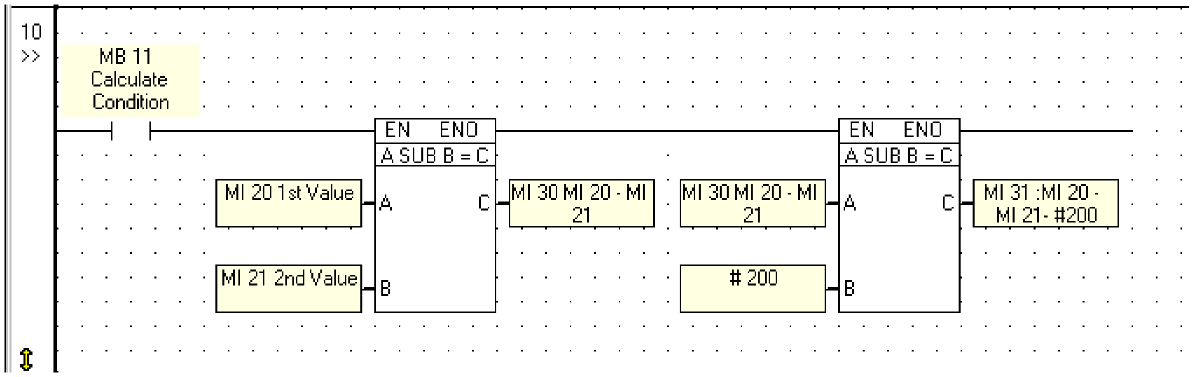
You can use the Subtraction function to subtract between two MI values.



You can use the Subtraction function to subtract between two integer values.



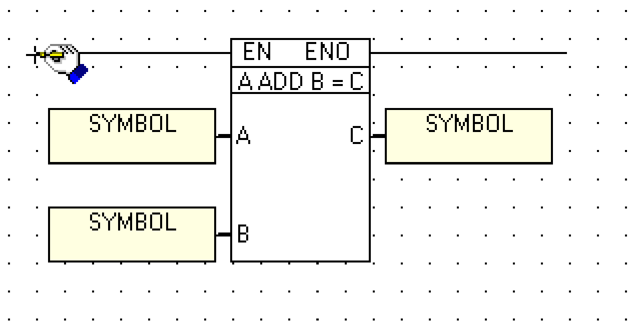
You can use Subtraction function blocks in series.



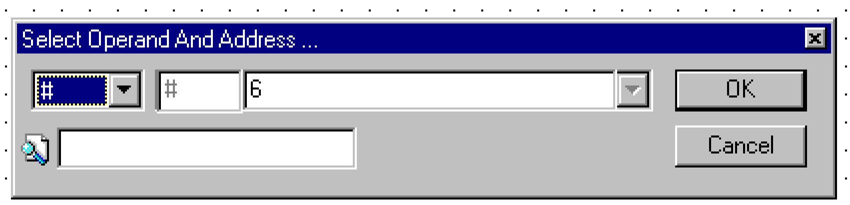
Math functions: Constant integers, MI,or SI

To execute a math function between an integer and MI/SI:

Each Math function has 3 elements: 2 input values and 1 output value. Each of these 3 elements has the possibility of being an integer (as well a MI or SI).



From the Select Operand and Address dialog box select # for the Operand type and Address. Enter the integer (number) value in the Symbol box.



Store Functions

An MI Operand contains an integer value (-32768 to +32767).

There are two ways to store an integer value in an MI:

- Store Direct
- Store Indirect

The last integer value written into a specific MI will overwrite any previous integer value stored there before.

Example:

MI 6 = 35. You then write the value 37 into MI 6, the value 35 will be replaced by the value 37.

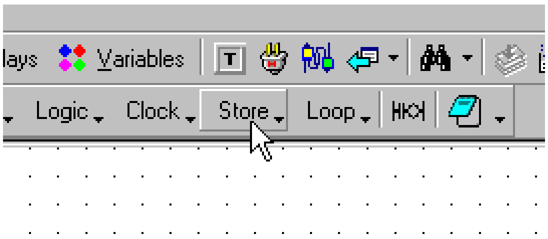
Store functions are featured in several sample applications, such as the application ' History of Events'. These applications may be found by selecting Sample U90 Projects from the Help Menu.

Store Direct function

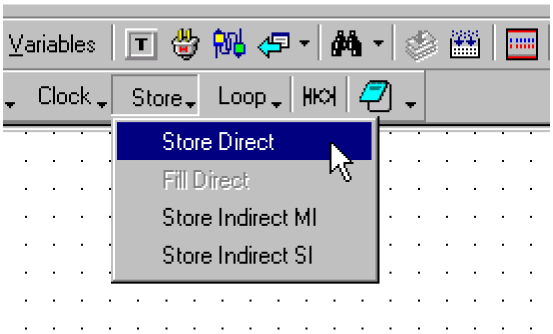
Store Direct allows you to write a constant, MI or SI value into another MI or SI.

To use the Store Direct function:

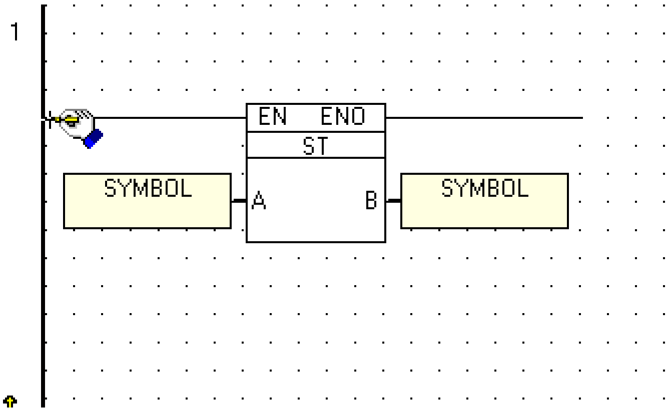
1. Click **Store** on the Ladder Toolbar.



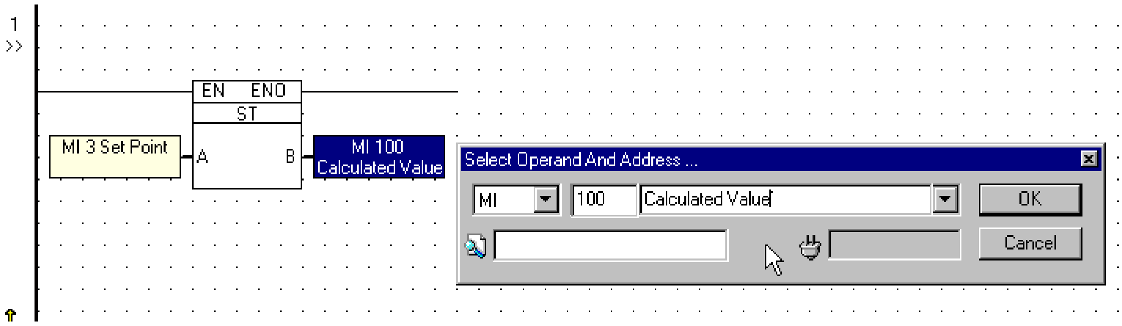
2. Select **Store Direct** from the Store Menu.



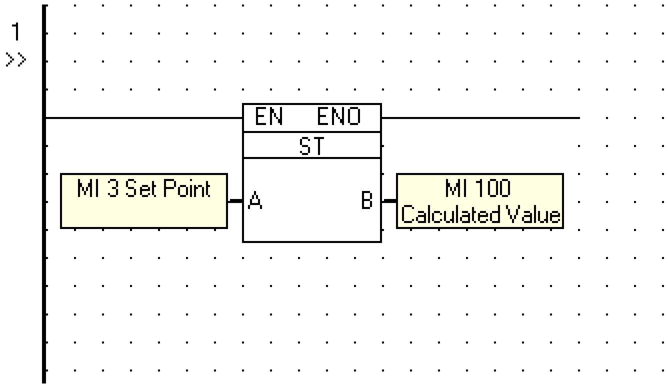
3. Move the Store Direct element to the desired net.



4. Enter the desired Operands and Addresses.



5. The Store Direct element appears on the net with the set Operands and Addresses.



According to the above example, the value in MI 3 will be stored in MI 100. The previous value in MI 100 is **lost**. The current value in MI 3 remains **unchanged**.

Store Indirect function

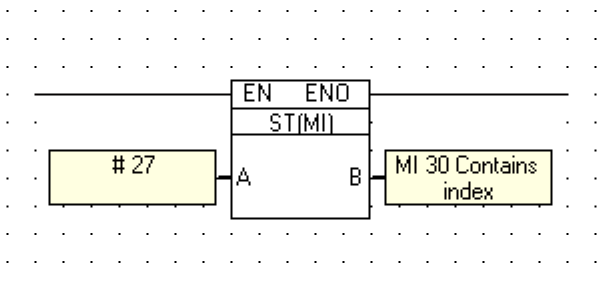
Store Indirect allows you to write an integer value (constant, MI or SI) into another MI or SI using indirect addressing.

For example:

When using the Store Indirect MI, if the value stored in the B parameter is 5; then MI 5 is the address where the value will be stored.

When using the Store Indirect SI, if the value stored in the B parameter is 2; then SI 2 is the address where the value will be stored.

For example:



According to the above example:

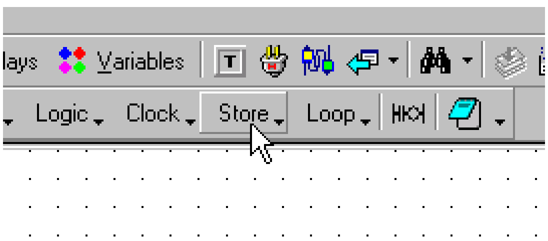
- If MI 30 contains the constant 5; then #27 will be stored in MI 5.
- If MI 30 contains the constant 35; then #27 will be stored in MI 35.

There are two types of Store Indirect function:

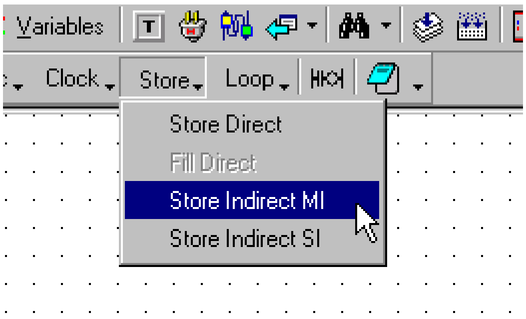
- The Store Indirect MI function relates to the MI address.
- The Store Indirect SI function relates to the SI address.

To use the Store Indirect function:

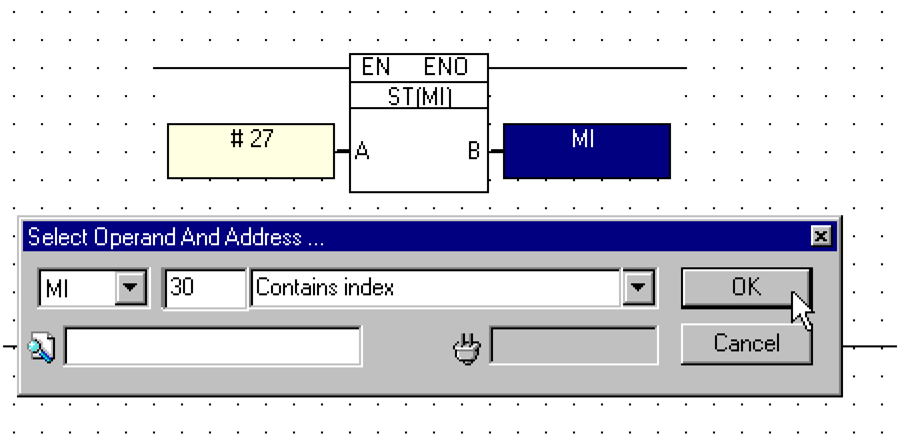
1. Click **Store** on the Ladder Toolbar.



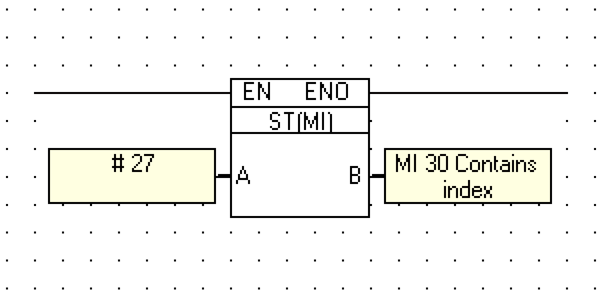
2. Select **Store Indirect MI** on the Store menu.



3. Enter the desired Operands, Addresses and Symbols. Click OK.



4. The **Store Indirect MI** element appears on the net.



Time Functions

Clock Functions

You perform clock and calendar functions in the U90 Ladder with Clock function blocks. These functions are on the **Clock** drop-down menu of the Ladder toolbar:

- Time
- Day of the Week
- Day of the Month
- Month
- Year

U90 Ladder provides 2 methods for executing Clock functions:

- Direct
- Indirect

You set the value of **Direct Clock** functions when you write your project.

The **user** sets the value of an **Indirect Clock** function from the PLC via the keypad.

To learn how to use Clock functions, check sample applications, such as the applications ' School Bell Direct', 'Database Log', and 'Print & Time'. To open these applications, select Sample U90 Projects from the Help Menu.

Time of Day

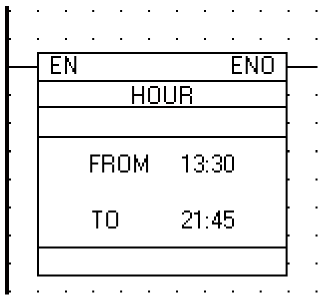
The Time function block is used for 24 hour time functions.

Direct Time Function:

The Direct Time function block has a 'from' (start) and a 'to' (end) time set by the programmer.

If the RTC is between these two times: power will flow through the function block.

If the RTC is not currently between these two times: power will not flow through the function block.



According to the above example:

Between 13:30 and 21:45 the function block will go to logic "1" (ON).

From 21:46 to13:29 the function block will go to logic "0" (OFF).

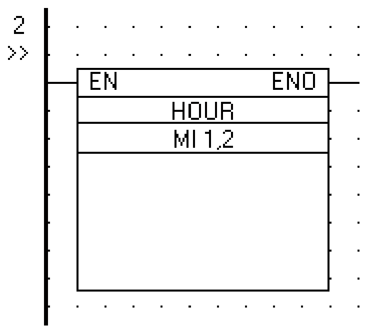
Indirect Time Function:

The Indirect Time function block is linked to two consecutive MIs or SIs. These integer values are entered by the user via the keypad.

If the RTC is between these two times: power will flow through the function block.

If the RTC is not currently between these two times: power will not flow through the function block.

You must create a **Time Function Variable** in Hour (CT) format for the user to enter the start and end times.



Direct Clock function

The Direct Clock function allows the programmer to write a Ladder program using calendar conditions for:

- Time of Day
- Day of the Week
- Day of the Month
- Month
- Year

These functions are located on the **Clock** drop-down menu of the Ladder toolbar.

You set the value of **Direct Clock** functions when you write your project.

You must use the **Indirect Clock** functions if you want the user to set the value of a Clock function via the PLC's keypad.

Day of the Week

The Day of the Week function block is used for weekday functions, e.g. Monday, Tuesday.

Direct Day of the Week:

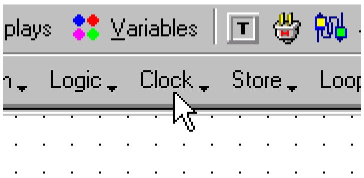
The programmer uses this function to select on which day(s) to activate a task.

If the RTC coincides with a selected day of the week: power will flow through the function block.

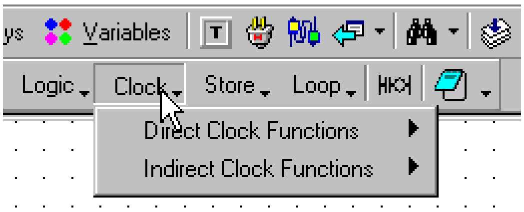
If the RTC does not coincide with a selected day of the week: power will not flow through the function block.

To link a Direct Clock function:

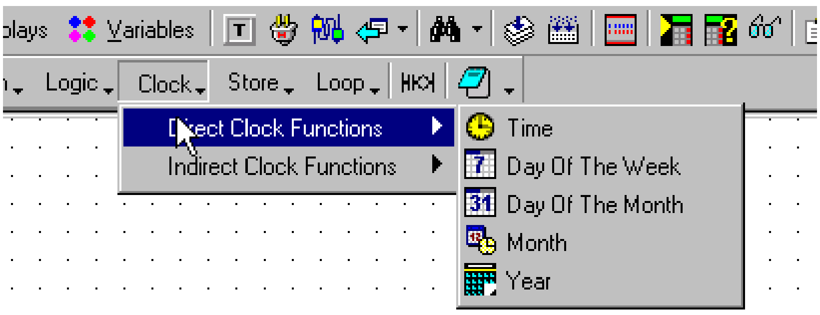
1. Click **Clock** on the Ladder toolbar.



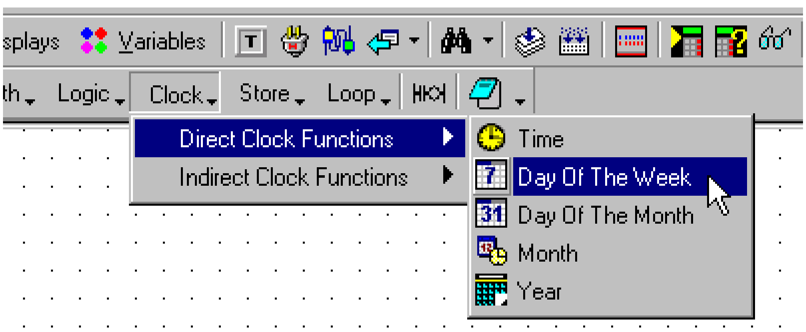
2. The **Clock** drop-down menu opens.



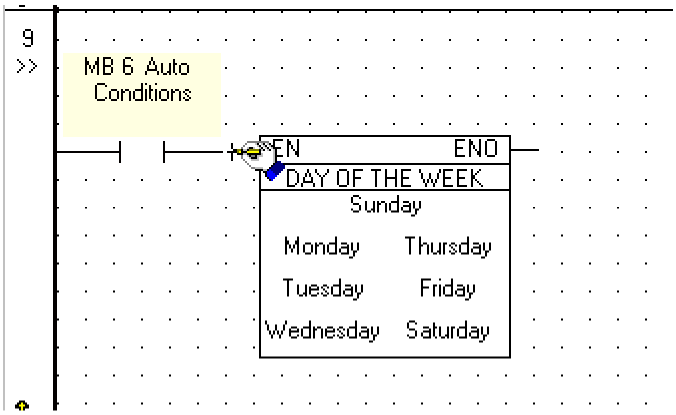
3. Select **Direct Clock Functions**.



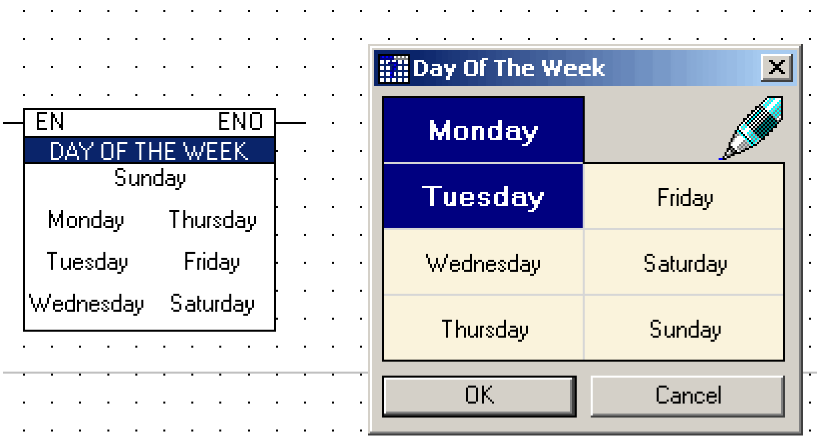
4. Select **Day Of The Week** from the Direct Clock Functions menu.



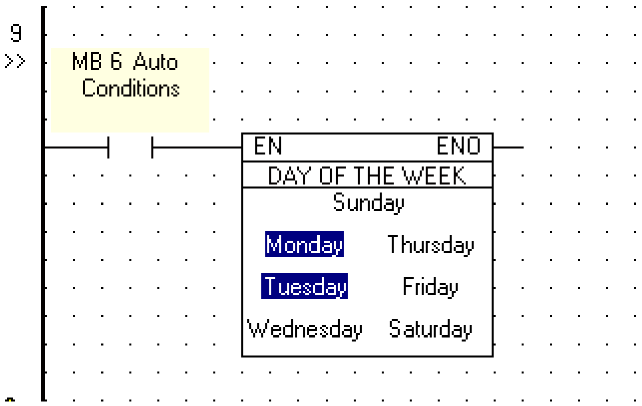
5. Move the **Day of the Week** element to the desired net.



6. Select the desired days from the **Day Of The Week** window and click OK.



7. The selected days appear in blue highlights in the element on the net.



According to the above example, the net result will be true (logic 1) only when MB 6 = 1 **and** on Monday or Tuesday.

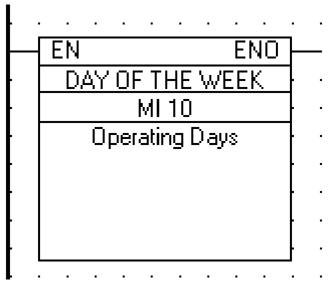
Indirect Day of the Week:

The Indirect Day of the Week function comprises:

- Indirect Day of the Week function block
- Time Function Variable in the Day of the Week format (CW)
- **Display** for entering values

The Indirect Day of the Week function values are entered by the user via the

- **Up** and **Down** scroll arrow keys for scrolling through the days of the week
- **+/-** keys for selecting the desired days of the week
- **Enter** key for confirming selection



The Indirect Day of the Week values are entered into a 7-bit bitmap in the linked MI.

								Sat	Fri	Thu	Wed	Tue	Mon	Sun
								0	1	0	1	0	1	0

According to the above example:

- On Monday, Wednesday and Friday the function block will go to logic "1" (ON).
- On Sunday, Tuesday, Thursday and Saturday the function block will go to logic "0" (OFF).

Day of the Month

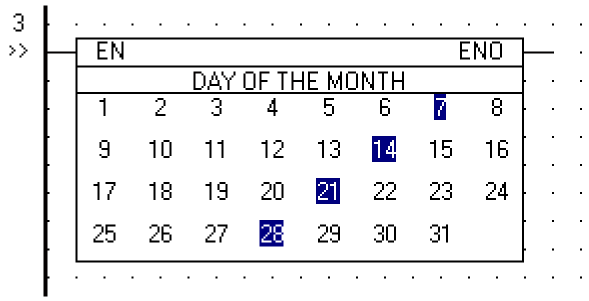
The Day of the Month function block is used for date functions, e.g. 14th and 21st of a month.

Direct Day of the Month:

The Direct Day of the Month function block has thirty-one boxes for the thirty-one possible days of a month.

If the RTC coincides with a selected day of the month: power will flow through the function block.

If the RTC does not coincide with a selected day of the month: power will not flow through the function block.



According to the above example:

- On the 7th, 14th, 21st and 28th the function block's output will be to logic "1" (ON).
- On the other days of the month the function block's output will be logic "0" (OFF).

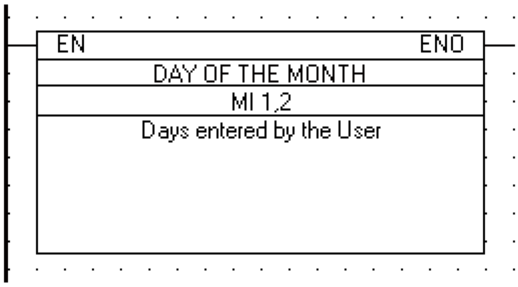
Indirect Day of the Month:

The Indirect Day of the Month function comprises:

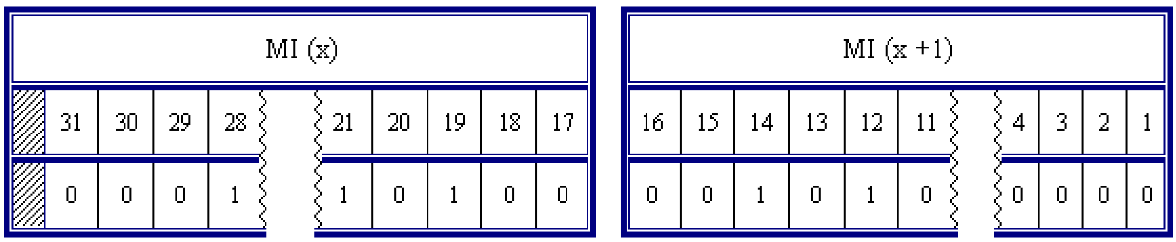
- Indirect Day of the Month function block
- Time Function Variable in Day of the Month format (CD)
- **Display** for entering values

The Indirect Day of the Month function values are entered by the user utilizing

- **Up** and **Down** scroll arrow keys for scrolling through the days of the month
- **+/-** keys for selecting the desired days of the month
- **Enter** key for confirming selection



The Indirect Day of the Month function values are entered into two MIs to create 31-bit bitmap in the linked MIs.



According to the above example:

- On the 12th, 14th, 19th, 21st and 28th of the month the function block's output will be logic "1" (ON).
- On the other days of the month the function block's output will be to logic "0" (OFF).

Year

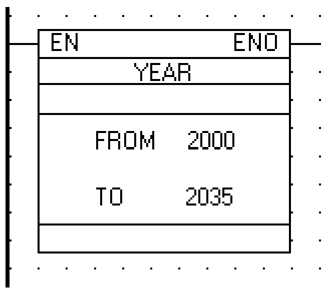
The Year function block is used for yearly time functions.

Direct Year Function:

The Direct Year function block has a 'from' (start) and a 'to' (end) year set by the programmer.

If the RTC is within these two years: power will flow through the function block.

If the RTC is not currently within these two years: power will not flow through the function block.



According to the above example:

- Between the years 2000 - 2035 the function block will go to logic "1" (ON).
- With the year 2036 the function block will go to logic "0" (OFF).

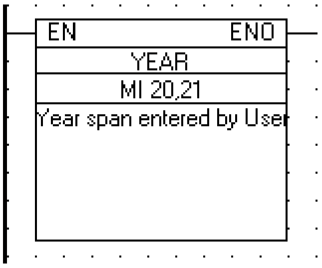
Indirect Year Function:

The Indirect Year function block is linked to two consecutive MIs or SIs. These integer values are entered by the user via the keypad.

If the RTC is within these two times: power will flow through the function block.

If the RTC is not currently within these two times: power will not flow through the function block.

You must create a **Time Function Variable** in Year (CY) format for the user to enter the start and end years.

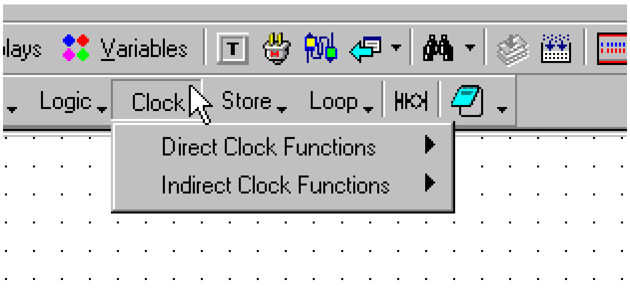


Direct Clock function example

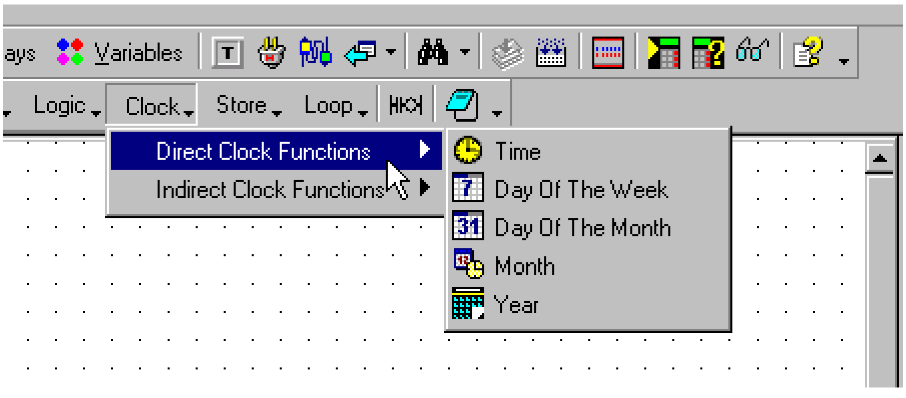
You want to create a project where a machine is working

- in January and March
- beginning on the 12th day of a month, until and including the 20th
- in the years 2000 and 2001
- between the hours 10:30 and 12:15.

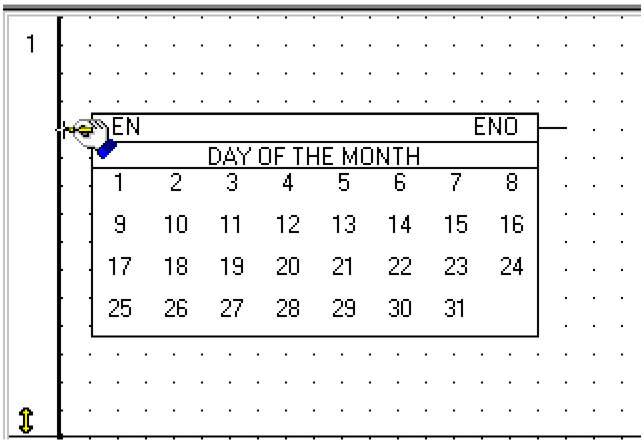
1. Click **Clock** on the Ladder toolbar.



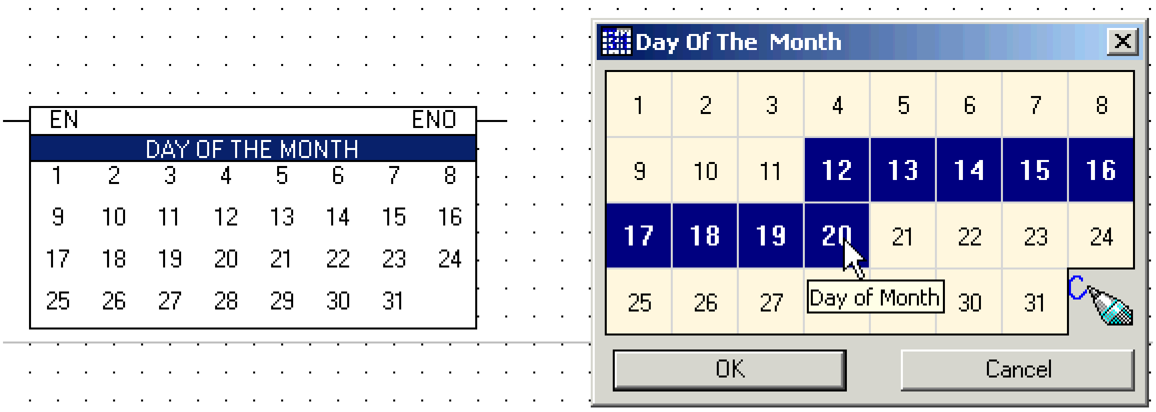
2. Select **Direct Clock Functions**. The Direct Clock Functions menu opens.



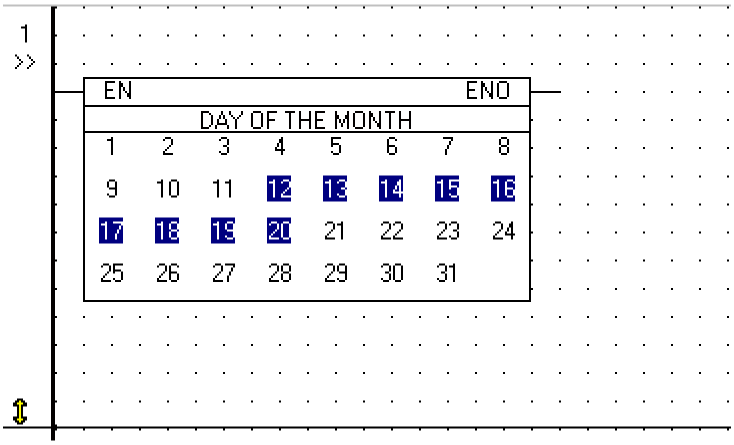
3. Select **Day of the Month** and place it in the desired place on the net.



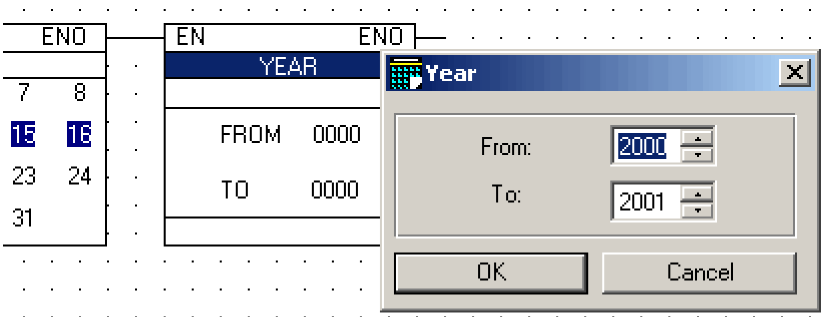
4. The Day of the Month menu opens.
5. Click the desired days of the month.



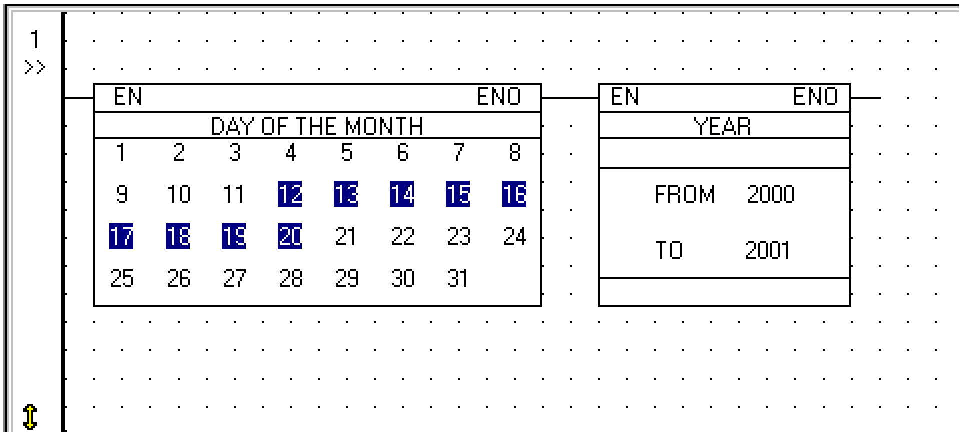
6. The **Days of the Month** function appears on the net with the selected days of the week highlighted.



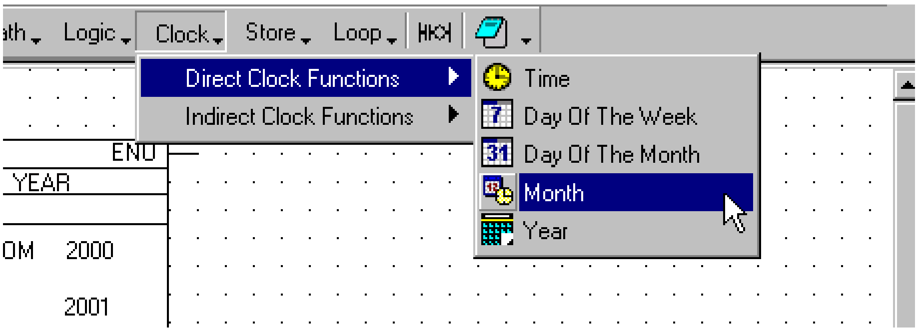
7. Select the **Year** function. The Year menu opens.
8. Enter the desired **Year** range.



9. The Year function appears with the desired values.

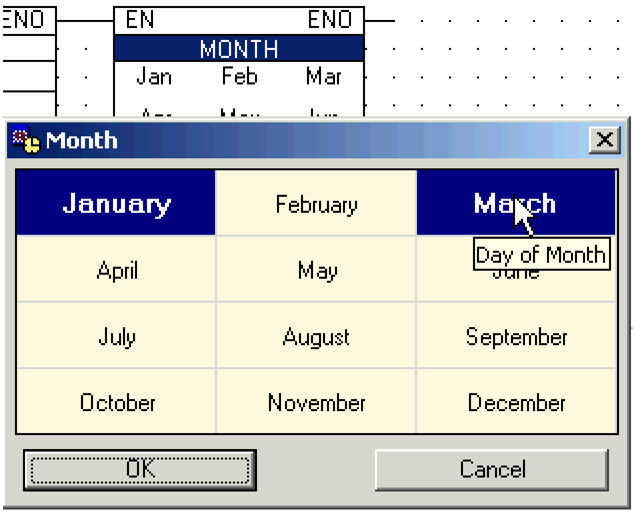


10. Select **Month** on the **Direct Clock Functions** menu.

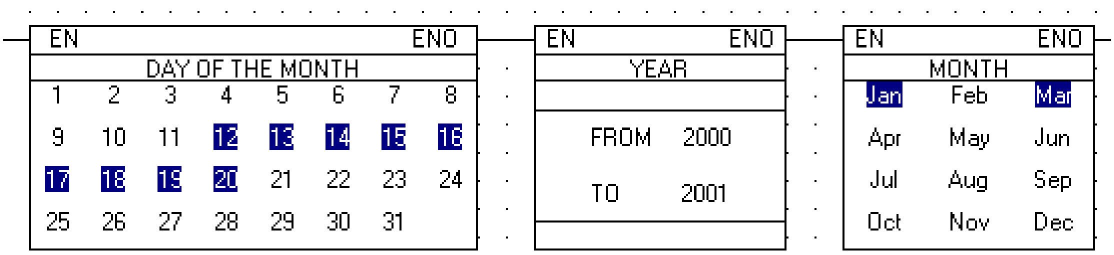


10. The **Month** menu opens.

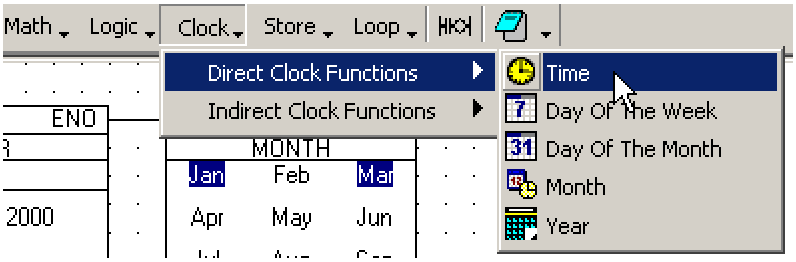
11. Select the desired Months. Click OK.



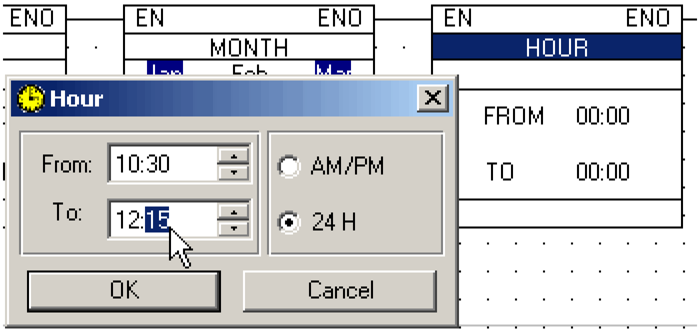
12. The **Month of the Year** function appears with the desired Months highlighted.



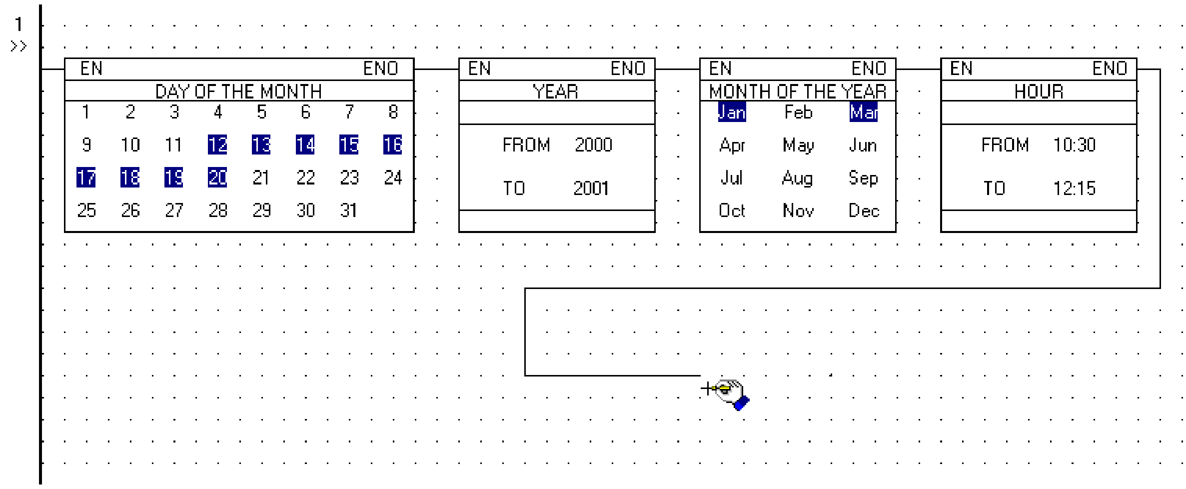
13. Select **Time** from the Direct Clock Functions menu.



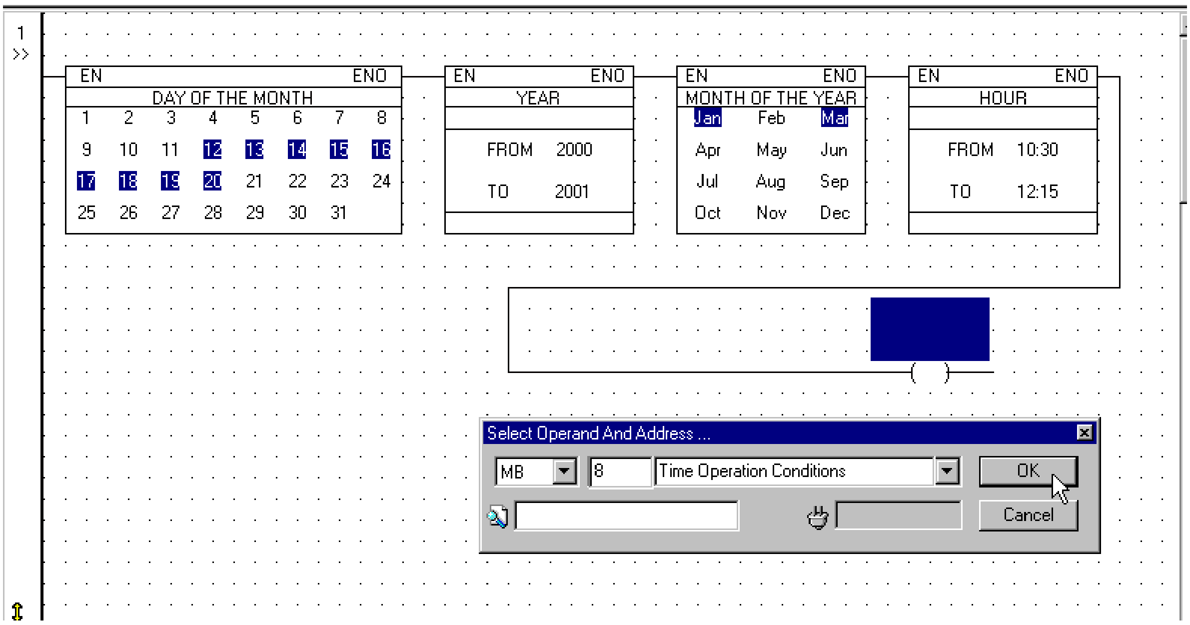
14. Enter the desired Time range in the **Hour** menu. Click OK.



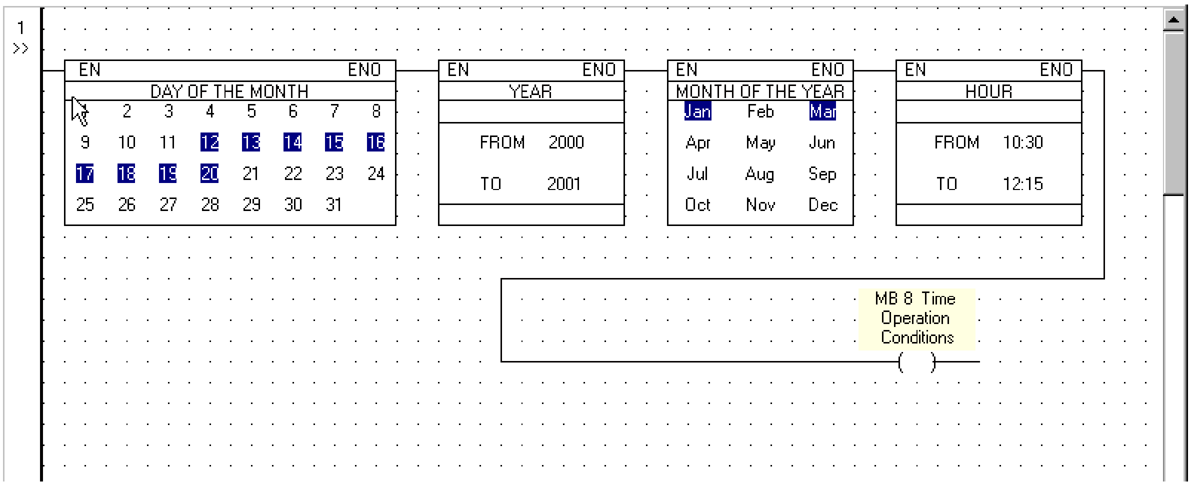
15. Expand the net rung as needed in the net using the **Line Draw** tool.



16. Select and place a Direct Coil on the net. Enter the desired Operand, Address and Symbol.



17. The net appears as shown below.



Indirect Clock function

Indirect Clock functions allows the programmer to write a Ladder program where the user will enter the time value via the keypad. Functions are provided for:

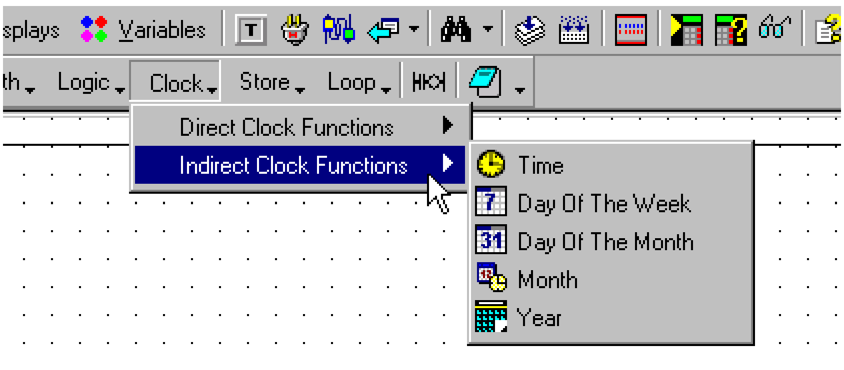
- Indirect Time of Day
- Indirect Day of Week
- Indirect Day of Month
- Indirect Month
- Indirect Year

These functions are located on the **Clock** drop-down menu of the Ladder toolbar.

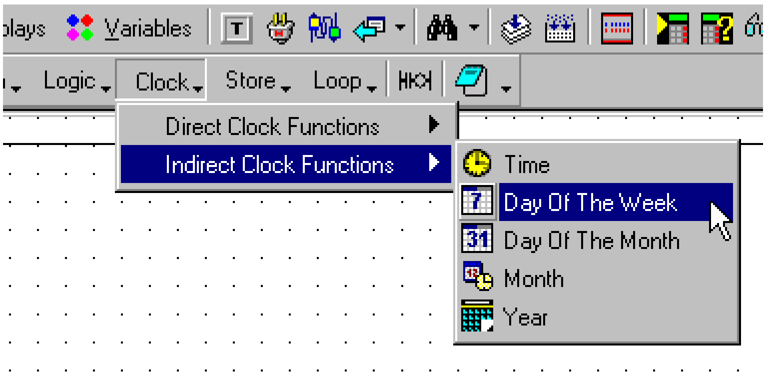
Indirect Day of Week function

This example shows you how to create a project where a machine works according to a time that the user enters via the keypad.

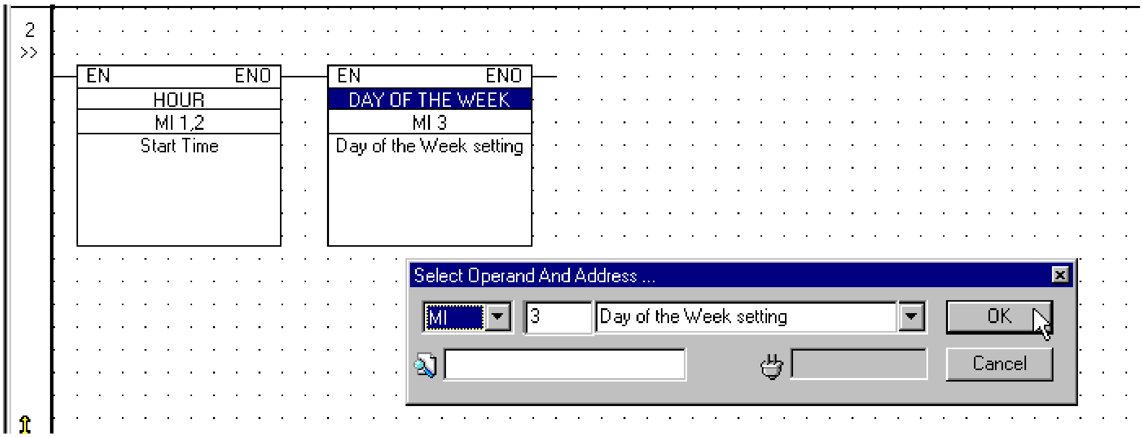
1. Select **Indirect Clock Functions** from the Clock menu of the Ladder toolbar.



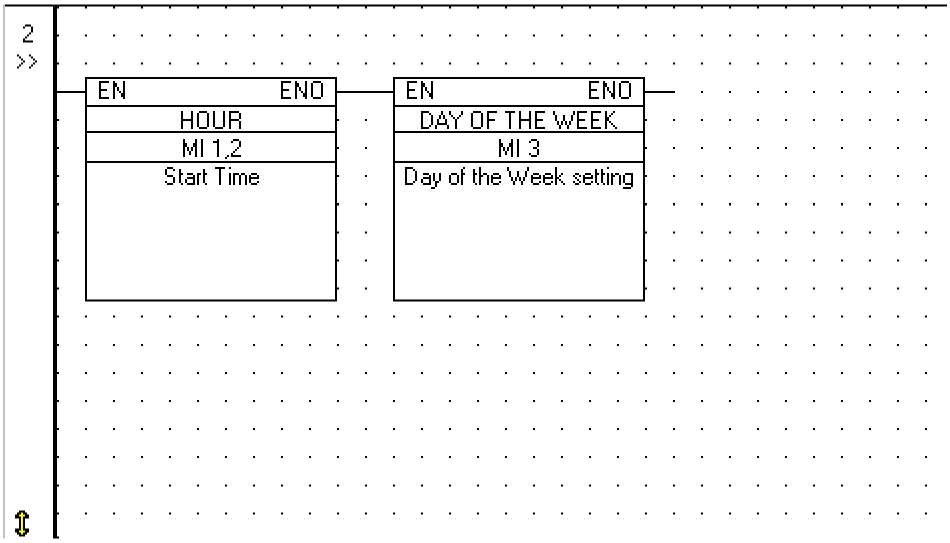
2. Select **Day Of The Week** from the **Indirect Clock Function** menu.



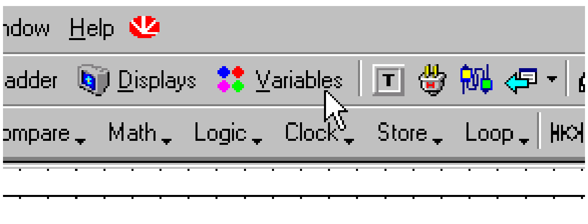
3. Place the **Day Of The Week** function on the desired net. Enter the desired Operand, Address and Symbol.



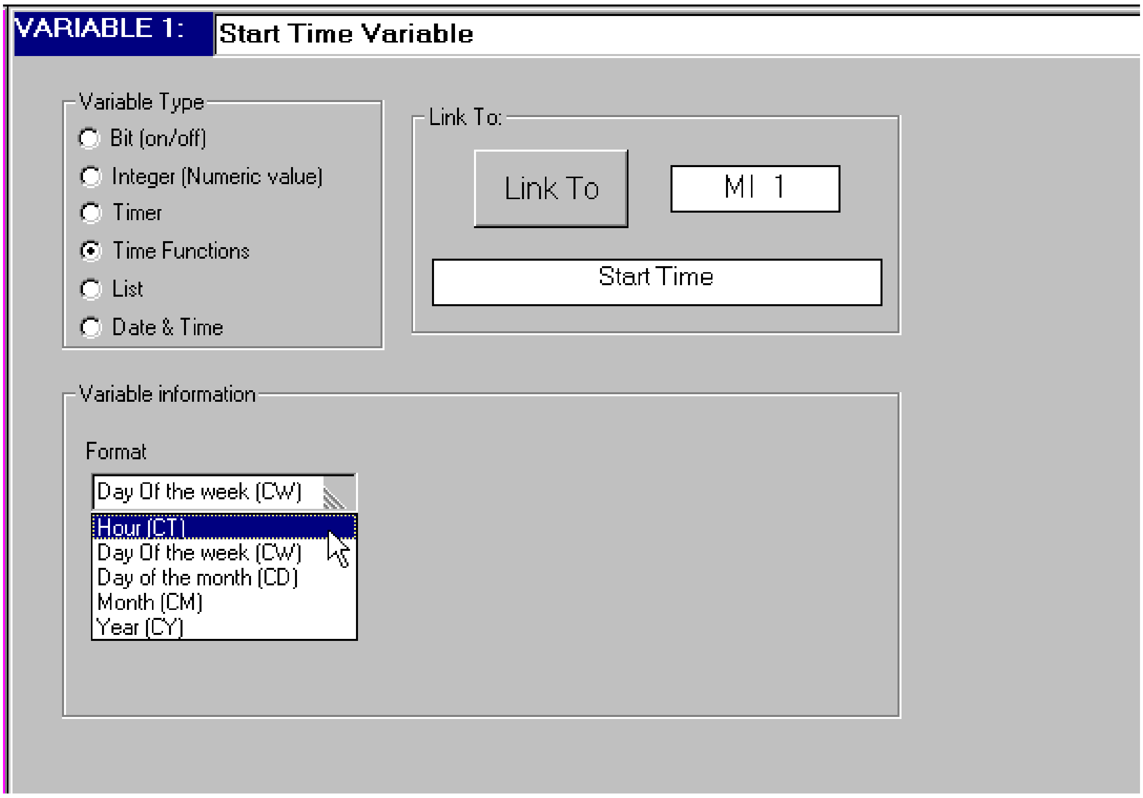
4. The **Day Of The Week** function appears with the selected Operand, Address and Symbol on the net.



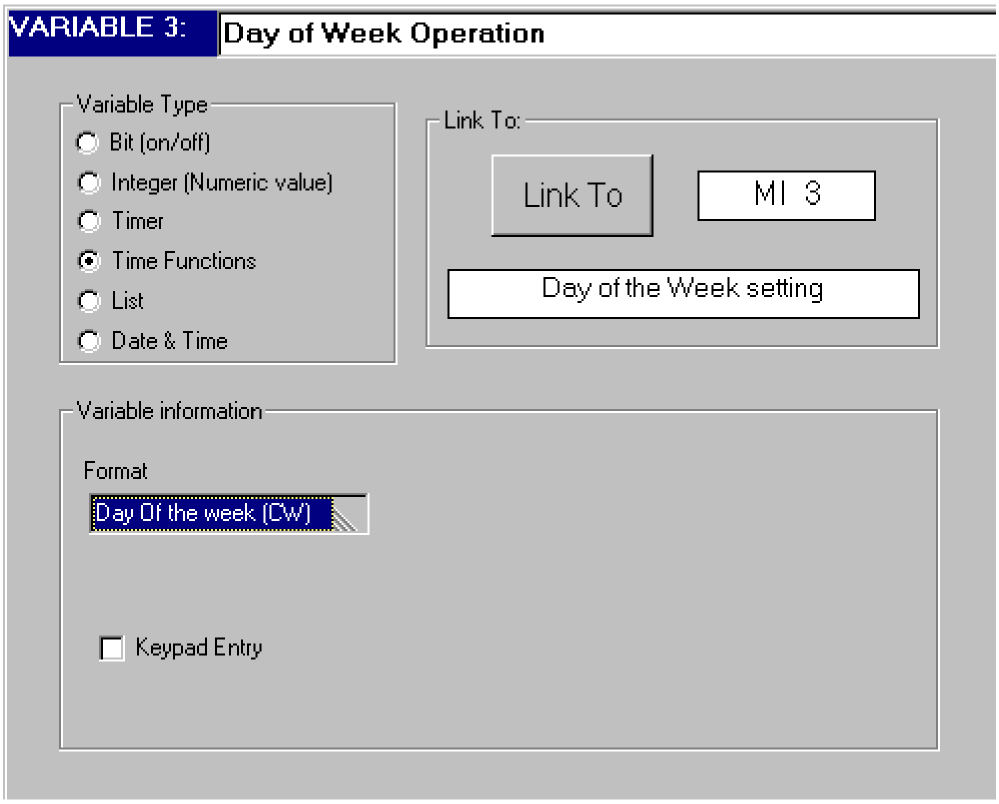
5. To enable the user to view and modify the Indirect Clock function values, you must now create HMI Displays and Variables. Click **Variables** on the Standard toolbar.



6. The Variable Editor opens. Select **Time Functions** for each Variable. Link the Variable to the appropriate MI. Select the appropriate Variable Information Format for the time. Below is the Start Time Variable for the time in hours.



7. The Day of the Week Variable.



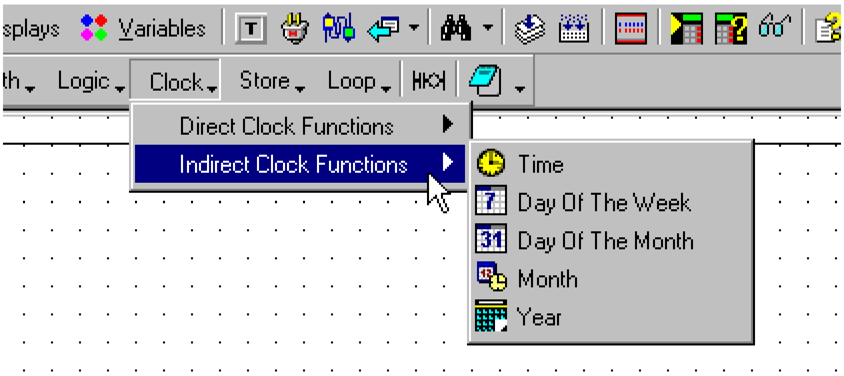
When you download the application to the controller, the user will use the Up/Down arrow keys to scroll through the days of the week. When the display shows the correct day, the user selects it by pressing the Enter key.

Note that in M90/91 controllers the Up key is numeric key 3, and the Down key is numeric key 6.

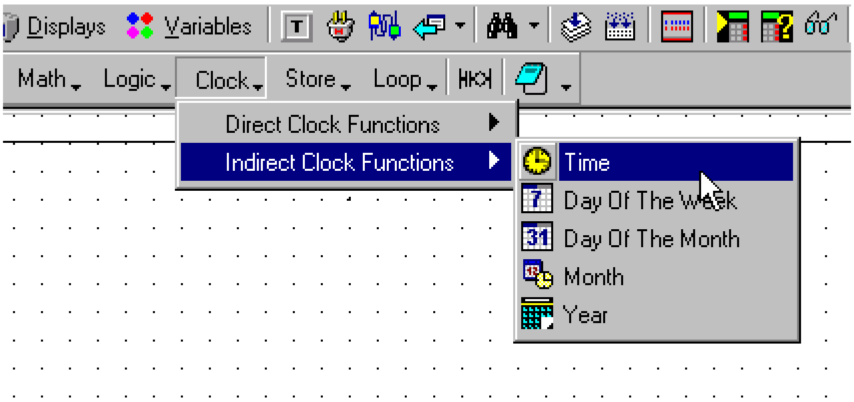
Indirect Clock function example

This example shows you how to create a project where a machine is working according to a time and date entered by the user via the keypad.

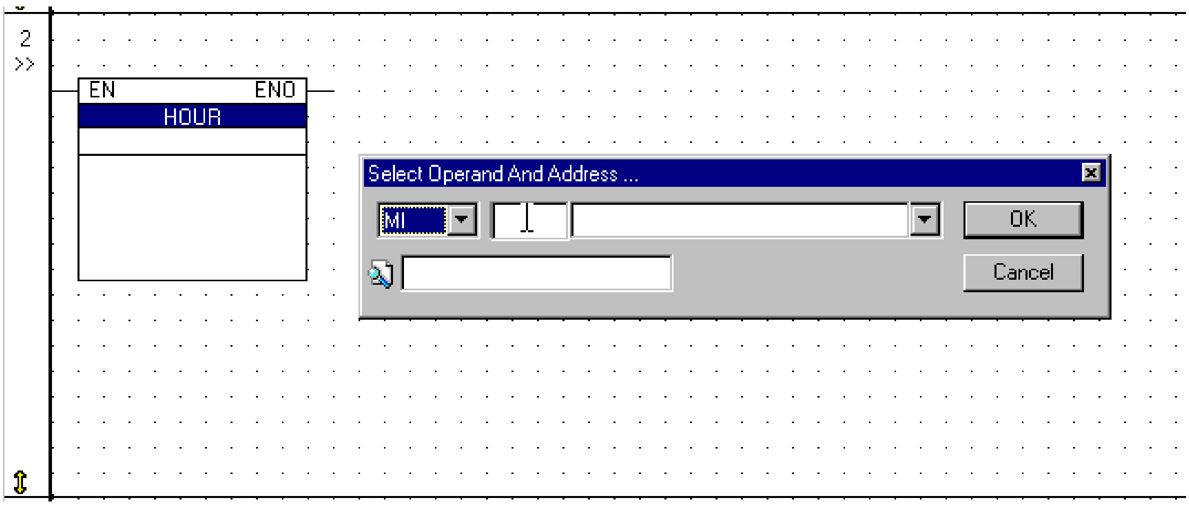
1. Select **Indirect Clock Functions** from the Clock menu of the Ladder toolbar.



2. Select **Time** from the Indirect Clock Functions menu.

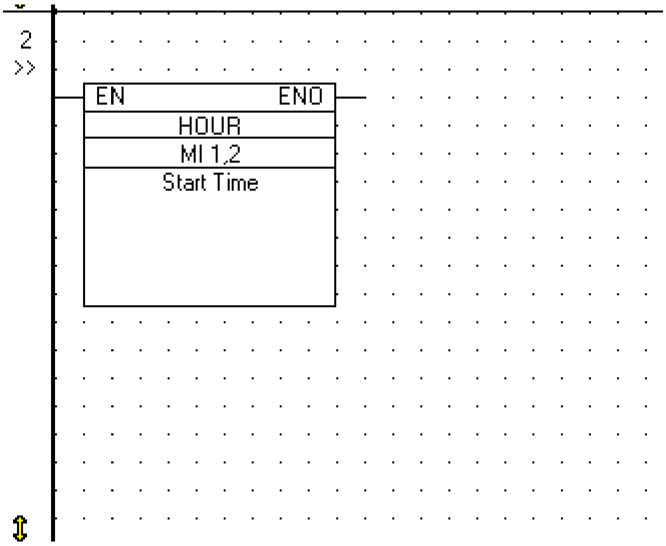


3. Enter the desired Operand, Address and Symbol.

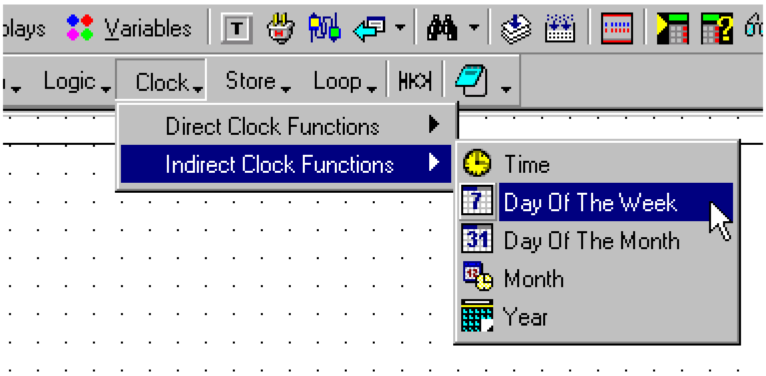


4. The Hour function appears with the selected Operand and Address. Note that the hour function is checking a range between two MIs / SIs. Therefore, two Operands are needed: the beginning and the end of the range.

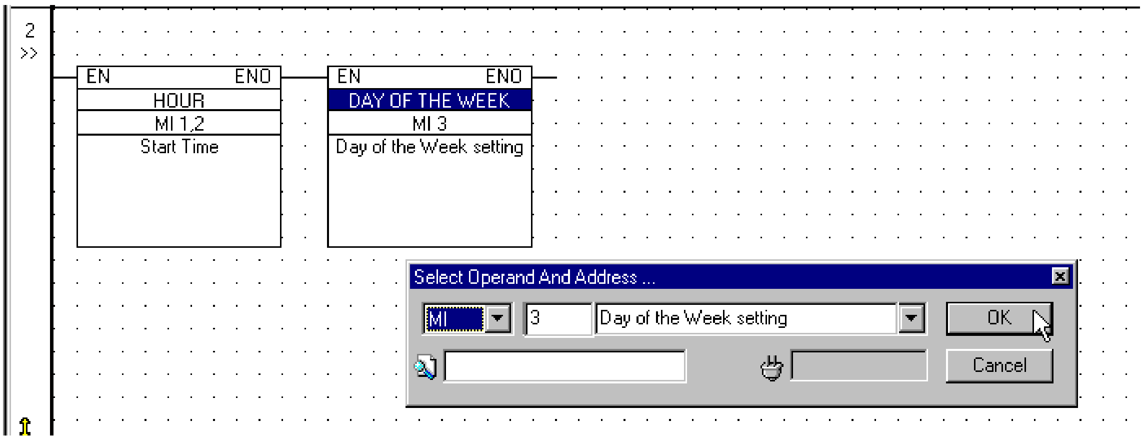
The program automatically takes the **next** Operand from the one you enter. According to the following example, you enter MI 1 and the program assigns the end of the range to MI 2, the **next** MI.



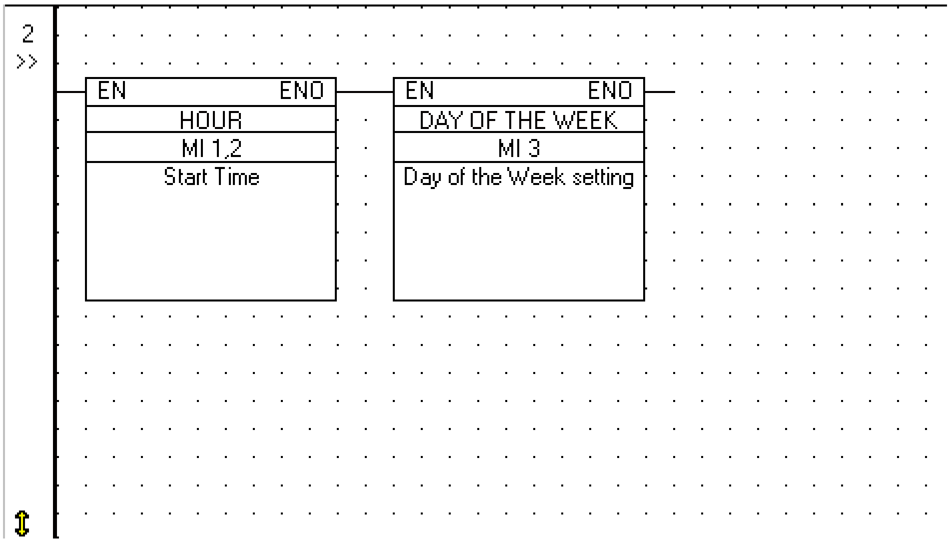
5. Select **Day Of The Week** from the **Indirect Clock Function** menu.



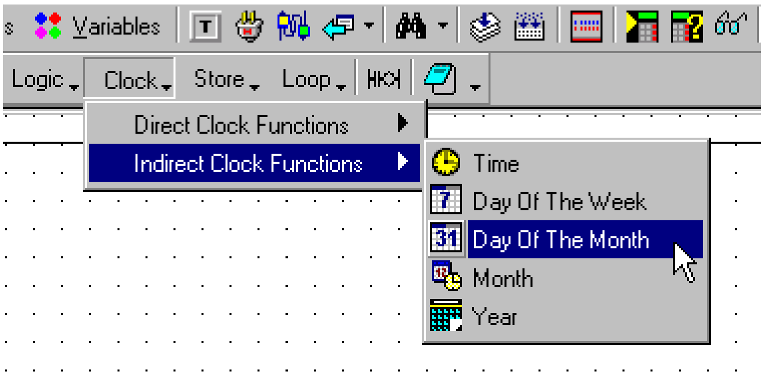
6. Place the **Day Of The Week** function on the desired net. Enter the desired Operand, Address and Symbol.



7. The **Day Of The Week** function appears with the selected Operand, Address and Symbol on the net.

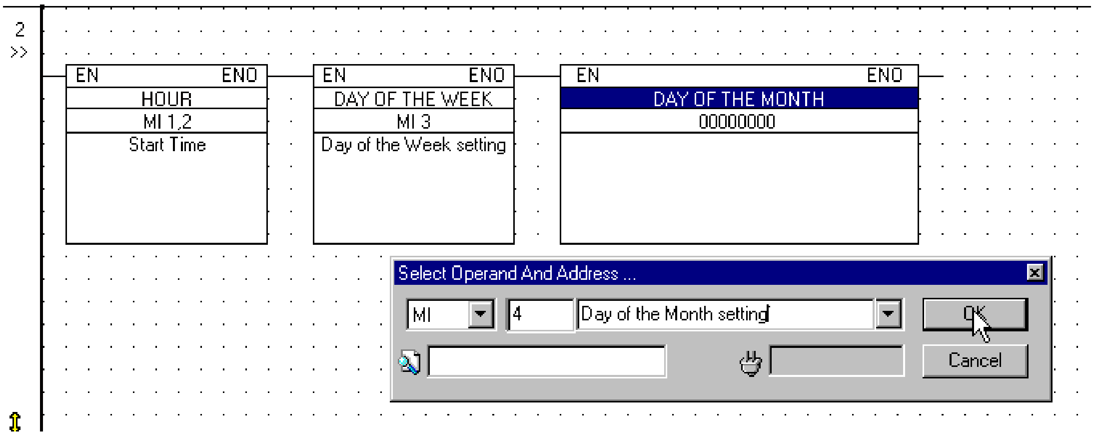


8. Select **Day of the Month** from the **Indirect Clock Function** menu.

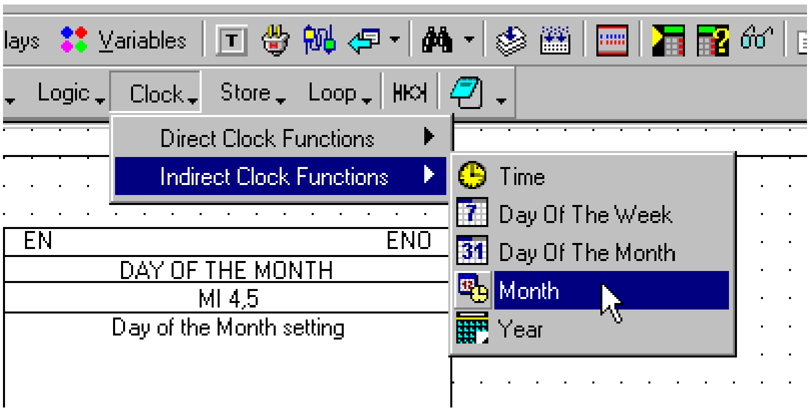


9. Enter the desired Operand, Address and Symbol. The Day of the Month function is a 32 - bit Bit map. Therefore it requires two MIs / SIs.

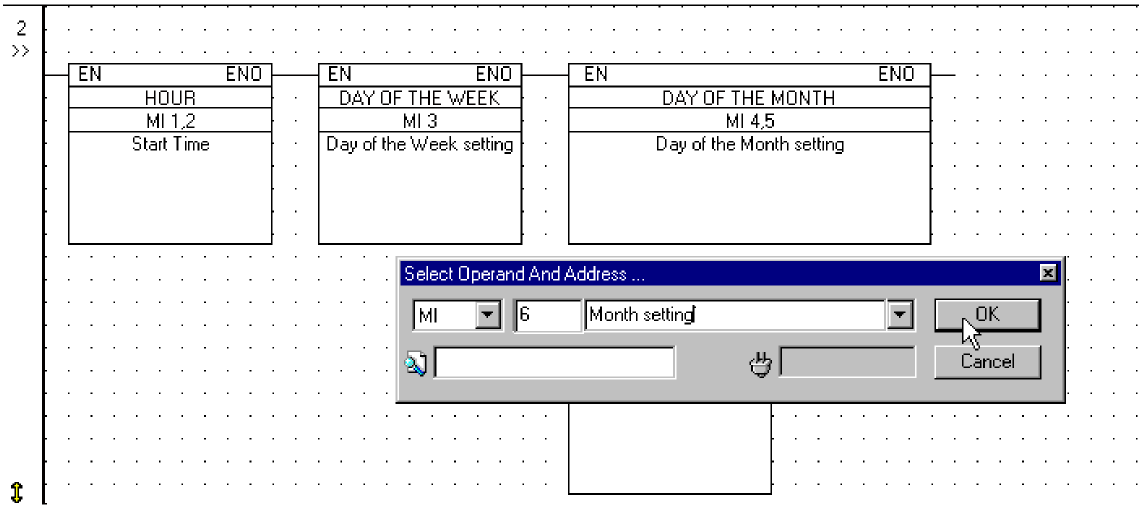
The program automatically takes the **next** Operand from the one you enter. According to the following example, you enter MI 4 and the program assigns the end of the range to MI 5, the **next** MI.



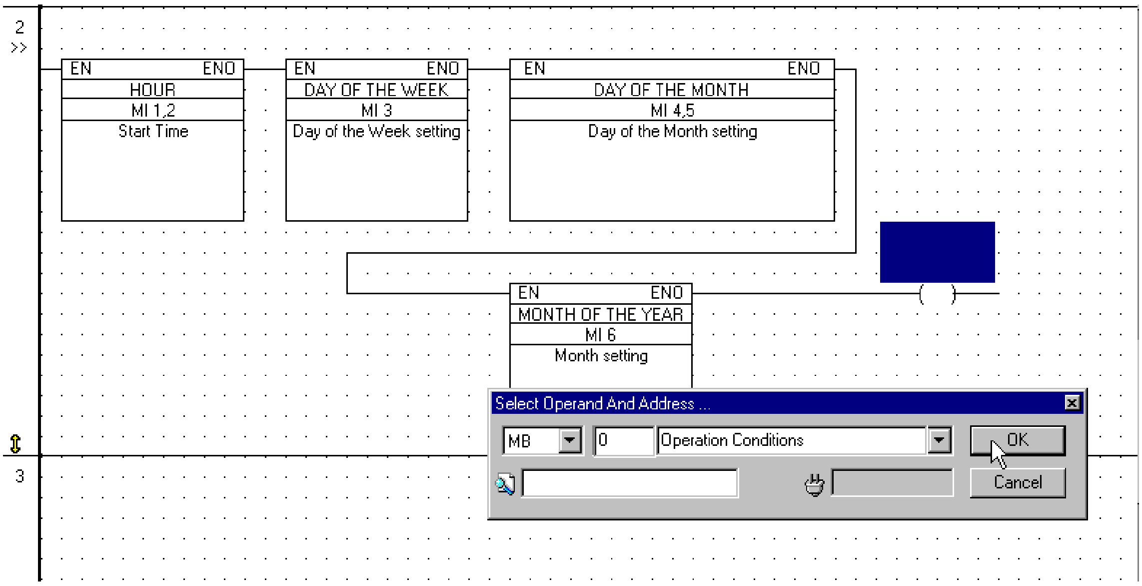
10. Select **Month** from the Indirect Clock Functions menu.



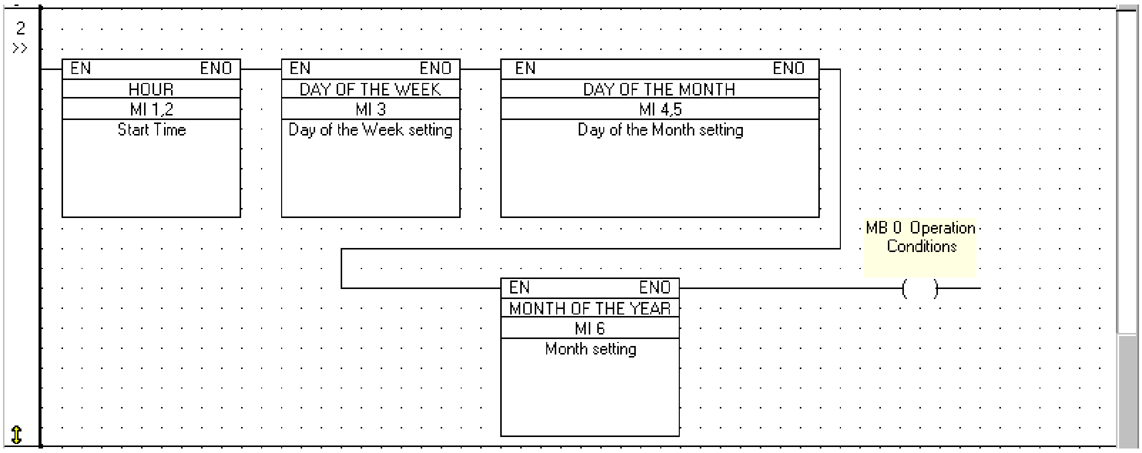
11. Enter the desired Operand, Address and Symbol.



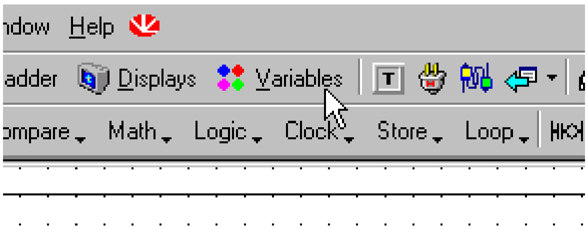
12. Place a **Direct Coil** at the end of the rung. Enter the desired Operand, Address and Symbol.



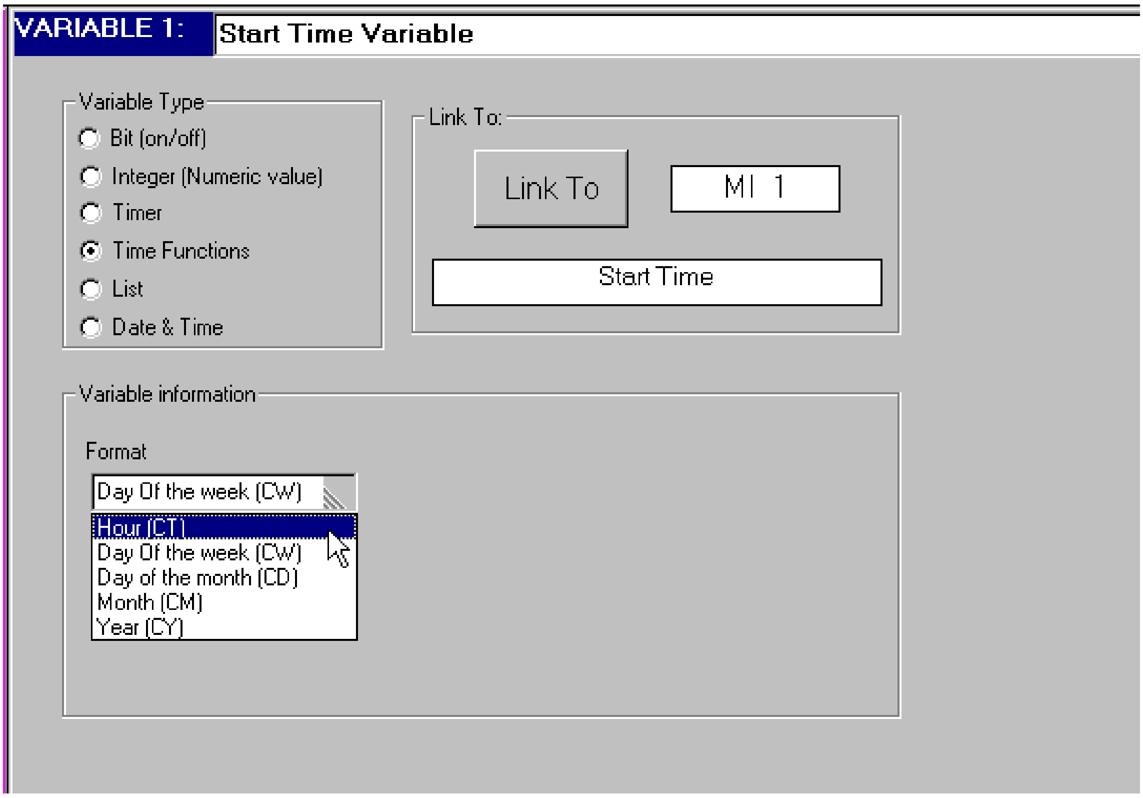
13. The net appears as shown in the next figure.



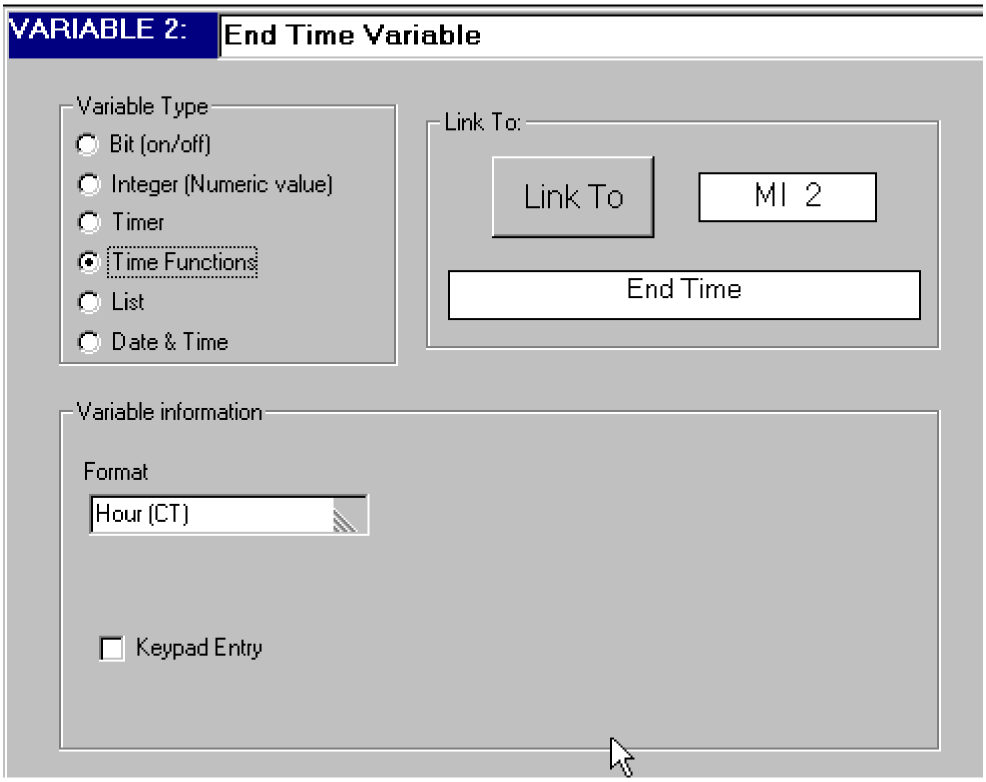
14. To enable the user to view and modify the Indirect Clock function values, you must now create HMI Displays and Variables. Click **Variables** on the Standard toolbar.



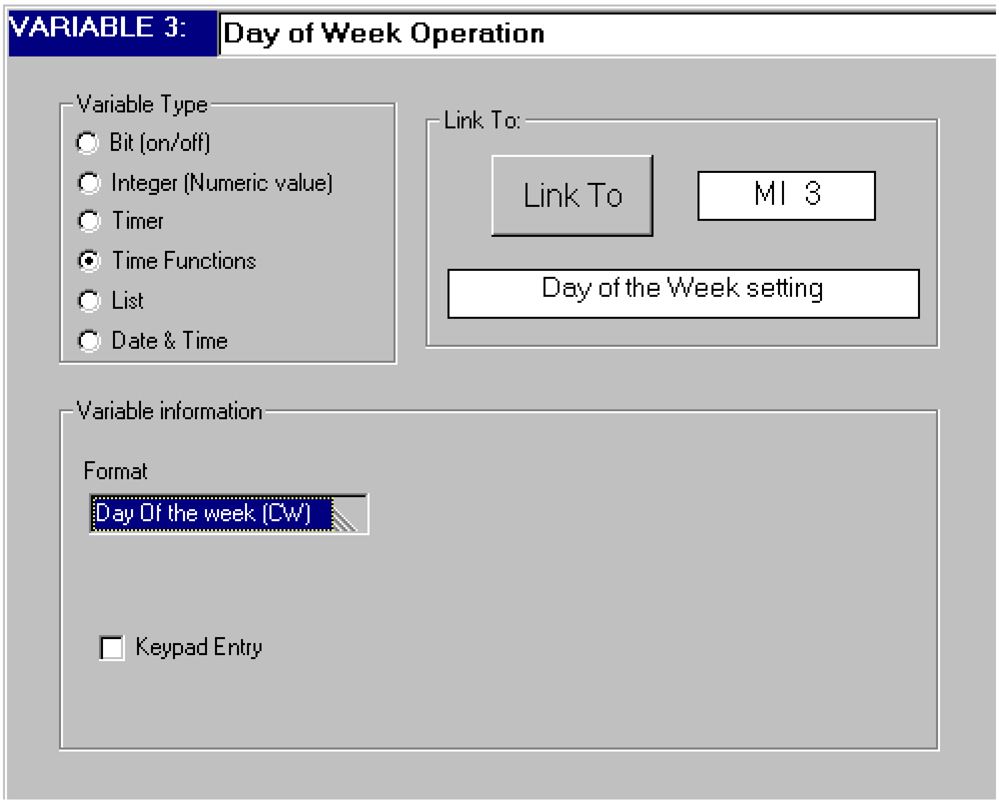
15. The Variable Editor opens. Select **Time Functions** for each Variable. Link the Variable to the appropriate MI. Select the appropriate Variable Information Format for the time. Below is the Start Time Variable for the time in hours.



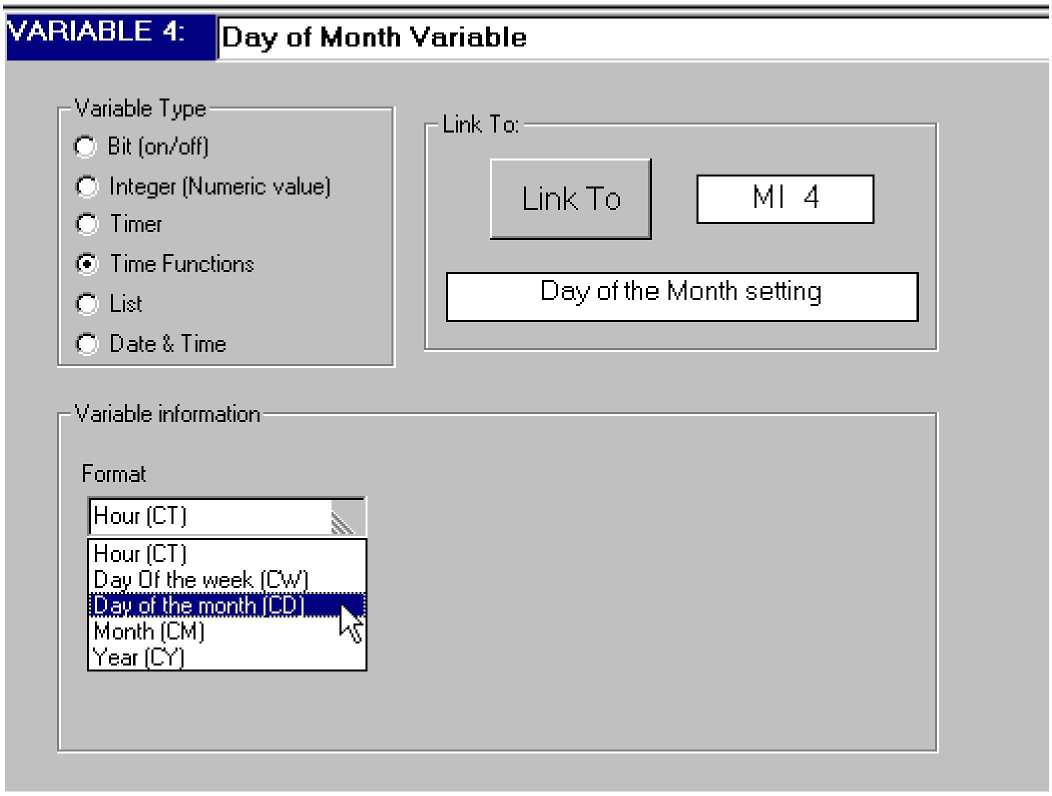
16. The End Time Variable for the time in hours.



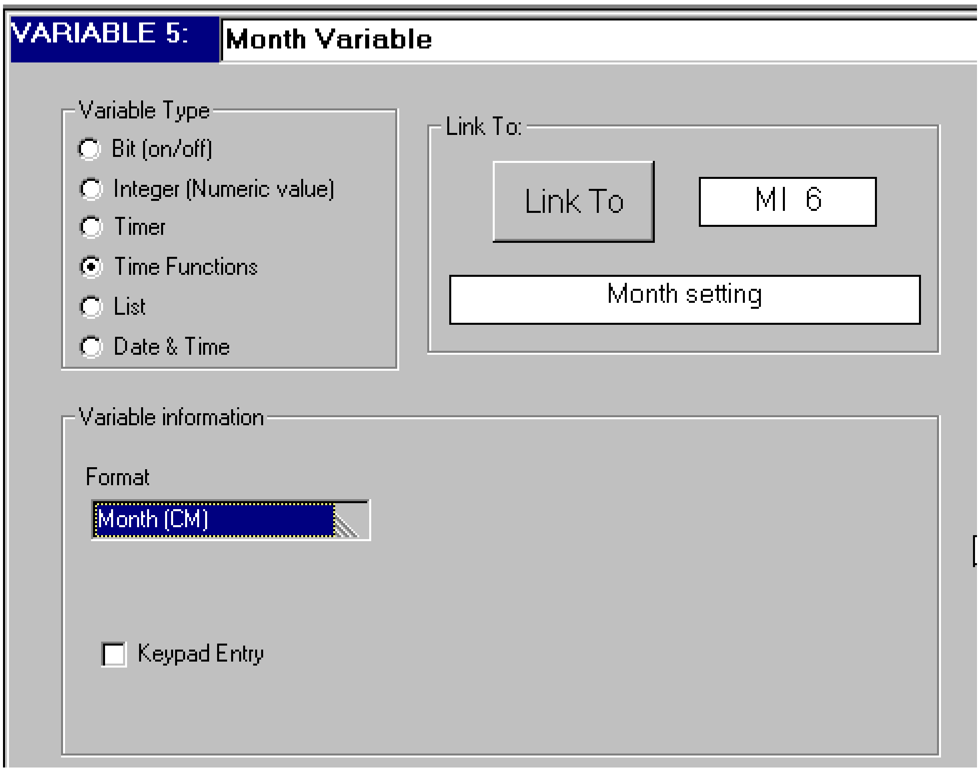
17. The Day of the Week Variable.



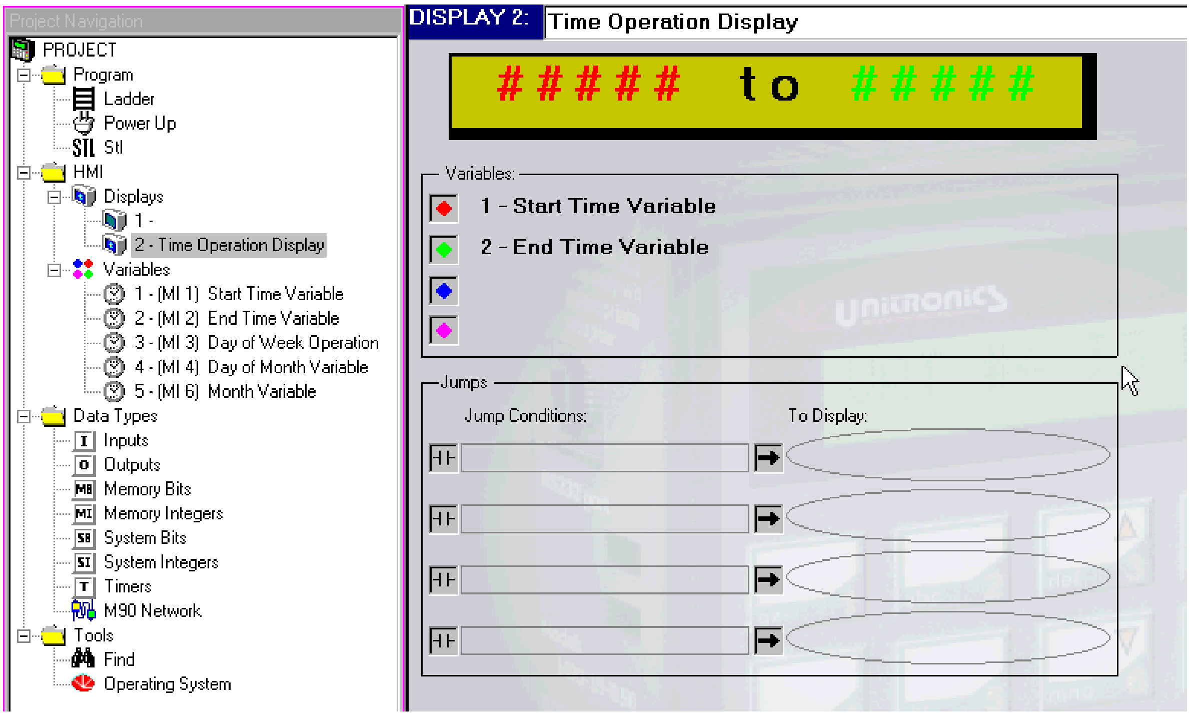
18. The Day of Month Variable.



19. The Month Variable.



20. Create the Displays for the Variables. Below is an example for viewing the time range in hours.



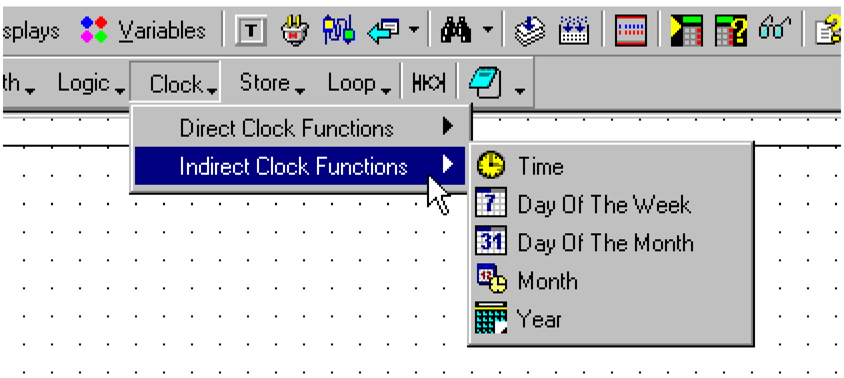
When you download the application to the controller, the user will use the Up/Down arrow keys to scroll through the days of the week, days of the month and month. When the display shows the correct day, the user selects it by pressing the Enter key.

Note that in M90/91 controllers the Up key is numeric key 3, and the Down key is numeric key 6.

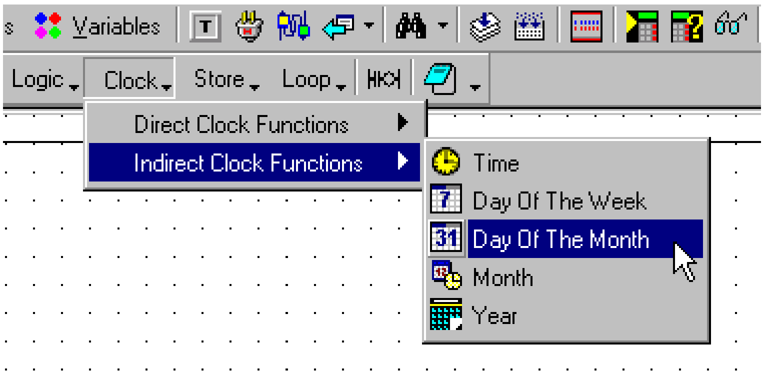
Indirect Day of Month function

This example shows you how to create a project where a machine works according to a time entered by the user via the keypad.

1. Select **Indirect Clock Functions** from the Clock menu of the Ladder toolbar.

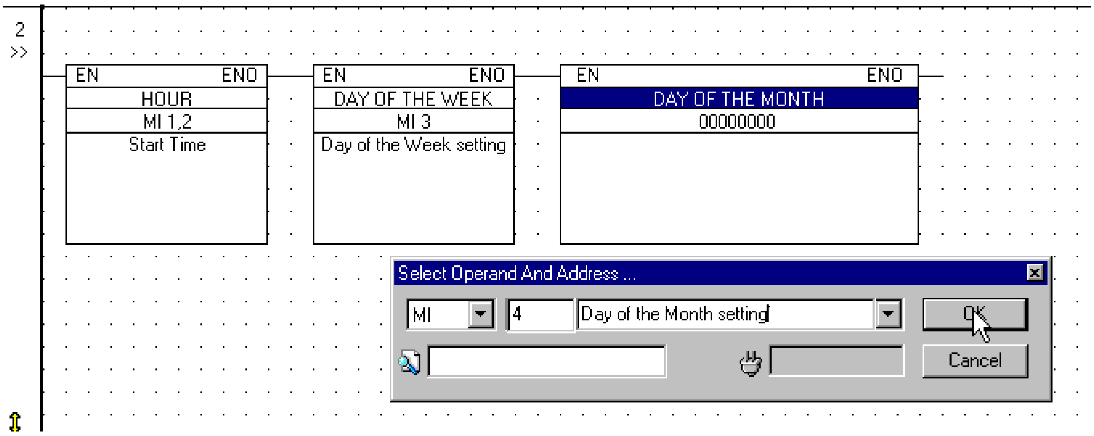


2. Select **Day of the Month** from the **Indirect Clock Function** menu.

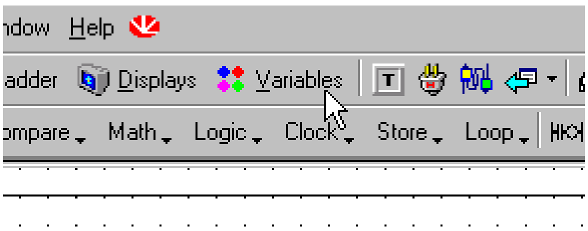


3. Enter the desired Operand, Address and Symbol. The Day of the Month function is a 32 - bit Bitmap. Therefore it requires two MIs / SIs.

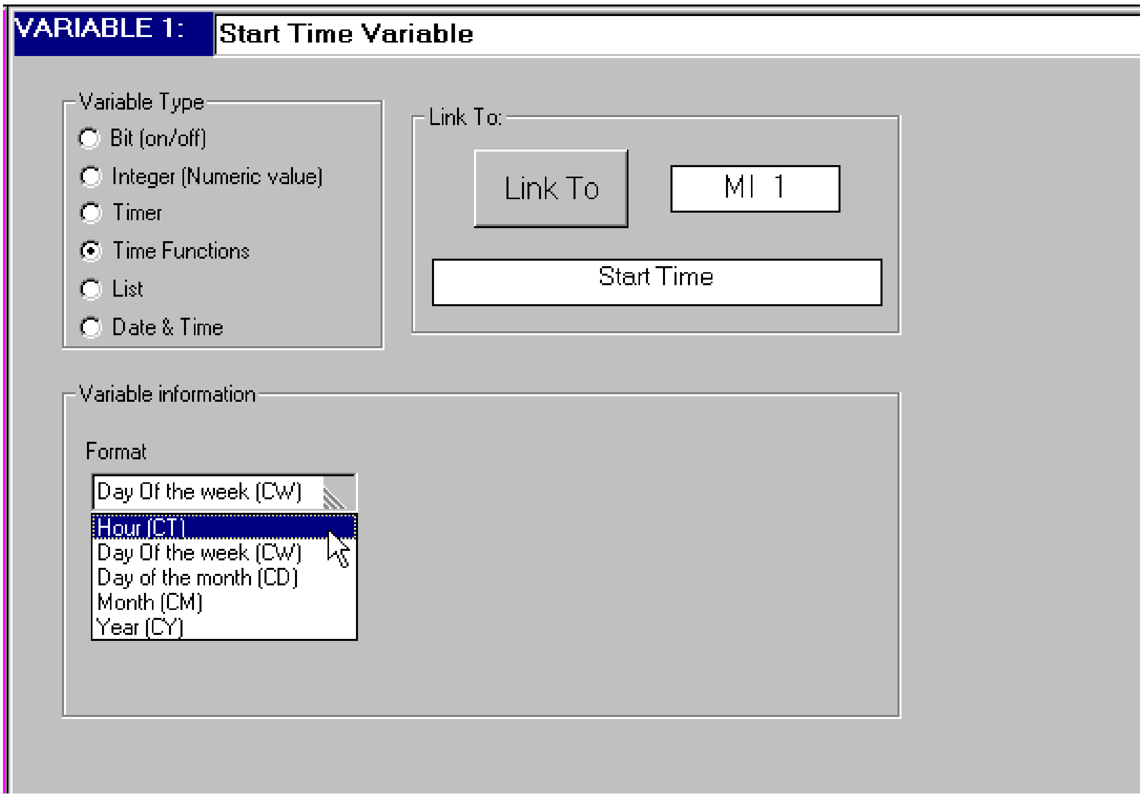
The program automatically takes the **next** Operand from the one you enter. According to the following example, you enter MI 4 and the program assigns the end of the range to MI 5, the **next** MI.



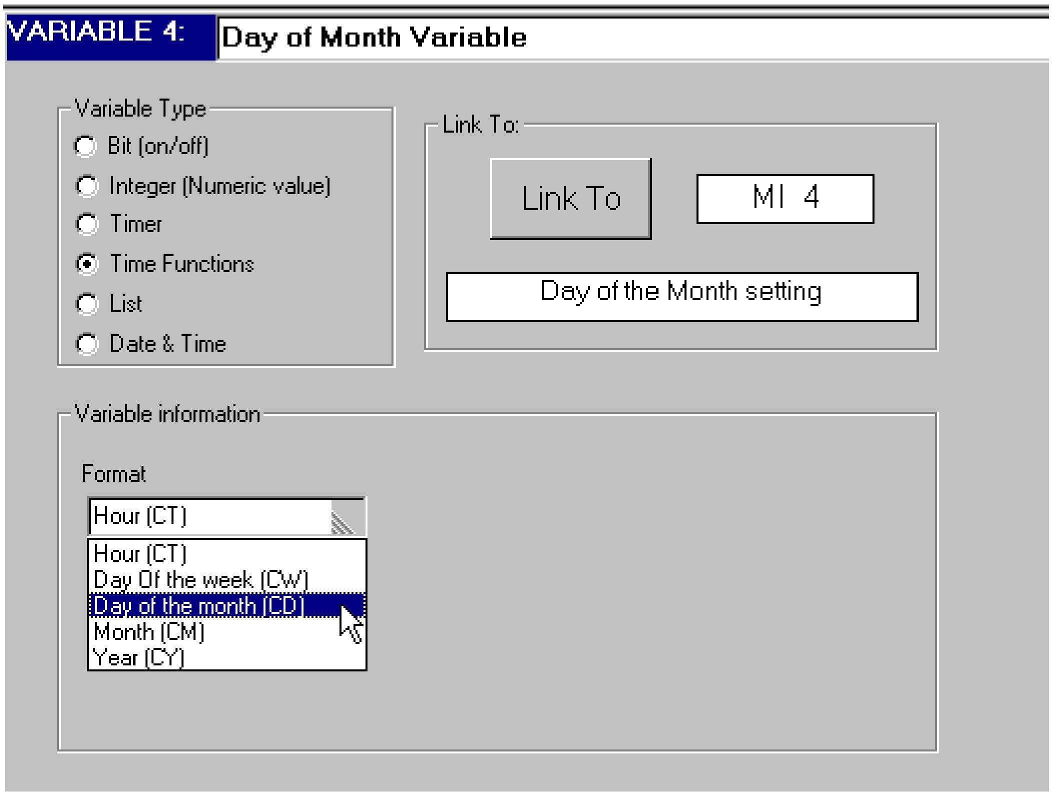
4. To enable the user to view and modify the Indirect Clock function values, you must now create HMI Displays and Variables. Click **Variables** on the Standard toolbar.



5. The Variable Editor opens. Select **Time Functions** for each Variable. Link the Variable to the appropriate MI. Select the appropriate Variable Information Format for the time. Below is the Start Time Variable for the time in hours.



6. The Day of Month Variable.



When you download the application to the controller, the user will use the Up/Down arrow keys to scroll through the days of the month. When the display shows the correct day, the user selects it by pressing the Enter key.

Note that in M90/91 controllers the Up key is numeric key 3, and the Down key is numeric key 6.

Special Functions: without Elements

Special Functions (Via SBs & SIs) List

Click on the function name to view a Help topic containing specific instructions on how to implement the function.

Special Functions: without Ladder elements

U90Ladder contains special functions that are not represented by Ladder Elements. You can perform these functions by storing values into the System Integers listed here.

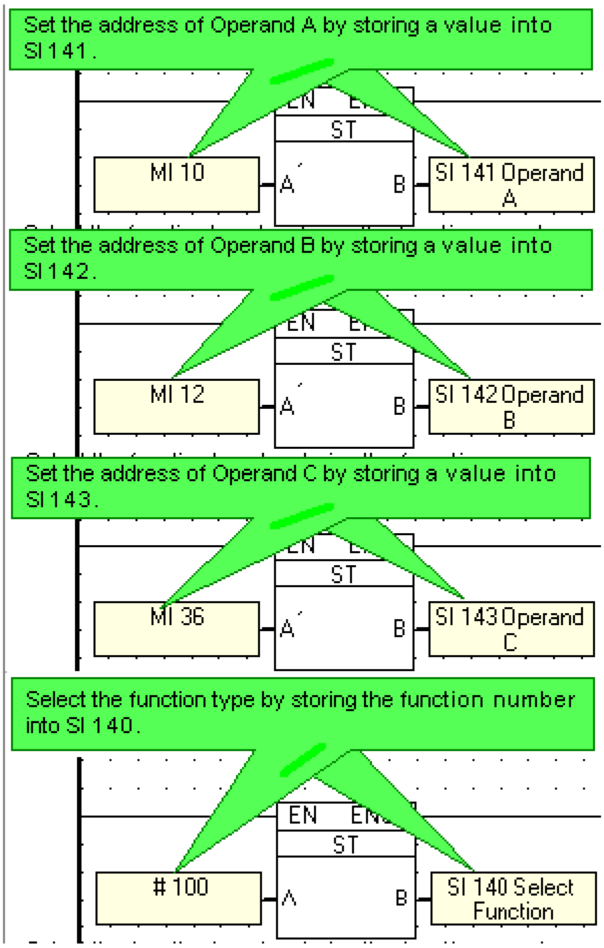
To implement a special function:

1. Store the parameters of the function in the relevant SI function operands.
2. Store the command number into SI 140.

Note that the command number must be stored into SI 140 **after** the parameters are stored into the operands.

SI	Description
140	Function Number
141	Function Operand #1
142	Function Operand #2
143	Function Operand #3
144	Function Operand #4
145	Function Operand #5
146	Function Operand #6
146	Function Operand #7

The example below shows the function A*B/C, which enables the PLC to multiply 2 operand values & divide the product by a third operand.



Function # (SI 140)	Description
100	Multiply A x B, Divide by C

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Functions activated by SI 140

Function Name	**Description**	**Parameters**	**Execute Function, Store into SI140**
A*B/C	Enables PLC to multiply 2 operand values & divide the product by a third operand.	• SI 141 Operand A (multiplicand). • SI 142 Operand B (multiplicand), • SI 143 Operand C (divisor).	• 100
Change COM Port Parameters	Enables you to change the serial communication port default settings for M91 controllers. M90 models do not support this function.	• SI 141 Baudrate • SI 142 Data bits • SI 143= Parity e • SI 144 Hardware flow control • SI 145 = Timeout 10ms units • SI 146 = Stop bits SB 141 indicates whether the COM port has been successfully initialized with the new parameters successfully: 1 = success, 0 =fail	SI 140: 310
Communication Utility	Enables PLC to receive data from external devices, such as bar-code readers, via an RS232 port.	• SI 141 STX • SI 142 ETX • SI 143 ETX Length or Silent • SI 144 Maximum Length	• 300 Additional Functions: • Set SB 61 to Copy Data in Receive Buffer to Vector

		• SI 145 Start Address: Receive Buffer • SI 60 # of Bytes currently in Receive Buffer • SI 61 # of Bytes in Receive Buffer when SB 60=1 • SI 146 Copy Data: Format • SB 60 Data Successfully Received	• Set SB 62 to Clear Receive Buffer, Clear SI 60, Clear SI 61,& Reset SB 60
Copy Vector	Sets a vector, copies source values, then writes those values into a corresponding target vector.	• SI 141 Source Vector • SI 142 Vector Length • SI 143 Target Vector	• Copy MIs to MIs: 20 • Copy MIs to DBs: 21 • Copy DBs to MIs: 22 • Copy DB to DB: 23
Copy vector of MBs	Sets an MB vector, copies source values, then writes those values into a corresponding target MB vector.	• SI 141 Source MB Vector • SI 142 Target Vector • SI 143 Vector Length	• 24
Fill Vector	Copies a source value, then write that value into every operand within the target vector.	• SI 141 Start of Target vector, • SI 142 Length of Target vector, • SI 143 Fill Value; register whose value will be written into each register within the target vector	• Fill MI vector: 30 • Fill DB vector: 31 • Fill MB vector: 36
Set bit in MI vector	Sets a bit within an MI vector	• SI 141 Start of MI vector, • SI 142 Location of bit to be set within vector (offset)	• 37
Reset bit in MI vector	Resets a bit within an MI vector	• SI 141 Start of MI vector, • SI 142 Location of bit to be reset within vector (offset)	• 38
Test bit in MI Vector	Selects a bit within a vector of registers, and stores its status in an MB.	• SI 141 Start of Target vector, • SI 142 Location of bit to be set within vector (offset), • SI 143 Target Bit, determines the address of the MB, where the value of the selected bit will be stored.	• 39
Find Mean, Maximum, and Minimum Values	Finds within vector: Mean, Minimum, & Maximum.	• SI 141 Start of vector, • SI 142 Length of vector	• Find in MI vector: 40 • Find in DB vector: 41
GSM PIN Code via MI	Uses an MI vector to supply a GSM modem PIN code	• SI 141 Start of vector	• 410
Interrupt	Causes program to stop immediately without regard to program scan	See Interrupt for details	• 500
Loadcell	M91 PLCs support Loadcell via I/O Expansion modules IO-LCxx. Check the Loadcell topic for details and a commands list.		
Load Indirect	Takes value contained in a **source** operand and	• SI 141 Data source	• Load MI to MI: 10

	loads that value into a **target** operand using indirect addressing	• SI 142 Load target	• Load SI to MI: 11 • Load MI to SI: 12 • Load SI to SI: 13
Load Timer Preset/Current Value	Load a preset or current timer value into another operand	SI 141 to select the timer; 0-63	• Load Timer Preset: 202 • Load Timer Current: 203
MODBUS	Enables MODBUS Master/Slave communications	See MODBUS for details	• Configure: 600, enable PC applications access (see MODBUS topic) • Configure: 600 • Read Coils: 601 • Force Coil: 602 • Force Coils: 603 • Read Output Registers: 604 • Preset Register: 605 • Preset Registers:606 • Read Output Registers in Float Format: 607 • Preset Float Registers: 608 • Read Input Registers: 609 • Read Input Registers in Float Format: 610 • Read Inputs: 611 • Loopback Test: 612
SMS Phone Number: via MI Pointer	Uses an MI vector to supply a phone number in the SMS phone book	• SI 141 Start address of the MI vector containing the phone number	• Store 400 into SI 140
Store Timer's Preset/Current Value	Store a value into a timer to change the preset or current timer value.	• SI 141 to select the timer; 0-63, • SI 142 to determine the timer value, • SI 143 to select the timer's resolution	• Store Timer Preset: 200 • Store Timer Current: 201
Square Root	Finds the square root of a number	• SI 141 Store the number	• Store 110 into SI 140
Temperature	Convert C° to F°	• SI 141 Data Source: C° value • SI 142 Result: F° value Degree value representation: 500 means 50.0	130
Temperature	Convert F° to C°	• SI 141 Data Source:F° value • SI 142 Result: C° value Degree value representation: 500 means 50.0	131

Functions activated by SBs

Function Name	Description	Parameters	Activating SB-SI
Convert MB to MI, MI to MB	Converts 16 bits or more into a integer value, or an integer value into 16 bits	• SI 170 Address of MI containing integer value • SI 171 Start address of MB array (vector) • SI 172 Amount of MBs	• Set SB 170 to activate MB to MI • Set SB 171 to activate MI to MB
Copy MI to Output vector, Input vector to MI	• Copy a vector of Inputs (**I**) to a register. • Copy a register value to a vector of Outputs (**O**)	• SI 170 Address of MI containing integer value • SI 171 Start address of bit array (vector) • SI 172 Amount of bits	• Set SB 170 to activate I to MI • Set SB 171 to activate MI to O
Database	The M90/91 has a special memory area containing integers that are function as a database.	Within the database, you can access and use integers 0 through 1023 via SI 40 and SI 41. See Using the Database for details.	
Delete SMS messages	Delete SMS messages from a SIM card	SI 187, Number of SMS messages to be deleted	Set SB 193 to delete messages (default 20 messages)
Immediate: Read Inputs & HSC, Set/Reset Outputs	Perform immediate actions, without regard to the program scan.	Model-dependent; see Immediate: Read Inputs & HSC, Set/Reset Outputs for details.	
Long Integer Functions	• Uses adjacent MIs in performing calculations and storing results. • M91 Only.		• Set SB 82 to treat 2 registers as 'long integer'
Linearization	Convert analog values from I/Os into decimal or other integer values	SI 80 - 85: (x,y) variable ranges.	Set SB 80 to activate the **Linearization** function.
Shift Register	Load SI 87 with a value, use SBs to shift register bits left/right	• SI 87 Contains the **number** to be shifted • SI 88 contains the number of **bits** to be shifted (Default is 1 bit)	• Set SB 87 to shift left • Set SB 88 to shift right

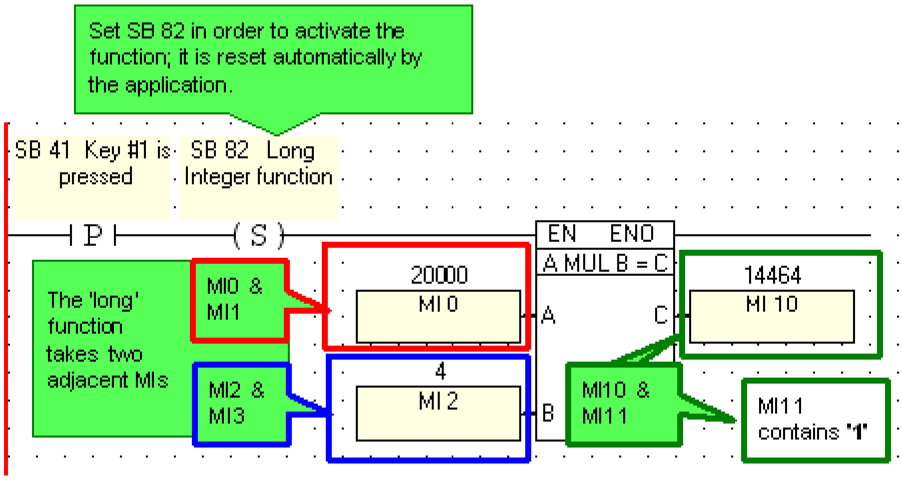
'Long' Integer functions

This special function is only supported by M91 controllers (OS 91). Note that constant values are not supported, only MI value may be used.

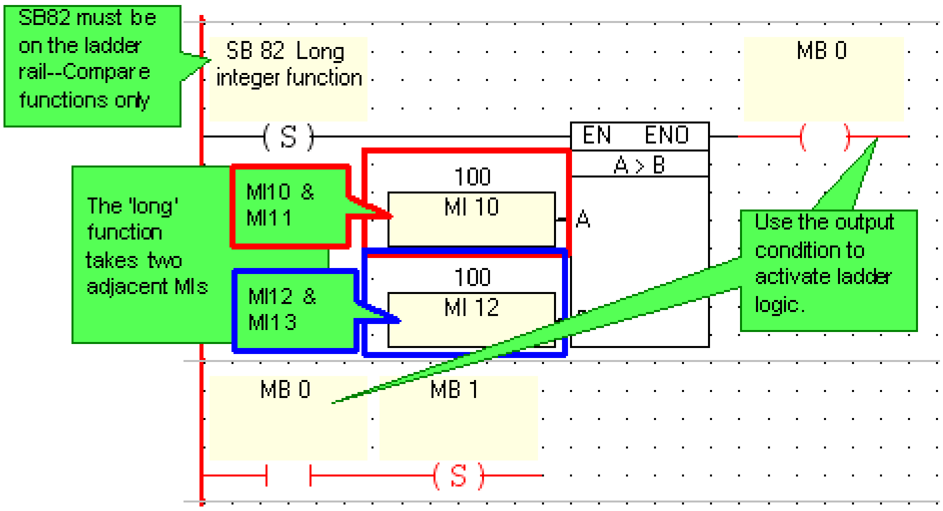
Long integer functions are activated via SB82. A long integer function uses adjacent MIs in performing calculations and storing results. When SB82 is used as the activating condition for a Math, Compare, or Store function, selecting a single MI as an input value causes the following MI to be included with the input. The selected MI value fills the 2 'lower bytes' of the long register, and the following MI fills the 2 'higher bytes'. The same logic holds for the output value.

In the example below, the values in MI 0 and MI 1 provide the 'A' input, MI 2 and MI 3 provide the 'B' input. Note that MI 0 provides the value that fills the 2 'lower bytes', and MI 1 provides the value that fills the 2 'higher bytes' of the long integer.

The result is stored in MI 10 (low) and 11 (high).

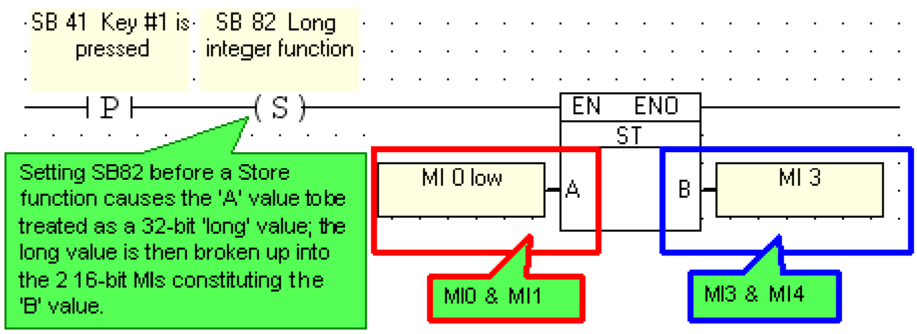


In the Compare function below, MI 10 contains 100, MI 11 contains 3, MI 12 contains 100, and MI13 contains 0, making the comparison true. Note that to activate Compare functions, SB 82 must be on the left ladder rail. This is **not** so for Math and Store functions.



You can use the Store function in two ways; these can enable you to display long values on the LCD. Note that in order to display long values, the variable used to represent the 'low' byte should be configured to show leading zeros. Display is restricted to positive values within the range of 0-99,999,999.

Setting SB82 before a Store function causes the 'A' value to be treated as a 32-bit 'long' value; the long value is then broken up into the 2 16-bit MIs constituting the 'B' value.

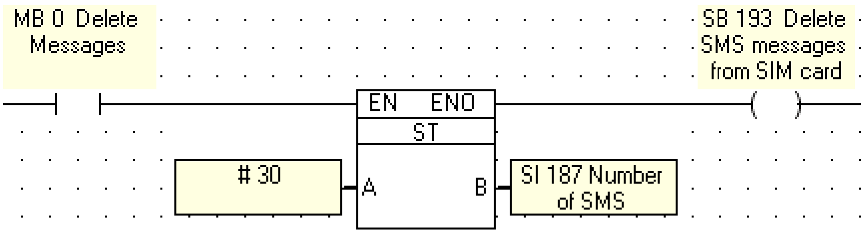


Resetting SB82 before a Store function causes the 'A' value to be treated as a 2 16-bit values; the values are then stored as a long 32-bit 'B' value.

Deleting SMS messages

In order to delete SMS messages from a SIM card, turn SB 193, Delete SMS Messages, ON. When used alone, SB 193 will delete 20 messages from the SIM card.

Using SB 193 in conjunction with SI 187, Number of SMS messages to be deleted, enables you to delete up to 30 SMS messages.



GSM PIN Code via MI

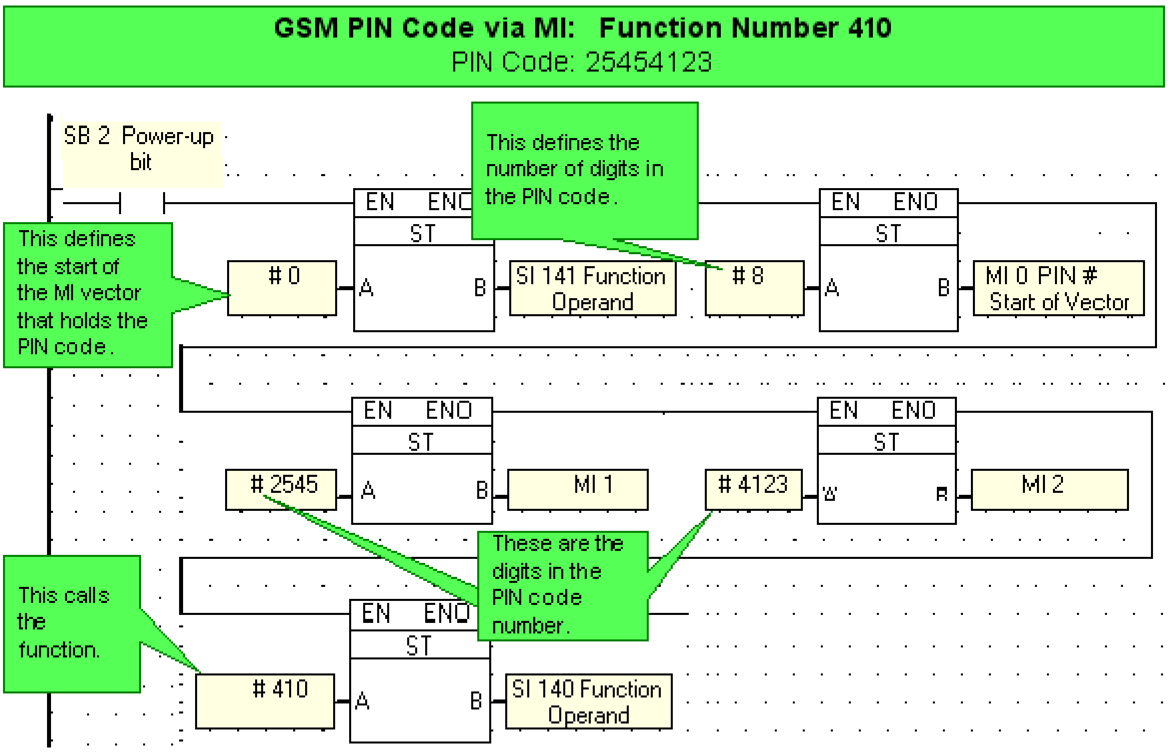
Use this utility to use an MI vector to supply a GSM modem PIN code. When you use this function, the controller will look for the number in the MIs, bypassing the PIN code in the SMS message dialog box.

Note that since there is no Ladder element for this function; you perform it by:

- Storing the start address of the MI vector needed to contain the PIN into SI 141,
- Storing 410 into SI 140 to select the function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters. Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

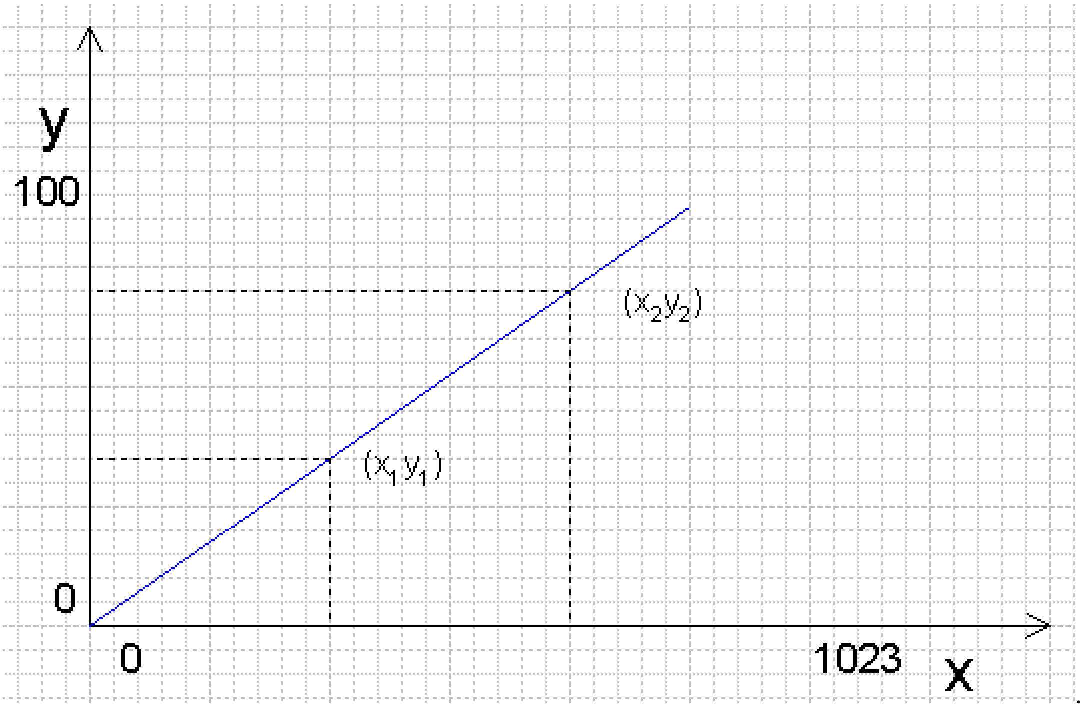
The PIN code should be called before the modem is initialized; the function should therefore be called as a power-up task.

Note that if the MIs contain an incorrect PIN code format, the error will be indicated by Error message #18 in SI 180--Illegal PIN Format.



Linearization

Linearization can be used to convert analog values from I/Os into decimal or other integer values. An analog value from a temperature probe, for example can be converted to degrees Celsius and displayed on the controller's display screen.



Linearize values for Display

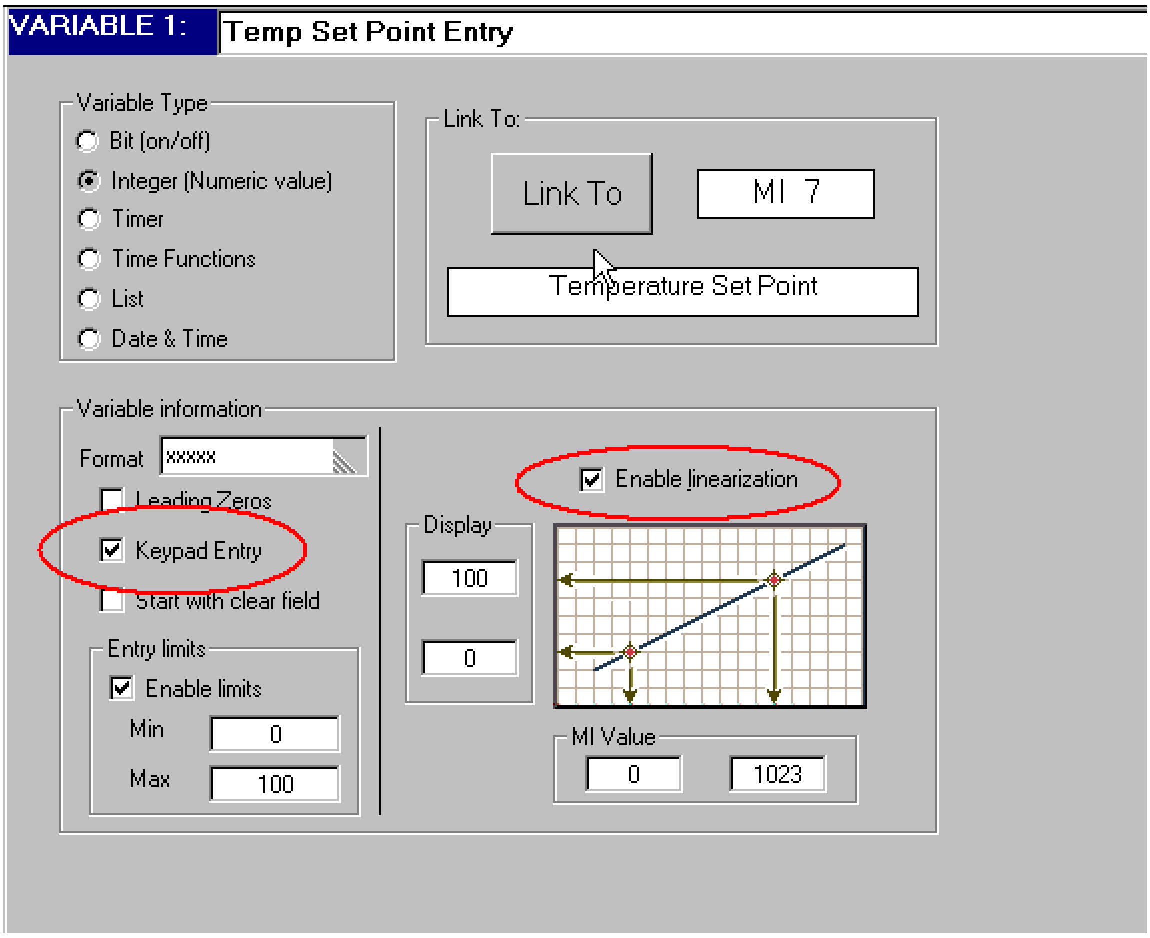
Note that the linearized value created in this way may be displayed-- **but** the value **cannot** be used anywhere else within the project for further calculations or operations.

You can enter an Analog value, such as temperature, via the keypad, then convert that value into a Digital value for comparison with a digital value from a temperature probe by selecting **Enable Linearization** in the linked Variable.

This conversion process is Reverse Linearization.

To enable Analog to Digital conversion:

1. Create a Display for entering the analog value.
2. Create an Integer Variable.
3. Select keypad entry and enable linearization.
4. Enter the linearization values for the x and y axes.



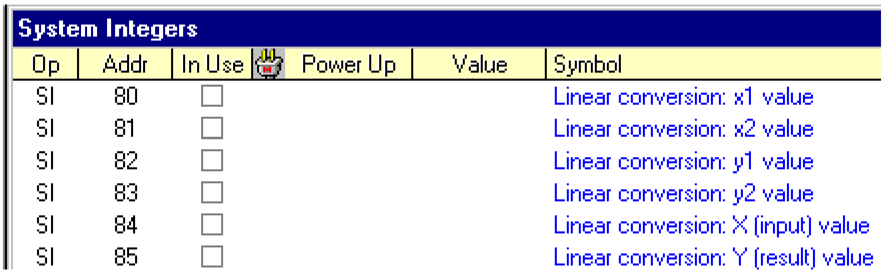
According to the above example:

- A temperature entry of 100^0 C will be converted to 1023 Digital value.
- A temperature entry of 50^0 C will be converted to 512 Digital value.

Linearize values in the Ladder

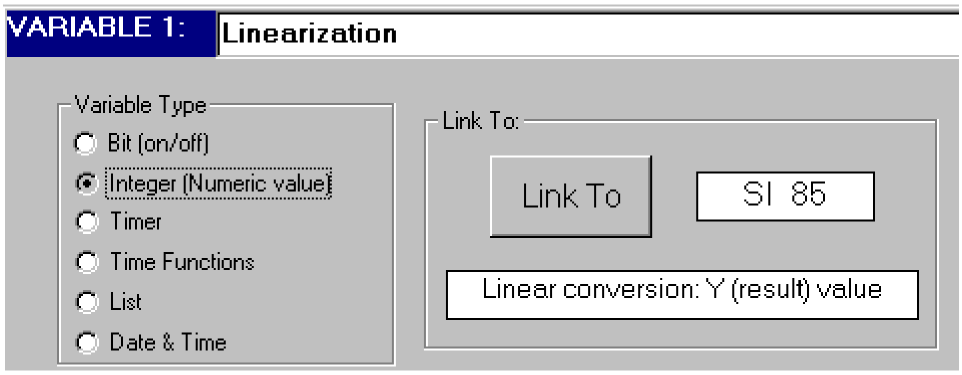
You can also linearize values in your Ladder and display them on the LCD.

1. In your Ladder project, use SI 80 - 85 to set the (x,y) variable ranges. Use SB 80 to activate the **Linearization** function.

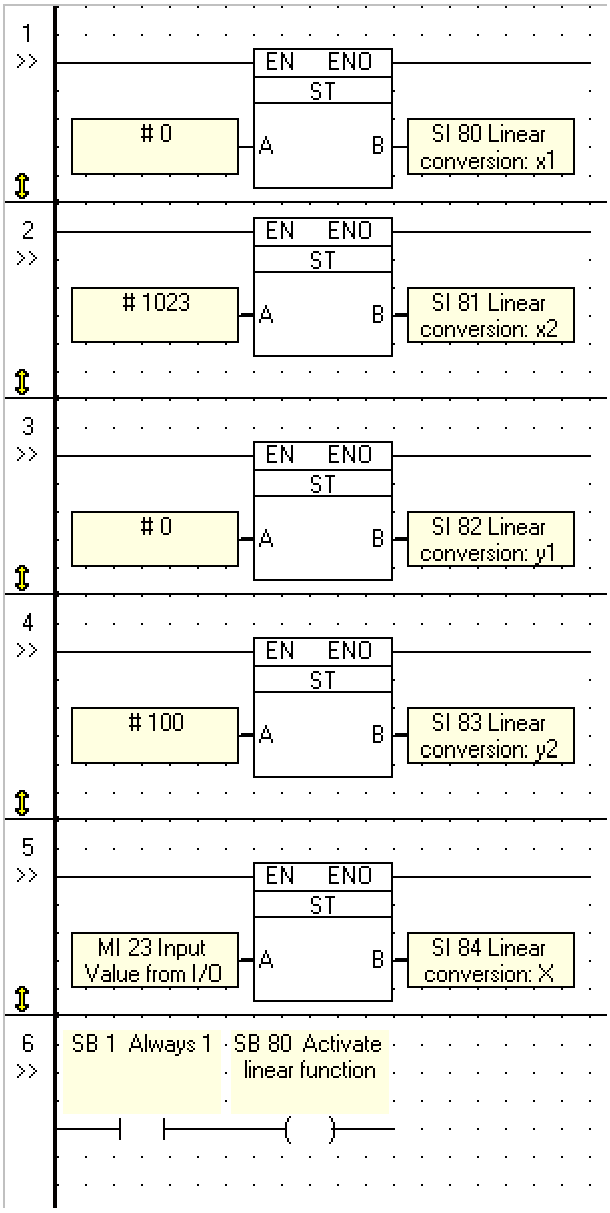

System Integers

Op	Addr	In Use	Power Up	Value	Symbol
SI	80	☐			Linear conversion: x1 value
SI	81	☐			Linear conversion: x2 value
SI	82	☐			Linear conversion: y1 value
SI	83	☐			Linear conversion: y2 value
SI	84	☐			Linear conversion: X (input) value
SI	85	☐			Linear conversion: Y (result) value

The linearization values created here can be displayed by linking SI 85 to a Display;the value **can** be used elsewhere within the project for further calculations or operations.



Example: write the variable ranges into SI 80 - 83, then writing an analog input into SI 84:

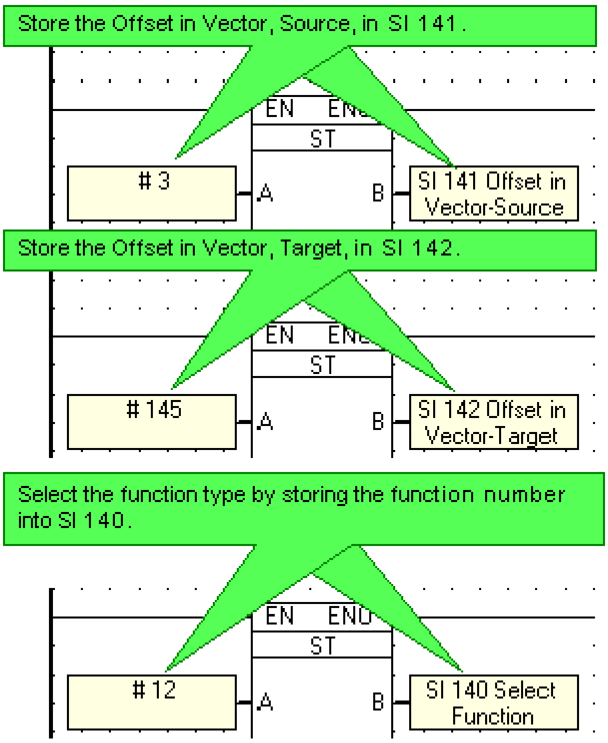


Load Indirect

Load Indirect allows you to take a value contained in a **source** operand and load that value into a **target** operand using indirect addressing. Note that since there is no Ladder element for this function; you perform it by storing values into:

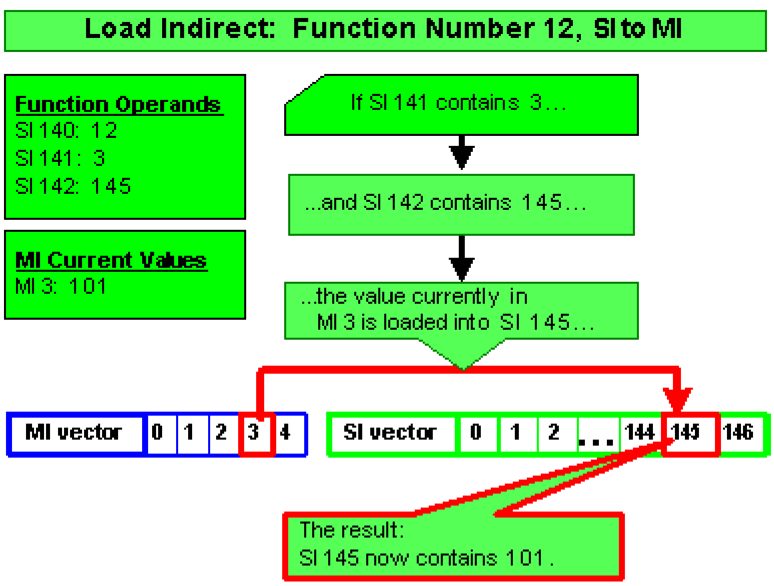
- SI 141 to determine the data source,
- SI 142 to determine the load target,
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

To use Load Indirect:



Function # (SI 140)	Offset in Vector, Source (SI 141)	Offset in Vector, Target (SI 142)
10	MI	MI
11	SI	MI
12	MI	S
13	SI	S

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.



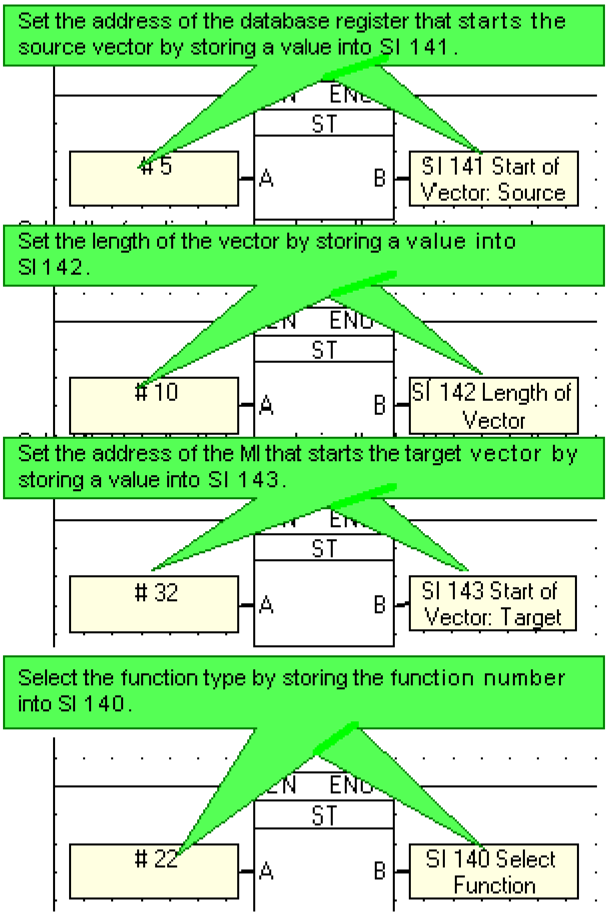
Copy Vector

Vector Copy enables you to set a range of operands, copy the values of each operand within that range **(source)**, then write those values into a corresponding range of operands of the same length **(target)**. You can copy from/to a vector of MI registers or Database registers by selecting the appropriate function.

Note that since there is no Ladder element for this function; you perform it by storing values into:

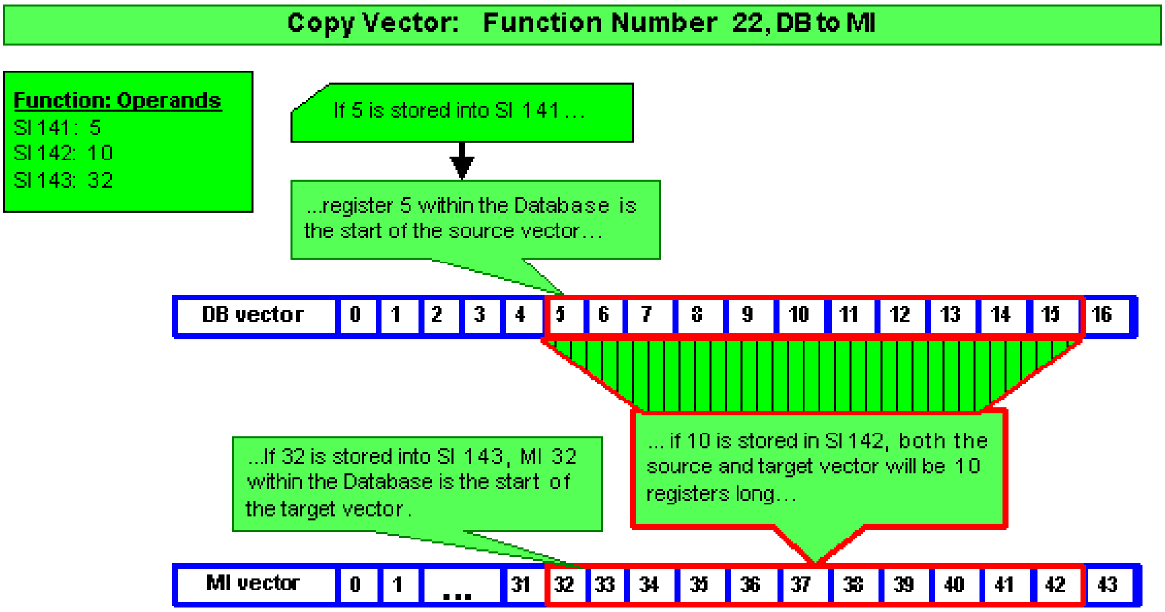
- SI 141 to determine the source vector,
- SI 142 to determine the length of the vector,
- SI 143 to determine the target vector,
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

To use Copy Vector:



Function # (SI 140)	Source Vector, (SI 141)	Target Vector, (SI 142)
20	MI	MI
21	MI	DB
22	DB	MI
23	DB	DB

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.



Fill Vector

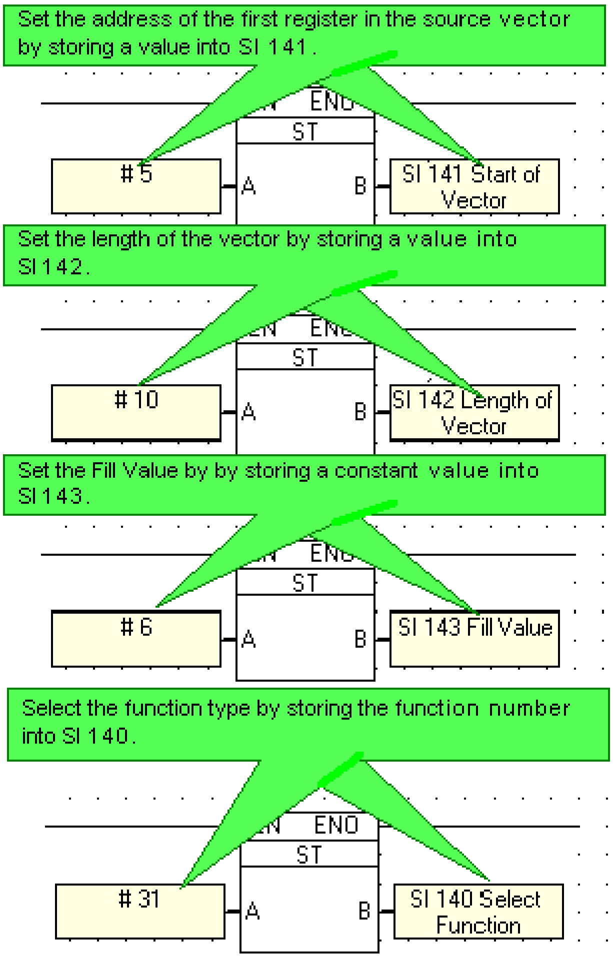
Fill Vector enables you to set a range of registers. The function copies a value from a desired operand or constant value **(source)**, then writes that value into every operand within the range **(target vector)**.

You can fill a vector of MI registers or Database registers by selecting the appropriate function.

Note that since there is no Ladder element for this function; you perform it by storing values into:

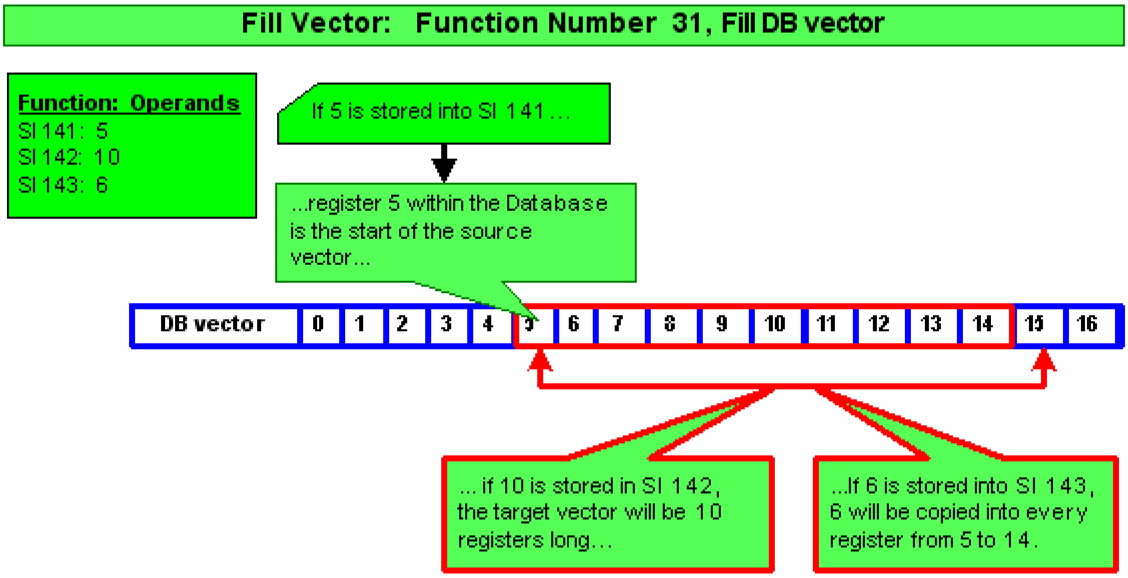
- SI 141 to determine the start of the target vector,
- SI 142 to determine the length of the target vector,
- SI 143 to select the Fill Value; the register whose value will be written into each register within the target vector,
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

To use Fill Vector:



Function # (SI 140)	Description
30	Fill MI Vector
31	Fill DB Vector
36	Fill MB vector

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.



Find Mean, Maximum, and Minimum Values

This function enables you to take a vector of registers and find the:

- Mean of all the values in the vector,
- Minimum value in the vector,
- Maximum value in the vector.

You can base the function on a vector of MI registers or Database registers by selecting the appropriate function.

Note that since there is no Ladder element for this function; you perform it by storing values into:

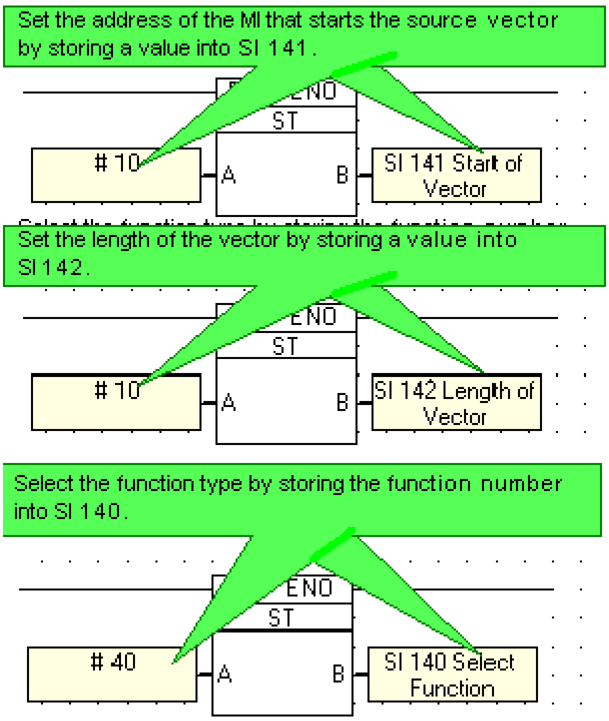
- SI 141 to determine the start of the vector,
- SI 142 to determine the length of the vector,
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

The results will be placed in:

- SI 143: Mean
- SI 144: Minimum
- SI 145: Maximum

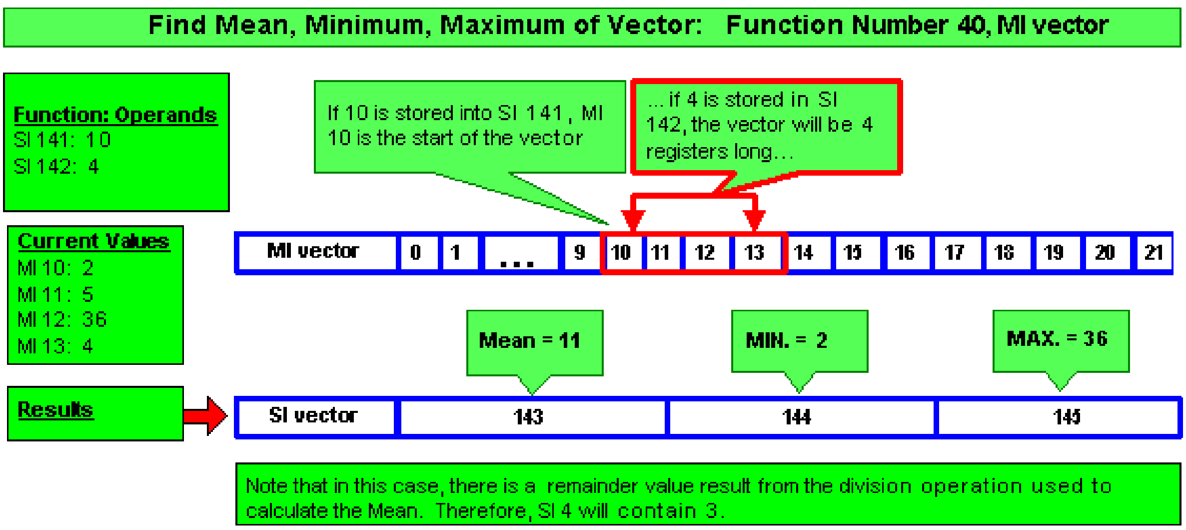
Note that if a remainder value results from the division operation used to calculate the Mean, that remainder value will be place in SI 4, Divide Remainder.

To use this function:



Function # (SI 140)	Description
40	Find Mean, Minimum, Maximum in MI vector
41	Find Mean, Minimum, Maximum in DB vector

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.



A*B/C

This function enables you to:

- Multiply 2 operand values,
- Divide the product by a third operand.

The product of the multiplication operation is temporarily stored in a long integer to avoid overflow problems.

Since there is no Ladder element for this function; you perform it by storing values into:

- SI 141 to provide Operand A (multiplicand),
- SI 142 to provide Operand B (multiplicand),
- SI 143 to provide Operand C (divisor),

Store 100 into SI 140 to call the function. In your application, call the function **after** you have entered all of the other parameters.

The results will be placed in:

- SI 144,
- SI 4: Divide Remainder.

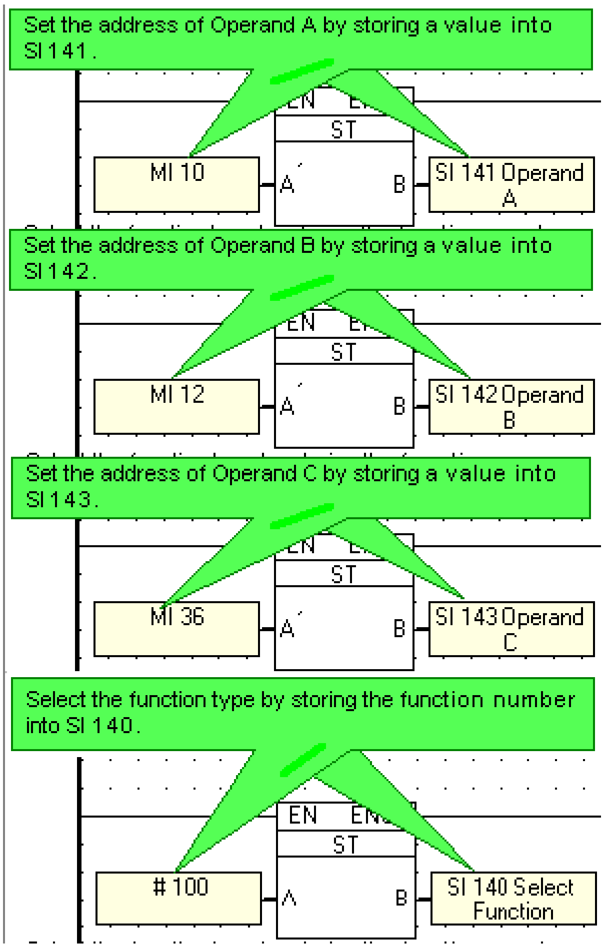
If the result is out of the integer range:

- SB 141 will turn ON.

If the value contained in Operand C (divisor) is 0:

- SB 4: Divide by 0, will turn ON.

To use this function:



Function # (SI 140)	**Description**
100	Multiply A x B, Divide by C

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Square Root

This function enables you to find the square root of a number.

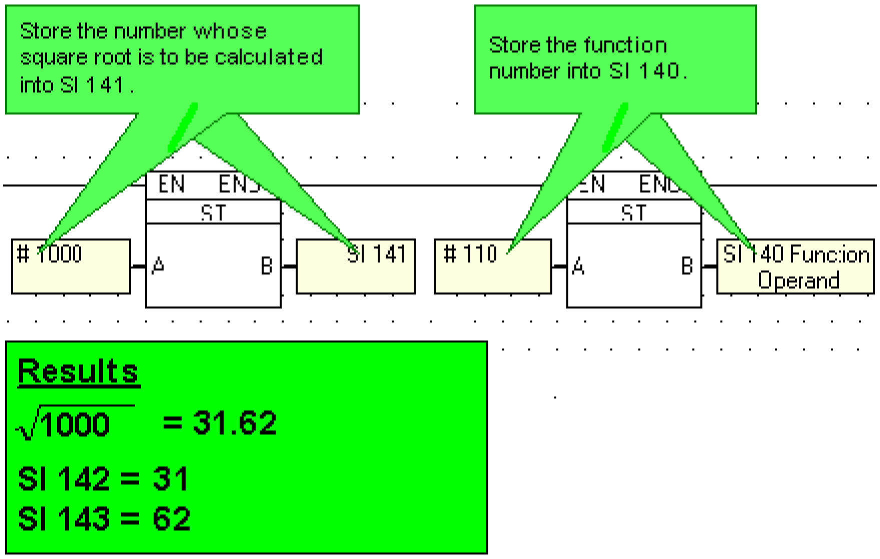
Since there is no Ladder element for this function; you perform it by storing the number whose square root is to be calculated into SI 141.

Store 110 into SI 140 to call the function. In your application, call the function **after** you have entered all of the other parameters.

The results will be placed in:

- SI 142. This contains the whole number result.
- SI 143. If the result is not a whole number, this contains up to 2 digits to the left of the decimal point.

To use this function:



Function # (SI 140)	Description
110	Calculate square root

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Store Timer's Preset/Current Value

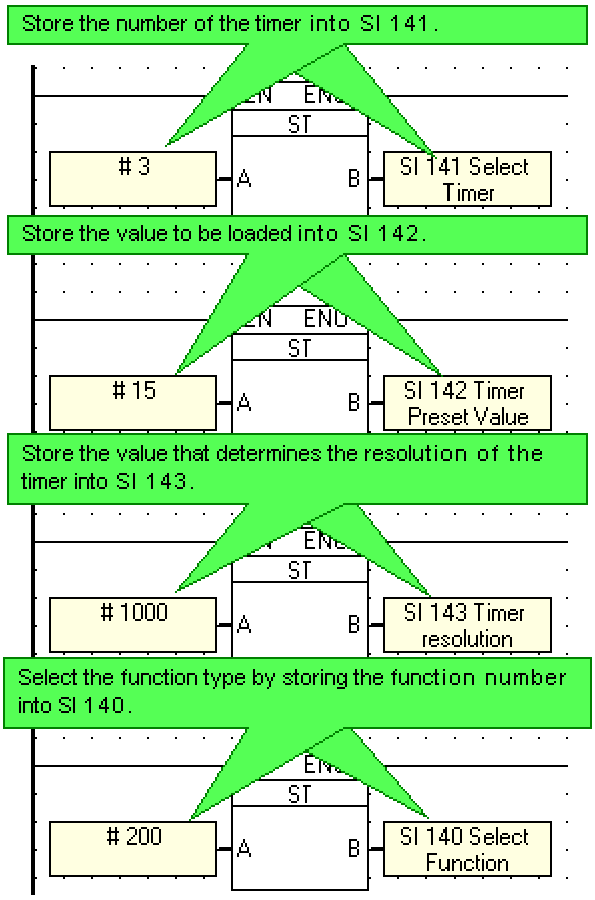
This function allows you to take a value and store it into a timer to change the preset or current timer value. Since there is no Ladder element for this function; you perform it by storing values into:

- SI 141 to select the timer; 0-63,
- SI 142 to determine the timer value,
- SI 143 to select the timer's resolution (timer units, or 'ticks'),
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

Take into account that:

- Since you cannot change the resolution of a timer when the application is running, SI 143 is not used in a Store Timer's Current Value function.
- A timer's current value can be changed at any time, including when the timer is active. The new value can be either greater or smaller than the previous value; storing 0 into a timer's current value stops it immediately.
- A change of Timer Preset value without changing the resolution will take effect when the timer restarts.
- Changing the resolution of the timer's preset value does not affect the current resolution; it is therefore recommended that the resolution not be changed while the timer is active.
- The timer value is 14 bits.

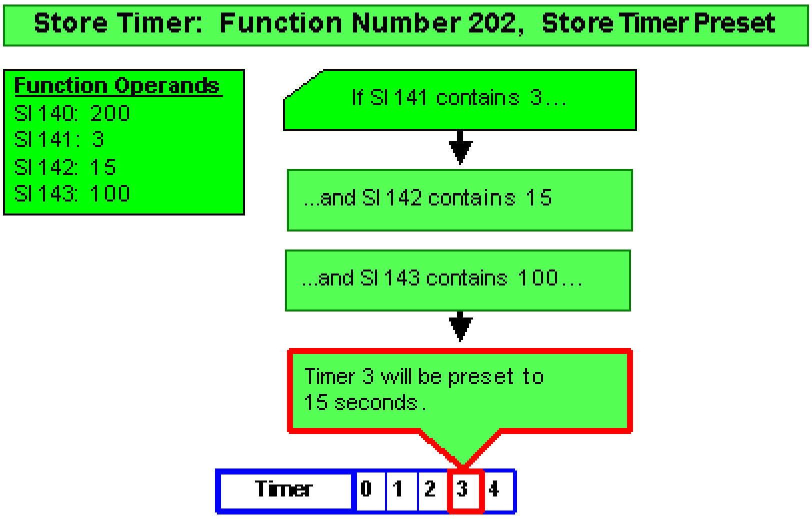
To use this function:



Function # (SI 140)	Description
200	Store Timer Preset
201	Store Timer Current

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Timer Resolution (stored into SI 143)	
Value	**Resolution**
0	Maintain Timer Resolution
1	10mS (0.01S)
10	100mS (0.1S)
100	1000mS (1.0S)
1000	10000mS (10.0S)

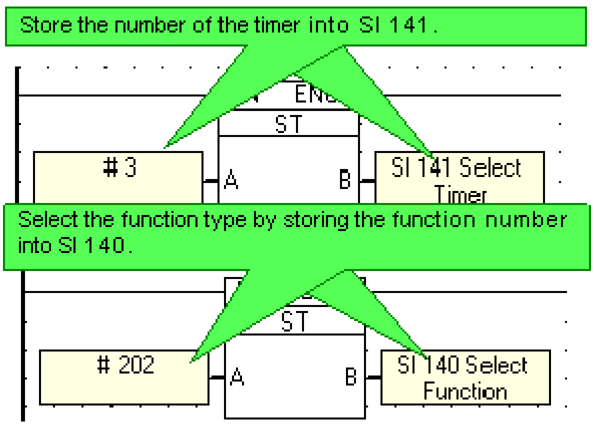


Load Timer Preset/Current Value

This function allows you to take a preset or current timer value and load it into another operand. Note that since there is no Ladder element for this function; you perform it by storing values into:

- SI 141 to select the timer; 0-63,
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

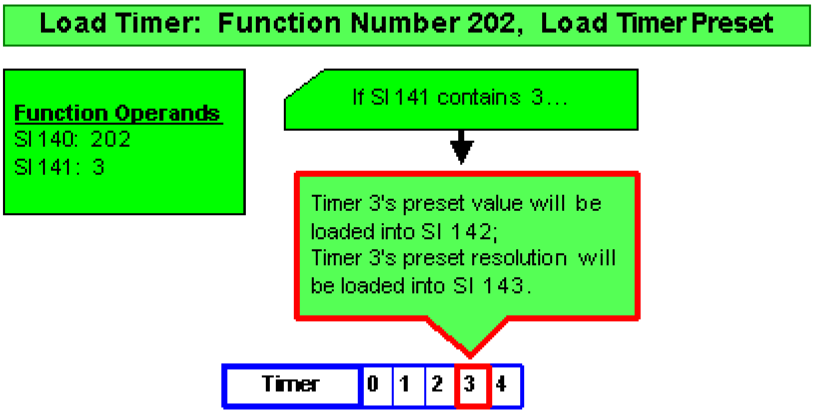
To use this function:



Function # (SI 140)	Description
202	Load Timer Preset
203	Load Timer Current

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Timer Resolution (stored into SI 143)	
Value	**Resolution**
1	10mS (0.01S)
10	100mS (001S)
100	1000mS (1S)
1000	10000mS (10S)



Communication Utilities

Use this utility to enable your controller to receive data from external devices, such as bar-code readers, via an RS232 port. Since there is no Ladder element for this function; you perform it by storing values into SIs.

Note that the communication settings stored into these SIs only take effect at power-up.

SI	Parameter	Value to Store	Notes
141	STX (Start of Text)	Select one of the 3 STX option by storing its value into SI 141: • 0-255(ASCII) • -1: No Start of Text (not recommended) • -2: No Start of Text (Enables access by Unitronics PC applications)	The STX parameter indicates where the data block begins. • -1: Note that the ASCII character '/' (backslash) cannot be used to indicate the start of the data block. • -2: enables applications such as U90 Ladder and Remote Access to access a networked PLC. Note that these applications use the 'backslash' character (/) (ASCII character 47) as the Start of Text (STX) character.
142	ETX (End of Text)	Select one of the 3 ETX option by storing its value into SI 142: • 0-255(ASCII) • -1: ETX marked by Length • -2: ETX marked by 'Silence'	The ETX parameter indicates where the data block ends. When the ETX is registered by the function, SB 60 turns ON. • If you use an ASCII character (0-255), note that if this character occurs **after** the Length parameter defined in SI 143, SB 60 turns ON. • Selecting -1 causes the function to use the **length** of a data block alone to determine its end. • Selecting -2 causes the function to use the **duration** of silent time following the STX to determine the end of a data block.
143	ETX Length or Silent	• Length: up to 128 (relevant if you store -1, Length, into SI 142 to provide ETX) • Silent: up to 24000	• This defines both the length of text, or silence, that signals the end of text. • Note that the duration of a silent 'counter' unit is approximately 2.509 mS. The 'silent' value should be lower than the TimeOut value. • When defined as length, SI 143 cannot exceed SI 144.
144	Maximum Length	Up to 128	• This is the maximum legal length for

			received text. • When the maximum length is exceeded, the Receive Buffer is automatically cleared, and SB 60 is turned OFF, enabling new data to be received. • This can be used to detect buffer overflow.
145	Start Address: Receive Buffer	MI Address	This MI contains the start address for the vector of registers that serves as the Receive Buffer.
60	Number of Bytes currently in Receive Buffer	Read only	SI 60 indicates how many bytes of data are currently in the Receive Buffer.
61	Number of Bytes in Receive Buffer when SB 60=1	Read only	SI 61 indicates how many bytes of data are in the Receive Buffer when SB 60 turns ON.
146	Copy Data: Format	• 0: copy each received byte • 1: copy in groups of 4 received bytes.	• **0** causes each separate byte to be copied to a separate register including STX and ETX. For example, if the PLC receives an STX character, 4 data bytes, and an ETX character, the data will be copied into a vector of 6 MIs: the first containing the STX, 4 MIs for the data bytes; the last MI will contain the ETX. • **1** causes every **4** bytes to be copied to a single register, without the STX and ETX. This is used when the received data is in numeric format. For example 12345 would be copied to 2 consecutive MIs. The first MI would contain 1234, the second would contain 5.
140	Start receiving	300	In your application, use this to call the function after you have entered all of the other parameters. Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

SB	Description	Notes
60	Data Successfully Received	Read only. Turns ON when the ETX condition is registered by the system.
61	Copy Data in Receive Buffer to MI Vector	Write only. • Turning this SB ON causes the buffer contents to be copied to the MI vector defined in SI 145. The data will be copied according to the format defined in SI 146. • If SI 146 is set to 0, this SB can be set at any time. If SI 146 is set to 1, this SB can be set after SB 60 turns ON.
62	Clear Receive Buffer, Clear SI 60, Clear SI 61, Reset SB 60	• This SB must be turned ON to enable a new message, or data block, to be received. • Turn this SB ON to enable data to be received **before** the maximum length, defined in SI 144, is exceeded.

Note that if no data is received for a period exceeding the TimeOut, you will lose the data in the buffer.

To see how to use the Communications Utility, check the sample application **Read Card - Display Number Value.U90**. This may be found by accessing Sample U90 Projects from the Help menu.

This application demonstrates how to read a magnetic card number using an "IDTECH" card reader, then display that number on the PLC's screen. The card reader transmits the number in ASCII characters in this format:

< %?[CR];xxxxx?[CR] > where **xxxxx** is the card number.

The ASCII character used to mark the Start Of Text (STX) is < **;** > (semicolon). End Of Text (ETX) is marked with the character < **?** > .

Since the card number is 5 digits long, the card number is copied to 2 separate MIs. The MIs are linked to 2 variables that are shown on the PLC's screen in 2 separate Displays.

The parameters must be written into their respective operands using one scan condition. For this purpose, it is recommended to use SB 2 Power-up bit, as shown in the sample application.

MODBUS

MODBUS enables you to establish master-slave communications with any connected device that supports the MODBUS protocol. Any controller in the network may function as either master or slave using any of the controller's existing COM Ports.

Unitronics currently supports RTU (binary) transmission mode. Note that the M90 series does **not** support MODBUS; M91 models support MODBUS via built-in COM ports.

Although Jazz PLCs do not comprise built-in COM ports, Jazz can support MODBUS, provided that you install an appropriate add-on port module, available separately. Note that

- Serial communications capabilities are determined by the type of Add-on Module.
- Default COM settings and pin-outs are given in the technical specifications of the relevant Add-on Port.
- The MJ20-PRG Programming Port may be used for RS232 communications with devices that supply active (RS232 positive voltage) DTR and RTS signals.

Since there are no Ladder elements for MODBUS functions; you perform them by storing values into SIs in accordance with the tables and figures shown below.

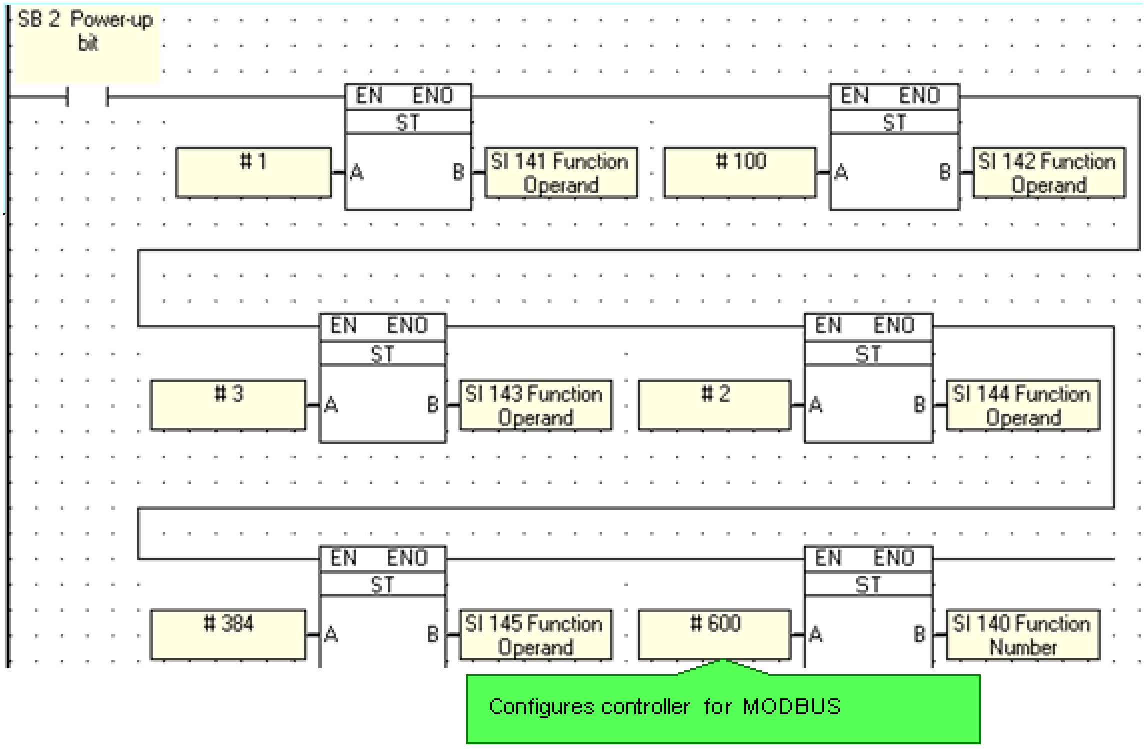
MODBUS Configuration

Before you can run a MODBUS command, you must configure MODBUS parameters for both Master and Slave devices.

Configuration Parameters

These parameters configure a controller for MODBUS communications. A device is configured for MODBUS by storing the value 600 into SI 140.

To configure a slave device, build a Ladder net that stores the appropriate values into the SIs according to the following table, and that ends by storing the value 600 into SI 140.



Parameter	Store into SI	Function
Network ID	141	Range: 0-25. This is the Network ID number of the device on the network. You can either assign an ID via an MI, or directly via a constant number. Do not assign the same ID number to more than one device.
Time out	142	Time out units:10 msecs; a Time out value of 100 is equal to 1 second. This is the amount of time a master device will wait for an answer from a slave.
Retries	143	This is the number of times a device will try to send a message.
Maximum Time Delay	144	Time units: 2.5 msec. This is the maximum time interval permitted between 2 messages. This should be set to 2, setting the permitted interval to 5 msecs (n x 2.5 =interval).
Baud Rate	145	Store the value into SI 145 to set the baud rate. Note that Jazz does not support the following baud rates: 110, 38400, 57600. In addition, ‘2’ Stop Bits is not supported. In Jazz controllers, use Function 310 to modify the default settings of an Add-on Port. Legal Baud rates are: 110 300 600 1200 2400 4800 9600 19200

		38400 (store 384) 57600 (store 57600)
Call MODBUS Configuration	140	This must be the final parameter stored. Storing the value 600 into SI 140 configures the controller for MODBUS. Storing the value 599 into SI 140 configures the controller for MODBUS and also enables Unitronics' PC applications to access the PLC.

PC-PLC Communication: known issue

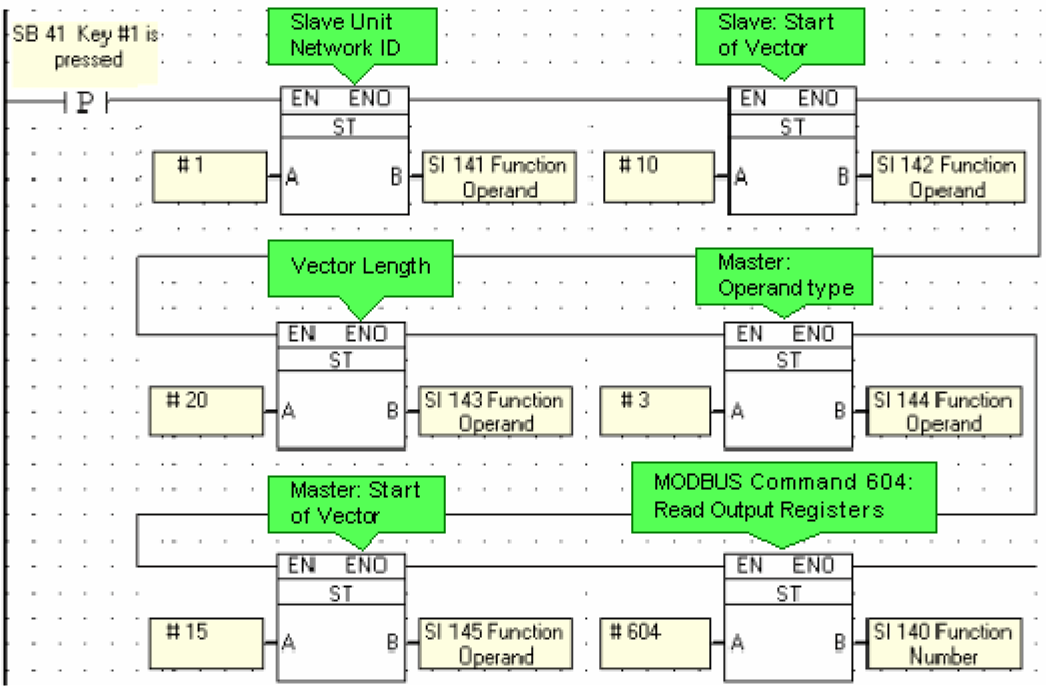
Note that Unitronics software applications, such as U90 Ladder, Remote Access, and DataXport, all use the 'backslash' character (/) (ASCII character 47) as the Start of Text (STX) character. Therefore, in order to enable a Unitronics' PC application to access a PLC communicating via MODBUS:

- Configure MODBUS by using Command Number 599 instead of 600. This means that after you store all of MODBUS Configuration parameters as shown above, you must store 599 into SI 140.
- Do NOT use controller ID number 47 in your network. Doing so will cause communication conflicts, since MODBUS protocol uses the controller ID number to begin communications strings while Unitronics applications use ASCII character 47 as an STX.

MODBUS Commands

Before you can call a MODBUS command, you store the appropriate parameter values into the correct SIs in accordance with the Command Parameters table. After this is done, call the command by storing the command number into SI 140.

The figure below shows how to implement the MODBUS command Read Output Registers.



Command Parameters

Parameter	Store into SI	Function
Slave Unit Network ID	141	The ID of the slave device containing the data to be read (data source).
Slave: Start of Vector	142	The start of the vector of operands in the slave. Check the Slave Address Tables below.
Vector Length	143	The vector length. **Note** A MODBUS command cannot read/write more than 1900 bit operands at one time. In addition, 0 is not a legal length.
Master: Operand Type	144	Store the number that relates to the type of operand you wish to write to in the master device. **MB** – **1** **SB** – **2** **MI** – **3** **SI** – **4** **I** – **9** **O** – **10** **T (current)** – **129** **T (preset)** – **128**
Master start of Vector	145	
MODBUS Command	140	

Note • While a master attempts to send a command, SB 63 Function In Progress is ON. The number of attempts that the master will make is the number in Retries +1, where '1' is the initial access attempt.

• When a master attempts to access a slave device, and the slave does not answer, SB 66 Function In Progress will turn ON. This bit will remain on according to the following: (the number of retries + 1) x (Time Out), where '1' is the initial access attempt. Note that the Time Out parameter is in units of 10 msec.

MODBUS Command Number

MODBUS Commands	U90 Command # (Value to store into SI 140
Read Coils	601
Force Coil	602 The value you enter in SI 145 (0 or 1) is written (forced) to the coil whose address is given in SI 144. Do not set Vector length (SI 143).
Force Coils	603
Read Registers	604
Preset Register	605
Preset Registers	606
Read Input Registers	609
Read Inputs	611
Loopback Test	612

MODBUS Indications: SBs and SIs

SB 66	**Turns ON when:**	**Turns OFF when**
Function in Progress Shows status of master's **MODBUS Configuration**	• A master PLC initiates MODBUS communication. • Remains ON during the MODBUS session.	• The **MODBUS: Configuration** is activated. • An answer is received from a slave. • The TimeOut defined in the **Configuration** is exceeded. • Certain Status Messages are given
SI 66 **Status Messages** Shows status of master's data requests and the replies the master receives from the slaves	• Automatically initialized to 0 when MODBUS operation is activated. • Updated at the end of each attempt to communicate via MODBUS. • Indicates status of **MODBUS** communications, according to the table below. Note that the current value always shows the most **recent** status.	

<table>
<tr><th>#</th><th>Status Message</th></tr>
<tr><td>0</td><td>Status OK</td></tr>
<tr><td>1</td><td>Unknown Command Number
This is received from the slave device.</td></tr>
<tr><td>2</td><td>Illegal Data Address
• Master: an invalid address is found by the master before a data request is sent to a slave. This may result, for example, when an MI is used to provide vector length.
• Slave: The slave notifies the master that the data request command includes invalid addresses.</td></tr>
<tr><td>3</td><td>Slave to Master: Illegal Data Type Quantity
Number of operands requested by user exceeds the maximum
Note A MODBUS command cannot read more than 124 16-bit integers, or 1900 bit operands at one time.
In addition, 0 is not a legal vector length.</td></tr>
<tr><td>4</td><td>Master--Time Out
The amount of time the master will attempt to establish a MODBUS session</td></tr>
<tr><td>5</td><td>No Communication
The MODBUS session cannot be established.</td></tr>
<tr><td colspan="2">Note Messages 4 & 5. TimeOut and Number of Retries are defined as Configuration Parameters. A Retry is an attempt to establish a MODBUS session.
If, for example, TimeOut is defined as 2 seconds, and number of Retries as 3:
- the controller will try to establish the session once, and will continue to try for 2 seconds.
- If the first attempt fails, the Status Message value will be 4, Master TimeOut.
-The controller will try twice more, for a total of 3 retries over 6 seconds.
- If all attempts fail, the Status Message value will be 5.
-If any attempt succeeds, the Status Message will be 0.</td></tr>
<tr><td>*6</td><td>Master-slave data incorrectly synchronized</td></tr>
<tr><td>*7</td><td>Master-slave data incorrectly synchronized</td></tr>
<tr><td>8</td><td>Master to application: Illegal Data Type Quantity
Number of operands requested by user exceeds the maximum permitted for that FB operation in the master.
Note A MODBUS command cannot read more than 124 16-bit integers, 62 double registers, 62 float registers, or 1900 bit operands at one time.
In addition, 0 is not a legal vector length.</td></tr>
<tr><td>9</td><td>Slave ID =0
An attempt does to communicate with Slave ID 0.</td></tr>
<tr><td>*11</td><td>Master-slave data incorrectly synchronized</td></tr>
<tr><td colspan="2">* Messages 6, 7, and 11mean that the master has found incompatible elements in the data sent between master and slave.</td></tr>
</table>

Slave Address Tables

Coils		MODBUS Command Number	
Pointer Value From:	Operand type	Read	Write
0000	MB	#601 Read Coils	#602/603 Force Coils
3000	SB		#602/603 Force Coils
4000	I (read-only)		Read-only
5000	O		#602/603 Force Coils
6000	T(read-only)		Read-only

Registers			MODBUS Command Number	
Pointer Value From:	Operand type	Register size	Read	Write
0000	MI	16 bit	# 604 Read Registers	# 16 Preset Registers
4000	SI	16 bit		
6900	Timer preset	16 bit		
7200	Timer current	16 bit		

Examples

The examples below show that:

- MODBUS addressing systems start at **1**.
- Unitronics PLC addressing starts at **0**.

Bit Operands

Read a 10-bit vector of inputs from a slave Unitronics PLC, starting at Input 20, into MB 8 - MB 17 in a master Unitronics PLC via Read Coils (Command 601)

- Unitronics PLC as the MODBUS master

  Store 4020 into SI 142 (Slave: Start of Vector parameter), 10 into SI 143 (Read: Vector Length parameter), 1 into SI 144 (Master: Operand Type), 8 into SI 145, and 601 into SI 140. Within the slave PLC, the master PLC will read I 20 - I 29 and force their status into MB 8 - MB 17 .

- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 34021(30001 + 4000 + 20), and the Read: Vector Length to 10, enabling the master device to read I 20 - I 29 within the slave PLC.

Write a 3-bit vector of outputs into a slave Unitronics PLC, O 8 O 10; from data source I 5 -I 7 in a master Unitronics PLC via Force Coils (Command 603).

- Unitronics PLC as the MODBUS master

  Store 5008 into SI 142 (Slave: Start of Vector parameter), 3 into SI 143 (Read: Vector Length parameter), 9 into SI 144 (Master: Operand Type), and 603 into SI 140. Within the slave PLC, the master will copy the status of its operands I 5 -I 7 to the slave's operands O 8 - O 10.
- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 35009 (30001 + 5000 + 8) and the Read: Vector Length parameter to 3, enabling the master device to write to O 8 - O 10 within the slave controller.

Registers

Read a 2-register long vector of **16-bit integers** from a slave Unitronics controller, starting at SI 80, via Read Holding Registers (Command 604) into a master PLC registers, MI 101-109

- **Unitronics PLC as the MODBUS master**
  Store 4080 into SI 142 (Slave: Start of Vector parameter), 2 into SI 143 (Read: Vector Length parameter), 3 into SI 144 (Master: Operand Type),and 604 into SI 140. Within the slave PLC, the master PLC will read the values of MI 32 - MI 40 and copy them into its own registers, SI 80 - SI 81.
- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 40033 (40001 + 0000 + 3), and the Read: Vector Length parameter to 9, enabling the master device to read MI 32 - MI 41 within the slave controller.

Note • M91 does not support 32-bit registers.

Write a 6-register long vector of **16-bit integers** into a slave Unitronics controller, starting at MI 32, via Preset Registers (Command 606); the data source is MI 100 - 105 in the Master PLC

- **Unitronics PLC as the MODBUS master**
  Store 32 into SI 142 (Slave: Start of Vector parameter), 6 into SI 143 (Read: Vector Length parameter), 3 into SI 144 (Master: Operand Type),and 606 into SI 140. Within the slave PLC, the master PLC will copy its internal registers values from MI 100 - 101 into the slave's MI 32 - MI 38.
- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 40033, and the Read: Vector Length parameter to 6, enabling the master device to write to MI 32 - MI 37 within the slave controller.

Change COM Port Parameters

This Special Function enables you to change the serial communication port default settings for M91 controllers. M90 models do not support this function.

In Jazz controllers, use Function 310 to modify the default settings of an Add-on Port. Note that Jazz does not support the following baud rates: 110, 38400, 57600. In addition, ‘2’ Stop Bits is not supported.

Since there are no Ladder elements for Special Functions, you perform them by storing values into SIs in accordance with the tables and figures shown below.

Configuration Parameters

After the parameters below have been stored into the appropriate SIs, initialize the COM port by storing 310 into SI 140.

SB 141 indicates whether the COM port has been successfully initialized with the new parameters successfully: 1 = success, 0 =fail.

Parameter	Store into SI	Function
Network ID	141	Store the value into SI 141 to set the baud rate. Legal Baud rates are: • 110 • 300 • 600 • 1200 • 2400 • 4800 • 9600 • 19200 • 38400 (store 384) • 57600 (store 57600)
Data bits	142	Set Data Bits: • 7 • 8
Parity	143	Set Parity: • even = 0 • odd = 1,none = 2
Hardware Flow Control	144	Set Flow Control: • 1 for l • 0 for none
Time out	145	Time out units: 10 msecs; a Time out value of 100 is equal to 1 second. Legal values: 50 100 150 200 500 6000
Stop bits	146	Set Stop bits: • 1 • 2
COM Init	140	This must be the final parameter stored. Storing the value 310 into SI 140 initializes the COM port with the new parameters.

-

Interrupt

This function is time-based. You call an interrupt routine by storing 500 into SI 140. The interrupt function causes:

- The program scan to pause every 2.509 mSec. The interrupt causes the program to stop immediately without regard to the program scan, even if it occurs in the middle of a net.
- A jump to the net which follows the interrupt. The nets following the interrupt comprise the interrupt routine. Note that the interrupt routine should be as short as possible, and must not exceed approximately 0.5 mSec.
- When the interrupt routine is finished, the program continues from where it left off.

Note that the nets containing the Interrupt routine must be the last ones in the program. The format must be as shown in the example below:

- Store 500 into SI140 to call the function
- Jump to End
- The nets containing the actual interrupt routine.

Note
- When you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.
- SB 180 Initialize GSM Modem cannot be written to during an interrupt routine

Jazz Controllers

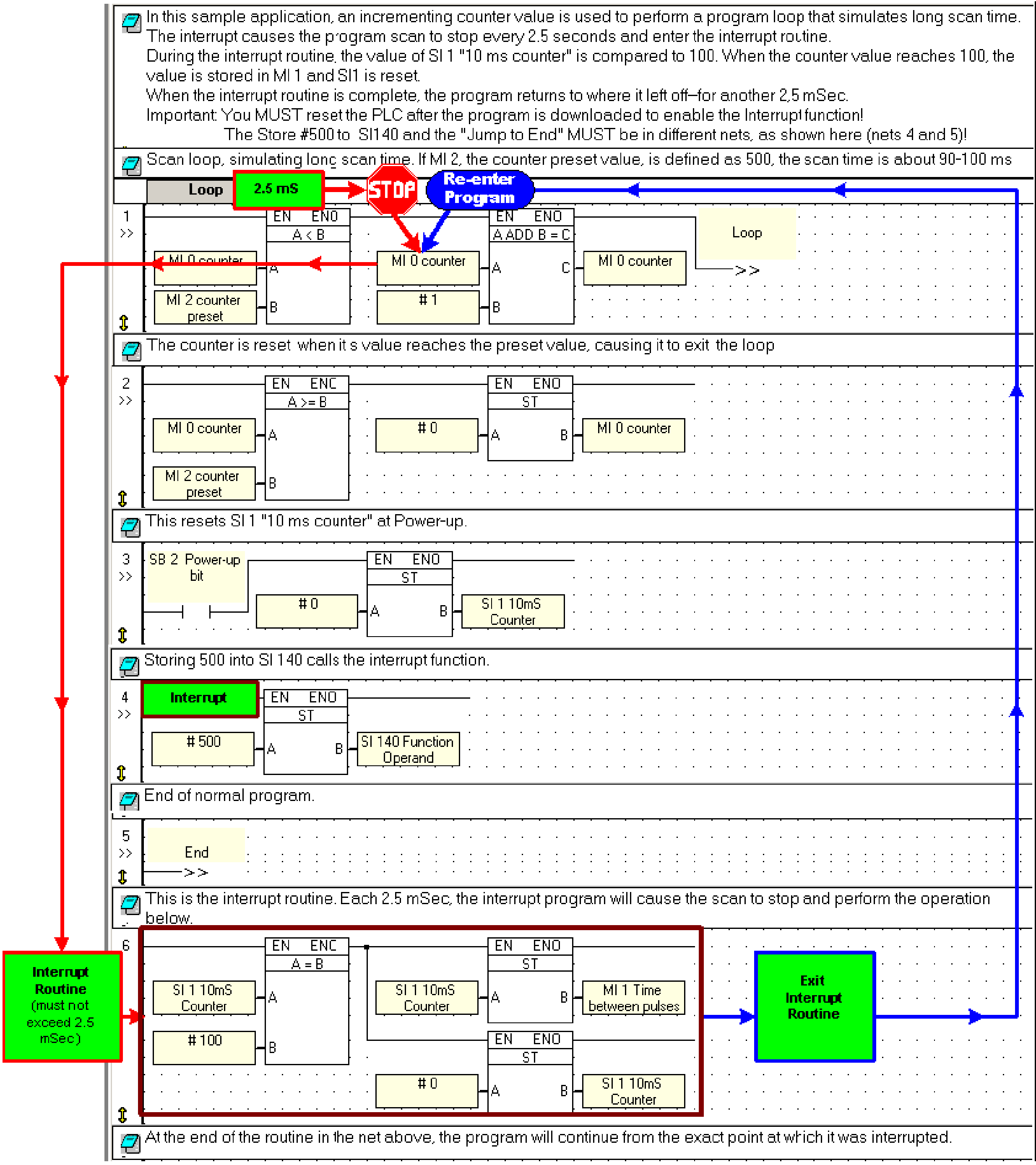
The following table lists operands that Jazz cannot write to during Interrupt.

Jazz can write to these operands during normal program cycles.

SB#	Description
9	Backlight Intensity
39	Force HMI Keypad Entry Complete
61	Communication: Copy Buffer Contents to MI vector
62	Communication: Clear Buffer, Clear SB 60--Enables reception of new messages
72	Initialize Modem
76	Disconnect Modem
77	Dial Remote Modem
80	Activate linear function
82	"Long" integer function
141	Function Operand
170	MB to MI
171	MI to MB
172	I to MI
173	MI to O
180	Initialize GSM Modem for SMS (M90/91 as well)
183	Send SMS
188	Ignore Received SMS
189	Print SMS message & <CR> & <LF> (0x0D & 0x0A)
190	Print SMS message & <LF> & <LF> (0x0A & 0x0A)
191	Print SMS message (No <CR>, No <LF>)
192	Get antenna quality. The quality is contained in SI 185 (GSM Quality)

193	Delete SMS Messages
194	Print SMS message: include communication terminators STX and ETX
SI#	**Description**
8	Unit ID
30	Current Second-according to RTC
31	Current Time-according to RTC
32	Current Date-according to RTC
33	Current Year-according to RTC
71	Modem: Phone Number
80	Linear conversion: x1 value
81	Linear conversion: x2 value
82	Linear conversion: y1 value
83	Linear conversion: y2 value
84	Linear conversion: Y (result) value
140	Function Number
141	Function Operand
142	Function Operand
143	Function Operand
144	Function Operand
145	Function Operand
146	Function Operand
147	Function Operand
170	Address of MI containing integer value
171	Start address of bit array (vector)
172	Quantity of bits in array
179	Info Password
181	SMS: Send to Phone Number
182	SMS: String Number to Send
187	Number of SMS messages to be deleted

Example


In this sample application, an incrementing counter value is used to perform a program loop that simulates long scan time.
The interrupt causes the program scan to stop every 2.5 seconds and enter the interrupt routine.
During the interrupt routine, the value of SI 1 "10 ms counter" is compared to 100. When the counter value reaches 100, the value is stored in MI 1 and SI1 is reset.
When the interrupt routine is complete, the program returns to where it left off--for another 2,5 mSec.
Important: You MUST reset the PLC after the program is downloaded to enable the Interrupt function!
The Store #500 to SI140 and the "Jump to End" MUST be in different nets, as shown here (nets 4 and 5)!
Scan loop, simulating long scan time. If MI 2, the counter preset value, is defined as 500, the scan time is about 90-100 ms
Loop
2.5 mS
STOP
Re-enter Program
A < B
MI 0 counter
MI 2 counter preset
MI 0 counter
1
A ADD B = C
MI 0 counter
Loop
The counter is reset when it s value reaches the preset value, causing it to exit the loop
A >= B
MI 0 counter
MI 2 counter preset
0
ST
MI 0 counter
This resets SI 1 "10 ms counter" at Power-up.
SB 2 Power-up bit
0
ST
SI 1 10mS Counter
Storing 500 into SI 140 calls the interrupt function.
Interrupt
500
ST
SI 140 Function Operand
End of normal program.
End
This is the interrupt routine. Each 2.5 mSec, the interrupt program will cause the scan to stop and perform the operation below.
Interrupt Routine (must not exceed 2.5 mSec)
A = B
SI 1 10mS Counter
100
SI 1 10mS Counter
ST
MI 1 Time between pulses
0
ST
SI 1 10mS Counter
Exit Interrupt Routine
At the end of the routine in the net above, the program will continue from the exact point at which it was interrupted.

Convert MB to MI, MI to MB

A register is built of 16 bits.

Using the MB to MI function, you can convert 16 bits or more into a integer value. Conversely, you can convert an integer value into 16 bits or more using the MI to MB function.

Note that if the converted values exceed 16 bits, the function will write the value to consecutive registers. Any values in those registers will be overwritten.

To apply the functions, use the following System Integers (SI) and System Bits (SB)

SI	Description	SB	
SI170	Address of MI containing integer value	SB170	MB to MI
SI171	Start address of MB array (vector)	SB171	MI to MB
SI172	Amount of MBs		

You can use this function, for example to send an SMS when there is a change in the status of the controller' s inputs:

1. Represent the status of the inputs using MBs.
2. Convert these MBs into an MI
3. Perform a XOR operation on the result.

When there is a change in input status, the XOR operation will return a value different than 0, which may then be used to trigger the sending of an SMS.

Examples

Example 1:

1. Store the value 7 into SI 170, 10 into SI 171 and 9 into SI 172.
2. Set SB 170 to ON.

The program will calculate the binary value of a 9 bit array which starts with MB 10. The resulting value will be placed into MI 7.

Example 2:

1. Store the value 7 into SI 170, 10 into SI 171 and 9 into SI 172.
2. Set SB 171 to ON

The program will calculate the binary value of the value contained in MI 7. The result will be scattered on a 9 bit array which starts with MB 10.

Copy MI to Output vector, Input vector to MI

Using this function, you can:

- Copy a vector of Inputs (`I`) to a register.
- Copy a register value to a vector of Outputs (`O`).

Note that a register contains 16 bits. If the converted values exceed 16 bits, the function will write the value to consecutive registers. Any values in those registers will be overwritten. When a register value is copied to outputs, the function will store the register value in consecutive outputs.

Jazz controllers do not support this feature during Interrupt.

Input to Register

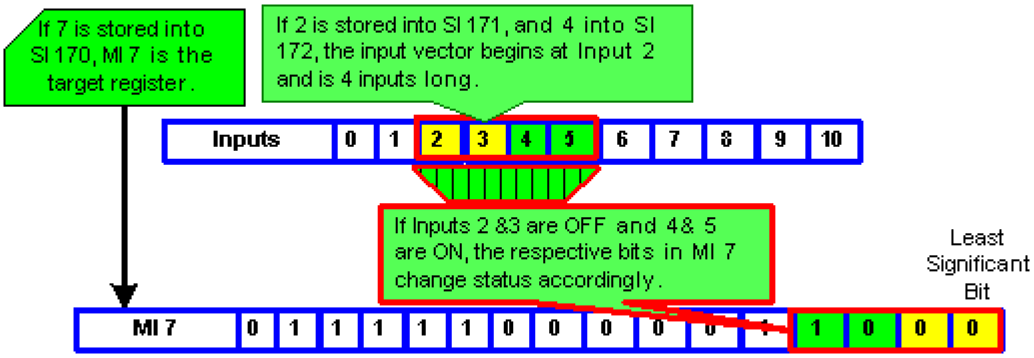
SI	Description	SB	Function
SI170	Address of MI containing integer value	SB172	I to MI
SI171	Start address of bit array (vector)	SB173	MI to O
SI172	Amount of bits		

Example: Input to MI, SB 172

1. Store the value 7 into SI 170, 2 into SI 171 and 4 into SI 172.
2. Set SB 172 to ON.

The program takes the status of I2 to I5, and changes the status of the respective bits in MI 7.

Bits in the target register that are outside of the defined range are not affected.



Example: MI to Output, SB 173

1. Store the value 7 into SI 170, 3 into SI 171 and 7into SI 172.
2. Set SB 173 to ON.

The program will take the binary value of the MI 7, and change the status of the respective outputs in the defined vector, O3 to O9.

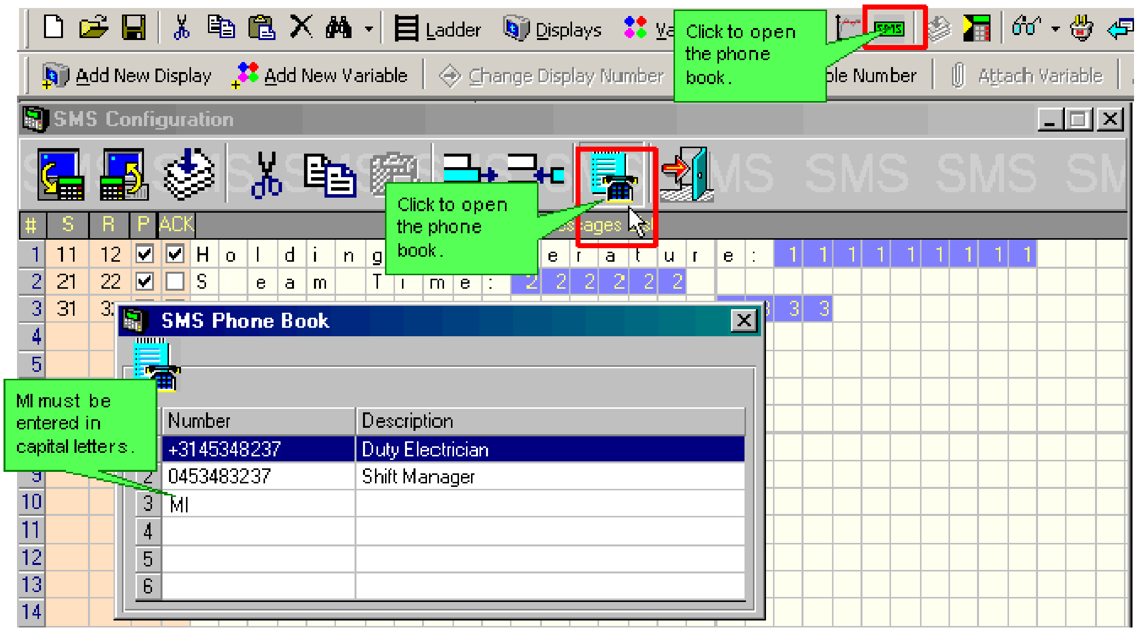
SMS Phone Number: via MI Pointer

Use this utility to use an MI vector as one of the phone numbers in the SMS phone book. This allows you to:

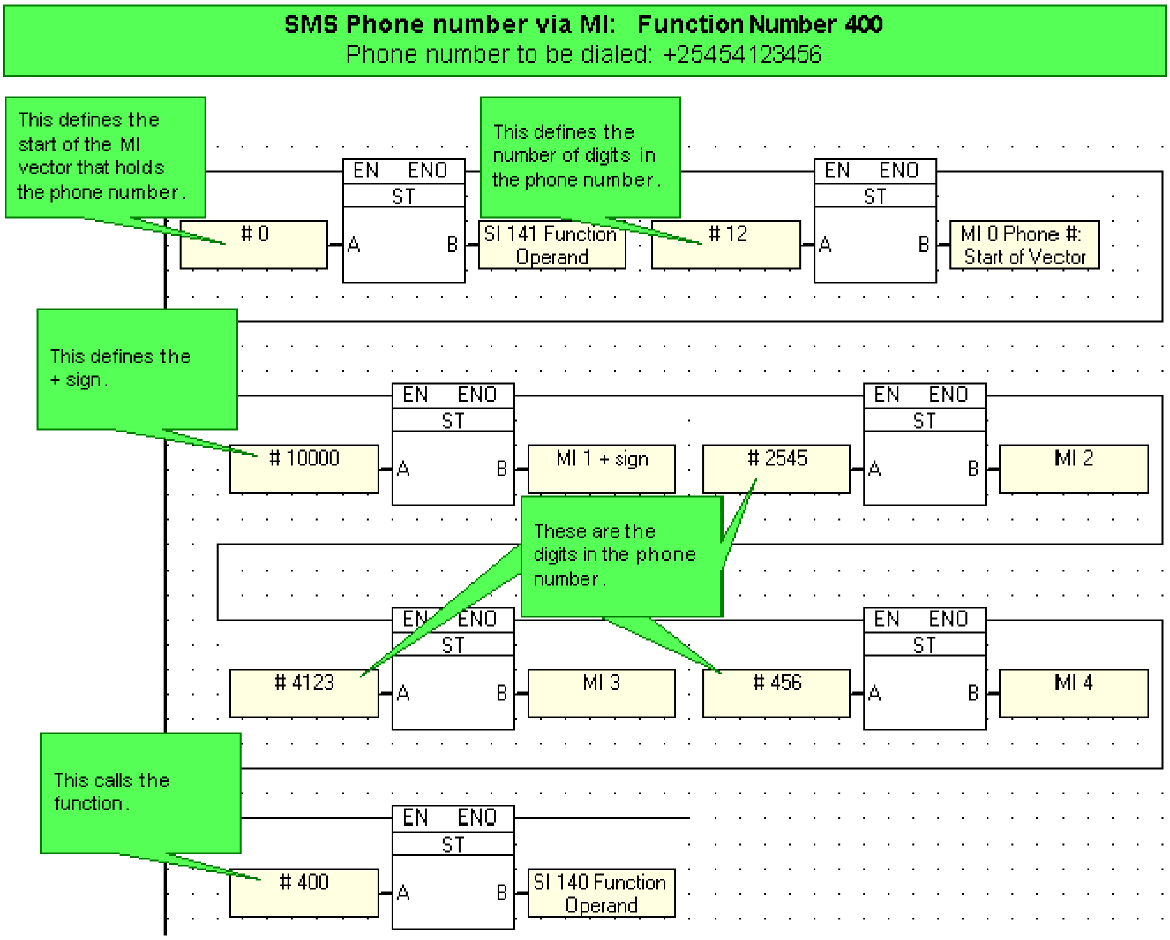
- Enable a number to be dialed via the PLC's keypad.
- Exceed the 6 number limit of the SMS phone book.

Note that since there is no Ladder element for this function; you perform it by:

- Storing the start address of the MI vector needed to contain the phone number into SI 141,
- Entering the character's MI, in capital letters, in the **SMS phone book**,



- Using the index number of that line to call the number, which enables the number in the MI vector to be called,
- Storing 400 into SI 140 to select the function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters. Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.



Shift Register

You can use the following SIs and SBs to perform Shift Left and Shift Right Functions.

SI	Symbol	Description
87	Shift Value	This register contains the number to be shifted.
88	Shift By	This register contains the number of bits to be shifted (Default is 1 bit).

SB	Symbol
87	Shift Left
88	Shift Right

Example : Shift Left

To shift the number 64 **left** by 1 bit:

1. Use a Store function to write the number 64 into SI 87.
2. Use a Store function to write the number 1 into SI 88.
3. Turn SB 87 ON.

Once the function is performed SI 87 will contain 128.

In binary:

Start value: 0000000001000000 = 64

After Shift Left: 0000000010000000 =128

Example : Shift Right

To shift the number 64 **right** by 1 bit:

1. Use a Store function to write the number 64 into SI 87.
2. Use a Store function to write the number 1 into SI 88.
3. Turn SB 88 ON.

Once the function is performed SI 87 will contain 32.

In binary:

Start value: 0000000001000000 = 64

After Shift Right: 0000000000100000 =32

Access Indirectly Addressed Registers: Using the Database

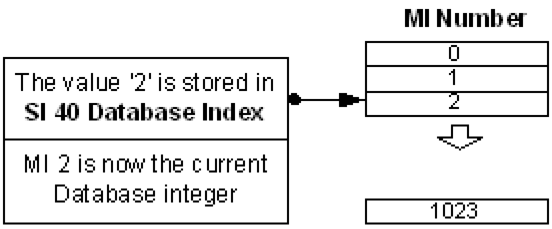
The M90/91 OPLC has a special memory area containing integers that are function as a database. These integers are not related in any way to system or memory integers. Within the database, you can access and use integers 0 through 1023 via SI 40 and SI 41.

Jazz controllers do not offer a Database.

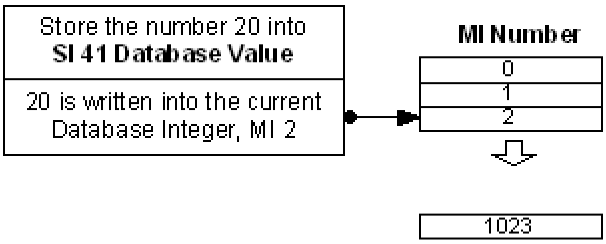
Note that when you run Test (Debug) Mode, the current value in SI 140 (Function Number) will **not** be displayed.

Writing Values

1. Use SI 40 Database Index to access a particular MI.
   For example, to access MI 2 you store the number 2 into SI 40.

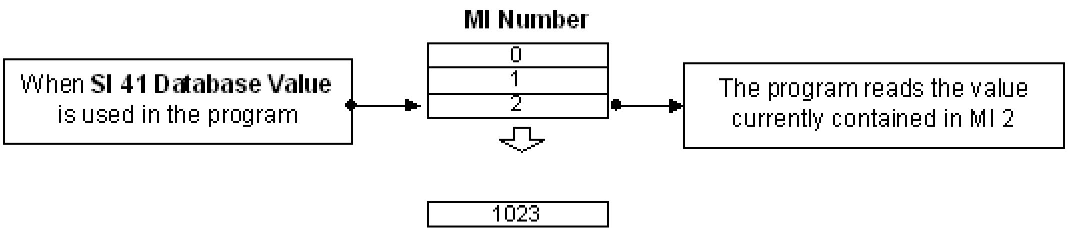


2.Use SI 41 Database Value to write a value into MI 2.
For example, you can store a number value into SI 41.



Reading Values

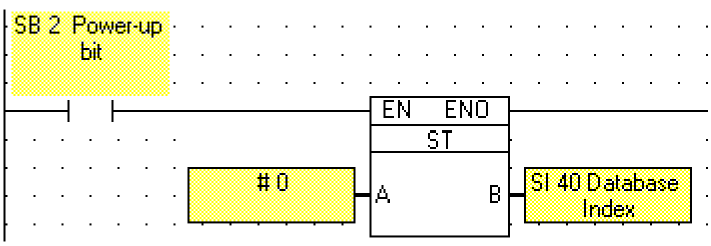
When you use SI 41 Database Value in your program, the program actually reads the MI that is referenced by SI 40 Database Index.



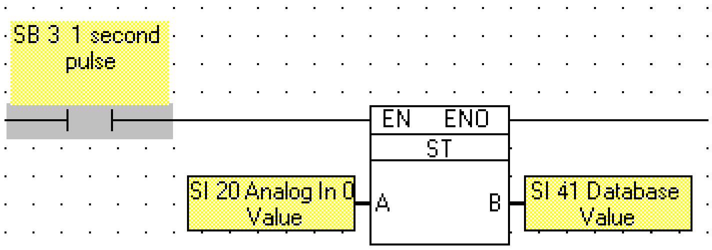
Examples

Example 1: Write

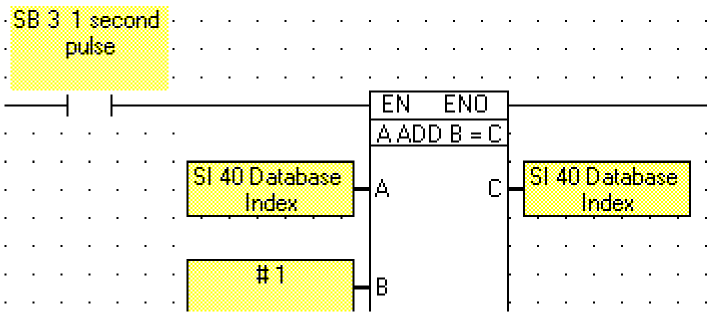
In the net below, 0 is stored in SI 40 when the M90 OPLC is powered up. This means that integer 0 is now the current 'database' integer.



In the net below, the analog value contained in SI 20 is stored in SI 41 every second. According to the net above, the current 'database' integer is 0. The analog value is therefore stored in integer 0.



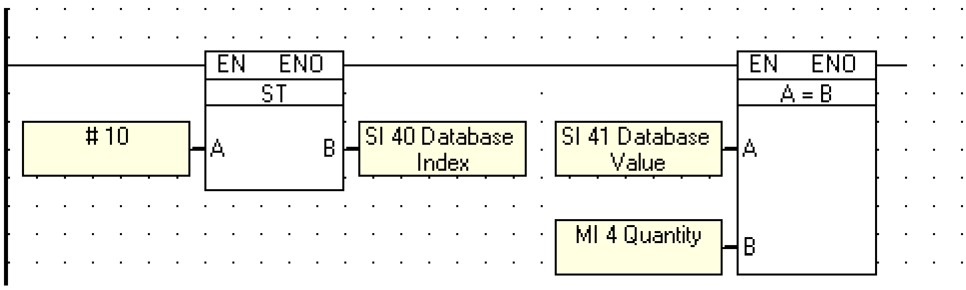
In the next net, the value in SI 40 is incremented by 1every second, changing the current database integer. This means that the first analog value will be stored in integer 0, the second analog value in integer 1, and so on.



Example 2: Read

In the first part of the net below, 10 is stored into SI 40. Integer 10 is the 'database' integer. In the second part of the net, the value in SI 41 is compared to the value in integer 4.

The value in SI 41 is the value actually in integer 10—the current database integer.



Loadcell

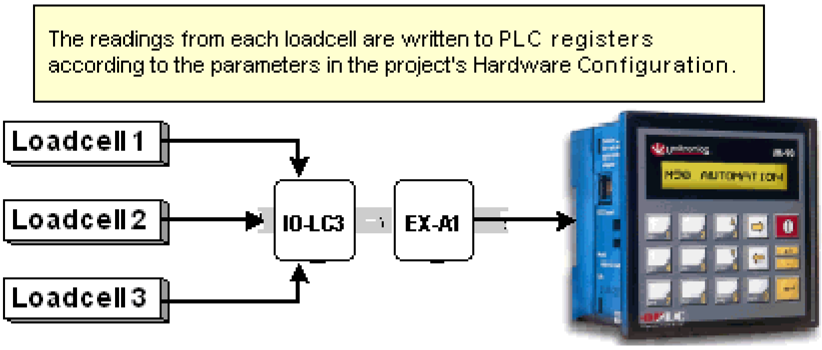
Loadcell

The Loadcell utility enables you to include an I/O module that is connected to a loadcell or strain-gauge in your control application. Unitronics I/O expansion loadcell modules are intelligent I/O modules that are capable of receiving analog values directly from loadcells.

IO-LC1 offers 1 Loadcell input; IO-LC3 module offers 3 Loadcell inputs. Each IO-LCx module is capable of providing excitation for up to 12 loadcells.

Note
- Both negative and positive (signed and unsigned) values can be processed by the I/O-LCx and the support software, enabling a range of applications.
- This feature is not supported by the M90 series.

U90 Ladder offers Special Function commands that enable you to calibrate the loadcell. You can also use the appropriate commands to tare and zero the loadcell, compensate for deadload and scale movement, and set the input range.



Once you connect the loadcell and calibrate at least 2 points, you can begin to run a loadcell application. The loadcell input can be read in 6 different ways:

- Gross weight
- Net weight
- Net Min. Weight
- Net Max. Weight
- Scaled to uV/V
- Raw Value

Most applications will require only the Gross or Net weight. Raw Value and uV/V readings may be useful for troubleshooting purposes.

Loadcell Quickstart

In order to build and run a basic loadcell application, you must first:

1. Connect a Unitronics controller to an EX-A1 Expansion Module adapter.
2. Connect the EX-A1 to a Loadcell I/O Expansion Module, such as the I/O-LC3.
3. Connect the I/O-LCx to one or more loadcells.
3. In U90 Ladder, define **Hardware Configuration** to suit your application.
4. Write a U90Ladder application that **calibrates at least 2 points per loadcell**. This is demonstrated in the Quickstart application explained below.

Once the application is downloaded to the controller, the system can be run and the Loadcell input read by the controller.

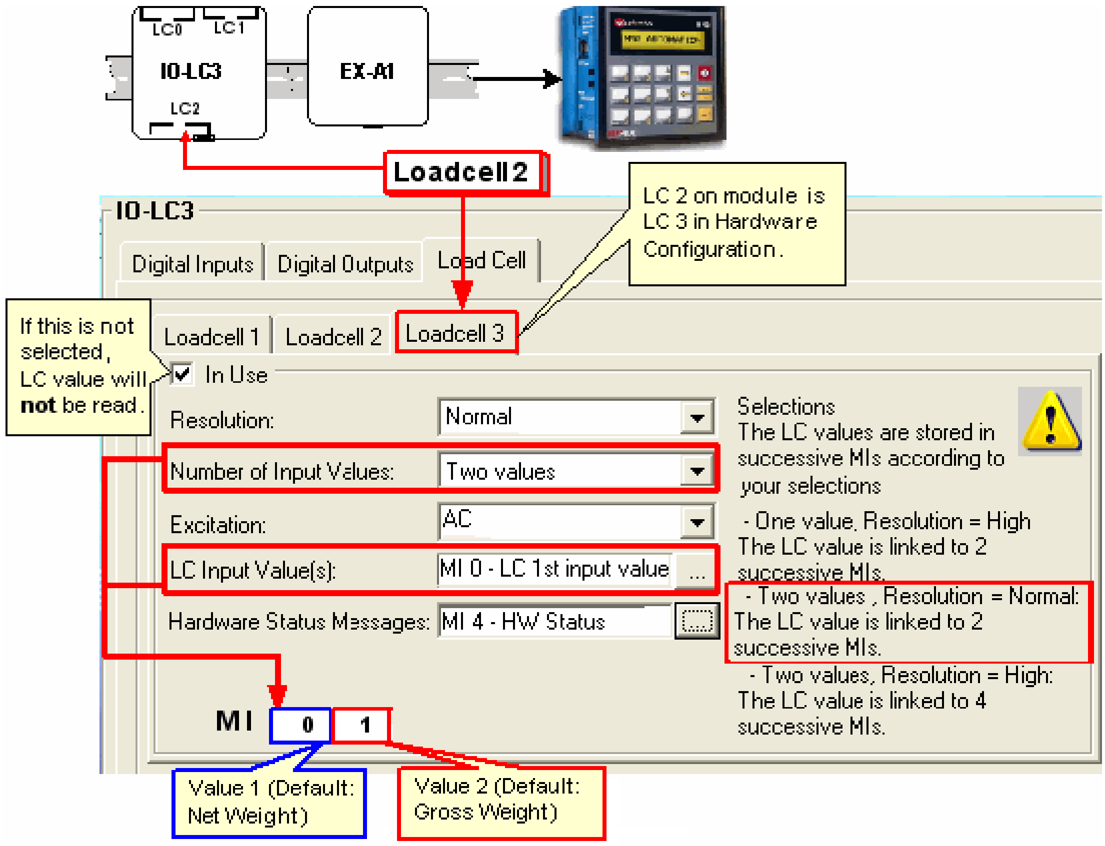
Loadcell Quickstart Application

This section shows you the most basic elements required to build a U90Ladder Loadcell application. It is based on the loadcell module IO-LC3, and includes a single loadcell, Loadcell 3. Wiring diagrams are shown in the technical specifications supplied with the module. You can find a Loadcell Quickstart application in Help>Sample Applications.

Hardware Configuration

1. Open Hardware Configuration, select the appropriate M91 controller model, then click & drag the IO-LC3 expansion module onto the DIN rail at the bottom of the window.
2. Click the IO-LC3 on the DIN Rail; itsHardware Configuration opens.
3. Select the Loadcell 3 tab, the parameters are displayed.
4. Enter the Loadcell 3 parameters shown in the following figure. To learn about these parameters, check Loadcell Hardware Configuration.

Note • Loadcell 0 on the IO-LC3 is Loadcell 1 in Hardware Configuration; Loadcell 2 on the IO-LC3 is Loadcell 3 in Hardware Configuration.

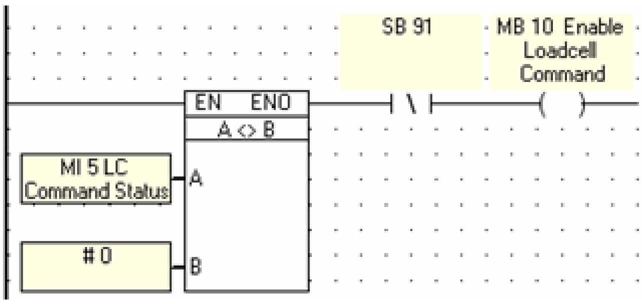


4.Click Exit; the Ladder Editor opens.

Is the Module busy?

This net enables you to check if the Loadcell I/O module is free before running a Loadcell command. Each time a command is run, Command Status Messages are indicated in the MI address stored into SI 142.

The coil, linked to MB 10 Enable Loadcell Command in the following figure, will turn ON when the module is free and able to process commands.



Note • SB 91, I/O Expansion Module--Command Buffer Full must be OFF in order for commands to be sent to the Loadcell module. If your application comprises more than 1 Loadcell I/O module, you can send commands simultaneously by checking the status of SB 91 before sending the command.

• If your application comprises more than 1 Loadcell I/O module, you should use a different Command Status MI and a different Enable Loadcell bit for each module.

Calibrating Points

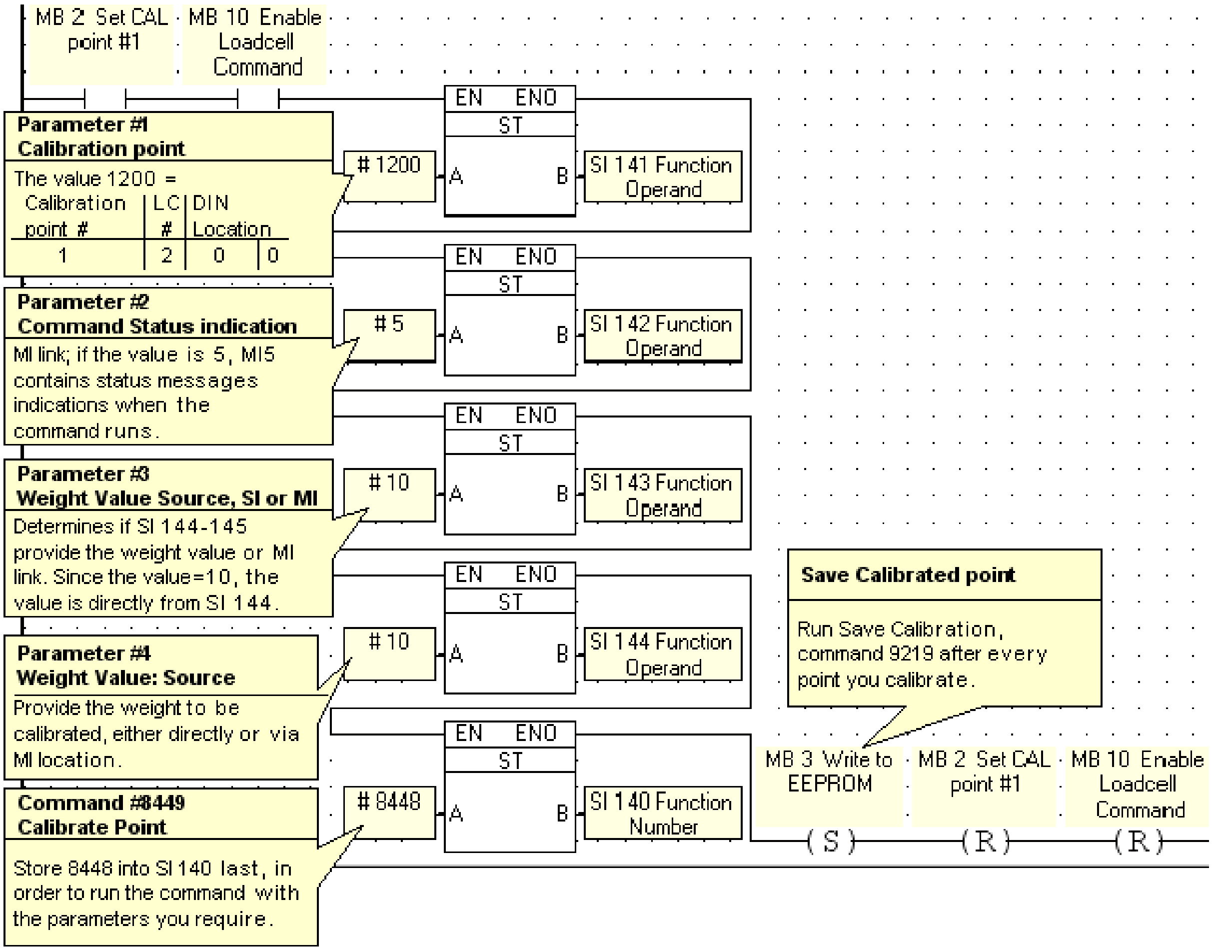
To calibrate points, the Loadcell must be hooked up to the PLC. A known weight is placed on the scale; the Calibrate Point command #8448 matches the raw value reading from the input to the weight value given in the command parameters. After calibrating a point, you must save it with a Save Calibration command, #9219; this burns it into the module's EEPROM memory, protecting the calibration in the event of a power outage. The nets shown in the following two figures calibrate 2 points.

To check whether the module is busy before running commands, use the contact status of MB 10 Enable Loadcell Command.

Refer to the Help topic Calibration for detailed information regarding the calibration process.

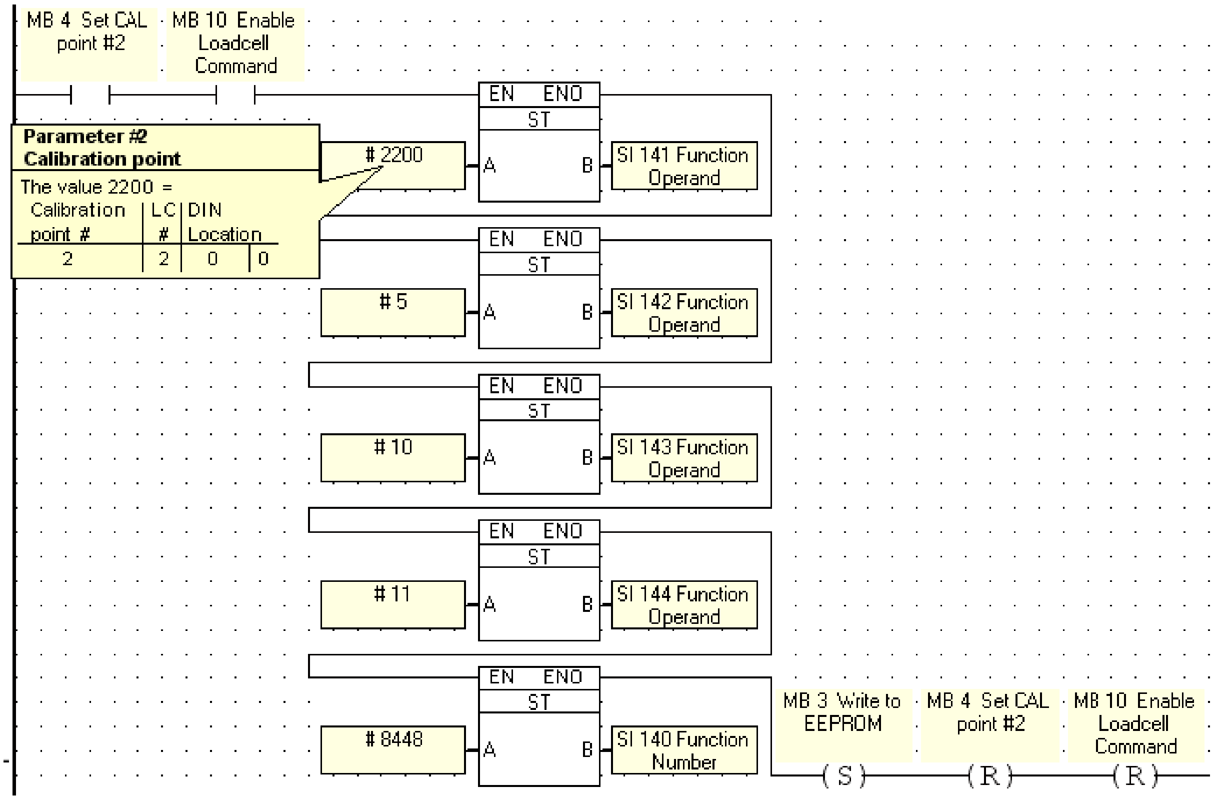
Calibrating Point 1

To calibrate point 1, store a value of 1xxx into SI 141 as shown below. The figure below shows all of the parameters required to calibrate point 1; note that the command number itself is the last value stored.



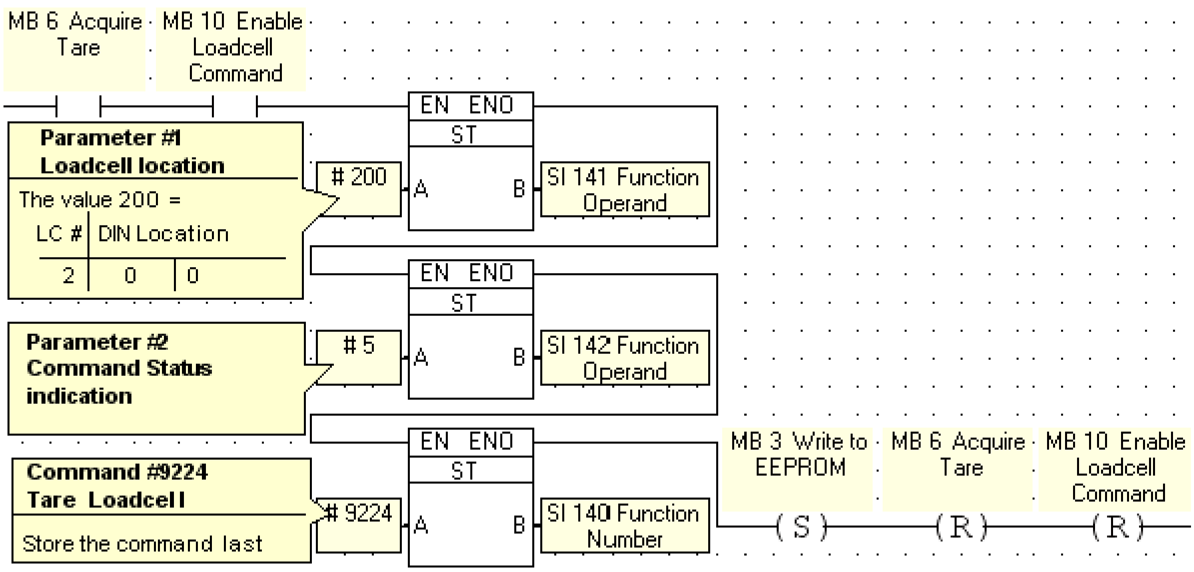
Calibrating Point 2

To calibrate point 2, store a value of 2xxx into SI 141 as shown below. The figure below shows all of the parameters required to calibrate point 2; note that the command number itself is the last value stored. Note that MI 10 provides the weight value for the first calibrated point; MI 11 provides the weight value for the second calibrated point.



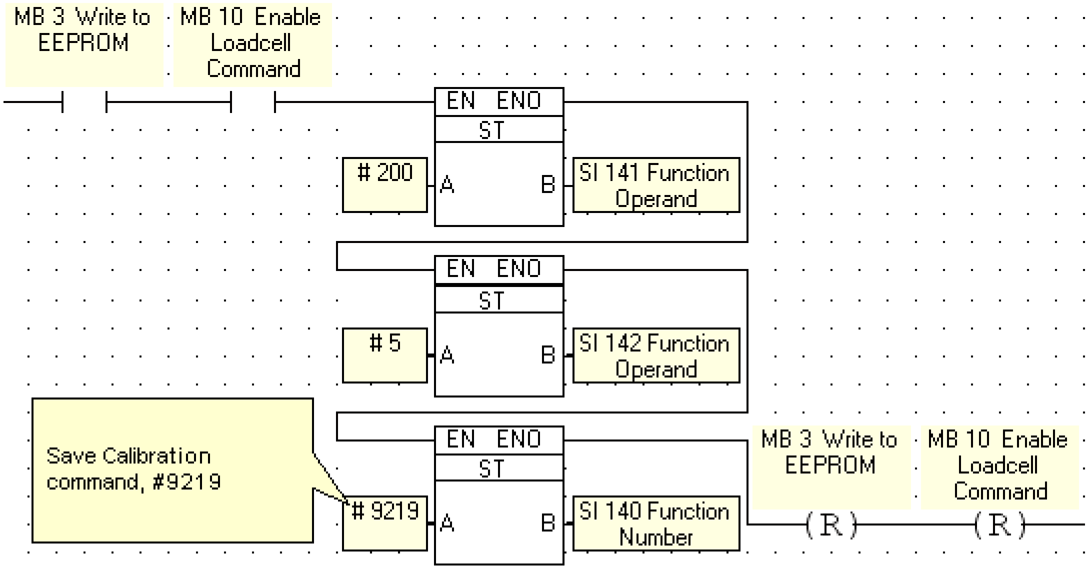
Acquiring Tare

Although it is not required by the loadcell, most applications will require tare. The Acquire Tare FB enables you to place the items to be tared on the scale, then use a condition to read the tare weight into the loadcell. Note that a Save Calibration command saves the tare weight.



Saving Calibration

The net below shows how to burn calibrated points and the tare to the module's EEPROM.



General Loadcell Parameters

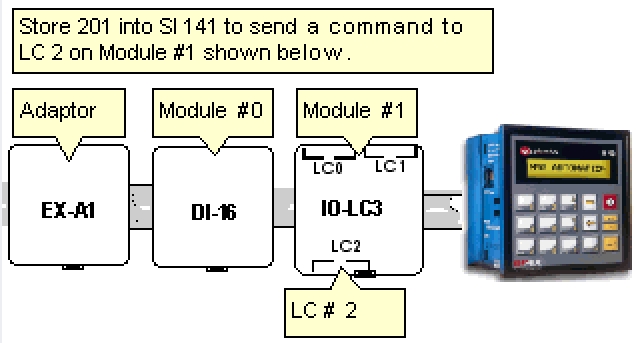
Call Loadcell commands using the Special Function SIs. First, store the required parameters into SIs 141-147. Last, store the command number into SI 140.

Note • The required data is stored into the SIs as decimal digits as shown below. The values you store depend on the command you wish to run.

The Help topics for each command show the actual digit values that you can store into the SIs, as for example in the Calibration topic.

Command parameters

<table>
<tr><th>SI</th><th>Parameter</th><th>Comments</th></tr>
<tr><td>SI 141</td><td>LC Number & DIN rail location</td><td>This parameter is divided into 4 or 5 decimal digits, depending on the command.
<table>
<tr><td>According to Command</td><td>According to Command</td><td>LC #</td><td colspan="2">DIN Rail Location</td></tr>
<tr><td>X</td><td>X</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
<table>
<tr><td>To Access</td><td>Store this value to SI 141</td></tr>
<tr><td>LC 0, Module 0</td><td>0</td></tr>
<tr><td>LC 1, Module 0</td><td>100</td></tr>
<tr><td>LC 2, Module 7</td><td>207</td></tr>
</table>
Notes:
• If the selected Loadcell is not marked 'In Use', the LC Command Status Messages MI will contain 11, Illegal parameter
• if the module is not located in the entered location, the LC Command Status Messages MI will contain 6, Communication Error (I/O module does not exist)</td></tr>
</table>



SI 142

Command Status Messages

Value	Message
0	Function in Progress
1	Command carried out successfully
2	I/O Expansion Command Buffer is full, please retry. Can be avoided by using **SB 91, I/O Expansion Module--Command Buffer Full**, as a condition
3	The I/O expansion module linked to the configuration is busy
5	Timeout Exceeded
6	Communication Error (I/O module does not exist)
11	Illegal parameter
13	Power supply not connected
16	Scale is currently in motion (is only relevant if In-Motion function is applied)
17	Signal is out of range (this value occurs when the Out of Range bit is ON)
18	Illegal weight (Occurs during calibration, if the raw value of weight being calibrated is too close to the raw value of an already calibrated weight; minimum distance is 256 or 100 Hex)
19	Command not supported in uV/V mode
20	Not calibrated (This value appears when less than 2 points have been calibrated)
21	EEPROM Protection Error (Indicates when too many Save Calibration FBs are run too frequently. Check the activating conditions for the Save Calibration FB, and whether your application contains loops)

Use SIs 143-147 to write or read values to the Loadcell when a command, such as calibration commands, requires. The Help topic for each command show you which values you store to these operands.

SI 143	Write/Read to LC Source (MI or SI) & Length:
SI 144 SI 145	Write: Address or Value
SI 146	Read to PLC
SI 147	Read to MI vector

Commands Quick Reference List

To run a command, store the command number into SI140 after storing the parameters in SIs 141-147 as required by the command.

The Help topics for each command contain details.

Calibration

Name	# SI 140	Parameters	Store to	Description
Calibrate point	8448	Calibration point #, LC #, location	SI 141	Matches a Raw Value with a Weight value. These points are used to linearize the input value.
		Status indication	SI 142	
		Weight value location, direct or MI, 1-2 registers according to resolution	SI 143	
		Contain either weight value or MI link address, according to SI 143	SIs 144, 145	
Edit Calibrated Point	8449	Calibration point #, LC #, location	SI 141	Writes new Raw Value and Weight values for a calibrated point.
		Status indication	SI 142	
		Location of Raw or Weight values written to LC, direct or MI, 2-4 registers according to resolution	SI 143	
		Contain either Raw or Weight value or MI link address, according to SI 143	SIs 144, 145	
Read Calibration Point	8705	Calibration point #, LC #, location	SI 141	Read current raw and weight values of a Calibration Point from LC, write values into PLC registers.
		Status indication	SI 142	
		Contain either Raw or Weight value location, direct or MI, 2-4 registers according to resolution	SIs 146, 147	
Delete Calibration Point	8193	Calibration point #, LC #, location	SI 141	Delete a Calibration Point from the LC.
		Status indication	SI 142	
Save Calibration	9219	Calibration point #, LC #, location	SI 141	Burns calibration, calibrated points, tare, zero, and input range into the module's EEPROM.
		Status indication	SI 142	
Clear Calibration	9219	1, LC #, location	SI 141	Deletes a specific Loadcell's calibration from module's memory, **not** EEPROM. Clear/Save Calibration use same command #; different value stored into SI 141.
		Status indication	SI 142	
Disable all other Loadcells	9228	LC location	SI 141	Number & location of the LC that will **not** be disabled.
		Status indication	SI 142	
Enable all	9228	1, LC #, location	SI 141	Enables all LCs on module, Disable/Enable

Loadcells		Status indication	SI 142	use same command #; different value stored into SI 141.

Tare & Zero

Name	# SI 140	Parameters	Store to	Description
Acquire Tare from LC	9224	LC #, location	SI 141	Acquires Tare weight from scale connected to LC.
		Status indication	SI 142	
Acquire Zero from LC	9224	1, LC #, location	SI 141	Acquires Zero value from scale; scale must be empty. Acquire Tare/Zero use same command #; different value stored into SI 141.
		Status indication	SI 142	
Edit Tare Value	8456	LC #, location	SI 141	Acquires a new tare value from a register or constant value within the PLC.
		Status indication	SI 142	
		Location of Tare values, direct or MI, 1-2 registers according to resolution	SI 143	
		Contain either Tare values or MI link address, according to SI 143	SI 144, 145	
Edit Zero Value	8456	1, LC #, location	SI 141	Acquires a new zero value from a register or constant value within the PLC . Edit Tare/Zero use same command #; different value stored into SI 141.
		Status indication	SI 142	
		Location of Tare values, direct or MI, 1-2 registers according to resolution	SI 143	
		Contain either Tare values or MI link address, according to SI 143	SI 144, 145	
Read Tare from LC	8712	LC #, location	SI 141	Copies the current tare value applied to specified LC into the linked PLC registers.
		Status indication	SI 142	
		Store 10 (low resolution) or 20 (high resolution)	SI 146	
		Store address of MI to contain Tare value	SI 147	
Read Zero from LC	8712	1, LC #, location	SI 141	Copies the current zero value applied to specified LC into the linked PLC register. Read Tare/Zero use same command #; different value stored into SI 141.
		Status indication	SI 142	
		Store 10 (low resolution) or 20 (high resolution)	SI 146	
		Store address of MI to contain Zero value	SI 147	

Loadcell Setup

Name	# SI 140	Parameters	Store to	Description
Motion Band	8517	LC #, location	SI 141	Determines the amount of weight change the module uses to decide if the scale is in motion.
		Status indication	SI 142	
		Location of Motion Band value, direct or MI, 1-2 registers according to resolution	SI 143	
		Contain Motion Band value or MI link address, according to SI 143	SIs 144, 145	
Set Filter and Rounding	8452	Rounding value (0-6), LC #, location	SI 141	Changes default filter parameters, settling time, & active band. Rounding further smooths the LC reading.
		Status indication	SI 142	
		Location of Settling Time & Active Band values, direct or MI, 2-4 registers according to resolution	SI 143	
		Contain Motion Band value or MI link address, according to SI 143	SI 144, 145	
Auto Zero Tracking	8455	LC #, location	SI 141	Zeros gross weight, compensates for small variations at zero point. Motion Band must be applied.
		Status indication	SI 142	
		Number of values for Time: Scale Stable, Tracking Band, Tracking Range; 3 or 6 registers per value	SI 143	
		MI link address, Start of vector, 3-6 registers according to SI 143.	SI 144	

Advanced Loadcell Functions

Name	# SI 140	Parameters	Store to	Description
Set & Activate Setpoint	8454	Output #, LC value mode (0-3) LC #, location	SI 141	Implement a Setpoint using an LC output Location of values. Note that when Setpoint is active, the Ladder application cannot control the output value.
		Status indication	SI 142	
		Number of values for Setpoint Type, Setpoint Value, Hysteresis; 3 or 6 registers per value	SI 143	
		MI link address, Start of vector, 3-6 registers according to SI 143.	SI 144	
Deactivate Setpoint	8198	Output #, LC value mode (0-3) LC #, location	SI 141	Suspends Setpoint, returns output control to Ladder application.
		Status indication	SI 142	
Change Representation Mode	9481	Value to be changed (1or 2) LC #, location	SI 141	Changes the LC representation mode, default for first register is Net Weight, and Gross Weight for second register. 0 - Net weight 1 -Gross weight 2 - Net Min 3 - Net Max
		Status indication	SI 142	
		Source of Representation Mode, direct or MI	SI 143	
		Contains Representation Mode value (0-7) or MI link address,	SI 144	

		according to SI 143		6 - uV/V 7 - Raw value
Reset Net Min/Max Values	9226	LC #, location	SI 141	Resets the Net Minimum value to positive full-scale, & Net Maximum value to negative full-scale.
		Status indication	SI 142	

@@@@

Input Range

Name	# SI 140	Parameters	Store to	Description
Set Gain	8461	LC #, location	SI 141	Limits the input range. The gain is applied to the signal **after** offset compensation.
		Status indication	SI 142	
		Source of Gain Value , direct or MI	SI 143	
		Contains Gain Value or MI link address, according to SI 143	SI 144	
Set Offset	8461	1, LC #, location	SI 141	Sets offset compensation, which is applied to the input signal before the gain. Offset default is set to 0mV (no offset). Set Gain/Offset use same command #; different value stored into SI 141
		Status indication	SI 142	
		Source of Offset Value, direct or MI	SI 143	
		Contains Offset Value or MI link address, according to SI 143	SI 144	
Read Gain	8717	LC #, location	SI 141	Copies the Gain Value from the Loadcell to the PLC.
		Status indication	SI 142	
		Store 10	SI 146	
		Store address of MI containing Gain value	SI 147	
Read Offset	8717	1, LC #, location	SI 141	Copies the Offset Valuefrom the Loadcell to the PLC. Read Gain/Offset use same command #; different value stored into SI 141
		"Status indication	SI 142	
		Store 10	SI 146	
		Store address of MI containing Offset value	SI 147	

Change Excitation Mode

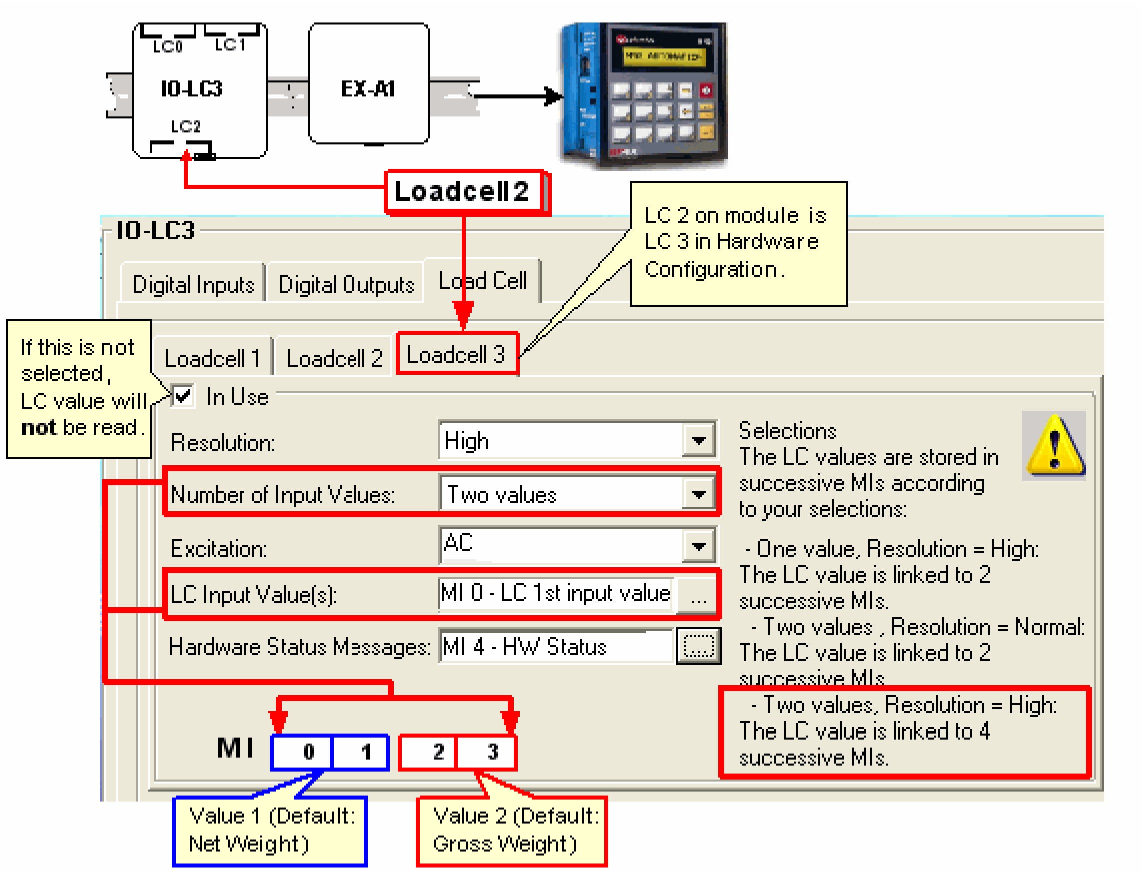
Name	# SI 140	Parameters	Store to	Description
Change Excitation Mode	8270	0 (change to DC mode), LC #, location	SI 141	Temporarily change the excitation supplied to the loadcell. This method is intended to use only for diagnostic purposes, such as when using a DC milli-voltmeter.
		1 (change to AC mode), LC #, location		
		Status indication	SI 142	

Loadcell Hardware Configuration

The IO-LCx Hardware Configuration enables you to configure a loadcell, plus the digital input and digital outputs located on the module. These digital I/Os enable you to implement setpoints that are processed within the I/O module, independently of the controller and its program scan, enabling a fast response to process events.

Configuring a Loadcell

The number of Loadcell tabs in the Hardware Configuration window depends upon the loadcell module.



Parameter	Type	Function
In use		Select 'In Use' to enable the loadcell for the application. **Note** □ A loadcell marked 'in use' can be suspended according to application conditions via the Advanced Calibration function Enable/Disable loadcell. This may be done to shorten the application's calibration time.
Resolution	MI	Selecting High enables you to link the input value to one or 2 MIs, Normal to an MI. Note that you can process 2 MIs values as 'long' integers as explained in the Help topic Special Function 'Long' Integers.
LC Input Value(s)	MI	When the application runs, these registers contain the weight value input to the controller from the I/O LCx. The LC values are **automatically linked** to successive MIs according to the Number of Input Values and Resolution you select. Take care not to overwrite these MIs during the application. Selections: • One value, Resolution = Normal: the LC value is linked to 1 MI. • One value, Resolution = High : the LC value is linked to 2 successive MIs. • Two values , Resolution = Normal: the LC value is linked to 2 successive MIs.

		• Two values, Resolution = High: the LC value is linked to 4 successive MIs. The default representation mode for the first value is **Net Weight**, and **Gross Weight** for the second.
Excitation		AC is the default, recommended Excitation method. You may select the DC option if your application requires.
Hardware Status Messages	MI	Provides a bitmap showing the status of the module.

Bit#	Description	Turns ON when:	Turns OFF when:
0	Scale motion Only relevant if Motion Band is included in application and activated	Scale is in motion	• At Power-up • When Scale is steady
1	Input Value Range Linked to I/O module's Out of Range LED indicator	Input value is out of range Possible causes: • 1 or more signal wires are disconnected • A/D input voltage is out of range	Input value is in range
2	Input Value Validity	Input Value is invalid Possible causes: • Channel is temporarily disabled, via the Disable all other Loadcells command • Bit is ON at Power-up until the first input value is received from the loadcell	Input Value is valid
3	Loadcell Calibration Status	When less than 2 points are calibrated	At least 2 points are calibrated
4	Input Power Supply Status Linked to I/O module's Out of Range LED indicators	No Power • When the input power is not supplied, the indicators blinks rapidly	Power Supply OK

Note □ Bits 6 & 7 are linked to Outputs 0 & 1, located on the I/O module. Bit 6 is related to Output 0, Bit 7 to Output 1.

Bits 6 & 7 can be used to monitor the setpoint output's status from within the Ladder application.

The I/O module itself controls the setpoint function of the outputs. The module turns the outputs ON and OFF when the current loadcell input value reaches setpoint. Since the function is based in the firmware of the expansion module, when the output's status changes as a result of reaching/departing from setpoint, the status change is not registered by the Ladder application.

<u>Examples</u>

- When setpoint output 1 is assigned to load cell channel 0, Bit 7 of load cell 0 status will indicate the state of output 1.
- When setpoint output 0 is assigned to load cell channel 2, Bit 6 of load cell 2 status will indicate the state of output

	0.		
6	Setpoint Status, Output 0	Output 0 is ON	Output 0 is OFF
7	Setpoint Status, Output 1	Output 1 is ON	Output 1 OFF

SB91	I/O Exp. Module--Command buffer is full	ON when commands **cannot** be sent to the I/O module.	OFF when commands **can** be sent to the I/O module..

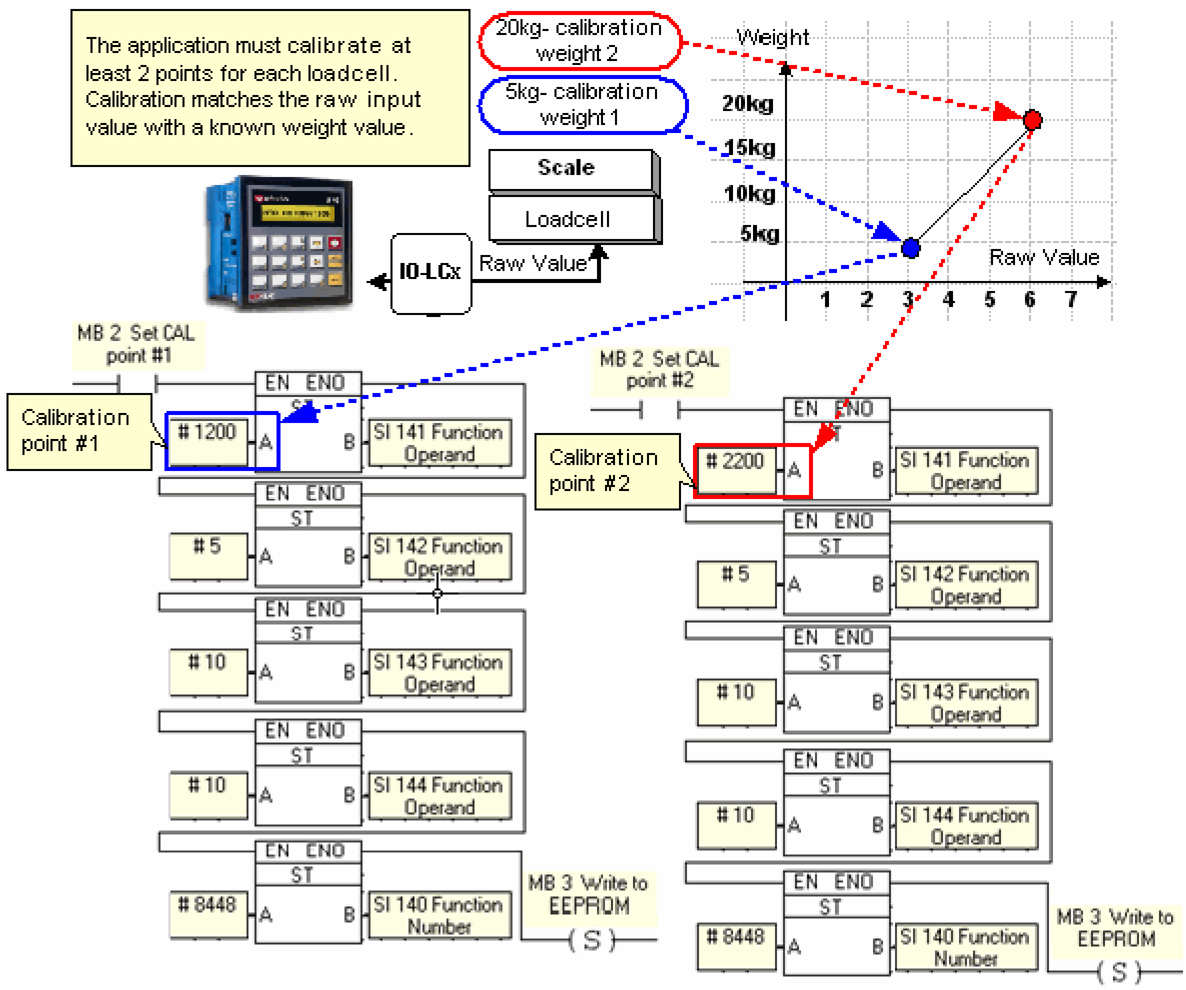
Calibration

Calibration parameters include calibrated points, input range settings, tare and zero values. These may be burned to the module's EEPROM using the Save Calibration command. Before you can begin to implement a Loadcell application, you must calibrate at least two points, although up to 12 points may be calibrated; all other calibration parameters are optional. However, note that if the application requires you to set Input Range/Gain, you must make these settings **before** you calibrate points. Setting the Input Range/Gain after calibrating points invalidates these points.

Calibrating Points

A Calibration Point matches a Raw Value with a Weight value. These points are used to linearize the input value.

To calibrate points, connect the controller to the loadcell via the I/O-LCx. Initial calibration is generally performed with known weights as shown in the following figure. After calibration has been performed, advanced calibration enables points to be added or edited via the ladder without weight being physically placed on the loadcell.



Notes

- If the application requires you to set Input Range/Gain, you must make these settings **before** you calibrate points. Setting the Input Range/Gain after calibrating points invalidates the calibrated points.
- Zero does not have to be calibrated.
- Points do not have to be calibrated in any particular order.
- All calibrated points must be separated by a raw value minimum of 256 (100 Hex).
- Calibration is an immediate operation; motion is not checked before the operation is carried out.
- Calibration should be performed with greater accuracy than is required by the application. For example, in an application that requires 100g accuracy, calibrate in units of 10g, then round off the represented value by 10.
- The highest Calibrated Point weight value should 80–100% of the scale capacity.
- Calibration cannot be performed if the selected representation mode is uV/V.
- During calibration, increase filter depth by:
  - Increasing Settling Time.
  - Disabling other Loadcells.

Calibrate point, Command # 8448

Matches a Raw Value with a Weight value. These points are used to linearize the input value.

Store the following parameters before storing the command number into SI 140.

Command parameters

SI 141	Determines the number of a calibration point, the Loadcell to be calibrated, and the DIN rail location of the module. Four digits are stored in SI 141. <table><tr><td>Calibration Point #</td><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>1-12</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table> • To calibrate Point 1, for LC 3, located on the last module on the DIN rail, store 1207 into SI 141. • To calibrate Point 2, for the same LC, store 2207 into SI 141.
SI 142	MI address; this MI will contain the Command Status indication
SI 143	Determines the source of the weight value. If you have set your Hardware Configuration to High Resolution, use 2 registers to provide the weight value. <table><tr><td>Take calibration values from</td><td>Store this value to SI 143</td></tr><tr><td>1 MI</td><td>10 (in this case, store the MI address in SI 144)</td></tr><tr><td>2 MIs</td><td>20 (in this case, store the first MI address in SI 144)</td></tr><tr><td>SI 144</td><td>4 (in this case, the value in SI 144 is written to the Loadcell according to the command)</td></tr><tr><td>SIs 144 & 145</td><td>5 (in this case, the value in SIs 144 and 145 are written to the Loadcell)</td></tr></table>
SI 144, SI 145	These two SIs provide the weight to be calibrated, either the weight value or the location of the MI containing the weight value. <table><tr><td>If the value of SI 143 is:</td><td>Result</td></tr><tr><td>4</td><td>The weight value will be taken directly from SI 144 (low resolution)</td></tr><tr><td>5</td><td>The weight value will be taken directly from SI 144 and SI 145 (high resolution)</td></tr><tr><td>10</td><td>The number of the MI containing the weight value will be taken from SI 144 (low resolution)</td></tr><tr><td>20</td><td>The numbers of the first MIs containing the weight value will be taken from SI 144 (high resolution)</td></tr></table>
SI 140	Command number:**8448**

Edit Calibrated Point, Command # 8449

Enables you to write new Raw Value and Weight values for a calibrated point.

Command parameters

SI 141	Determines the number and location of the point to be edited. <table><tr><td>Calibration Point #</td><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>1-12</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table>
SI 142	MI address; this MI will contain the Command Status indication

SI 143

Determines the location of the Raw and Weight values written to the Loadcell.

Take values from	Store this value to SI 143
1 MI	10 (in this case, store the MI address in SI 144)
2 MIs	20 (store the first MI address in SI 144)
4 MIs	40 (store the first MI address in SI 144)
SIs 144 (Raw Value) & 145 (Weight Value)	5) the values in SIs 144 and 145 are written to the Loadcell)

SI 144 SI 145

These two SIs provide either the Raw and Weight values or the location of the MIs containing the weight value, that is written to the Loadcell.

If the value of SI 143 is:	Result
5	The Raw Value and Weight Value will be taken directly from SI 144 and SI 145 respectively
20	The value in SI 144 provides the start address of an MI vector that is 2 MIs long. The first MI provides the Raw value, the second provides the Weight value.
40	(High Resolution) The value in SI 144 provides the start address of an MI vector, that is 4 MIs long. The first 2 MIs provide the Raw value, the second 2 MIs provide the Weight value.

SI 140

Command number:**8449**

Read Calibration Point, Command # 8705

Use this function to read the current raw and weight values of a Calibration Point from the Loadcell and write them into PLC registers.

Notes • If the point being read is not in use, both returned values will be -32768 (0x8000) for integer and -8388608 (0x800000) for long.

Command parameters

SI 141

Determines the number and location of the point to be read.

Calibration Point #	LC #	DIN Location	
1-12	0-2	Always 0	0-7

SI 142

MI address; this MI will contain the Command Status indication

SI 146 SI 147

Determines the number of MIs that will hold the data read from the Loadcell.

If the value of SI 146 is:	Result, SI 147
20	The value in SI 147 provides the start address of an MI vector that is 2 MIs long. The Raw Value will be written into the first MI, the Weight Value will be written into the second.
40	(High Resolution) The value in SI 147 provides the start address of an MI vector that is 4 MIs long. The Raw Value will be written into the first 2 MIs, the Weight Value will be written into the second 2 MIs.

SI 140	Command number: **8705**

Delete Calibration Point, Command # 8193

Use this function to delete a Calibration Point from the Loadcell.

Notes • The loadcell will stop functioning if deleting a point causes the number of Calibration Points to be less than 2.

Command parameters

SI 141	Determines the number and location of the point to delete. Calibration Point # / LC # / DIN Location 1-12 / 0-2 / Always 0 / 0-7
SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number: **8193**

Calibration Point #	LC #	DIN Location	
1-12	0-2	Always 0	0-7

Save Calibration, Command # 9219

When you save the calibration, calibrated points, tare, zero, and input range are burned into the module's EEPROM memory. This protects the calibration in the event of a power outage, reset, or power-up. When you calibrate the Loadcell, save each point after it is calibrated.

To preserve any changes made to calibrated points, input range settings, tare and zero values, use Save Calibration any time these parameters are edited.

Command parameters

SI 141	Determines the number and location of the point to be saved. **Save** Each point must be saved after it is calibrated. LC # / DIN Location 0-2 / Always 0 / 0-7 • Storing the value 202 into SI 141 and 9219 into SI 140 saves the calibration of Loadcell 3 on the 3rd module on the DIN rail.
SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number: **9219**

Clear Calibration, Command # 9219

This deletes a specific Loadcell's calibrated points, tare, zero, and input ranges from the module's memory. However, Clear Calibration does not erase the values from the EEPROM. They may be retrieved from the EEPROM by resetting the controller.

To delete all values from the EEPROM, run Clear Calibration followed by Save Calibration. Clear Calibration and Save Calibration use the same command number; the difference is the value stored into parameter SI 141.

Command parameters

SI 141	Determines the location of the Loadcell calibration to be cleared. **Clear** <table><tr><td>Clear</td><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>1</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table> • Storing the value **1**202 into SI 141 and 9219 into SI 140 clears the calibration (all calibrated points) of Loadcell 3 on the 3rd module on the DIN rail.
SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number: **9219**

Disable\Enable all other Loadcells, Command # 9228

Disable All Other Loadcells disables all loadcells in the expansion module **except** for the loadcell selected in the command.

During Calibration, the Disable All Other Loadcells command can be used to increase filter depth for a specified settling time by eliminating the delay caused by channel change (approx. 300ms) and thus ensuring faster and more accurate calibration.

To prevent channel changing from wasting settling time, use this function to disable all other loadcells except for the one you are currently calibrating.

Enable All Other Loadcells re-enables all loadcells in the expansion module.

Notes
- After this command runs, and the Command Status Messages MI linked to the selected Loadcell Configuration indicates 1, updated values for all of the enabled channels are already available at their linked operands. This indication can be used to trigger a process, such as calibration.
- Disabled Loadcells: the Hardware Status Messages MI linked to the selected Loadcell Configuration The status bit "Value not valid" will rise in the disabled load cells' Status Message MI.

Enable and Disable use the same command number; the difference is the value stored into parameter SI 141

Command parameters

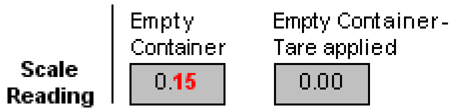
SI 141	Determines the number and location of the loadcell that will **not** be disabled. **Disable all other Loadcells** <table><tr><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table> • Storing the value 202 into SI 141 and 9219 into SI 140 disables all Loadcells on the 3rd module on the DIN rail except for Loadcell 3. **Enable all Loadcells** <table><tr><td>Enable</td><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>1</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table> • Storing the value **1**202 into SI 141 and 9219 into SI 140 enables all Loadcells on the 3rd module on the DIN rail.

SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number: **9228**

Tare & Zero

Applying Tare and Zero accomplish the same aim: to start a weighing session with a value of zero.

The Tare value may include, for example, the container of the material to be weighed.



If the scale does not read 0 when empty, use Zero to compensate.

When Tare is applied, it is reflected in the net weight.

When Zero is applied, only the gross weight will be zero at the beginning of a weighing session.

Tare & Zero
Acquire Tare/Zero: Value read from Loadcell, Command #9224

Acquire Tare: In this method, the tare value is acquired from the scale. The objects comprising the tare, such as a pallet or materials container, are placed on the scale, and Acquire Tare is activated.

Acquire Zero: The scale must be empty to acquire Zero. Acquire Zero is **not** related to the Auto-Zero Tracking function, which enables the module to compensate for the accumulation of undesired material on the scale in the course of operations.

Note • Loadcell Name determines from which loadcell the tare/zero will be acquired. After the tare has been acquired, the tare value will be applied to that loadcell.

- Use the Save Command to save Tare and Zero values to the module's EEPROM memory.
- Tare and Zero cannot be acquired when running uV/V mode.
- If the Motion Band is activated, the tare value cannot be acquired until the scale is stable.

Acquire Tare/Zero use the same command number; the difference is the value stored into parameter SI 141.

Command parameters

<table>
<tr><td>SI 141</td><td>Determines the number and location of the Loadcell to be tared.
Acquire Tare
<table>
<tr><td>LC #</td><td colspan="2">DIN Location</td></tr>
<tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
Storing the value 103 into SI 141 and 9224 into SI 140 acquires the Tare value from Loadcell 2 on the 4th module on the DIN rail.
Acquire Zero
<table>
<tr><td>Zero</td><td>LC #</td><td colspan="2">DIN Location</td></tr>
<tr><td>1</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
Storing the value 1202 into SI 141 and 9224 zeros Loadcell 3 on the 3rd module on the DIN rail.
</td></tr>
</table>

SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number: **9224**

Advanced Tare& Zero Functions

Edit Tare/Zero: value via operand or constant, Command #8456

Enables the tare or zero value to be acquired from a register or constant value within the controller. You use Edit Tare/Zero to change a specific loadcell's existing tare/zero value.

Edit Tare/Zero use the same command number; the difference is the value stored into parameter SI 141.

Command parameters

<table>
<tr><td>SI 141</td><td>Determines the number and location of the loadcell.
Edit Tare
<table><tr><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table>
Edit Zero
<table><tr><td>Zero</td><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>1</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table>
Storing the value 1202 into SI 141 and 9224 edits Loadcell 3 on the 3rd module on the DIN rail.</td></tr>
<tr><td>SI 142</td><td>MI address; this MI will contain the Command Status indication</td></tr>
<tr><td>SI 143</td><td>SI 144 and SI 145 provide either the values, or the location of the MIs containing the values that are used to edit the values.
<table><tr><td>If the value of SI 143 is:</td><td>Result</td></tr>
<tr><td>4</td><td>The Tare/Zero value will be taken directly from SI 144.</td></tr>
<tr><td>5</td><td>(High Resolution) the Tare/Zero value will be taken directly from SI 144 and SI 145.</td></tr>
<tr><td>10</td><td>The value in SI 144 provides the address of an MI that provides the Tare/Zero value.</td></tr>
<tr><td>20</td><td>(High Resolution) The value in SI 144 provides the start address of an MI vector that is 2 MIs long; providing 2 values for the Tare/Zero Value.</td></tr></table></td></tr>
<tr><td>SI 140</td><td>Command number:8456</td></tr>
</table>

Read Tare/Zero: reading the current Tare or Zero Value, Command #8712

Copies the current tare or zero value applied to the specified loadcell input into the linked PLC register.

Read Tare/Zero use the same command number; the difference is the value stored into parameter SI 141.

Command parameters

<table>
<tr><td>SI 141</td><td>Determines the number and location of the loadcell to be read.
Read Tare.
<table>
<tr><td>LC #</td><td>DIN Location</td><td></td></tr>
<tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
Storing the value 202 into SI 141 and 9224 copies the tare value from Loadcell 3 on the 3rd module on the DIN rail.

Read Zero
<table>
<tr><td>Zero</td><td>LC #</td><td>DIN Location</td><td></td></tr>
<tr><td>1</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
• Storing the value 1202 into SI 141 and 9224 copies the zero value from Loadcell 3 on the 3rd module on the DIN rail.</td></tr>
<tr><td>SI 142</td><td>MI address; this MI will contain the Command Status indication</td></tr>
<tr><td>SI 143</td><td>SI 144 and SI 145 provide the location of the MIs to which the containing the values that are used to edit the values.
<table>
<tr><td>If the value of SI 143 is:</td><td>Result</td></tr>
<tr><td>10</td><td>The value in SI 144 provides the address of an MI that will hold the Tare/Zero value.</td></tr>
<tr><td>20</td><td>(High Resolution) The value in SI 144 provides the start address of an MI vector that is 2 MIs long; providing 2 values to hold the Tare/Zero Value.</td></tr>
</table></td></tr>
<tr><td>SI 140</td><td>Command number:8712</td></tr>
</table>

Loadcell Setup

Setup commands provide additional parameters that you may require for your application. Setup includes Motion Band, Filter & Rounding, and Auto-Zero.

Note • Setup is not saved to EEPROM.

Motion Band, Command #8517

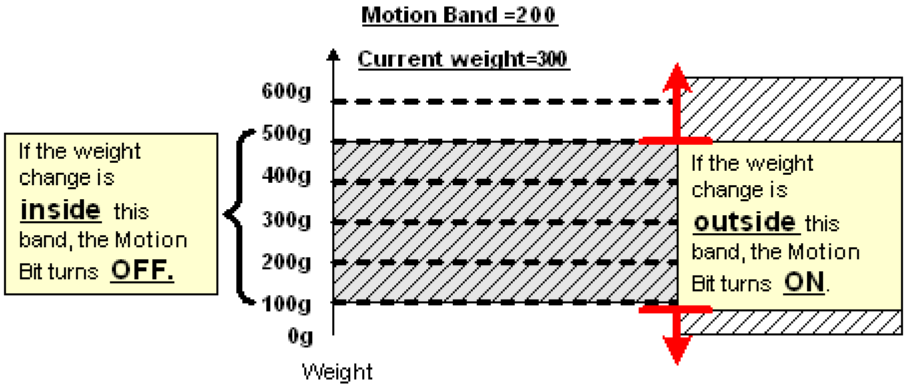
When the weight on the scale changes, the scale needs time to stabilize.

The Motion band determines the amount of weight change the module uses to decide if the scale is in motion.

Bit 0, of the MI that is linked to **LC Hardware Status Messages in Hardware Configuration, is the In-motion indicator. Bit 0 is ON when the s**cale is in motion, and OFF when the scale is steady.

As the module reads the signals from the loadcell(s) it calculates the weight value. If a weight change falls within the Motion Band, Bit 0 turns OFF.

In the figure below, the in-motion indicator (Bit 0) turns ON when the weight change is below 100 grams, or more than 500 grams. When the weight change falls within the band, Bit 0 turns OFF.



Notes • The In-motion indication is OFF:
- at Power-up
- or when the scale is not calibrated.

• In order for the In-Motion indication to function properly, the filter Active Band must be equal or higher than the In-Motion Tolerance. Refer to the Filter and Rounding function for description and power-up defaults.

• If the Motion Band is active, the tare/zero values cannot be acquired when the scale is in motion.

Command parameters

<table>
<tr><td>SI 141</td><td>Determines the Loadcell number, and the DIN rail location of the module. Four digits are stored in SI 141.
<table>
<tr><td>LC #</td><td>DIN Location</td><td></td></tr>
<tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table></td></tr>
<tr><td>SI 142</td><td>MI address; this MI will contain the Command Status indication.</td></tr>
<tr><td>SI 143</td><td>Use SI 143 to apply Motion Band.
SI 144 and SI 145 provide either the Motion Band values, or the location of the MIs containing the values that are used to apply the Motion Band.
<table>
<tr><td>If the value of SI 143 is:</td><td>Result</td></tr>
<tr><td>4</td><td>The Motion Band value will be taken directly from SI 144.</td></tr>
<tr><td>5</td><td>(High Resolution) The value in SI 144 provides the start address of an MI vector, the Motion Band value will be taken directly from SI 144 and SI 145.</td></tr>
<tr><td>10</td><td>The value in SI 144 provides the address of an MI that provides the Motion Band value.</td></tr>
<tr><td>20</td><td>(High Resolution) The value in SI 144 provides the start address of an MI vector that is 2 MIs long.</td></tr>
</table></td></tr>
<tr><td>SI 140</td><td>Command number:#8517</td></tr>
</table>

Set Filter and Rounding, Command #8452

The Filter & Rounding command changes the default filter parameters, settling time, and the active band. Rounding further smooths the loadcell reading.

Settling Time	The time, in units of 10msec, that the filter requires to settle to the final reading. **Notes** The default settling time is 1 second, the minimum time 1 is 12.5 milliseconds, and the maximum is 24 seconds. A value of zero disables the filter. Settling time rises with the number of active loadcells. The minimum settling times are: - 12.5ms for one active loadcell. - 675ms for two active loadcells. - 1,012.5ms for three active loadcells. Using a settling time of zero sets the settling time to its minimum value without returning an error.
Active Band	The band of weight changes in which the filter is active. The filter is turned off by weight changes that exceed the active band. This allows a rapid response to large weight changes. When the weight changes become smaller than the active band, the filter turns on. An active band of zero forces the filter to be always active. **Notes** If the Motion Band is on, the filter's Active Band must be equal or higher than the Motion Band.

Command parameters

SI 141

Determines the value used to round, the Loadcell to be calibrated, and the DIN rail location of the module. Four digits are stored in SI 141.

Rounding Value	LC #	DIN Location	
Table below	0-2	Always 0	0-7

Setting	0	1	2	3	4	5	6
Round by	1	2	5	10	20	50	100

Note Value rounding will not take effect in uV/V and Raw value representation modes.

SI 142

MI address; this MI will contain the Command Status indication

SI 143

Use SI 143 to apply Settling Time and Active Band.

SI 144 and SI 145s provide either Settling Time and Active Band values, or the location of the MIs containing the values that are used to smooth the Loadcell reading.

If the value of SI 143 is:	Result
5	The Settling Time and Active Band values will be taken directly from SI 144 and SI 145
20	The value in SI 144 provides the start address of an MI vector that is 2 MIs long. The first MI provides the Settling Time value, the second provides the Active Band.
40	(High Resolution) The value in SI 144 provides the start address of an MI vector that is 4 MIs long. The first 2 MIs provide the Settling Time value, the second 2 MIs provide the Active Band.

SI 140

Command number:**8452**

Auto Zero Tracking, Command #8455

When activated, Auto-Zero Tracking zeros the gross weight according to the conditions you set, enabling the module to automatically compensate for small variations at the zero point, such as those caused by a buildup of litter on the scale platform, or by temperature fluctuations near the scale.

Before Auto-zero Tracking can zero the scale:

- The Motion Band must be applied.
- The In-Motion bit, Bit 0 of the MI linked to **LC Hardware Status Messages** in Hardware Configuration, must already have turned OFF, indicating that the scale is steady.

Once these conditions are met, Auto-zero zeros the gross weight.

Notes
- Once Auto-Zero tracking is activated, it stays active until the function is stopped.
  To stop the function, run the Auto Zero tracking command and write 0 to the LC Time parameter.
- Auto zero tracking will not function in uV/V representation mode.

Auto Zero Tracking uses the following parameters to zero the scale.

Command parameters

Parameter	Function
Time: Scale Stable, 10 mS units	The time in which, in units of 10 mSec, the scale must be stable in order to trigger Auto-Zero Tracking. **Notes** □ To stop Auto Zero tracking, initialize this parameter to 0. □ Power-up default: 0 (auto zero tracking is off). □ To clear the auto zero tracking offset, initialize this parameter to 0, and then enter a new time value.
Tracking band, Weight from last Auto-0	This determines the maximum distance from the point of the last zero (auto or manual) in which auto-zero tracking is activated [weight units].
Tracking Range, Weight from Calib. 0	This determines the maximum weight from the point of the last calibrated zero in which auto-zero is activated.

Command parameters

<table>
<tr><td>SI 141</td><td>Determines the Loadcell number, and the DIN rail location of the module. Four digits are stored in SI 141.
<table><tr><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table></td></tr>
<tr><td>SI 142</td><td>MI address; this MI will contain the Command Status indication</td></tr>
</table>

SI 143	Use SI 143 to apply Time: Scale Stable. Tracking band and Tracking Range. SI 144 provides the start address for the vector of MIs the values that are used to apply Auto Zero Tracking. If the value of SI 143 is: — Result 30 — The value in SI 144 provides the start address of an MI vector that is 3 MIs long; providing the respective values for Time: Scale Stable. Tracking band and Tracking Range. 60 — (High Resolution) The value in SI 144 provides the start address of an MI vector that is 6 MIs long, providing 2 MIs for each value. • To stop Auto Zero Tracking, initialize the Time: Scale Stable parameter by running the command, when the MI used by SI 144 to provide the Time: Scale Stable parameter equals zero. • To clear the auto zero tracking offset, run the command twice; the first time initialize Time Scale stable as described above, the second time with a new time value.
SI 140	Command number:**#8455**

Advanced Loadcell Functions

Setpoint

Each digital output located on the I/O module is associated with a setpoint. The I/O module itself controls the setpoint function of the outputs. The module turns the outputs ON and OFF when the current loadcell input value reaches setpoint. Setpoint activity is therefore not linked to the program scan. Each output may be assigned a setpoint.

Since the function is based in the firmware of the expansion module, when the output's status changes as a result of reaching/departing from setpoint, the status change is not registered by the Ladder application. To monitor the outputs' status, the Hardware Status Messages MI provides a bitmap indicating status messages; Bit 6 is related to Output 0, Bit 7 to Output 1.

Therefore, use Bits 6 & 7 of the **LC Hardware Status Messages** MI to monitor the outputs' status, from within the Ladder application.

Note • Once the Setpoint is activated, it cannot be changed by setting the output via the Ladder application.

The setpoint remains OFF, regardless of its N.O./N.C.setting, when the loadcell input value is:

- invalid (i.e., powered off, LC disabled, out of range, loadcell not calibrated.
- In uV/V mode.

Examples

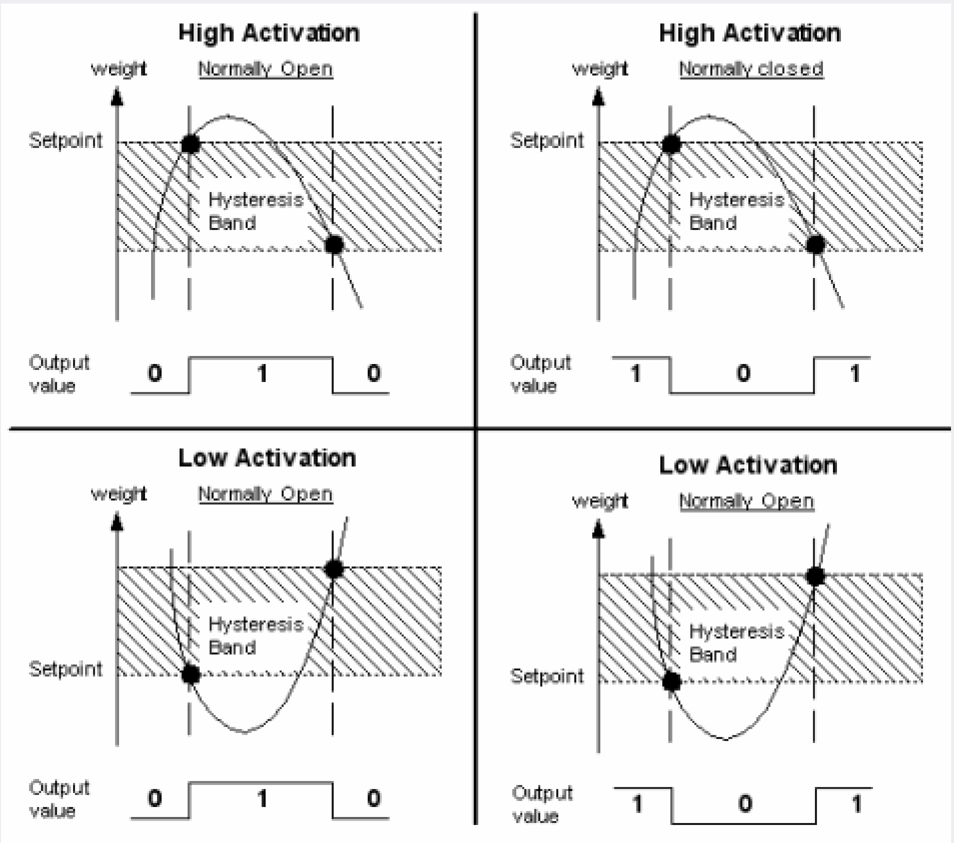
- When setpoint output 1 is assigned to load cell channel 0, Bit 7 of load cell 0 status will indicate the state of output 1.
- When setpoint output 0 is assigned to load cell channel 2, Bit 6 of load cell 2 status will indicate the state of output 0.

Bit	Description	Turns ON when:	Turns OFF when:
6	Setpoint Status, Output 0	Output 0 is ON	Output 0 is OFF
7	Setpoint Status, Output 1	Output 1 is ON	Output 1 OFF

Set and Activate Setpoint, Command #8454

Use this command to implement a desired setpoint.

Command parameters

Parameter	Function
LC Value Mode	Set the input value mode for the setpoint: • 0 - Net • 1 - Gross • 2 - Net Min • 3 - Net Max
LC Output Number	Select output: • Output - 0 • Output - 1
LC Setpoint Type	Select setpoint type: 0 - Normal state: Open Activation: Low 1 - Normal state: Open Activation: High 2 - Normal state: Closed Activation: Low 3 - Normal state: Closed Activation: High 
LC Setpoint Value	The actual value assigned to the setpoint.
LC Setpoint Hysteresis	Sets a band in which the output will not chatter due to overshoot or vibrations.

Command Parameters

SI 141	Determines the Output number, the LC Value Mode, and the DIN rail location of the module. Five digits are stored in SI 141. <table><tr><th>Output number</th><th>LC Value Mode</th><th>LC #</th><th colspan="2">DIN Location</th></tr><tr><td>• Output - 0 • Output - 1</td><td>• 0 - Net • 1 - Gross • 2 - Net Min • 3 - Net Max</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table>• Storing the number 11203 will apply Setpoint to output 1, using Gross, on Loadcell 2, module 4 on the DIN rail.
SI 142	MI address; this MI will contain the Command Status indication.
SI 143	Use SI 143 to apply Setpoint Type, Setpoint Value, and Hysteresis. SI 144 provides the start address for the vector of MIs the values that are used to apply Setpoint. <table><tr><th>If the value of SI 143 is:</th><th>Result</th></tr><tr><td>30</td><td>The value in SI 144 provides the start address of an MI vector that is 3 MIs long; providing the respective values for Setpoint Type, Setpoint Value and Setpoint Hysteresis.</td></tr><tr><td>60</td><td>(High Resolution) The value in SI 144 provides the start address of an MI vector that is 6 MIs long, providing 2 MIs for each value.</td></tr></table>
SI 140	Command number:**#8454**

Deactivate Setpoint, Command #8198

Use this to suspend the activity of a particular setpoint.

Note • Once the Setpoint is deactivated, the output may be controlled via the Ladder application.

Command parameters

SI 141	Determines the Output number, the LC Value Mode, and the DIN rail location of the module. Four digits are stored in SI 141. <table><tr><th>Output number</th><th>Reserved</th><th>LC #</th><th colspan="2">DIN Location</th></tr><tr><td>• Output - 0 • Output - 1</td><td>Always 0</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table>• Storing the number 10203 will suspend the Setpoint of output 1, on Loadcell 2, module 4 on the DIN rail.

SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number:**#8198**

Change Representation Mode, Command #9481

During hardware configuration, under Number of Values, you select whether to use one or two values. When you select a register for the Address: Value(s) parameter, selecting two values means that the register immediately following the register you select is used for the second value. The default representation mode for the first register is Net Weight, and Gross Weight for the second register.

By writing the desired mode number to the Loadcell, you can 'read' the value as:

- 0 - Net (Gross if no Tare) (Power-up default for 1st value)
- 1 - Gross (Power-up default for 2nd value)
- 2 - Net Min
- 3 - Net Max
- 6 - uV/V
- 7 - Raw value

Note

- When, after Change Representation Mode runs, the LC Command Status Messages MI returns '1', the requested value is already in its linked operand. This means that you can use the '1' status to trigger a process which relies on this specific representation value.
- The uV/V representation mode uses the default calibration. Therefore:
  - The uV/V rep. mode indicates the actual applied differential input voltage in micro-volts per every volt of the excitation, regardless of the user-selected input range and DAC (offset) compensation.
  - Setting **one** of the values representation modes to uV/V will force **both** values to be represented in uV/V (the rep. mode of the other value will not be overwritten).
  - It takes approximately 330msec to change between uV/V and other different representation modes.
- The A/D raw value is affected by the user-selected input range (gain and DAC (offset) compensation). To cancel this effect, use the Clear Calibration command to set default calibration. To return to the last saved calibration, reset the controller (no need to re-power-up neither the unit nor the controller).

Command Parameters

SI 141	Determines to which value the command is applied, the Loadcell number, and the DIN rail location of the module. Four digits are stored in SI 141.

Which Value	LC #	DIN Location	
0=1st Value 1=2nd Value	0-2	Always 0	0-7

- To change the mode for the 2nd value reading of LC3, located on the last module on the DIN rail, store 1207 into SI 141.

SI 142	MI address; this MI will contain the Command Status indication
SI 143	Determines the source of the representation mode value. <table><tr><td>Take value from</td><td>Store this value to SI 143</td></tr><tr><td>1 MI</td><td>10 (in this case, store the MI address in SI 144)</td></tr><tr><td>SI 144</td><td>4 (in this case, the value in SI 144 sets the representation mode).</td></tr></table>
SI 140	Command number:**#9481**

Reset Net Min/Max Values, Command #9226

Resets the Net Minimum value to positive full-scale, and the Net Maximum value to negative full-scale.

As soon as the scale becomes stable, meaning that the In-motion indication is OFF, the Net Min and Max values will be set to the net value.

A Net Min and Max reset occurs also at power-up.

Command parameters

SI 141	Determines the Loadcell number, and the DIN rail location of the module. Four digits are stored in SI 141. <table><tr><td>LC #</td><td colspan="2">DIN Location</td></tr><tr><td>0-2</td><td>Always 0</td><td>0-7</td></tr></table>
SI 142	MI address; this MI will contain the Command Status indication
SI 140	Command number:**#9226**

Input Range

The Input Gain parameter sets the amplification range for the input signal.

The Offset parameter is generally used to compensate for the deadload; particularly in cases where the combined weight of deadload and payload exceed the A to D converter input range.

Input Range and Offset are considered part of the loadcell's calibration. To burn these values into the module's EEPROM memory and protect them in the event of a power outage, use the Save Calibration command.

Set Gain/Offset, Command #8461

Set Gain limits the input range. The gain is applied to the signal **after** offset compensation.

Setting the Gain to 0 limits the input range to ±20mV (Default setting), setting it to 1 limits the input range to ±80mV.

Set Offset sets the offset compensation, which is applied to the input signal **before** the gain. By default, the offset is set to 0mV (no offset).

Possible values are in the range of ±31, where: 1LSB ≈ 0.5mV/V (= 2.5mV at exactly 5V excitation). Hence, the maximum offset compensation is ±15.5mV/V (= ±77.5mV at exactly 5V excitation).

To calculate the offset value, measure the differential voltage at the input, between the -SG and +SG terminals, and then calculate the offset value according to 1LSB ≈ 0.5mV/V.

If, for example, the differential voltage at the input is 10mV, use -4 as the offset value.

Notes
- Changing Gain or Offset requires you to recalibrate and save all calibrated points.
- If the application requires you to set Input Range/Gain, you must make these settings **before** you calibrate points. Setting the Input Range/Gain after calibrating points invalidates the calibrated points.
- Offset values out of the ±31 range will be truncated and no error will be returned.
- The uV/V rep. mode uses its own input range settings and therefore is not affected by the command.

Command parameters

SI 141	Determines the number and location of the Loadcell. **Set Gain** LC # | DIN Location 0-2 | Always 0 | 0-7 • Storing the value 202 into SI 141 sets the gain for Loadcell 3 on the 3rd module on the DIN rail. **Set Offset** Offset | LC # | DIN Location 1 | 0-2 | Always 0 | 0-7 • Storing the value **1**202 into SI 141 sets the Offset for Loadcell 3 on the 3rd module on the DIN rail.
SI 142	MI address; this MI will contain the Command Status indication
SI 143	SI 144 provides either the Gain/Offset value, or the location of the MI containing the value. If the value of SI 143 is: | Result 4 | The Gain/Offset value will be taken directly from SI 144. 10 | The value in SI 144 provides the address of an MI that provides the Gain/Offset value.
SI 140	Command number: 8461

Read Gain/Offset, Command #8717

Reads the input range Gain/Offset from the Loadcell to the PLC.

Command parameters

SI 141	Determines the number and location of the Loadcell. **Read Gain** LC # | DIN Location 0-2 | Always 0 | 0-7

<table>
<tr><td></td><td>
Storing the value 202 into SI 141 reads the gain for Loadcell 3 on the 3rd module on the DIN rail .
Read Offset
<table>
<tr><td>Offset</td><td>LC #</td><td colspan="2">DIN Location</td></tr>
<tr><td>1</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
Storing the value 1202 into SI 141 reads the Offset for Loadcell 3 on the 3rd module on the DIN rail.
</td></tr>
<tr><td>SI 142</td><td>MI address; this MI will contain the Command Status indication</td></tr>
<tr><td>SI 146</td><td>
<table>
<tr><td>If the value of SI 146 is:</td><td>Result</td></tr>
<tr><td>10</td><td>When the command runs, the value in SI 147 provides the address of an MI that will contain the Gain/Offset value.</td></tr>
</table>
</td></tr>
<tr><td>SI 140</td><td>Command number: 8717</td></tr>
</table>

Change Excitation Mode, Command #8270

Use this command to temporarily change the excitation supplied to the loadcell.

This method is intended to use only for diagnostic purposes,such as when using a DC milli-voltmeter.

Note
- Changing the excitation mode may add an offset to the A/D measurements. Therefore, the system should be calibrated using the same excitation mode the loadcell will work with.
- In general, the working excitation mode should be set via Hardware Configuration.
- The Change Excitation command overrides the hardware configuration excitation setting until the next system reset / power-up.
- Changing excitation mode may cause a momentary conversions-break (about 300msec) due to filter reset.

Command parameters

<table>
<tr><td>SI 141</td><td>
Determines which excitation mode, the Loadcell number, and the DIN rail location of the module. Four digits are stored in SI 141.
<table>
<tr><td>Mode</td><td>LC #</td><td colspan="2">DIN Location</td></tr>
<tr><td>0=DC
1=AC</td><td>0-2</td><td>Always 0</td><td>0-7</td></tr>
</table>
To switch LC3, located on the last module on the DIN rail, to DC mode, store 207 into SI 141. To switch to AC mode, store 1207.
</td></tr>
<tr><td>SI 142</td><td>MI address; this MI will contain the Command Status indication</td></tr>
<tr><td>SI 140</td><td>Command number:#8270</td></tr>
</table>

MODBUS

MODBUS enables you to establish master-slave communications with any connected device that supports the MODBUS protocol. Any controller in the network may function as either master or slave using any of the controller's existing COM Ports.

Unitronics currently supports RTU (binary) transmission mode. Note that the M90 series does **not** support MODBUS; M91 models support MODBUS via built-in COM ports.

Although Jazz PLCs do not comprise built-in COM ports, Jazz can support MODBUS, provided that you install an appropriate add-on port module, available separately. Note that

- Serial communications capabilities are determined by the type of Add-on Module.
- Default COM settings and pin-outs are given in the technical specifications of the relevant Add-on Port.
- The MJ20-PRG Programming Port may be used for RS232 communications with devices that supply active (RS232 positive voltage) DTR and RTS signals.

Since there are no Ladder elements for MODBUS functions; you perform them by storing values into SIs in accordance with the tables and figures shown below.

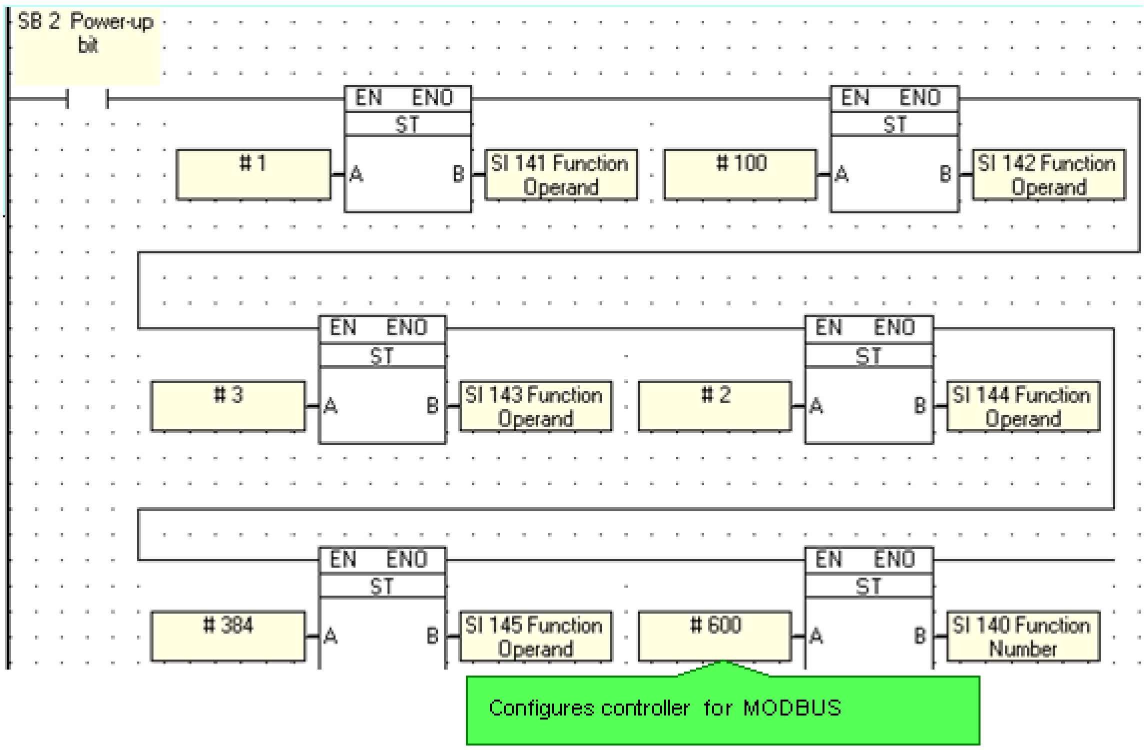
MODBUS Configuration

Before you can run a MODBUS command, you must configure MODBUS parameters for both Master and Slave devices.

Configuration Parameters

These parameters configure a controller for MODBUS communications. A device is configured for MODBUS by storing the value 600 into SI 140.

To configure a slave device, build a Ladder net that stores the appropriate values into the SIs according to the following table, and that ends by storing the value 600 into SI 140.



Parameter	Store into SI	Function
Network ID	141	Range: 0-25.

		This is the Network ID number of the device on the network. You can either assign an ID via an MI, or directly via a constant number. Do not assign the same ID number to more than one device.
Time out	142	Time out units:10 msecs; a Time out value of 100 is equal to 1 second. This is the amount of time a master device will wait for an answer from a slave.
Retries	143	This is the number of times a device will try to send a message.
Maximum Time Delay	144	Time units: 2.5 msec. This is the maximum time interval permitted between 2 messages. This should be set to 2, setting the permitted interval to 5 msecs (n x 2.5 =interval).
Baud Rate	145	Store the value into SI 145 to set the baud rate. Note that Jazz does not support the following baud rates: 110, 38400, 57600. In addition, ‘2’ Stop Bits is not supported. In Jazz controllers, use Function 310 to modify the default settings of an Add-on Port. Legal Baud rates are: 110 300 600 1200 2400 4800 9600 19200 38400 (store 384) 57600 (store 57600)
Call MODBUS Configuration	140	This must be the final parameter stored. Storing the value 600 into SI 140 configures the controller for MODBUS. Storing the value 599 into SI 140 configures the controller for MODBUS and also enables Unitronics' PC applications to access the PLC.

PC-PLC Communication: known issue

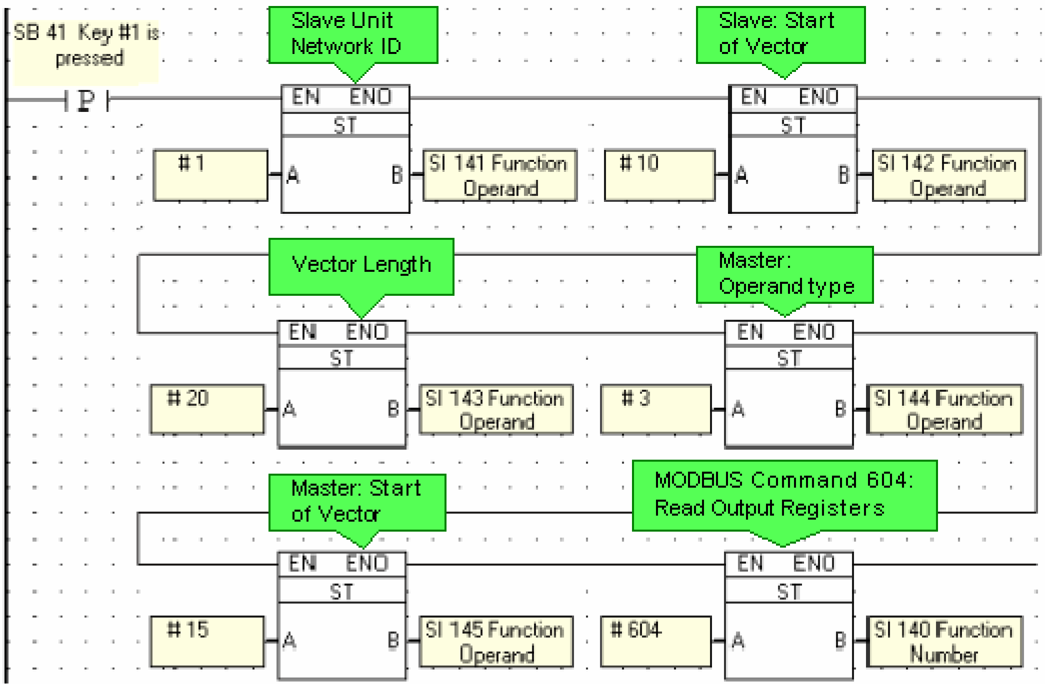
Note that Unitronics software applications, such as U90 Ladder, Remote Access, and DataXport, all use the 'backslash' character (/) (ASCII character 47) as the Start of Text (STX) character. Therefore, in order to enable a Unitronics' PC application to access a PLC communicating via MODBUS:

- Configure MODBUS by using Command Number 599 instead of 600. This means that after you store all of MODBUS Configuration parameters as shown above, you must store 599 into SI 140.
- Do NOT use controller ID number 47 in your network. Doing so will cause communication conflicts, since MODBUS protocol uses the controller ID number to begin communications strings while Unitronics applications use ASCII character 47 as an STX.

MODBUS Commands

Before you can call a MODBUS command, you store the appropriate parameter values into the correct SIs in accordance with the Command Parameters table. After this is done, call the command by storing the command number into SI 140.

The figure below shows how to implement the MODBUS command Read Output Registers.



Command Parameters

<table>
<tr><th>Parameter</th><th>Store into SI</th><th>Function</th></tr>
<tr><td>Slave Unit Network ID</td><td>141</td><td>The ID of the slave device containing the data to be read (data source).</td></tr>
<tr><td>Slave: Start of Vector</td><td>142</td><td>The start of the vector of operands in the slave. Check the Slave Address Tables below.</td></tr>
<tr><td>Vector Length</td><td>143</td><td>The vector length.
Note □ A MODBUS command cannot read/write more than 1900 bit operands at one time. In addition, 0 is not a legal length.</td></tr>
<tr><td>Master: Operand Type</td><td>144</td><td>Store the number that relates to the type of operand you wish to write to in the master device.
<table>
<tr><td>MB</td><td>1</td></tr>
<tr><td>SB</td><td>2</td></tr>
<tr><td>MI</td><td>3</td></tr>
<tr><td>SI</td><td>4</td></tr>
<tr><td>I</td><td>9</td></tr>
<tr><td>O</td><td>10</td></tr>
<tr><td>T (current)</td><td>129</td></tr>
<tr><td>T (preset)</td><td>128</td></tr>
</table></td></tr>
<tr><td>Master start of Vector</td><td>145</td><td></td></tr>
<tr><td>MODBUS Command</td><td>140</td><td></td></tr>
</table>

Note • While a master attempts to send a command, SB 63 Function In Progress is ON. The number of attempts that the master will make is the number in Retries +1, where '1' is the initial access attempt.

• When a master attempts to access a slave device, and the slave does not answer, SB 66 Function In Progress will turn ON. This bit will remain on according to the following: (the number of retries + 1) x (Time Out), where '1' is the initial access attempt. Note that the Time Out parameter is in units of 10 msec.

MODBUS Command Number

MODBUS Commands	**U90 Command # (Value to store into SI 140**
Read Coils	601
Force Coil	602 The value you enter in SI 145 (0 or 1) is written (forced) to the coil whose address is given in SI 144. Do not set Vector length (SI 143).
Force Coils	603
Read Registers	604
Preset Register	605
Preset Registers	606
Read Input Registers	609
Read Inputs	611
Loopback Test	612

MODBUS Indications: SBs and SIs

SB 66	**Turns ON when:**	**Turns OFF when**
Function in Progress Shows status of master's **MODBUS Configuration**	• A master PLC initiates MODBUS communication. • Remains ON during the MODBUS session.	• The **MODBUS: Configuration** is activated. • An answer is received from a slave. • The TimeOut defined in the **Configuration** is exceeded. • Certain Status Messages are given

SI 66 **Status Messages** Shows status of master's data requests and the replies the master receives from the slaves	• Automatically initialized to 0 when MODBUS operation is activated. • Updated at the end of each attempt to communicate via MODBUS. • Indicates status of **MODBUS** communications, according to the table below. Note that the current value always shows the most **recent** status.

#	Status Message
0	Status OK
1	Unknown Command Number This isreceived from the slave device.

2	Illegal Data Address • Master: an invalid address is found by the master before a data request is sent to a slave. This may result, for example, when an MI is used to provide vector length. • Slave: The slave notifies the master that the data request command includes invalid addresses.
3	Slave to Master: Illegal Data Type Quantity Number of operands requested by user exceeds the maximum Note A MODBUS command cannot read more than 124 16-bit integers, or 1900 bit operands at one time. In addition, 0 is not a legal vector length.
4	Master--Time Out The amount of time the master will attempt to establish a MODBUS session
5	No Communication The MODBUS session cannot be established.
Note Messages 4 & 5. **TimeOut** and **Number of Retries** are defined as **Configuration Parameters**. A Retry is an attempt to establish a MODBUS session. If, for example, TimeOut is defined as 2 seconds, and number of Retries as 3: - the controller will try to establish the session once, and will continue to try for 2 seconds. - If the first attempt fails, the **Status Message value will be 4**, Master TimeOut. -The controller will try twice more, for a total of 3 retries over 6 seconds. - If all attempts fail, the **Status Message value will be 5**. -If any attempt succeeds, the Status Message will be 0.	
*6	Master-slave data incorrectly synchronized
*7	Master-slave data incorrectly synchronized
8	Master to application: Illegal Data Type Quantity Number of operands requested by user exceeds the maximum permitted for that FB operation in the master. Note A MODBUS command cannot read more than 124 16-bit integers, 62 double registers, 62 float registers, or 1900 bit operands at one time. In addition, 0 is not a legal vector length.
9	Slave ID =0 An attempt does to communicate with Slave ID 0.
*11	Master-slave data incorrectly synchronized
* Messages 6, 7, and 11mean that the master has found incompatible elements in the data sent between master and slave.	

Slave Address Tables

Coils		**MODBUS Command Number**	
Pointer Value From:	Operand type	Read	Write
0000	MB	#601 Read Coils	#602/603 Force Coils

3000	SB	#602/603 Force Coils
4000	I (read-only)	Read-only
5000	O	#602/603 Force Coils
6000	T(read-only)	Read-only

Registers			**MODBUS Command Number**	
Pointer Value From:	Operand type	Register size	Read	Write
0000	MI	16 bit	# 604 Read Registers	# 16 Preset Registers
4000	SI	16 bit		
6900	Timer preset	16 bit		
7200	Timer current	16 bit		

Examples

The examples below show that:

- MODBUS addressing systems start at **1**.
- Unitronics PLC addressing starts at **0**.

Bit Operands

Read a 10-bit vector of inputs from a slave Unitronics PLC, starting at Input 20, into MB 8 - MB 17 in a master Unitronics PLC via Read Coils (Command 601)

- Unitronics PLC as the MODBUS master

  Store 4020 into SI 142 (Slave: Start of Vector parameter), 10 into SI 143 (Read: Vector Length parameter), 1 into SI 144 (Master: Operand Type), 8 into SI 145, and 601 into SI 140. Within the slave PLC, the master PLC will read I 20 - I 29 and force their status into MB 8 - MB 17 .
- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 34021(30001 + 4000 + 20), and the Read: Vector Length to 10, enabling the master device to read I 20 - I 29 within the slave PLC.

Write a 3-bit vector of outputs into a slave Unitronics PLC, O 8 O 10; from data source I 5 -I 7 in a master Unitronics PLC via Force Coils (Command 603).

- Unitronics PLC as the MODBUS master

  Store 5008 into SI 142 (Slave: Start of Vector parameter), 3 into SI 143 (Read: Vector Length parameter), 9 into SI 144 (Master: Operand Type), and 603 into SI 140. Within the slave PLC, the master will copy the status of its operands I 5 -I 7 to the slave's operands O 8 - O 10.

- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 35009 (30001 + 5000 + 8) and the Read: Vector Length parameter to 3, enabling the master device to write to O 8 - O 10 within the slave controller.

Registers

Read a 2-register long vector of **16-bit integers** from a slave Unitronics controller, starting at SI 80, via Read Holding Registers (Command 604) into a master PLC registers, MI 101-109

- **Unitronics PLC as the MODBUS master**
  Store 4080 into SI 142 (Slave: Start of Vector parameter), 2 into SI 143 (Read: Vector Length parameter), 3 into SI 144 (Master: Operand Type),and 604 into SI 140. Within the slave PLC, the master PLC will read the values of MI 32 - MI 40 and copy them into its own registers, SI 80 - SI 81.
- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 40033 (40001 + 0000 + 3), and the Read: Vector Length parameter to 9, enabling the master device to read MI 32 - MI 41 within the slave controller.

Note • M91 does not support 32-bit registers.

Write a 6-register long vector of **16-bit integers** into a slave Unitronics controller, starting at MI 32, via Preset Registers (Command 606); the data source is MI 100 - 105 in the Master PLC

- **Unitronics PLC as the MODBUS master**
  Store 32 into SI 142 (Slave: Start of Vector parameter), 6 into SI 143 (Read: Vector Length parameter), 3 into SI 144 (Master: Operand Type),and 606 into SI 140. Within the slave PLC, the master PLC will copy its internal registers values from MI 100 - 101 into the slave's MI 32 - MI 38.
- **SCADA as the MODBUS master**
  In the SCADA application, set the Slave: Start of Vector parameter to 40033, and the Read: Vector Length parameter to 6, enabling the master device to write to MI 32 - MI 37 within the slave controller.

Counter

Building a Counter

If you want to use a counter in your application, you build it using:

- Math function
- Compare function
- Store function

Use a Positive / Negative Transition contact on the event operand to activate the counter.

Example:

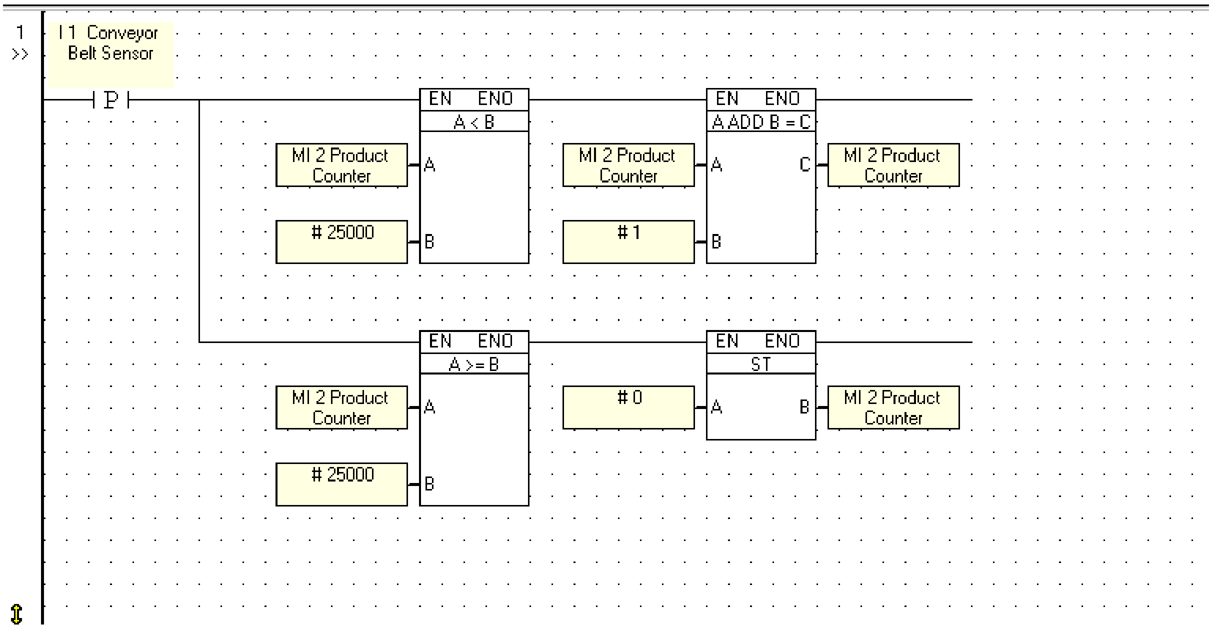
You want to count the gross number of a product traveling across a conveyor belt. There is a sensor (e.g. photocell, limit switch or proximity switch) at a specific point across the conveyor belt which senses the product as it passes.

The sensor is connected to an input. The Positive Transition from this input advances the counter by one.

When the counter value reaches the maximum defined value, the counter will reset to 0.

Counter Ladder example:

- Input 1 is the sensor
- MI 2 is the Counter
- The maximum defined value is 25000.



Keep in mind when building your counter that adding a number to 32767 will return a negative number.

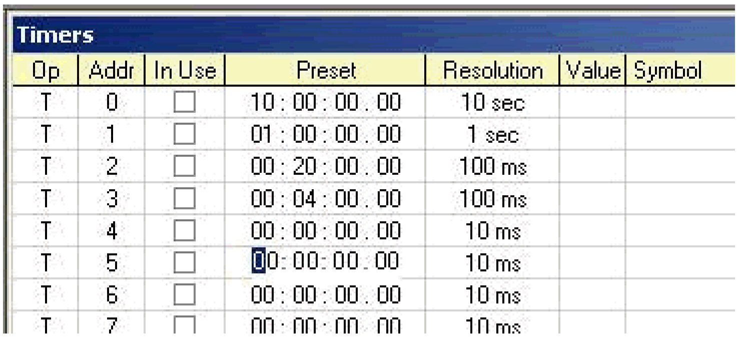
Counters are featured in several sample applications, such as the applications ' Time Interval- SI 1', 'Outputs-activate in sequence', and 'Logging analog values'. These applications may be found by selecting Sample U90 Projects from the Help Menu.

Timers

Timers (T)

U90 Ladder offers 64 On Delay Timers. Timers have a preset value, a current value, and a bit value. Timers always count **down** from the Preset Value. The timer value is 14 bits.

Click on the Timers folder in the Program Navigation pane to display the complete list of Timers. Scroll down to view the complete list.



Timers

Op	Addr	In Use	Preset	Resolution	Value	Symbol
T	0	☐	10 : 00 : 00 . 00	10 sec		
T	1	☐	01 : 00 : 00 . 00	1 sec		
T	2	☐	00 : 20 : 00 . 00	100 ms		
T	3	☐	00 : 04 : 00 . 00	100 ms		
T	4	☐	00 : 00 : 00 . 00	10 ms		
T	5	☐	00 : 00 : 00 . 00	10 ms		
T	6	☐	00 : 00 : 00 . 00	10 ms		
T	7	☐	00 : 00 : 00 . 00	10 ms		

To place a Timer in your program, place a direct coil in a net, and select T.

Timer resolutions

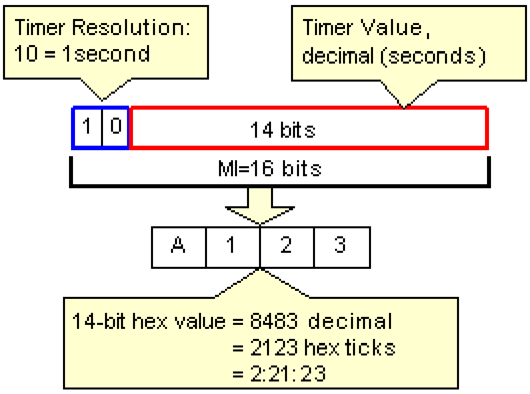
10mS (0.01S)(from 00:00:00.01 to 00:02:43.83)

100mS (0.1S)(from 00:00:00.10 to 00:27:18.30)

1000mS (1.0S)(from 00:00:01.00 to 04:33:03.00)

10000mS (10.0S)(from 00:00:10.00 to 45:30:30.00)

The first 14 bits (from the LSB) of the Timer register contains the value. The two most significant bits contain the Timer resolution.



Note that:

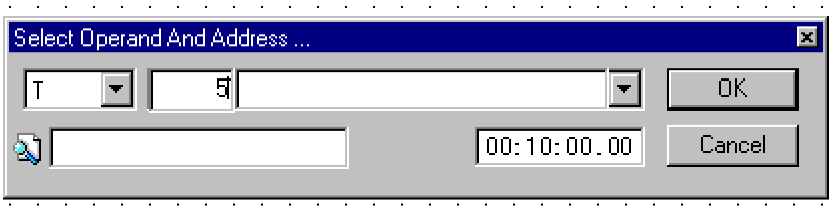
- A Timer value can be displayed in a Display as a current or elapsed value/
- The Resolution field is Read-only. The resolution is a function of the Timer Preset Value.
- You cannot change the **resolution** of a timer when the application is running.
- A timer's **current value** can be changed at any time, including when the timer is active. The new value can be either greater or smaller than the previous value; storing 0 into a timer's current value stops it immediately.
- A change of Timer Preset value without changing the resolution will take effect when the timer restarts.
- Changing the resolution of the timer's preset value does not affect the current resolution; it is therefore recommended that the resolution not be changed while the timer is active.
- During Stop mode, timers continue to run.

Setting Timers

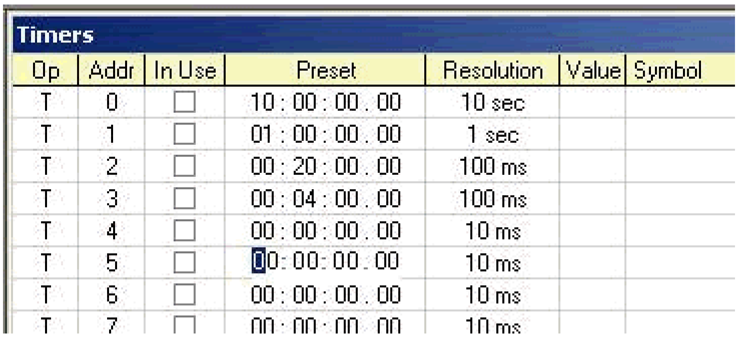
To set a Timer's time:

After selecting the Timer's Address, the Timer value field is activated.

1. Enter the time.



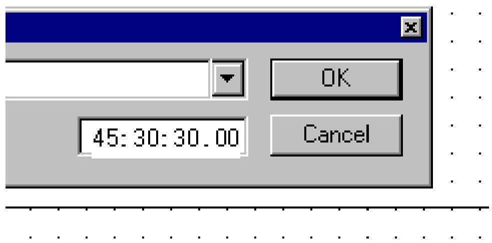
2. You can also write the time into a Timer via the Timer list window


Timers

Op	Addr	In Use	Preset	Resolution	Value	Symbol
T	0	☐	10 : 00 : 00 . 00	10 sec		
T	1	☐	01 : 00 : 00 . 00	1 sec		
T	2	☐	00 : 20 : 00 . 00	100 ms		
T	3	☐	00 : 04 : 00 . 00	100 ms		
T	4	☐	00 : 00 : 00 . 00	10 ms		
T	5	☐	00: 00: 00. 00	10 ms		
T	6	☐	00 : 00 : 00 . 00	10 ms		
T	7	☐	00 : 00 : 00 . 00	10 ms		

Note that the Resolution field is Read-only. The resolution is a function of the Timer Preset Value;

A Timer's maximum preset value is:



Note that the time format is: **HH:MM:SS.hh**.

Timer resolutions

10mS (0.01S)(from 00:00:00.01 to 00:02:43.83)

100mS (0.1S)(from 00:00:00.10 to 00:27:18.30)

1000mS (1.0S)(from 00:00:01.00 to 04:33:03.00)

10000mS (10.0S)(from 00:00:10.00 to 45:30:30.00)

Note that:

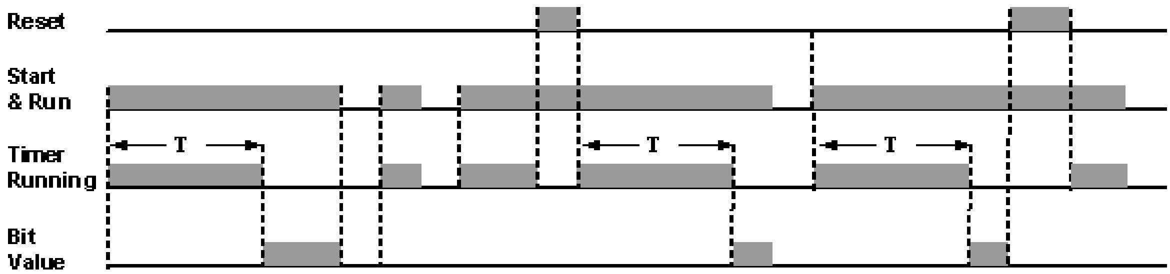
- A Timer value can be displayed in a Display as a current or elapsed value/
- The Resolution field is Read-only. The resolution is a function of the Timer Preset Value.
- You cannot change the **resolution** of a timer when the application is running.
- A timer's **current value** can be changed at any time, including when the timer is active. The new value can be either greater or smaller than the previous value; storing 0 into a timer's current value stops it immediately.
- A change of Timer Preset value without changing the resolution will take effect when the timer restarts.
- Changing the resolution of the timer's preset value does not affect the current resolution; it is therefore recommended that the resolution not be changed while the timer is active.

How Timers work

A Timer operand allows you to count time according to certain logic conditions.

A Timer has

- Preset value
- Current value
- Start and Run condition
- Bit Value



When the timer's Start & Run Condition is OFF, the timer's Bit Value is also OFF.

When the timer's Start & Run Condition rises, the timer's Preset Value is loaded into the timer's Current Value. The timer begins to run. Note that the timer's Bit Value is OFF.

If the timer's Start & Run Condition remains ON during subsequent PLC cycles, the Current Value of the timer continues to decrement.

When the timer has decremented to 0, and the timer's Start & Run Condition is still ON, the timer's Bit Value turns ON. Note that when the timer has finished running, its Current Value is 0.

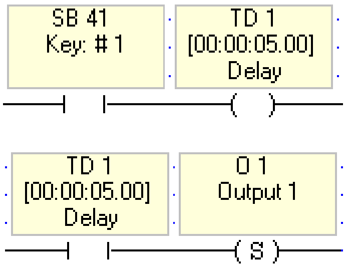
If the timer's Start & Run Condition falls while the timer is decrementing, the timer stops running. The current value of the timer remains.

Timer Reset takes precedence over the timer's Start & Run Condition. When the timer' Reset Condition rises, the timer's Bit Value turns OFF. The timer's Preset Value is loaded into the Current Value, and the timer's Start & Run Condition cannot activate the timer as long as Reset is ON.

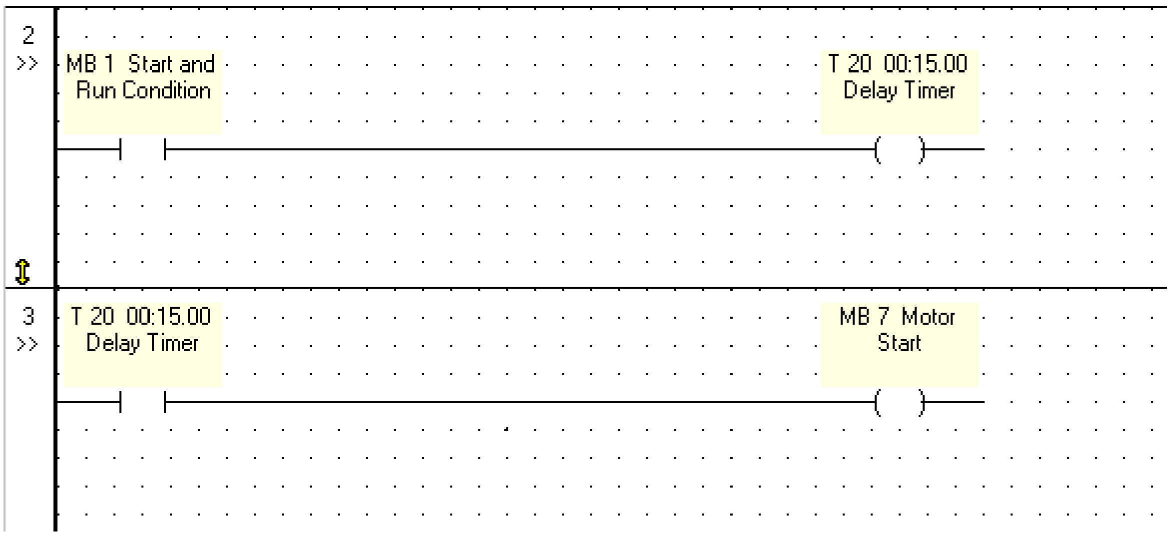
When the timer's Reset Condition falls while the timer's Start & Run Condition is ON, the timer begins to run, exactly the same as when the timer's Start & Run Condition rises.

Below, pressing Key #1 on the Vision keypad activates TD1, which is preset to 5 seconds. If Key #1 is held down for 5 seconds, TD1 decrements to zero. O1 switches on.

If, however, Key #1 is released before TD1 has finished, the timer stops. When Key #1 is pressed again, TD1 again begins to decrement from 5 seconds.



Either the current or elapsed timer value may be shown on the HMI display screen.



According to the above example:

- When MB 1 goes to logic 1 (ON), T 20 will begin to count down.
- When T 20 finished counting and goes to logic 1 (ON), MB 7 will go to logic 1 (ON) and the motor will start.

To place a Timer in your program, place a direct coil in a net, and select T.

Timer resolutions

10mS (0.01S)(from 00:00:00.01 to 00:02:43.83)

100mS (0.1S)(from 00:00:00.10 to 00:27:18.30)

1000mS (1.0S)(from 00:00:01.00 to 04:33:03.00)

10000mS (10.0S)(from 00:00:10.00 to 45:30:30.00)

Note that:

- A Timer value can be displayed in a Display as a current or elapsed value/
- The Resolution field is Read-only. The resolution is a function of the Timer Preset Value.
- You cannot change the **resolution** of a timer when the application is running.
- A timer's **current value** can be changed at any time, including when the timer is active. The new value can be either greater or smaller than the previous value; storing 0 into a timer's current value stops it immediately.
- A change of Timer Preset value without changing the resolution will take effect when the timer restarts.
- Changing the resolution of the timer's preset value does not affect the current resolution; it is therefore recommended that the resolution not be changed while the timer is active.

Store Timer's Preset/Current Value

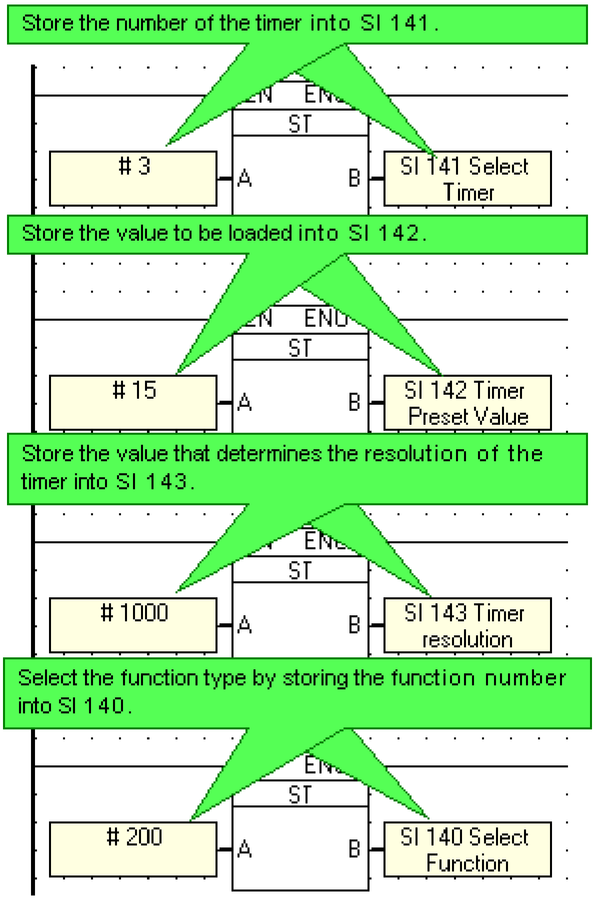
This function allows you to take a value and store it into a timer to change the preset or current timer value. Since there is no Ladder element for this function; you perform it by storing values into:

- SI 141 to select the timer; 0-63,
- SI 142 to determine the timer value,
- SI 143 to select the timer's resolution (timer units, or 'ticks'),
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

Take into account that:

- Since you cannot change the resolution of a timer when the application is running, SI 143 is not used in a Store Timer's Current Value function.
- A timer's current value can be changed at any time, including when the timer is active. The new value can be either greater or smaller than the previous value; storing 0 into a timer's current value stops it immediately.
- A change of Timer Preset value without changing the resolution will take effect when the timer restarts.
- Changing the resolution of the timer's preset value does not affect the current resolution; it is therefore recommended that the resolution not be changed while the timer is active.
- The timer value is 14 bits.

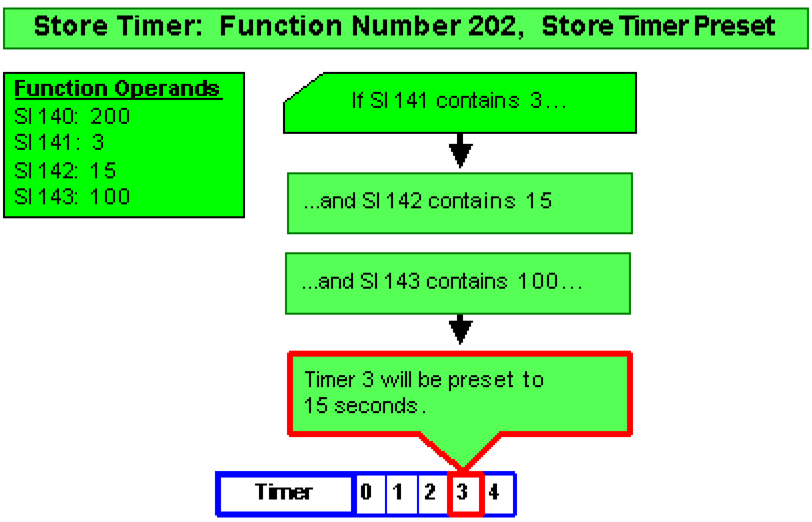
To use this function:



Function # (SI 140)	Description
200	Store Timer Preset
201	Store Timer Current

Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Timer Resolution (stored into SI 143)	
Value	**Resolution**
0	Maintain Timer Resolution
1	10mS (0.01S)
10	100mS (0.1S)
100	1000mS (1.0S)
1000	10000mS (10.0S)

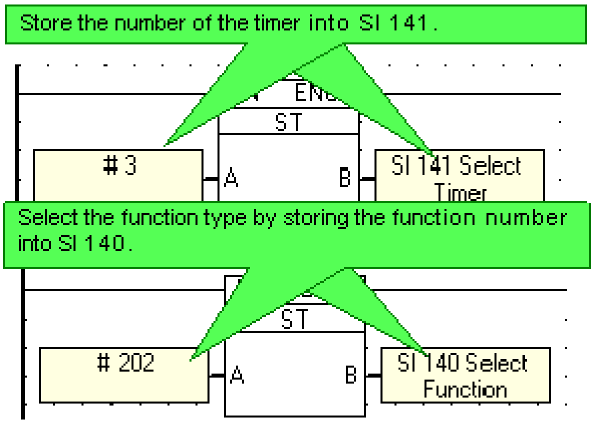


Load Timer Preset/Current Value

This function allows you to take a preset or current timer value and load it into another operand. Note that since there is no Ladder element for this function; you perform it by storing values into:

- SI 141 to select the timer; 0-63,
- SI 140 to select the type of function. Storing the function number calls the function. In your application, call the function **after** you have entered all of the other parameters.

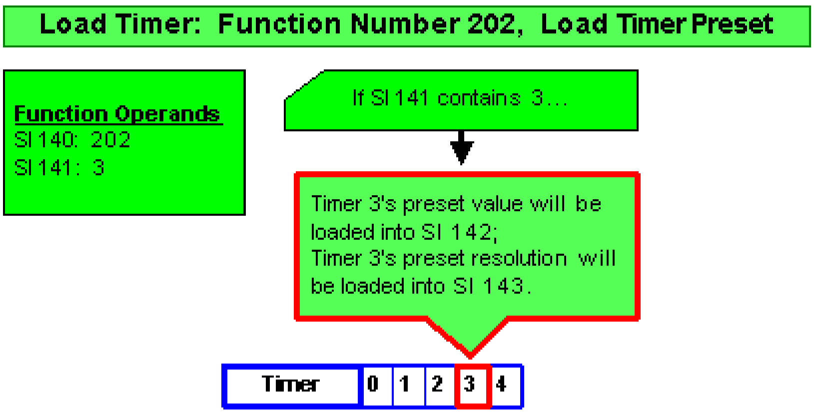
To use this function:



Function # (SI 140)	Description
202	Load Timer Preset
203	Load Timer Current

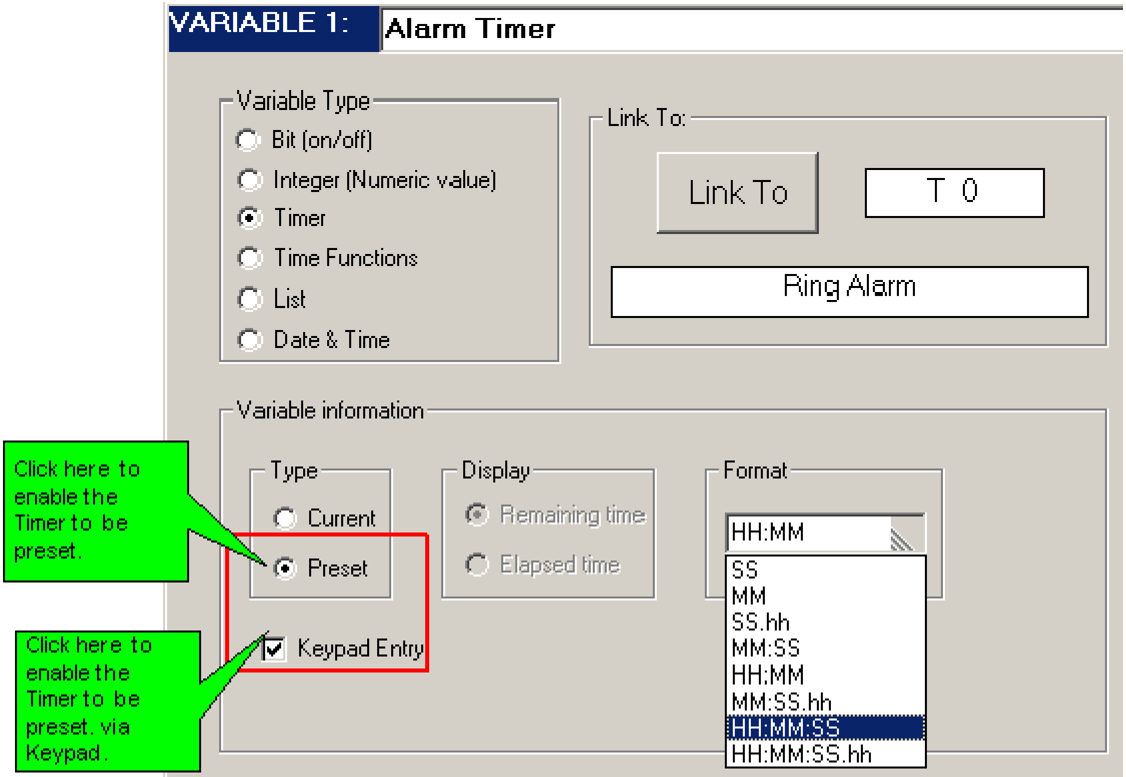
Note that when you run Test (Debug) Mode, the current value in SI 140 will **not** be displayed.

Timer Resolution (stored into SI 143)	
Value	**Resolution**
1	10mS (0.01S)
10	100mS (001S)
100	1000mS (1S)
1000	10000mS (10S)



Presetting Timers via Keypad

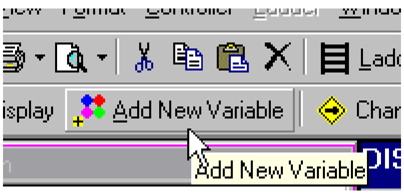
You can choose to set a timer via the keypad.



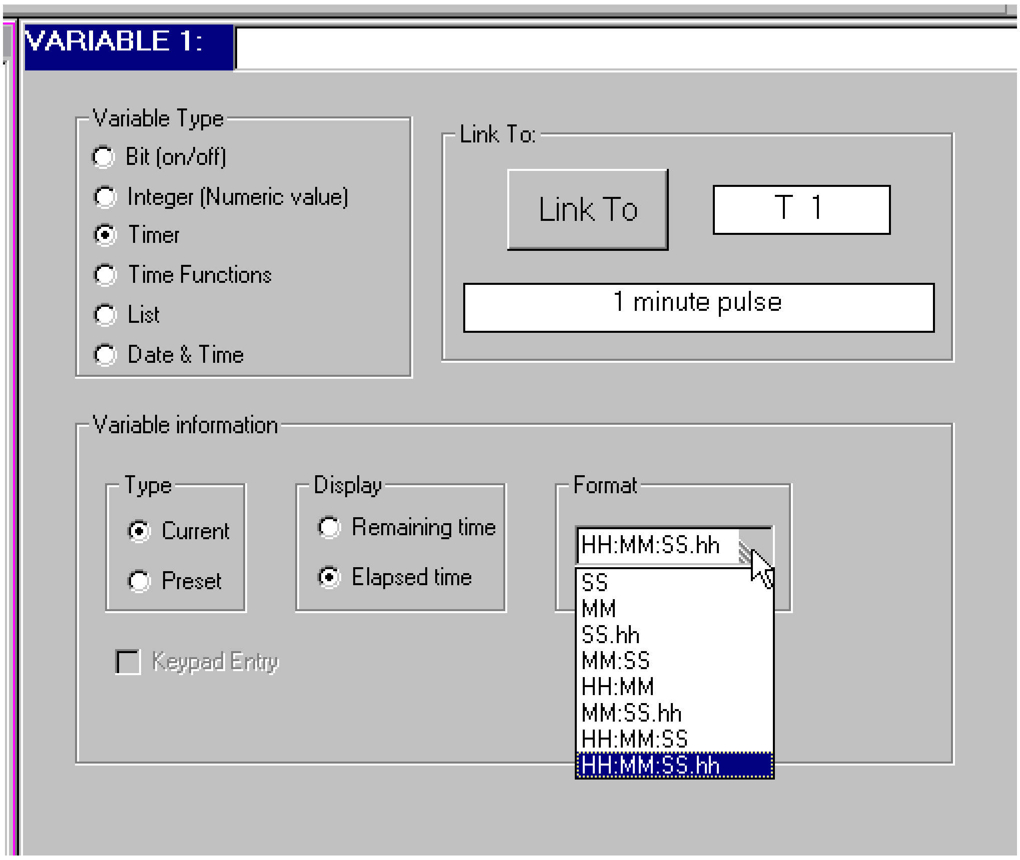
To enter values via keypad, you must select the **full timer format.**

Selecting a Timer Display format

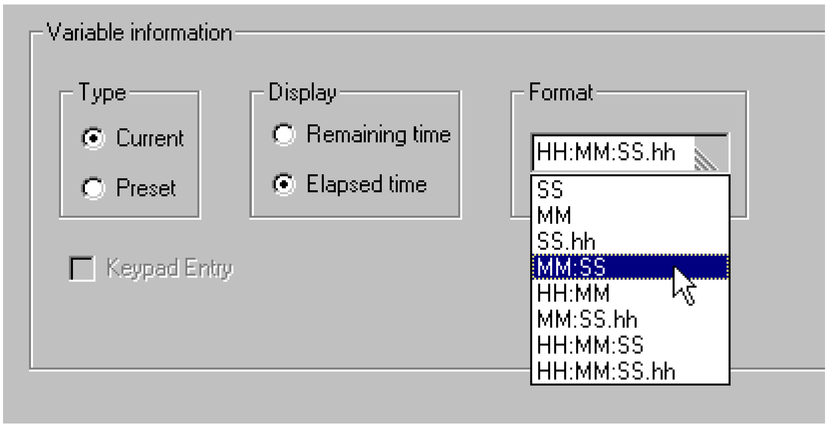
1. Click the Add New Variable icon on the HMI toolbar.



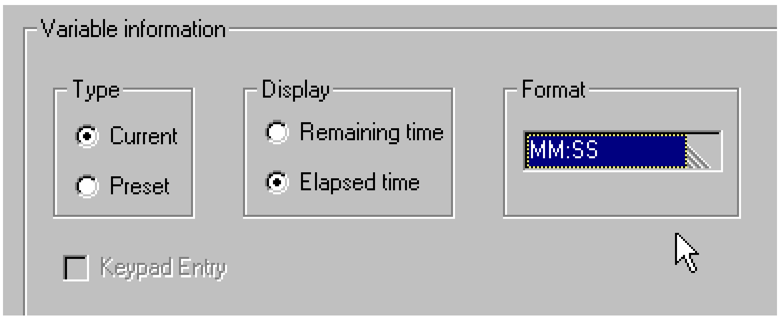
2. Select Timer, then link the desired T operand.
3. Open the Timer format drop-down menu in the Variable Editor.



3. Select the Timer format from the drop-down menu in the Variable Editor.



4. The selected format is displayed in the Format window.



PID

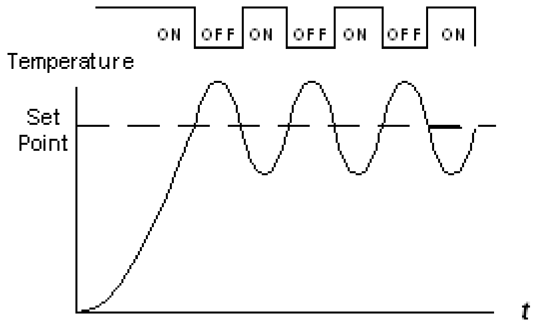
PID Function

The PID function uses system feedback to continuously control a dynamic process. The purpose of PID control is to keep a process running as close as possible to a desired Set Point.

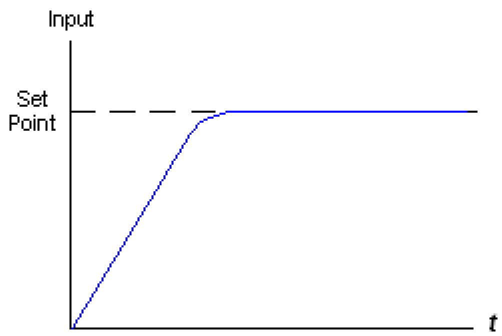
The M90 can run 4 closed PID loops.

About PID and Process Control

A common type of control is On-Off control. Many heating systems work on this principle. The heater is off when the temperature is above the Set Point, and turns on when the temperature is below the Set Point. The lag in the system response time causes the temperature to overshoot and oscillate around the Set Point.



PID control enables you to minimize overshoot and damp the resulting

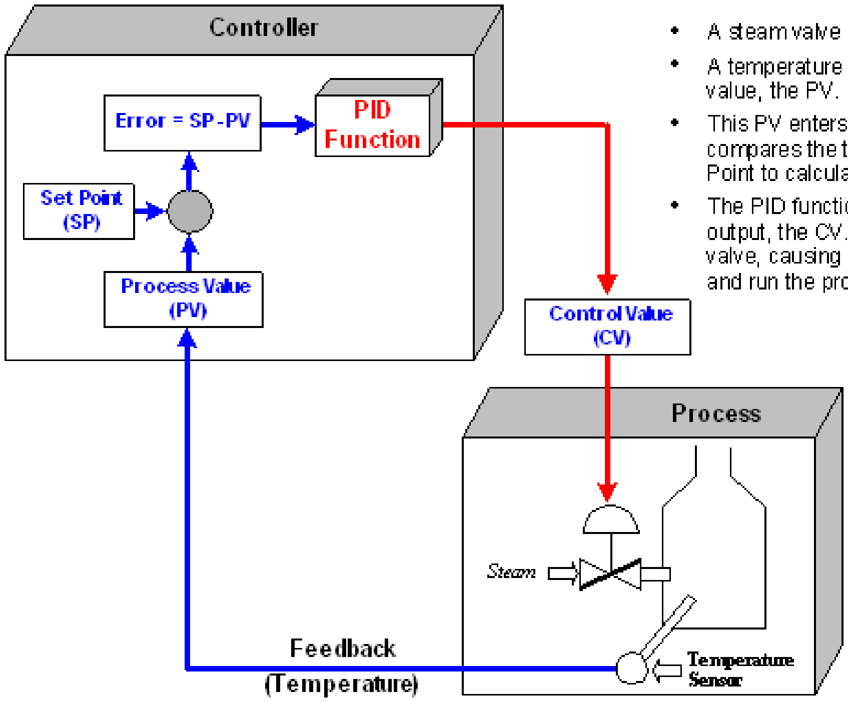


oscillations.

PID enables your controller to automatically regulate your process by:

1. Taking the output signal from the process, called the Process Variable (PV),
2. Comparing this output value with the process Set Point. The difference between the output Process Variable and the Set Point is called the Error signal.
3. Using the Error signal to regulate the controller output signal, called the Control Variable (CV), to keep the process running at the Set Point. Note that this output signal may be an analog or time-proportional variable value.

In the figure below, a system is regulated according to temperature.



- A steam valve releases heat into the system.
- A temperature sensor outputs a temperature value, the PV.
- This PV enters the controller. The PID function compares the temperature value with the Set Point to calculate the Error signal.
- The PID function regulates the controller output, the CV. This output controls the steam valve, causing it to vary the release of steam and run the process at the desired Set Point.

Inside the PID Function

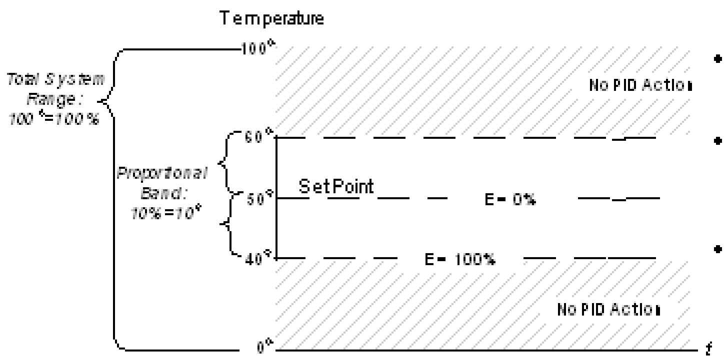
The PID function is based on 3 actions, Proportional, Integral, and Derivative. The PID output is the combined output of all 3 actions.

All of the PID functions are activated by changes in the process Error, the difference between the Process Value and the process Set Point value (E = SP – PV).

Proportional Band

The proportional band is a range defined around the Set Point. It is expressed as a percentage of the total Process Value (PV). When the PV is within this range, the PID function is active.

Note that the proportional band may exceed 100%. In this case, PID control is applied over the entire system range.



- The Process Value (PV) of this system is 0°-100°, a total range of 100°.
- The proportional band is set at 10 %. This means that the range of the proportional band is 40°-60°.
- When the Temperature is outside of the proportional band, the PID function is not active.

Proportional Action

Proportional action begins after the PV enters the proportional band; at this point, the Error is 100%. The action outputs a value that is in **direct linear proportion to the size of the Error value**.

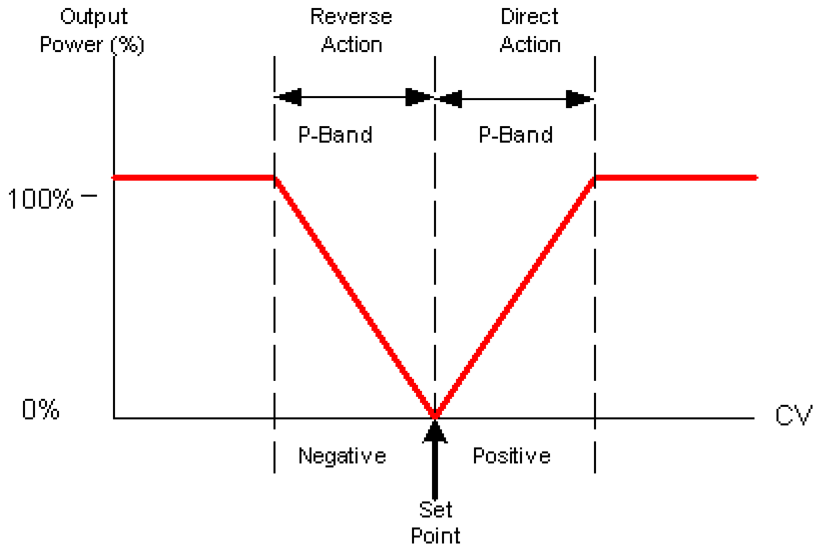
A broad proportional band causes a more gradual initial response from the controller. Typically, Set Point overshoot is low; but when the system stabilizes, oscillations around the Set Point tend to be greater.

A narrow band causes a rapid response that typically overshoots the Set Point by a greater margin. However, the system does tend to stabilize closer to the set point. Note that a proportional band set at 0.0% actually forces the controller into On-Off mode.

The drawback of proportional control is that it can cause the system to stabilize below set point. This occurs because when the system is at set point, Error is zero and the control value output is therefore pegged at zero as well. The majority of systems require continuous power to run at set point. This is achieved by integrating integral and derivative control into the system.

Direct and Reverse Action

Direct action causes the output to change in the same direction as the change in Error, meaning that a positive change in Error causes a positive change in the proportional band's output. Reverse action creates an inverse change in the output, meaning that a positive change in Error causes a negative change in output.

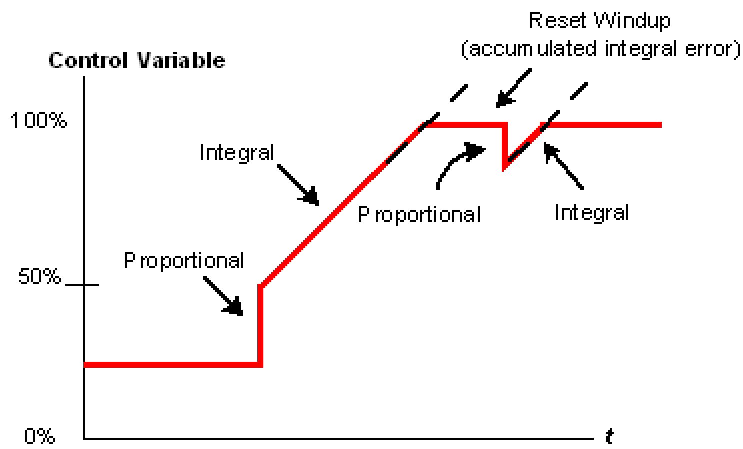


Integral Action

Integral action responds to the rate of change in the controller's CV output relative to the change in Error. The integral time you set is the amount of time, as calculated by the controller, required to bring the process to Set Point. Note that if you set a short integral time, the function will respond very quickly and may overshoot the Set Point. Setting a larger integral time value will cause a slower response. Integral time is sometimes called Reset.

The controller's CV output may reach and remain at 100%, a condition called saturation. This may occur, for example, if the process is unable to reach Set Point. This causes the Error signal to remain stuck in either the positive or negative range. In this situation, the integral action will grow larger and larger as the Error accumulates over time. This is called integral "wind up", which can cause the controller to overshoot the set point by a wide margin.

This situation can be prevented by setting an MB to clear the accumulated Integral error when saturation occurs.



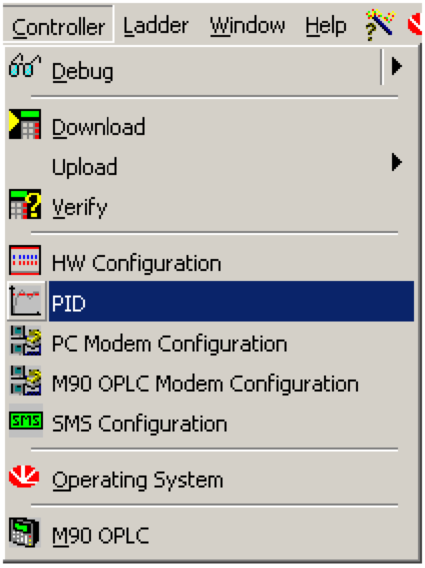
Derivative Action

Derivative action responds to the rate and direction of change in the Error. This means that a fast change in error causes a strong response from the controller.

The derivative action 'anticipates' the PV's value in relation to the Set Point and adjusts the controller's CV output accordingly, thus shortening the PID function's response time.

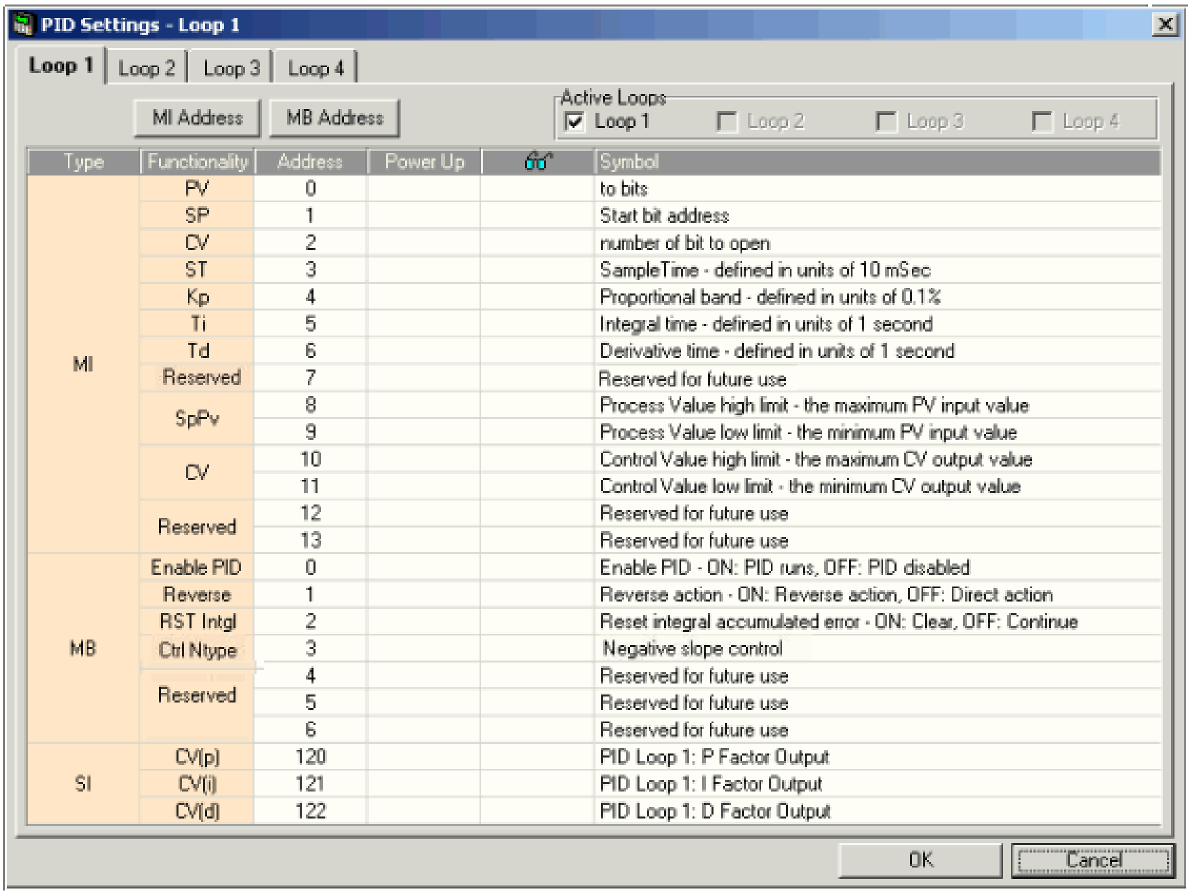
Defining a PID function

1. Select PID from the Controller menu.



The PID parameter box opens as shown below. The parameters are arranged in three groups. Each group is linked to a vector of operands.

2. Link operands to the PID parameters by:
   -Clicking the MI Address or MB Address buttons,
   OR
   -Clicking a parameter;
   the Select Operand & Address box opens.
3. Enter a vector's Start Address, then click OK; the parameters are linked to operands in that vector.
4. Repeat the procedure for each of the four PID loops.
5. Before you can use a PID loop, you must activate it by clicking the appropriate check box under Active Loops.



Type	Functionality	Address	Power Up		Symbol
MI	PV	0			to bits
	SP	1			Start bit address
	CV	2			number of bit to open
	ST	3			SampleTime - defined in units of 10 mSec
	Kp	4			Proportional band - defined in units of 0.1%
	Ti	5			Integral time - defined in units of 1 second
	Td	6			Derivative time - defined in units of 1 second
	Reserved	7			Reserved for future use
	SpPv	8			Process Value high limit - the maximum PV input value
		9			Process Value low limit - the minimum PV input value
	CV	10			Control Value high limit - the maximum CV output value
		11			Control Value low limit - the minimum CV output value
	Reserved	12			Reserved for future use
		13			Reserved for future use
MB	Enable PID	0			Enable PID - ON: PID runs, OFF: PID disabled
	Reverse	1			Reverse action - ON: Reverse action, OFF: Direct action
	RST Intgl	2			Reset integral accumulated error - ON: Clear, OFF: Continue
	Ctrl Ntype	3			Negative slope control
	Reserved	4			Reserved for future use
		5			Reserved for future use
		6			Reserved for future use
SI	CV(p)	120			PID Loop 1: P Factor Output
	CV(i)	121			PID Loop 1: I Factor Output
	CV(d)	122			PID Loop 1: D Factor Output

PID Function Parameters

Operand Type	Parameters	Function
MI	PV: Process Value	PV is the feedback from the process. PV is output from the process and input to the PID function. In a heating system, the temperature measured by a temperature sensor provides the PV.
	SP: Set Point	SP is the target value for the process. In a heating system, this is the temperature value set for the system. Note that the Set Point and Process value must be given in the same type of units (degrees Celsius, bars, meters per second, etc.)
	CV: Control Value	CV is the output from the PID function. CV is output from the PID function and input to the process. Note that this output signal may be an analog or time-proportional variable value.
	ST: Sample Time	Use this parameter to define the intervals between PID function updates, in units of 10mSecs.
	Kp: Proportional Band	Use this parameter to define the proportional band, in units of 0.1%. The proportional band is a percentage of the total Process Value (PV). It is a range defined around the Set Point. When the PV is within this range, the PID function is active.
	Ti: Integral Time	Use this parameter to define the integral time, in units of 1 second. Integral action responds to the rate of change in the controller's CV output relative to the change in Error. The integral time you set is the amount of time, as

		calculated by the controller, required to bring the process to Set Point.
	Td: Derivative Time	Use this parameter to define the derivative time, in units of 1 second. Derivative action responds to the rate and direction of change in the Error. This means that a fast change in error causes a strong response from the controller. The derivative action 'anticipates' the PV's value in relation to the Set Point and adjusts the CV accordingly, thus shortening the PID function's response time.
	Reserved	Reserved for future use.
	SPPV: Set Point for Process Value	High: Use this parameter to define the upper limit for the Process Value. Low: Use this parameter to define the lower limit for the Process Value.
	CV: Set Point for Control Value	High: Use this parameter to define the upper limit for the Control Value. Low: Use this parameter to define the lower limit for the Control Value.
	Reserved	Reserved for future use.
MB	Enable PID	Use this parameter in your program to turn the PID loop on and off. ON activates PID action: OFF deactivates PID action.
	Reverse	Use this parameter in your program to control PID output direction. Off activates Reverse Action, ON activates Direct Action. Direct action causes the output value to change in the same direction as the change in PV. Reverse action causes the output value to change in the opposite direction as the change in PV. **Note** In the case of a temperature control application, **Reverse** Action is **heating**, **Direct** Action is **cooling.**
	RST INTGL: Reset Integral Error	Use this parameter to clear integral error. If the system does not reach setpoint within the time defined in the parameter **Intgl. Time**, Integral error occurs and may increase. Use this parameter to prevent the error from growing large enough to interfere with the Integral operation.
	Ctrl Ntype: Negative slope control	Negative slope control. When the system is 'cooling' down, this helps to control undershoot and stabilize oscillations around the setpoint. When the MB is OFF, Negative Slope Control is ON; when the MB is ON, Negative Slope Control is suspended. For example, in a temperature application, when a heater turns off and the temperature drops sharply, falling below the minimum setpoint (SP),if this MB is OFF, the system will register the sharp drop and turn the heater on before the temperature reaches the low setpoint. The slope of change will be less steep, and the temperature will be more stable around setpoint.
	Reserved	Reserved for future use.
	Reserved	Reserved for future use.
SI	CV(P): Proportional	This is the Proportional component of the PID function, calculated by the controller.

Value	
CV(I): Integral Value	This is the Integral component of the PID function, calculated by the controller.
CV(P): Derivative Value	This is the Derivative component of the PID function, calculated by the controller.

Auto-tuning PID Loops--PID Server

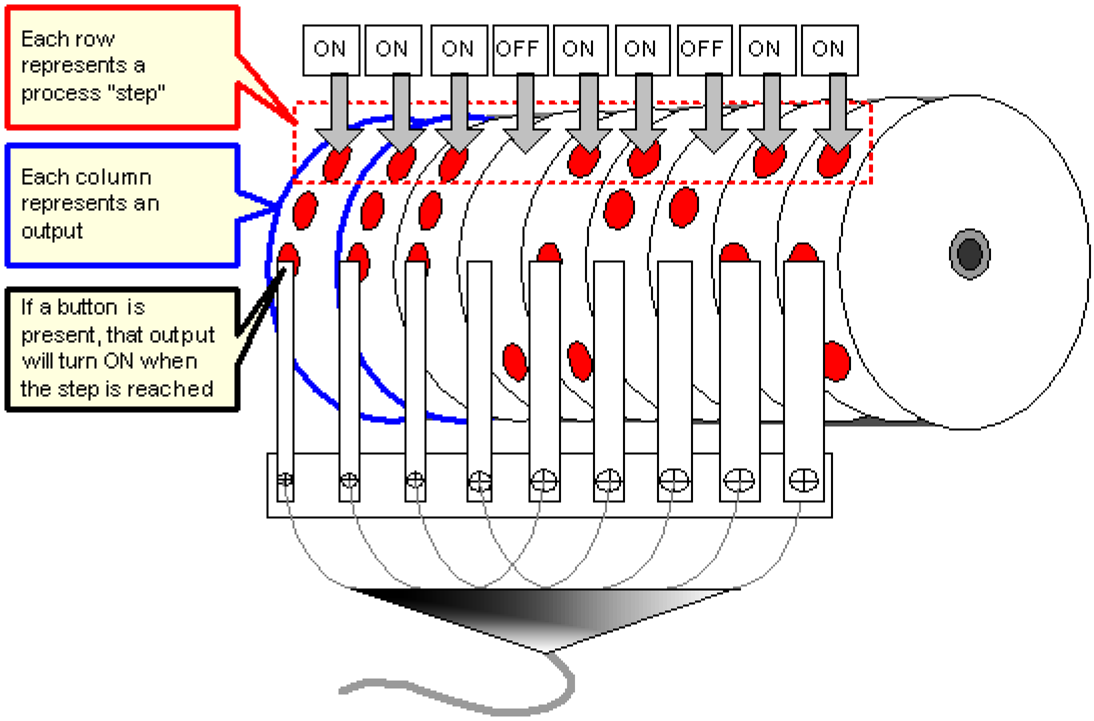
You can auto-tune PID loops by using Unitronics PID Server. This utility is located under the Tools menu.

Drum

Drum Sequencer

The Drum Sequencer utility simulates a mechanical drum sequencer as shown below. Drum instructions are best suited for repetitive processes that consist of a finite number of steps.

The utility is supported by the M91 OS 3.72 Build 01, Jazz OS 1.00 Build 2, and higher. Note that the M90 series does not support Drum.



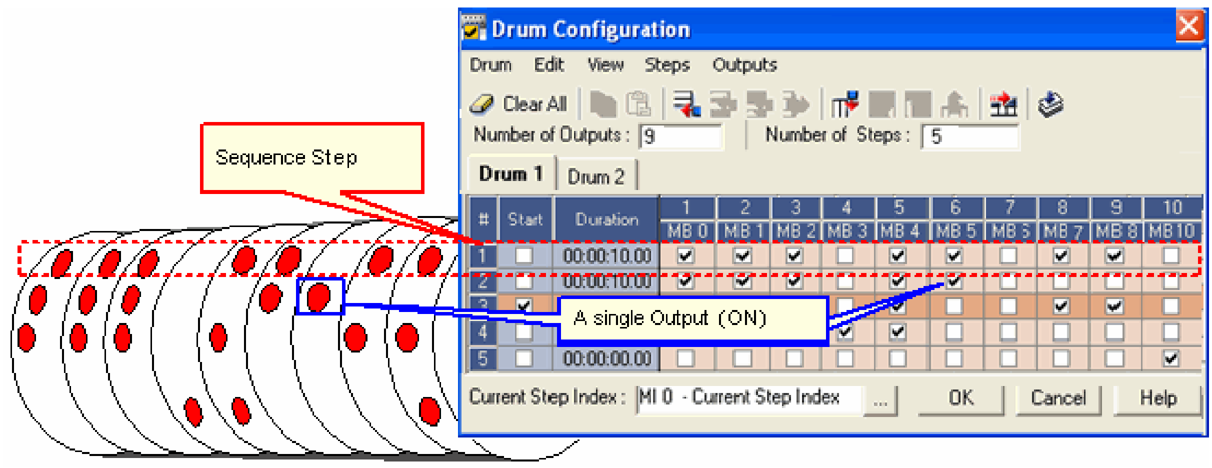
The U90 Ladder Drum Configuration supports two 'drums'. For each drum, you can:

- Define the number of steps on a 'drum"
- Specify the Start step
- Define the time duration of a step
- Define the number of output columns
- Link a coil (O or MB) to an output column.
- In each step, determine the status of each coil.

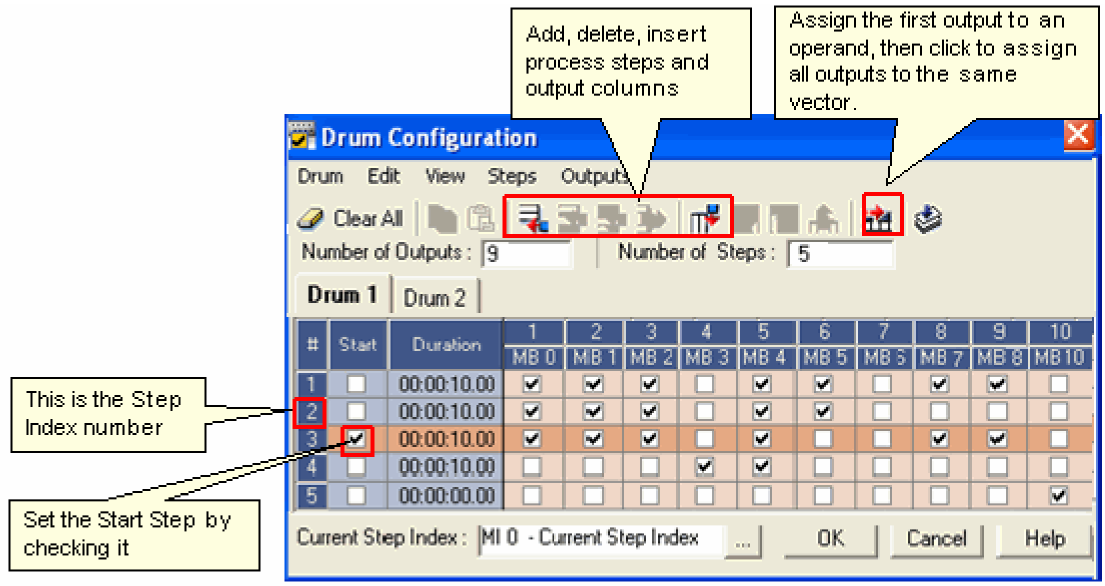
Once you have defined a drum, you start it and stop by toggling the status of SB 150 – Drum1 Run/Stop or SB152 Drum2 Run/Stop.

Drum Configuration

You can configure and run two drums independently of each other. A drum configuration contains rows of output bits. Each row is a Sequence Step, which correspond to the 'process steps' on a drum.

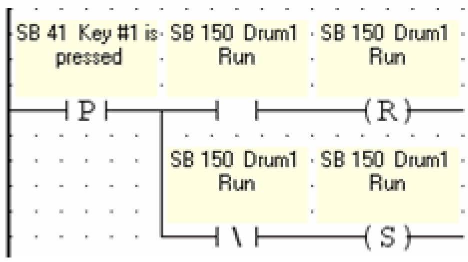


Name	Description
#	This is the Step Index number. Use this together with the Go To Step SBs to progress to a particular step.
Start	When the Drum Sequencer starts, this is the first step in the sequence by default.
Duration	This is the amount of time the drum stays in the step before progressing to the next step. If you do **not** set a Time, the drum will **remain** in that step, unless you use Go to Step SBs to change the current step.
Current Step Index	This MI contains the Step Index number of the current drum process step. You write to this MI to determine the destination step when you turn on a Go to Step SB.



Starting and Stopping a Drum

To start and stop a drum, toggle the status of the relevant SBs, either SB 150 – Drum1 Run/Stop or SB152 Drum2 Run/Stop. Note that these SBs are off by default. When a drum stops, it does not progress to the next step. The status of the drum's outputs is not affected. When the



Power-off or Reset

In order to restart a drum after power-up, or reset, you must turn on SBs 150 or 152.

At restart, if the drum was in the Stop state prior to power-up/reset, the drum starts at the Start Step.

If the drum was in the Run state, the drum restarts at the step in was in at power-up/reset. Note that the timer starts counting down from the **full** preset time, and **not** from the time that had already elapsed.

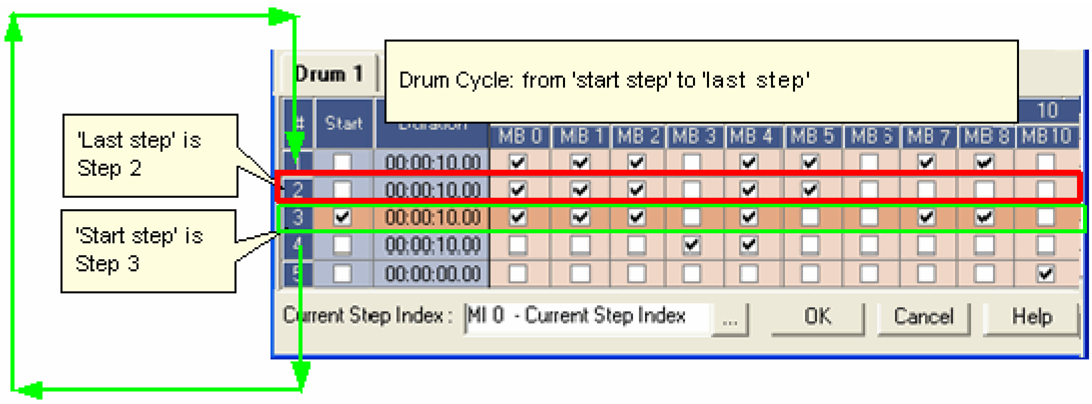
Note • Program download

- M91: If you download an application containing a drum, the controller is reset at download even if there are no changes in the drum. Note that you can deselect Drum at download.
- Jazz: Reset at every program download.

Progressing through Steps

Set a Duration time

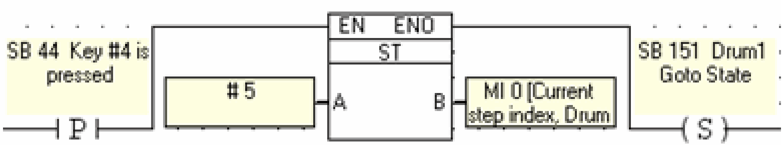
This is done in the Configuration. If you do **not** set a time, the drum will **remain** in that step, unless you use Go to Step SB. When the duration time set for the first step elapses, the drum progresses to the next step. When the last step in the drum is complete, the drum continues with the Start Step.



Go to Step SBs

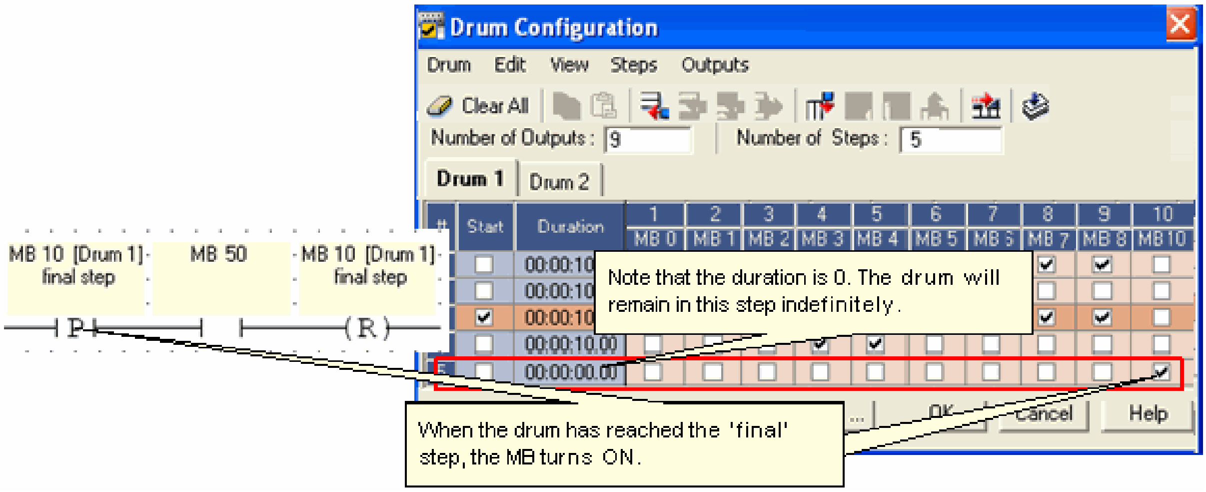
SBs 151 Drum1 Go to Step and 153 Drum2 Go to Step enable you to jump to another step at any time, even if the drum is in the middle of a different step:

- Jump to the next step by turning on the appropriate SB for that drum
- Jump to a specific step by storing a value into the MI you use for the Current Step Index in the Drum Configuration, and then turning on the appropriate SB in your Ladder application.



Final Step

In order to mark the final step in the drum, use a step that includes an output that you dedicate to that purpose. You can then use the changing output status to drive any task.



Note •

- If an application is configured for Drum and you download it to a controller with an outdated OS, the download will stop. If you choose to install a compatible OS, the PLC will stop and reset.
- If the PLC contains an application configured for Drum, and you download an application without Drum, the PLC will stop and reset.
- If the PLC contains an application configured for Drum, and you download an application containing changes in Drum, the PLC will stop and reset.
- Jazz PLCs are reset at every download.

Database

Access Indirectly Addressed Registers: Using the Database

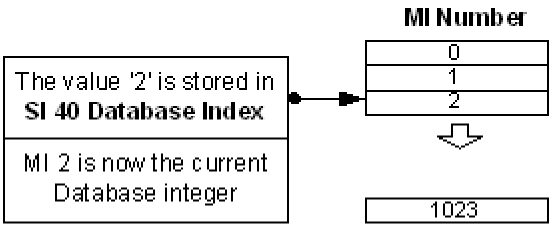
The M90/91 OPLC has a special memory area containing integers that are function as a database. These integers are not related in any way to system or memory integers. Within the database, you can access and use integers 0 through 1023 via SI 40 and SI 41.

Jazz controllers do not offer a Database.

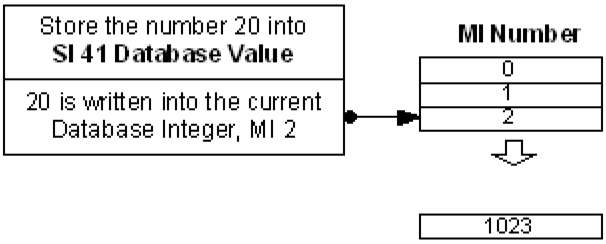
Note that when you run Test (Debug) Mode, the current value in SI 140 (Function Number) will **not** be displayed.

Writing Values

1. Use SI 40 Database Index to access a particular MI.
   For example, to access MI 2 you store the number 2 into SI 40.

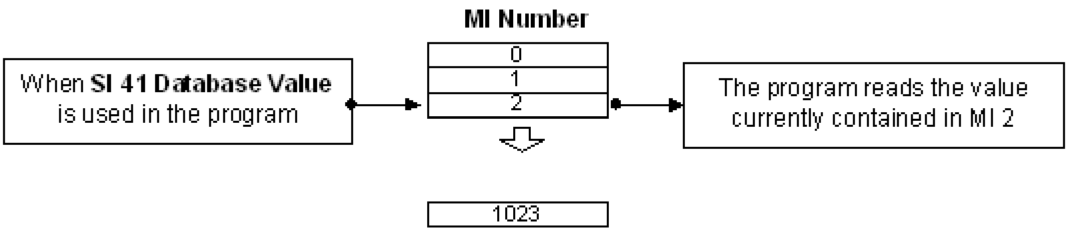


2. Use SI 41 Database Value to write a value into MI 2.
   For example, you can store a number value into SI 41.



Reading Values

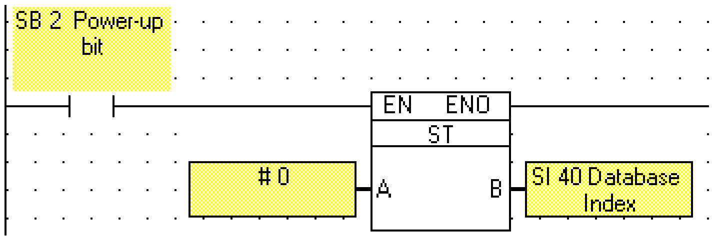
When you use SI 41 Database Value in your program, the program actually reads the MI that is referenced by SI 40 Database Index.



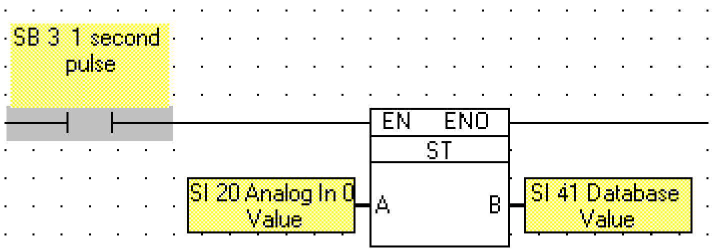
Examples

Example 1: Write

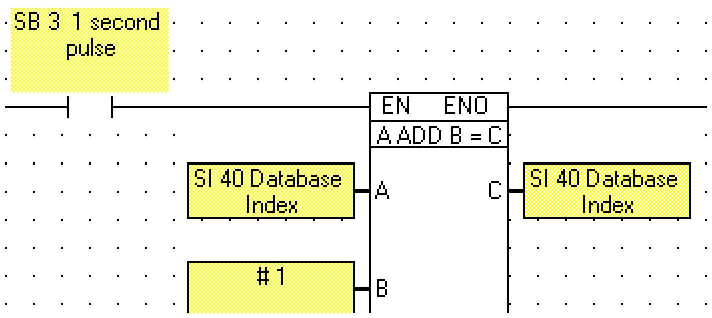
In the net below, 0 is stored in SI 40 when the M90 OPLC is powered up. This means that integer 0 is now the current 'database' integer.



In the net below, the analog value contained in SI 20 is stored in SI 41 every second. According to the net above, the current 'database' integer is 0. The analog value is therefore stored in integer 0.



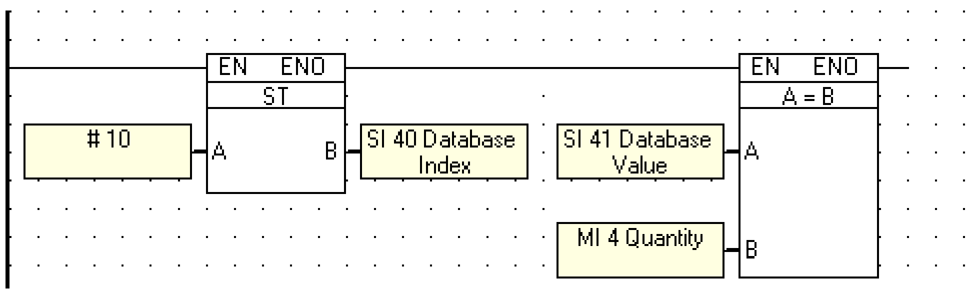
In the next net, the value in SI 40 is incremented by 1every second, changing the current database integer. This means that the first analog value will be stored in integer 0, the second analog value in integer 1, and so on.



Example 2: Read

In the first part of the net below, 10 is stored into SI 40. Integer 10 is the 'database' integer. In the second part of the net, the value in SI 41 is compared to the value in integer 4.

The value in SI 41 is the value actually in integer 10—the current database integer.



Database Utility

You can use this utility to:

- Download values to the Database in the controller.
- Read/Write up to 1000 values at one time, between the project and the controller.

Note that Jazz controllers do not contain a Database.

Downloading Values

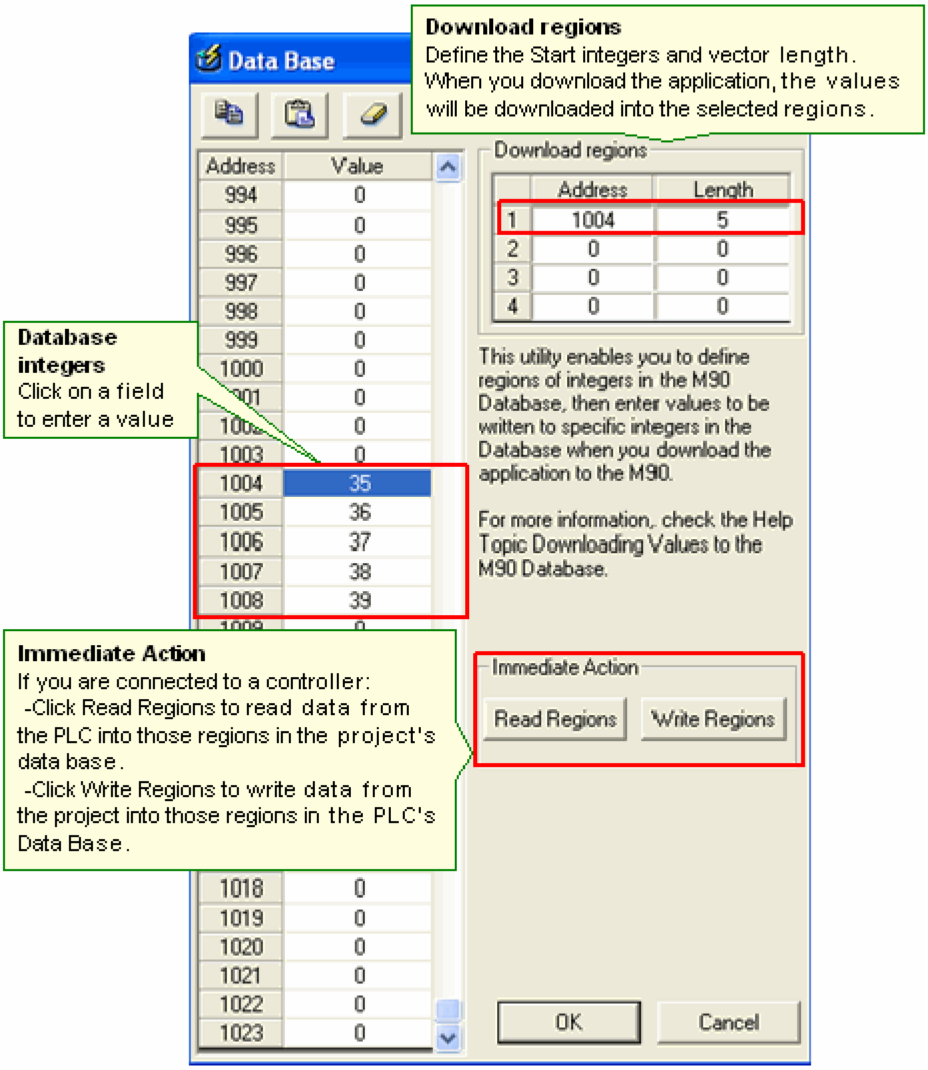
1. Click the Database button to open the utility, then define regions and enter values.
2. At download, select the Database option to write the values to the selected integers.

Immediate Action

If you are connected to a controller:

- Click Read Regions to read data from the PLC into those regions in the project's data base.
- Click Write Regions to write data from the project into those regions in the PLC's Data Base.

Note that since the Copy/Paste tools use the Windows Clipboard, you can copy and paste values to from other applications, such as Excel. This can be helpful in the case of 'Look-up' tables, where you can give the values required for any non-linear function.



Utilities

Information Mode

Information Mode allows you to display and edit data, and to perform certain preset actions. The system data is displayed on the LCD screen and may be edited via the keypad.

You can enter Information Mode at any time, without regard to what is currently displayed on the HMI screen. Viewing data does not affect the PLC program. Note that when you are in Information Mode, the keypad is dedicated to that purpose. The keypad cannot be used for normal application functions until you exit Information Mode.

To enter Information Mode, press the <i> key for several seconds. You navigate through the main menu to reach the category of data you want. Selecting a category opens a submenu.

The list below shows the categories of information that are available for viewing.

Using Information Mode, you can access:

- I/O status
- Analog Inputs: Operating range and current value
- Counter values
- MB and SB Status
- MI and SI current values
- Timers: Current timer value, preset value, and timer status
- PLC ID number
- RS232 Parameters
- Time and Date
- System Information

You can also restart your program, as well as initialize MBs and MIs.

A full description of Information mode is included in PLC user guides.

Update Real-Time-Clock (RTC)

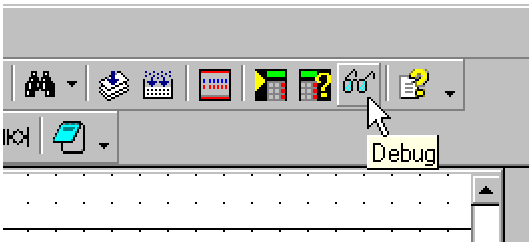
You can update the RTC by storing values into the following SIs.

SI	Description	Values to Store
SI 32	Current Date - according to RTC	Store the day and month as 4 digits. For example, 0402 is February4th; 3012 is December 30th
SI 33	Current Year - according to RTC	Store the year. For example, 1961, or 2002.
SI 34	Current Day of Week - according to RTC	1 to 7, where 1= Sunday, 7 = Saturday

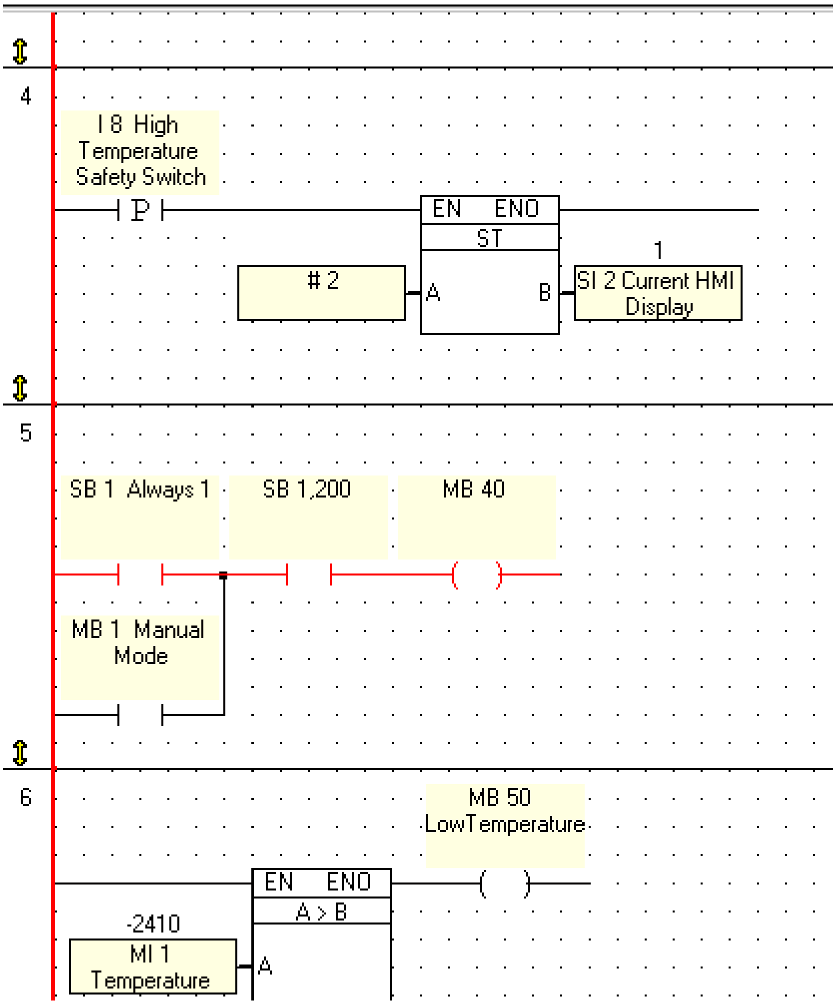
Testing your project (Debug mode)

To test a project:

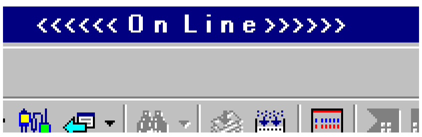
1. Connect the PLC to your PC.
2. Download your program into the M90 from your PC.
3. Click the **Test** icon on the Standard toolbar.



4. The left Ladder bar and any net with Logic flow will turn red. The current values of all MIs and SIs appear above the Operand Symbol.

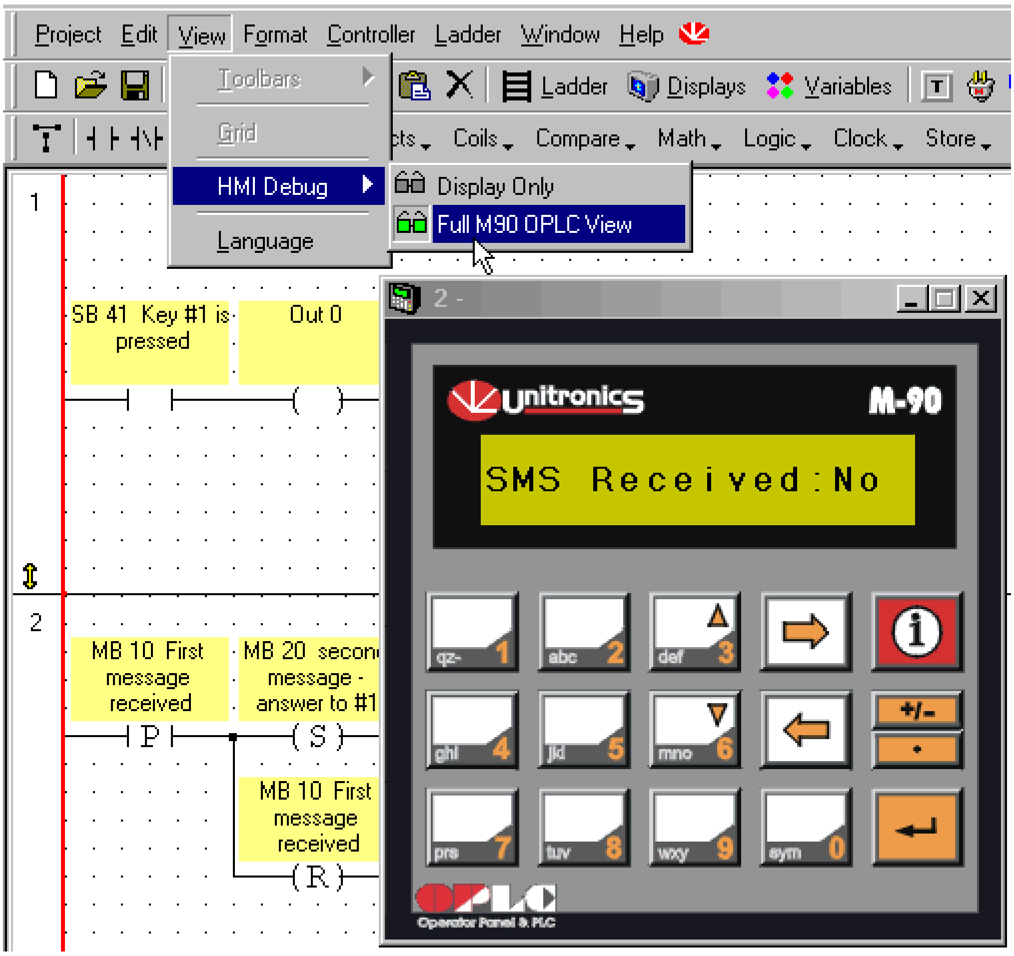


5. During **Test** mode the Title Bar notifies you that you are **On-Line**.



If you are working in a M90 network, the unit ID number appears as well.

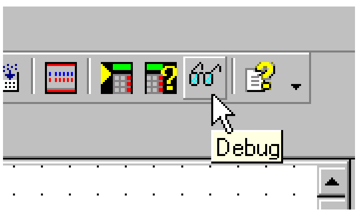
You can also view a fully functional, working representation of the PLC, by selecting Debug HMI from the View menu as shown below. You can choose to see only the current HMI display, or the complete PLC, complete with keypad keys. You can test the keypad keys by clicking them, or by using the corresponding numeric keys on your PC's keyboard.



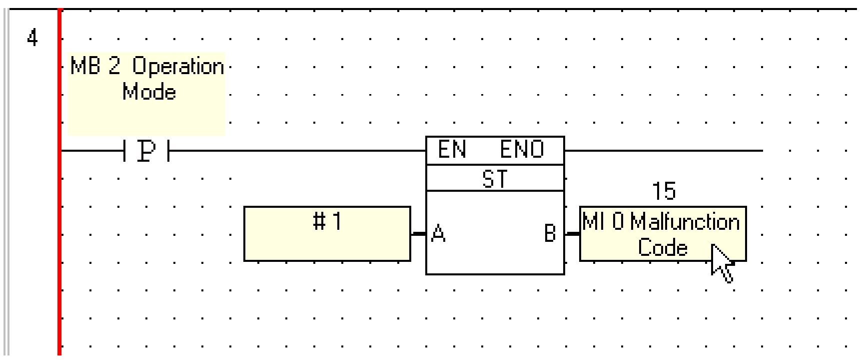
Test Mode: Changing an MI or MB value

To update a MI or MB value during Test Mode:

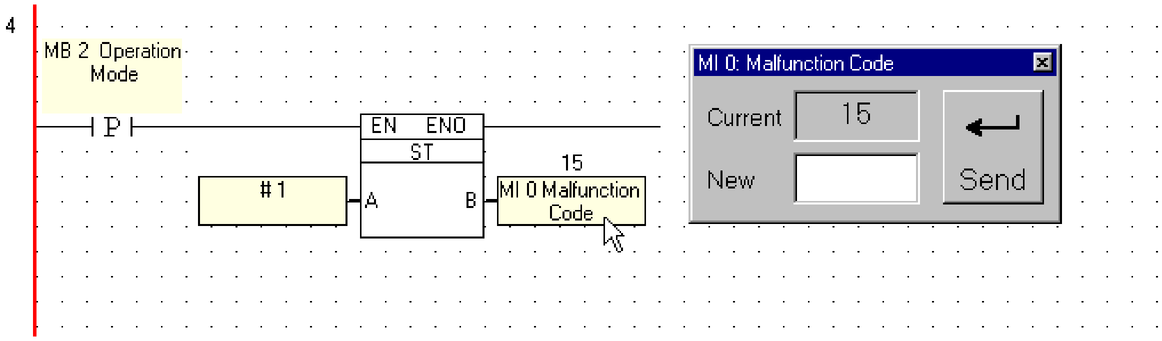
1. Enter Test Mode.



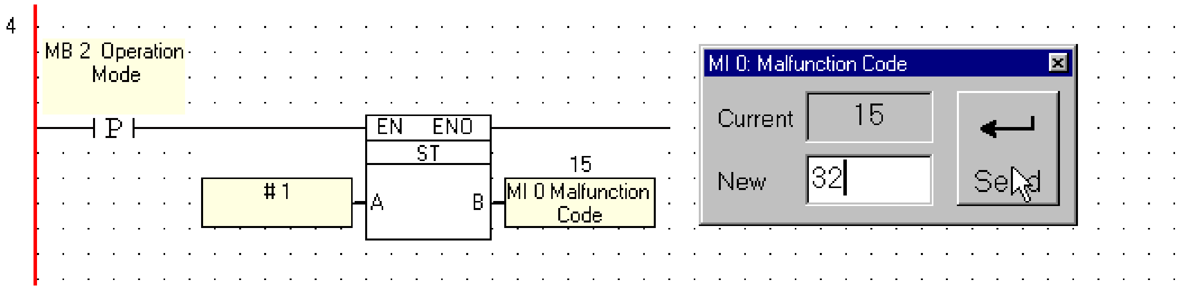
2. Click on the MI / MB value that you want to modify.



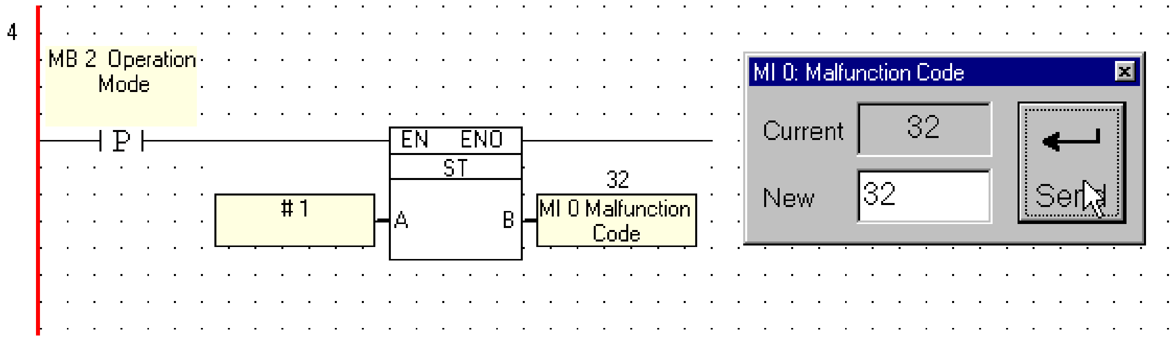
3. The Modify Window opens.



4. Enter the new value for the MB / MI in the **New** field.



5. Click **Send**. The new value is assigned.



Notes:

- Make sure that communication exists between the PC and controller.
- You cannot modify a MB / MI value if the application is writing into it in every cycle.

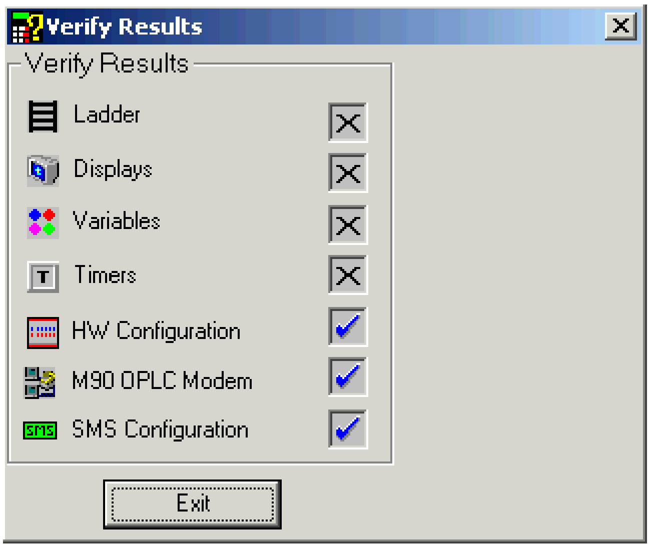
Verify Project

The Verify utility shows the differences between the project open in your PC and the program currently installed in the controller.

To use Verify:

1. Connect your PC to the controller using a program download cable
2. Select Verify from the Connection menu.

Verify marks different sections with an **X**, as shown below.



Project Downloader

The Project Downloader utility is included in Unitronics Remote Access software, which is located on the Unitronics Setup CD. The Downloader makes it possible to install .d90 files in local or remote controllers without using U90 Ladder.

About .d90 files

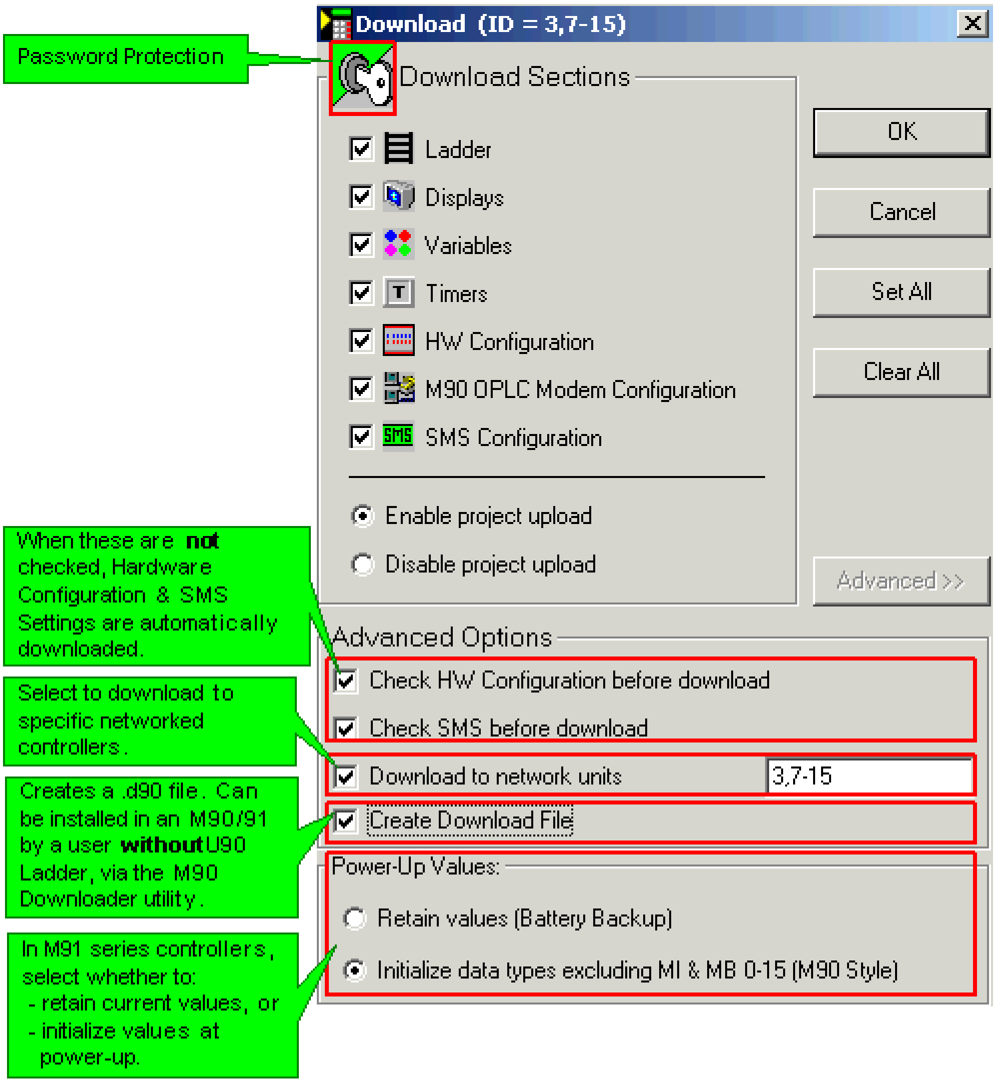
.d90 files are complete applications in a compressed format. You create .dvi files when, using U90 Ladder, you download programs to a controller. .d90 files cannot be opened by U90 Ladder or Remote Access.

To install a .dvi file can be installed into a PLC, use the Program Downloader, which is a utility included in Remote Access. U90 Ladder cannot be used to download .d90 files.

Creating Download files

Notes □ Both the PLC used to make the download file (source), and the M90 that is installed with the .d90 file (target) should be installed with the same OS version.
□ To avoid errors in the .d90 file, the Download process must run smoothly, without being aborted or affected by PC faults.
□ Database values can also be stored in the .d90 file..

1. Click Download, then click the Select All button.
2. Click the Advanced button and **Check Create Download file**.

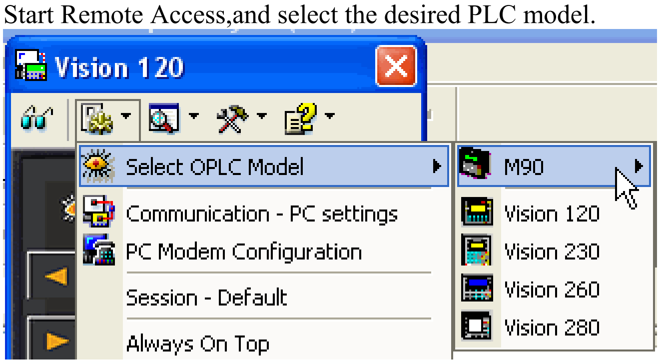


3. A dialog box opens, enabling you to select a Save location. Select a location, then click OK, a .d90 file is created.

Checking the integrity of the Download file

Although you do not need to have the Downloader installed on your PC in order to create .d90 files, you need to install it in order to check .d90 files.

1. After you have created the .d90 file, save the U90 Ladder project from which it was downloaded.
2. Open a new, empty project and download it--using the Select All option--to the PLC.
3. Start Remote Access,and select the desired PLC model.



4. Click the Project Downloader which is located on the Remote Access Tools menu.
5. Using the Downloader, navigate to the .d90 file and download it into the PLC.

6. Reopen the original U90 Ladder project used to create the .d90 file.
7. Select Verify from the Controller menu; the Verify process will compare the U90 project in your PC with the .d90 application installed in the PLC.
8. If the Verify process is successful, the .d90 file is valid.

For more information regarding the M90 Downloader, check the Remote Access Help.

Downloading .dvi files

This can only be done using the Program Downloader utility in Remote Access.

Battery Back-up values

M90/91 and Jazz controllers have an internal battery back-up for certain values during a power failure.

M90 models
The battery backs up values from:

- MI 0 - MI 15
- MB 0 - MB 15
- RTC value

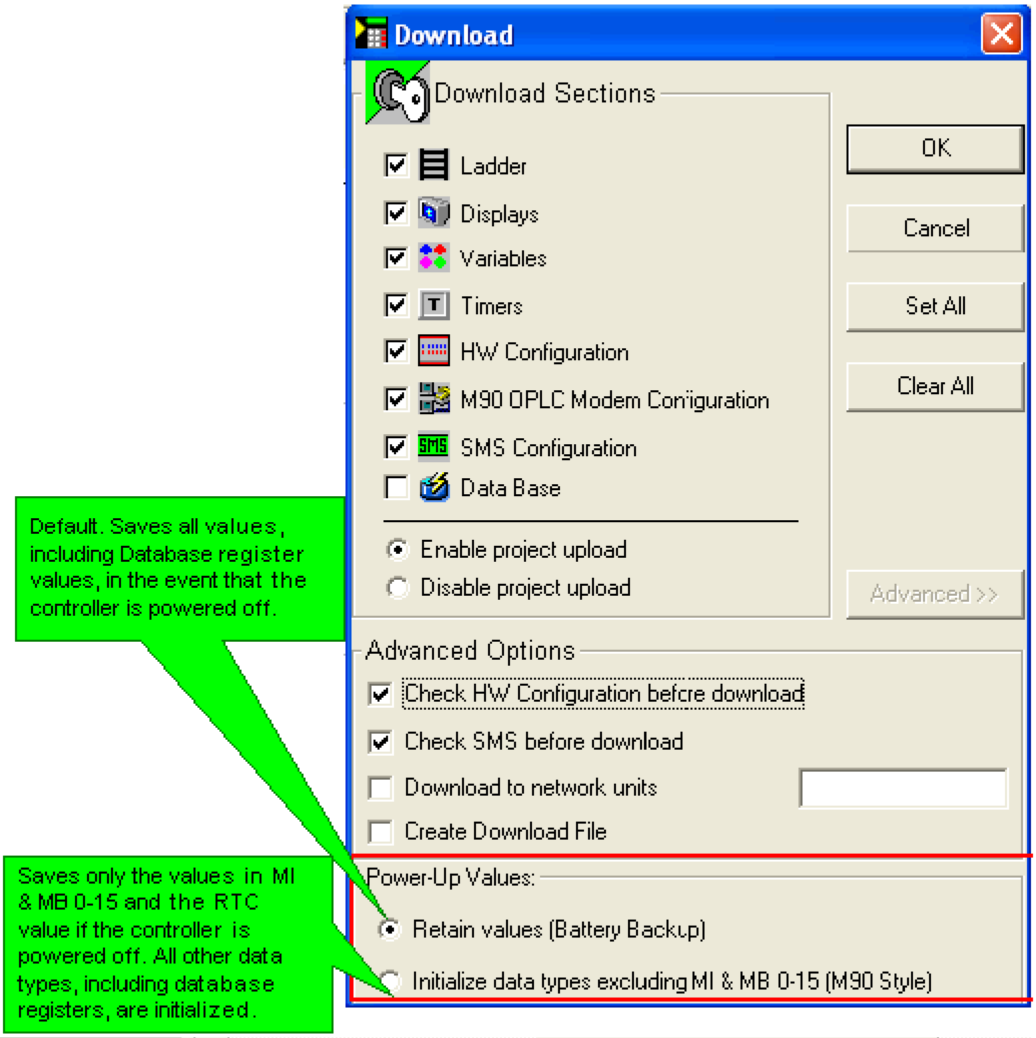
This means that only these values are saved if the controller is powered off. All other data types, including database registers, are initialized.

Therefore, any Operand that must retain its value during a power failure must be written into one of the above Operands.

M91/Jazz models
All system data, including Database and the RTC value are backed up.

You can control the back-up feature via Download options:

- The Retain Values Battery Backup option. This is checked by default. This option saves all values, including Database register values, in the event that the controller is powered off.
- Initialize Data Types Options excluding MI & MB 0-15 (M90 style). If you select this option, and the controller is powered off, only the values in MI & MB 0-15 and the RTC value are retained. All other data types, including database registers, are initialized. This makes the backup function like the M90. This may be useful in projects written initially for the M90.



Find and Replace

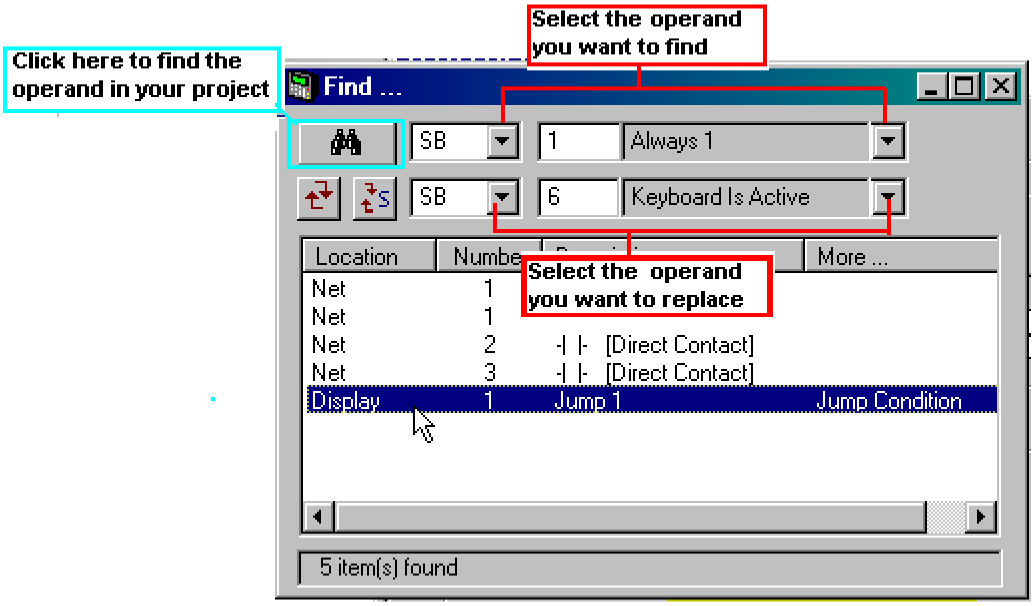
U90 Ladder offers 3 Find operations which may be accessed via the Find button on the U90 Ladder toolbar:

- Find and Replace Operand
- Find Comment Text
- Find Label

Find and Replace Operand

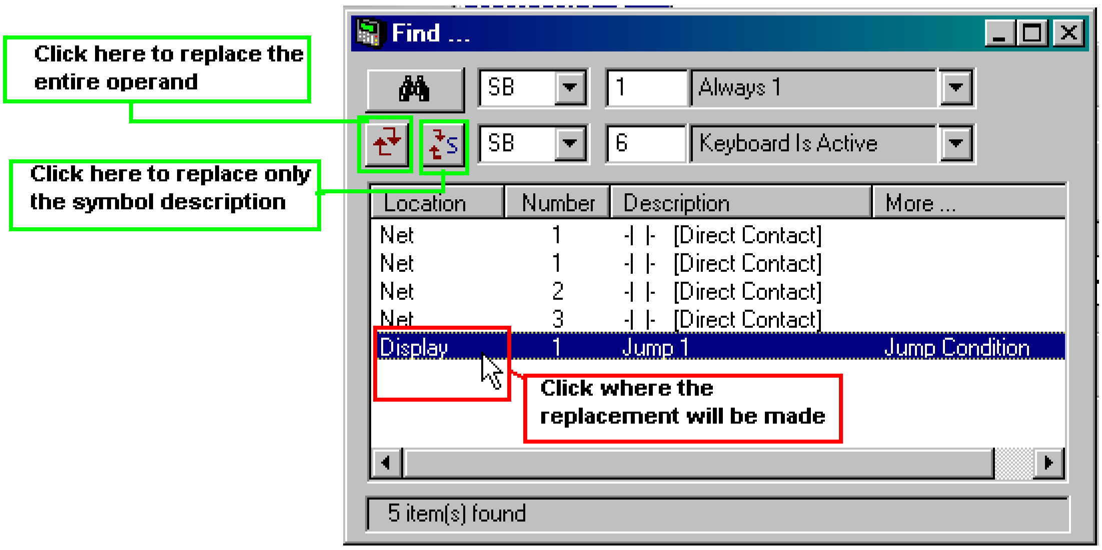
1. Select Find, or press Ctrl + F; the Find utility opens.
2. Select the name and address of the operand you wish to find.
3. Click the Find button shown below; a list appears showing every time that operand is used in the project.

4. Select the name and address of the operand you wish to replace as shown below.



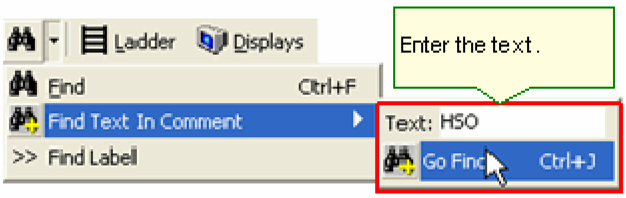
5. Select the location of the operand or description you wish to replace by clicking it within the list.

6. Replace operands or their descriptions by clicking the buttons shown below.



Find Comment Text

1. Click the Find button, then select Find Text in Comment.

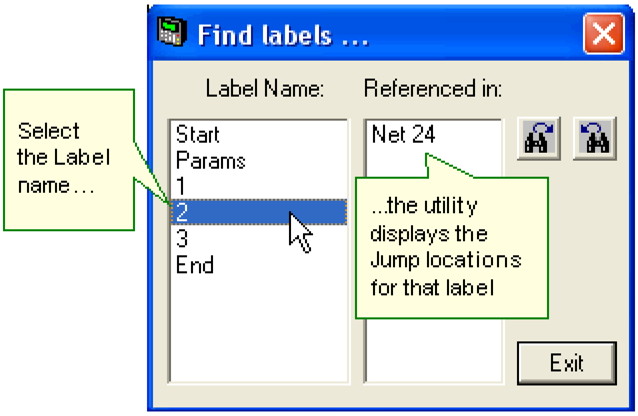


2. Enter the text, and then either click Go Find, or press Ctrl +J to start the search; the Find Text utility closes, and the search begins. If the text is found, the Ladder will scroll to display that comment.

3. To continue searching through the Ladder for the same text, press Ctrl + J. Note that every time you press Ctrl + J, the utility will continue to search down, even though the Find Comment window does not open.

Find Label

1. Click the Find button, then select Label; the utility displays the list of Labels in the Ladder in the left window.
2. Select a Label name; the utility displays the locations of the jumps linked to that Label.



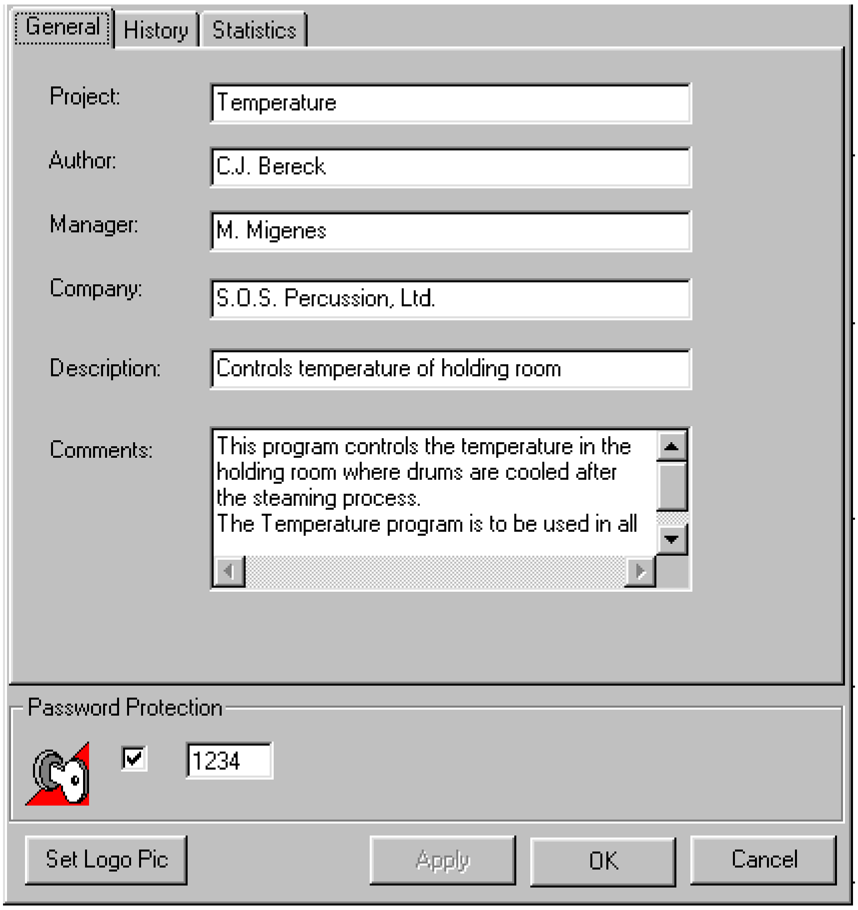
Program Password Protection

When you download a password-protected project into the controller:

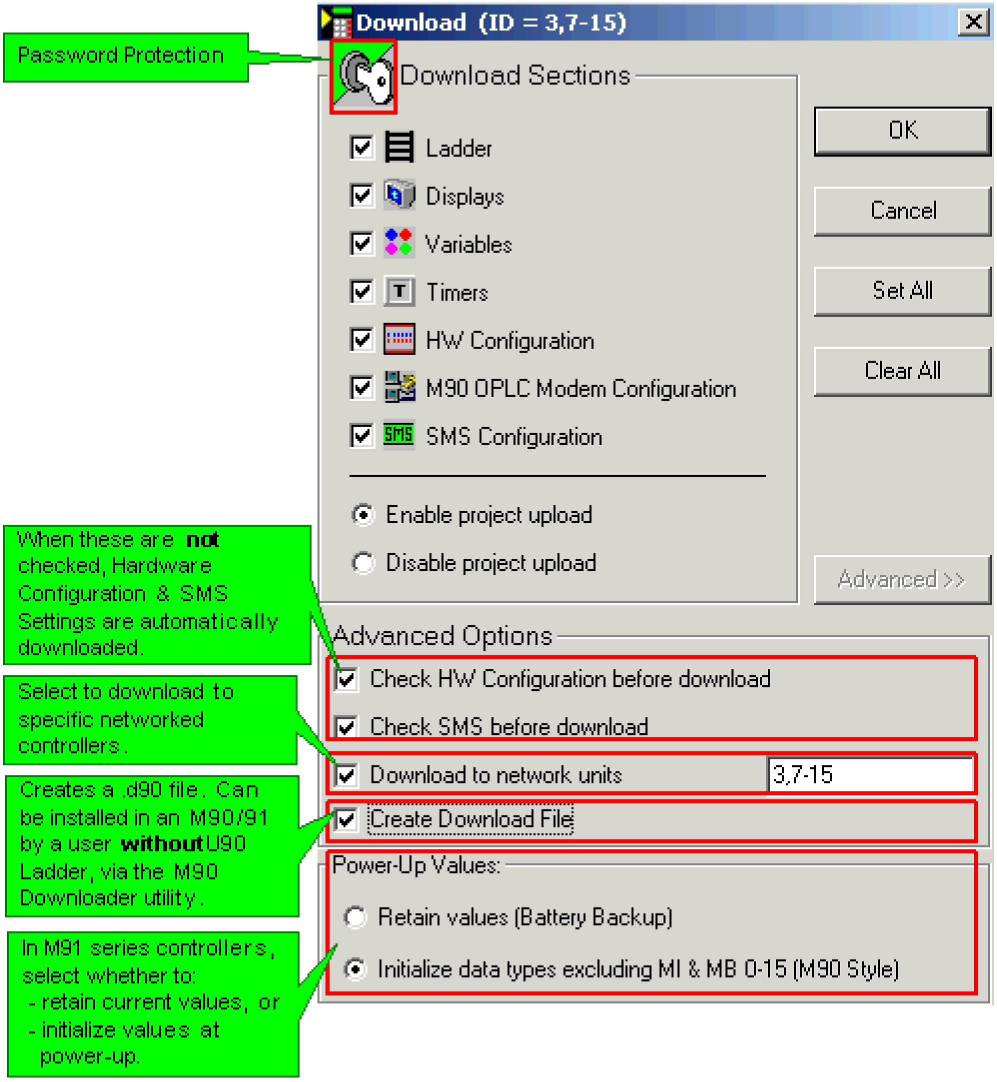
- The project cannot be uploaded without the password.
- Project sections cannot be downloaded without the password.

Applying a password

1. Display project properties by selecting Properties from the Project menu. The project Properties box opens.
2. Enable the password field by clicking on the Upload Password check box. When the box is checked, the keys turns and the field turns red. Note that if the box is not checked, you cannot access the password.
3. Enter the password. It must contain 4 digits as shown below--no symbols.



4. Click the **Download** icon on the Standard toolbar. The Download Window opens showing Download Sections. Note the ' password protected' key symbol.
5. Click on Set All. All of the sections are automatically checked as shown below.



6. Click OK. The project downloads.

Note that:

- This process resets the M90, and initializes all bit and integer values.
- If the controller already contains a password-protected project, you need to supply the password to download sections.
- If the controller already contains a password-protected program, you cannot upload the program without a password.

Display Integer values as ASCII or Hexadecimal

You can:

- Display the values in an MI vector as ASCII characters.
- Display a register value in hexadecimal format.

To do this, attach a numeric Variable to a Display. The variable uses linearization to display the value(s) in the desired format.

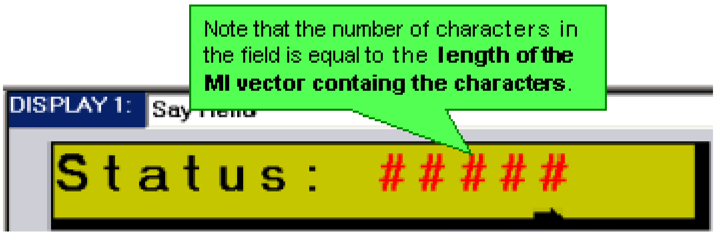
Note that non-supported ASCII characters will be shown as <space> characters.

ASCII -Hexadecimal character table

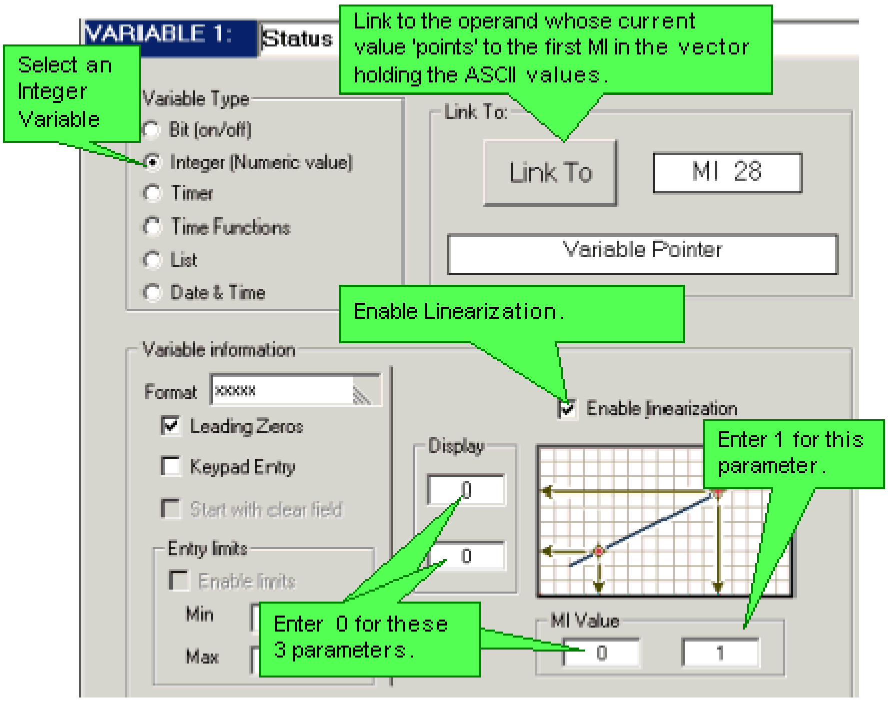
Vector as ASCII

When the application shown in the example below is downloaded, the ASCII characters 'Hello' will be displayed on the display screen when Key #3 is pressed.

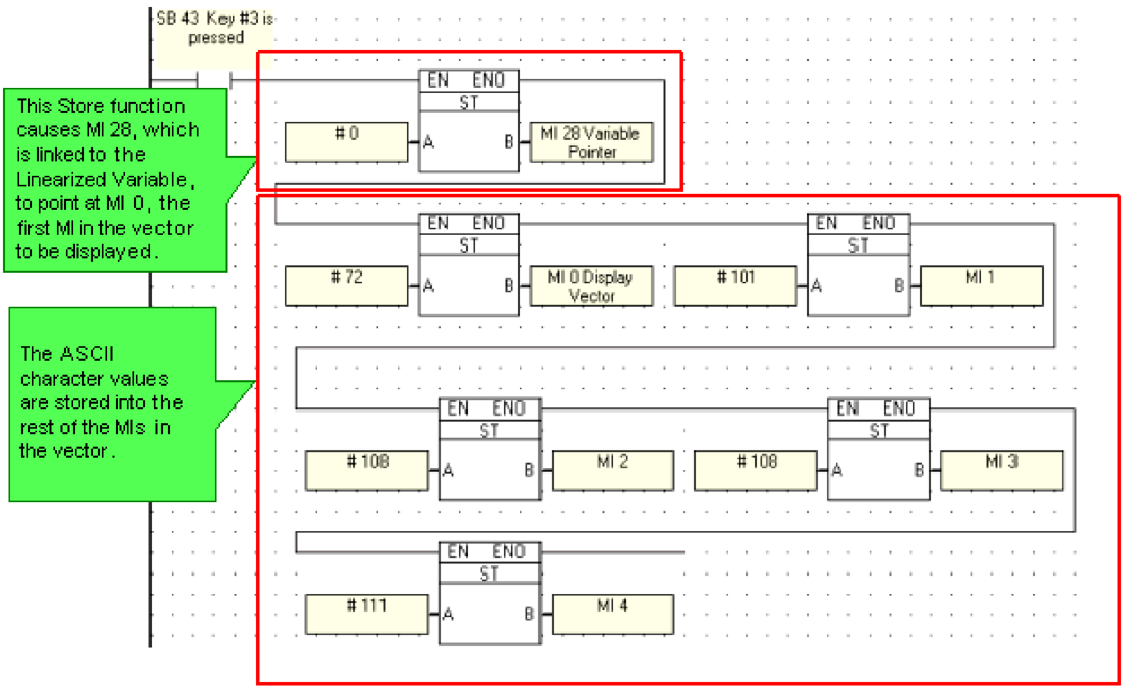
1.Create a Variable Field in a Display, then attach a Variable.



2.Define the Variable as shown below.



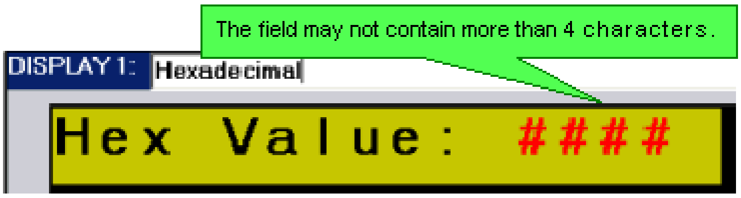
3.The Ladder net below sets the Variable pointer and stores ASCII values into the MI vector.



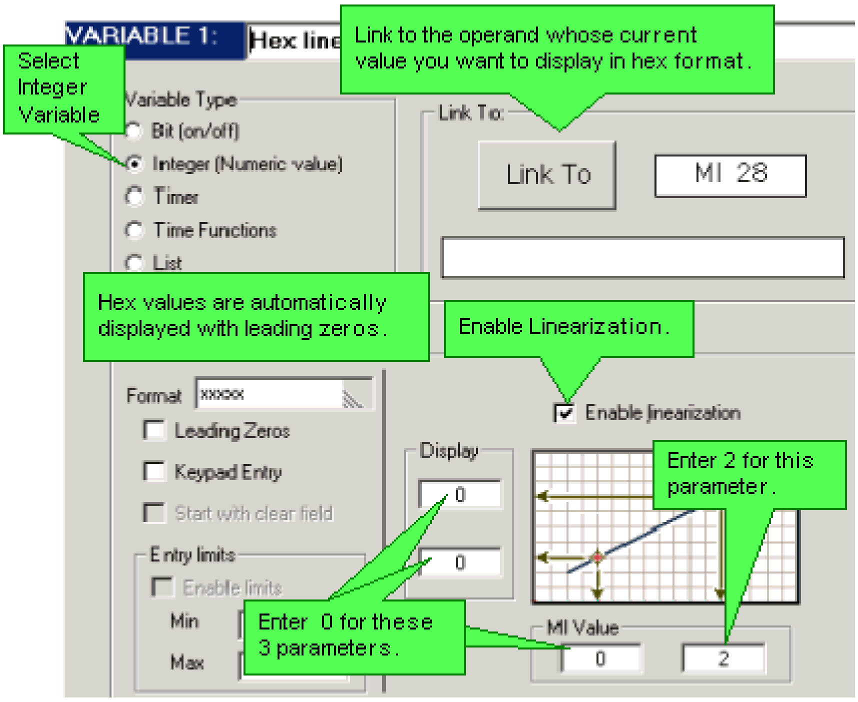
Register Value in Hexadecimal

When the application shown in the example below is downloaded, the hexadecimal value of 63 will be displayed on the display screen.

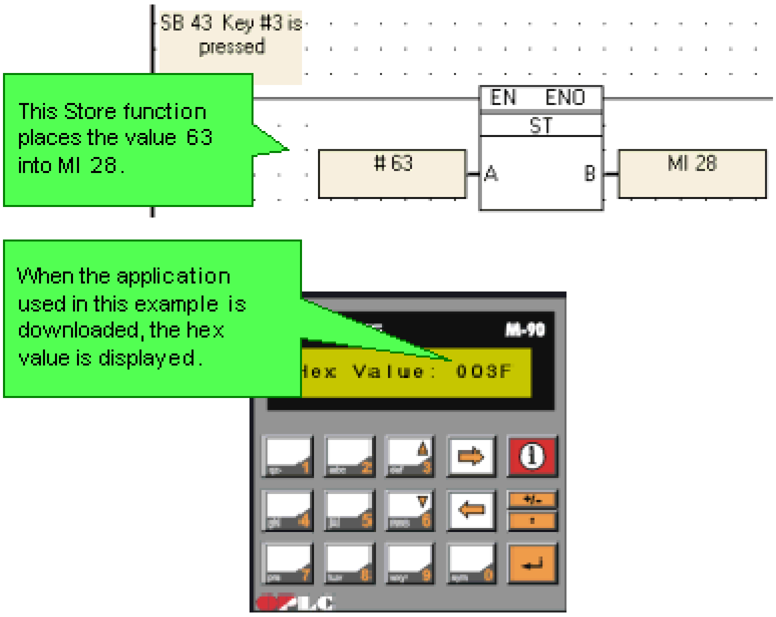
1. Create a Variable Field in a Display, then attach a Variable. Note that if the field is too short, only the right-most characters are displayed. For example, the hex value 63(3F) cannot be shown in a field one character long.



2. Define the Variable as shown below.



3. The Ladder net below stores the value into the MI.



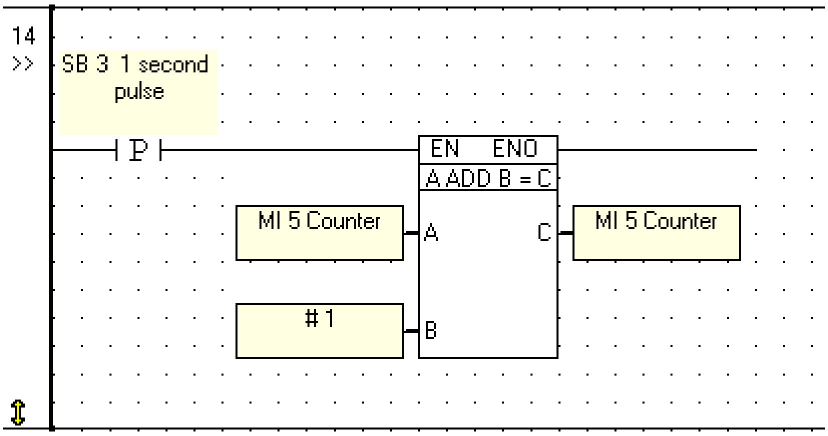
1 Second Pulse Oscillator

There is a built-in 1 second pulse oscillator that generates a 1 Hz pulse.

This pulse oscillator is embedded in **SB 3**. You can use this pulse oscillator as:

- Direct Contact
- Inverted Contact
- Positive Transition Contact
- Negative Transition Contact.

The following example creates a counter that progresses by one every one second.



10mS Counter

The value in SI 1 increments every 10mS. You can store a value into SI 1 at any time during your program, such as 0 to reset the counter.

Last number received: SMS

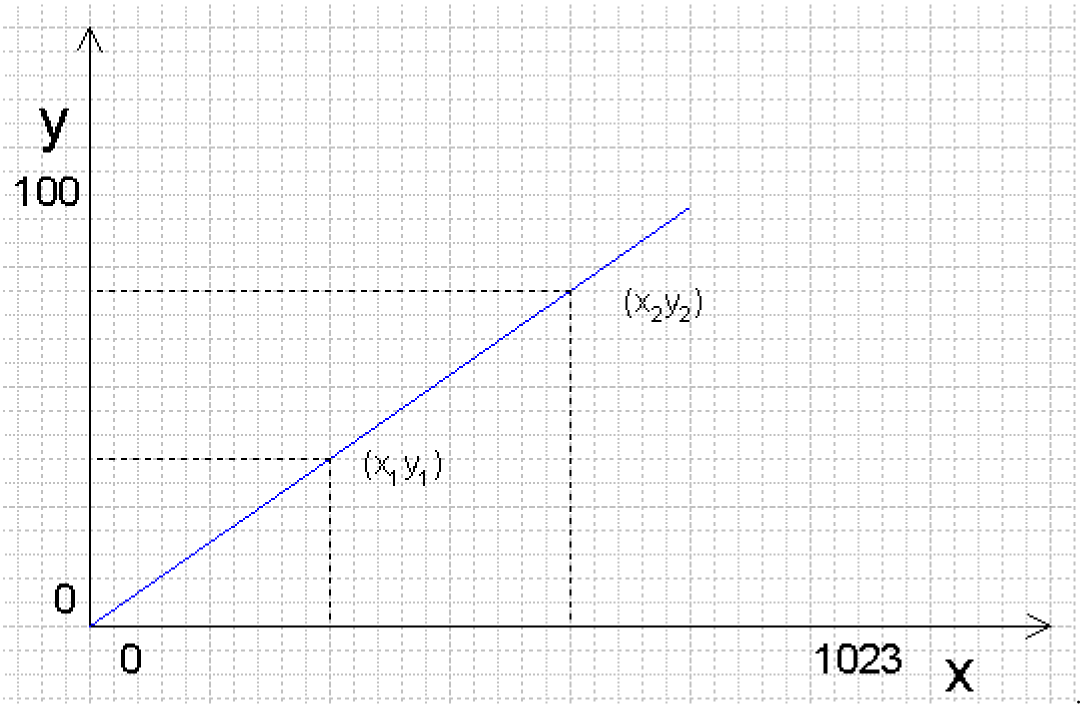
When the M90 receives an SMS, the number is stored in an SI vector:

- SI 188 Last received SMS number, number of digits
- SI 189 Last received SMS number, '+' sign
- SI 190 Last received SMS number, 1st group of 4 digits
- SI 191 Last received SMS number, 2nd group of 4 digits
- SI 192 Last received SMS number, 3rd group of 4 digits

Note that the vector is overwritten each time the M90 receives an SMS.

Linearization

Linearization can be used to convert analog values from I/Os into decimal or other integer values. An analog value from a temperature probe, for example can be converted to degrees Celsius and displayed on the controller's display screen.



Linearize values for Display

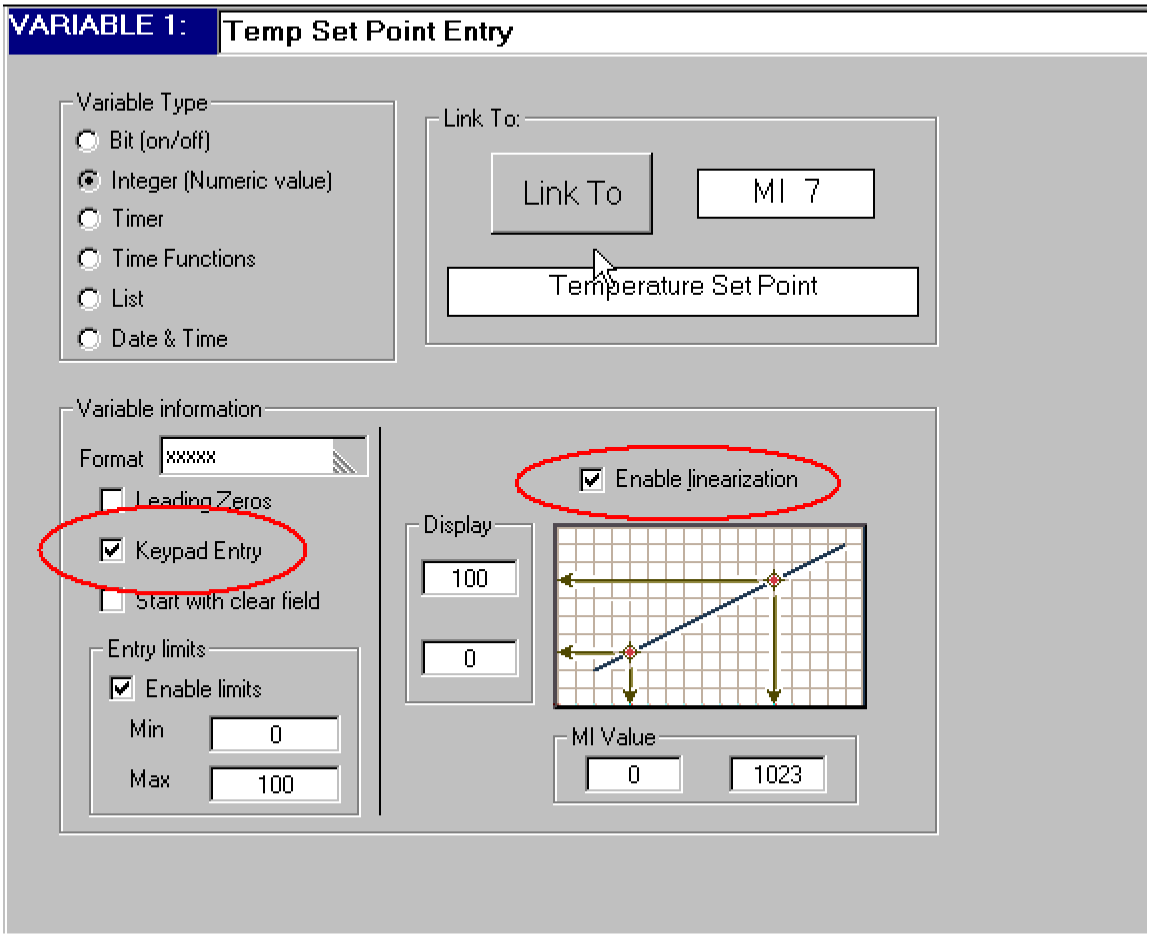
Note that the linearized value created in this way may be displayed-- **but** the value **cannot** be used anywhere else within the project for further calculations or operations.

You can enter an Analog value, such as temperature, via the keypad, then convert that value into a Digital value for comparison with a digital value from a temperature probe by selecting **Enable Linearization** in the linked Variable.

This conversion process is Reverse Linearization.

To enable Analog to Digital conversion:

1. Create a Display for entering the analog value.
2. Create an Integer Variable.
3. Select keypad entry and enable linearization.
4. Enter the linearization values for the x and y axes.



According to the above example:

- A temperature entry of 100^0 C will be converted to 1023 Digital value.
- A temperature entry of 50^0 C will be converted to 512 Digital value.

Linearize values in the Ladder

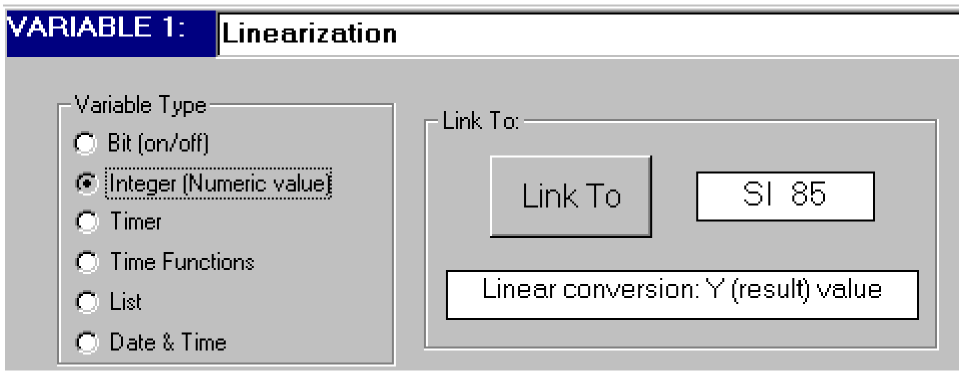
You can also linearize values in your Ladder and display them on the LCD.

1. In your Ladder project, use SI 80 - 85 to set the (x,y) variable ranges. Use SB 80 to activate the **Linearization** function.

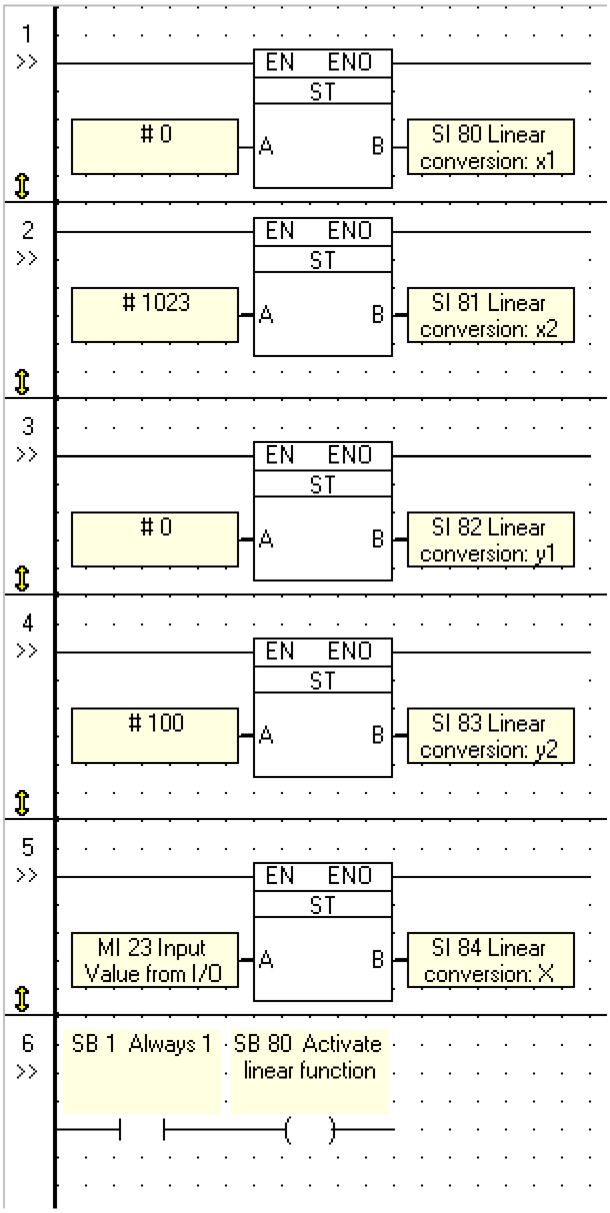
System Integers

Op	Addr	In Use	Power Up	Value	Symbol
SI	80	☐			Linear conversion: x1 value
SI	81	☐			Linear conversion: x2 value
SI	82	☐			Linear conversion: y1 value
SI	83	☐			Linear conversion: y2 value
SI	84	☐			Linear conversion: X (input) value
SI	85	☐			Linear conversion: Y (result) value

The linearization values created here can be displayed by linking SI 85 to a Display;the value **can** be used elsewhere within the project for further calculations or operations.



Example: write the variable ranges into SI 80 - 83, then writing an analog input into SI 84:



Troubleshooting

CANbus network problems

SB 236 indicates that there is an error in the CANbus network.

SI 236 CANbus Network: Failed Unit ID. Note that the first 3 bits turn ON only when the controller is unable to broadcast via the CANbus port. The value of SI 236 indicates the following messages:

Value	Message	May result from:
0	No Acknowledgement	CANbus power failure, crossed wires, incorrectly set termination points.
1	CANbus OFF	
2	CANbus Warning error	Poor transmission quality due to faulty wiring, or if the cable length exceeds recommendations.
4	One or more networked units cannot be read. If this bit is ON, check SI 238, SI 240-243.	

SI 237 CANbus Network Communication Error Code is a bitmap that indicates the LAST unit that cannot be read. Note that each controller can receive messages from up to 8 others. Example: Assume that there are 6 controllers in the network (3,6,8,13,17,34). Controller 3 is waiting for data from controllers 8 and 13 and 17. If the controller does not receive data from controller 13 (assume a 1 second timeout) then SI 237 will contain a value of 13. Bit 4 in SI 236 will also turn ON. Once controller 3 has received the data, Bit 4 turns OFF.

SIs 240, 241, 242, and 243 serve as a bitmap indicating which unit is in error. If, for example, the network includes unit ID numbers 8, 9 and 13, and PLC #9 cannot be accessed, then the ninth bit in SI 240 will turn ON. When the error is fixed, the bit falls to OFF.

Problem	Possible cause	Recommended Action
Failed communication	Baud rate settings	All M90's in the network must be set to the same CANbus baud rate. These may be edited in the M90 OPLC Advanced settings.
	Termination resistors	Check the M90 user guide for details.
	CANbus power supply	Check that the CANbus power supply is properly connected, and that the voltage is in the permissible range as described in the M90 User Guide.
	Incorrect ID number	You may not have assigned the correct unit ID number in your operand addresses (between 1-63). Check in the M90 OPLC settings.
PC cannot communicate with bridge	Incorrect ID number	When you communicate with the M90 unit that you are using as a bridge to the network, select Unit ID number 0, or select Stand-alone project in the M90 OPLC settings.
PC cannot communicate with network	Communication settings	If you are trying to communicate with an M90 network via a bridge, you must define your project as a Network project--however, U90 Ladder cannot automatically detect communication settings in a Network project. Make sure the current RS232 parameters in your project are the same as the parameters that are actually in the bridge.

	Incorrect baud rate	The bridge's RS232 port's baud rate cannot be set below 9600.

Direct Communication problems

If your PC is not able to establish direct communications with a locally connected PLC, refer to the following table:

Problem	Possible Cause	Recommended Action
No Communications	PLC is not turned on	Turn the PLC on. If the PLC does not turn on, click here.
	Communication cable	Check that: • You are using the correct communication cable. • The RS232 port of the PLC is connected to your PC's communication port according to the instructions in the product's User Guide.
	Communication settings	Refer to Communications Settings.
		If you are trying to communicate with an M90 network via a bridge, you must define your project as a Network project--however, U90 Ladder cannot automatically detect communication settings in a Network project. Make sure the current RS232 parameters in your project are the same as the parameters that are actually in the bridge. Remember: to download via an M90 bridge to a networked M90, you must select the unique ID of the networked M90.
	COM port is not enabled	Check that your PC communication port is enabled. This means checking your PC's BIOS/CMOS setup.
	COM port is defective	Refer to How do I use a PC to access an M90 via GSM modem?
	COM port is occupied	Close the application that is accessing the port. For more information, refer to How do I use a PC to access a PLC via GSM modem?

If you are still unable to establish communications:

Contact your local Unitronics distributor.

Why does the Controller display the 'Restart' message?

The most common reason for this event is a peak in electromagnetic (EMF) 'noise'. This may result from contactors, power relays, solenoid valves, etc. switching on and off, as well as from power transformers and motor speed drivers.

Recommendations

- Use different power supplies - highly recommended - one for the controller (CPU and inputs), and a different one for other electromagnetic devices;
- Use suppressors - reverse connected diodes for DC loads and RC filters for AC loads;
- Where possible, place the signal cables, including the 24V power supply, far away from power lines, especially from cables, coming in and out of motor drivers;
- If needed, use shielded cables for signals, including for 24 VDC and for power cables between the motor driver and the motor itself.

Taking these precautions should help prevent ' Controller Restart'. If the problem persists, contact support@unitronics or your local Unitronics representative.

Modem communication problems

If your controller is transferring data via modem, you can begin troubleshooting by entering Information Mode. You can then check the status of relevant System Bits and Integers to help diagnose the problem.

To begin diagnosing the problem, check the error code contained in SI 70. Refer to the error code table in How the M90 works with a modem.

The tables below show the more common causes of modem communication problems.

Problem	**SI 70 value**	**Possible Cause & Recommended Action**
Modem fails to initialize	2: Modem Did Not Reply	PLC-to-modem cable: Make sure that the cable is securely connected. Check the modem connection and pin-out of the PLC-to-modem adapter cables. Note that if you use cables comprising this pin-out, you must set the RS232 parameter Flow Control to N (none). Incompatible communication settings. Most modems automatically match the parameters of incoming data: baud rate, data bits, parity & stop bits. The M90's embedded modem settings are: 9600, 8 data bits, no parity, 1 stop bit. You may need to manually change your modem's communication settings to match these.
	0: No Error	SB 72 OFF: In order to work with a modem, you must select 'Use modem' in the M90 Modem Configuration box . This causes SB 72 Initialize Modem to turn ON when the M90 powers up. Note that if the M90 has also been configured to use SMS messaging, that the M90 will not be able to connect to a modem because the SMS feature overrides the modem. Check too, that SB 72 is not disabled in your program.
	6: Modem Report Error	Check the modem initialization commands. Refer to Configuring the M90 to use a modem.

Other problems:

Problem	**Possible cause**	**Recommended action**
Modem is busy	Modem is engaged	Check that the modem is free.
Connection established, but the PLC does not reply	Modem adapter cable	Check the PLC modem adapter cable pin-out, particularly that the DSR is connected to the RTS on the modem side.
PLC does not dial	Incorrect phone	Check the PLC's phone book. Refer to Configuring the controller to use a

	number	modem.

PC modem communication problems

If your PC is unable to communicate with a remote PLC via modem, refer to the table below.

Note □ The PC-modem cable is not the same type of cable used to connect between the controller and the modem. Ensure that the cable used to connect the PC to the modem provides connection points for all of the modem's pins.
□ Internal modems must be used in conjunction with the driver provided by the modem's manufacturer.

Problem	Possible Cause	Recommended Action
Modem fails to initialize	PC-to-modem cable	Make sure that the cable is securely connected, and that it is the original cable that was supplied with your modem.
	Incorrect initialization commands	To learn how to edit initialization commands, refer to Configuring my PC's modem.
	Incompatible communication settings	Most modems automatically match the parameters of incoming data: baud rate, data bits, parity & stop bits. The U90's modem communication settings are: 9600, 8 data bits, no parity, 1 stop bit. You may need to manually change your modem's communication settings to match these.
	Incorrect Com port	Assign the correct modem Com port. Refer to Configuring my PC's modem.
	Com port not enabled	Check that your PC communication port is enabled. This means checking your PC's BIOS/CMOS setup.
	Com port occupied	Close the application that is accessing the port.
Modem initializes, but no connection is established	Remote PLC's modem failed to initialize	Refer to PLC-to-Modem connections
	Remote PLC is not connected to modem	Check that the remote PLC is connected to the modem.
	PLC-to-modem cable	Make sure that the cable is securely connected, and that it is the original cable that was supplied with your modem.
	Modem is not connected to telephone line	Check that the modem of both the local PC and the remote PLC is correctly connected to a functioning telephone line.
	Incorrect phone number	Check the PC modem Phone Book. Refer to Configuring my PC's modem.
	No power supply to modem	Check the power supply to both the PC's and the M90's modem.
Modems connect, but the PLC's modem does not	PLC's modem did not initialize	Refer to PLC modem communication problems.

answer.		
	PLC-to-modem cable	Check the pin-out of the PLC-to-modem adapter cables. Note that if you use cables comprising this pin-out, you must set the PLC's RS232 parameter Flow Control to N (none).

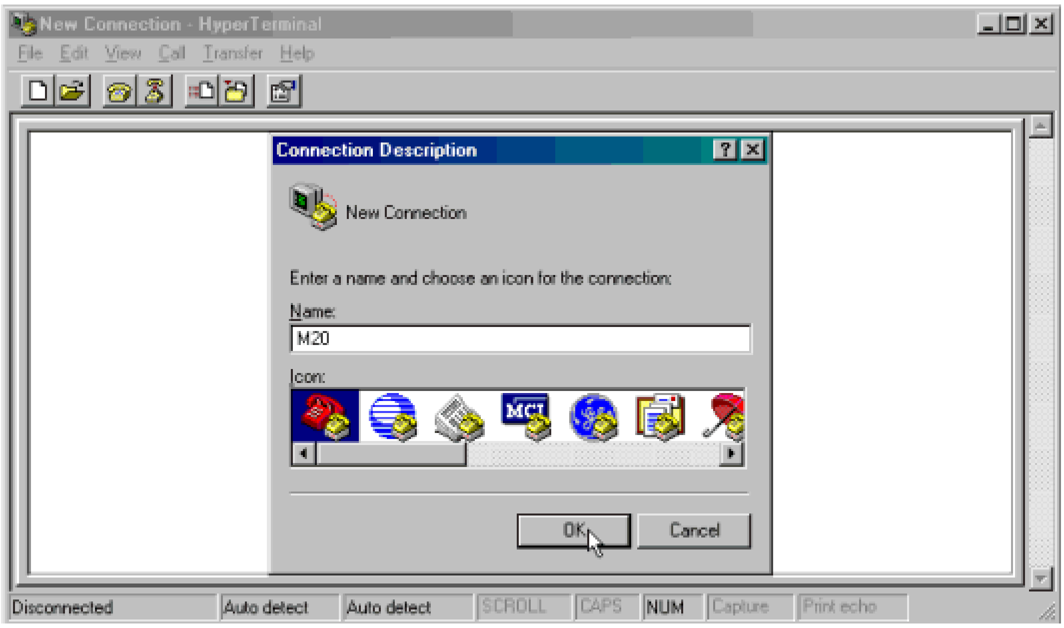
Using Hyperterminal for Modem Troubleshooting

You can use a standard Windows application called Hyperterminal to perform certain tasks, such as changing a modem's communication rate.

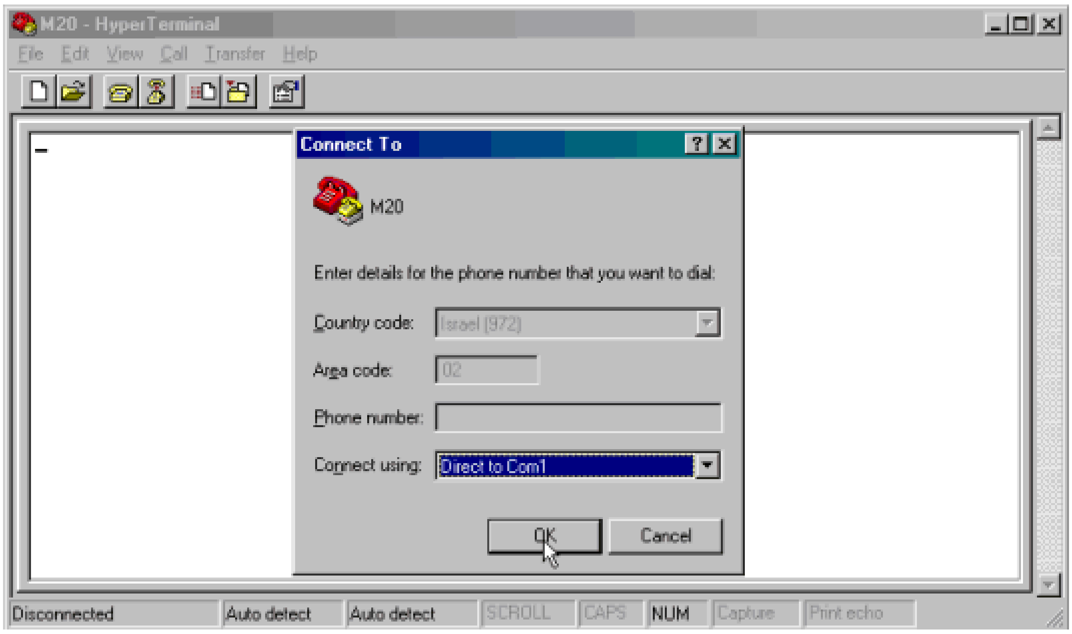
Note □ The modem driver does not need to be installed in order to access the modem via Hyperterminal.

Using Hyperterminal

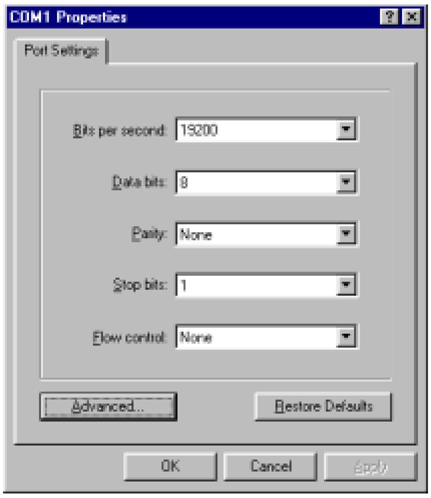
1. Open Hyperterminal. The program can generally be located by clicking the Start button in the lower left corner of your screen, then selecting Programs>Accessories>Communications>Hyperterminal. The New Connection window opens as shown below.
   Note □ Hyperterminal generally starts by pointing to the internal modem, if one is installed on the PC.



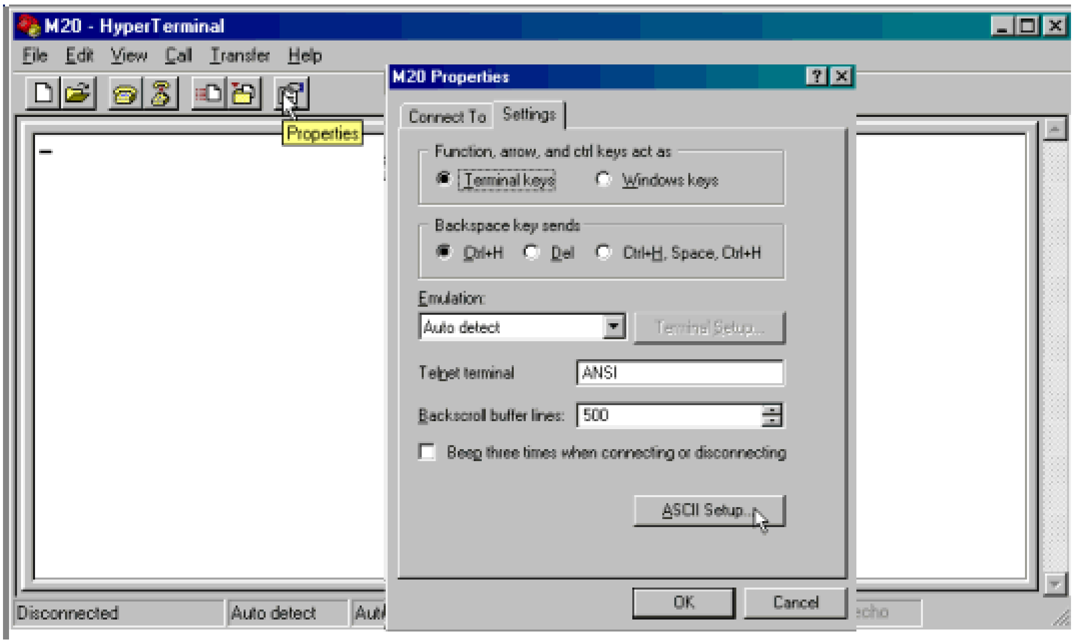
2. Enter a name for the new connection and select an icon, and then click OK. The Connect To box opens .
3. Select a COM port for the modem, and then click OK.



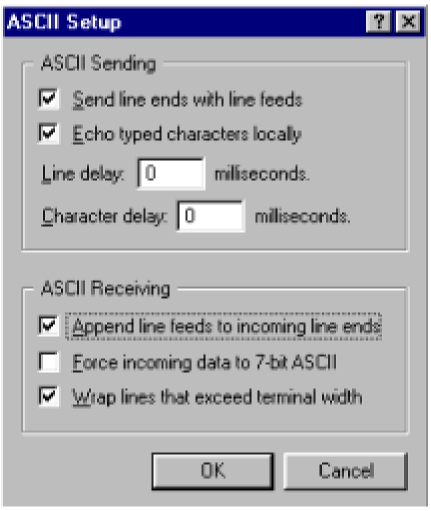
4. The Port Settings box opens as shown below. To enable your PC to communicate with the modem, set the COM port parameters to a BPS of either 9600 or 19200, Data bits=8, Parity=N, Stop bits=1, Flow control=None, and then click OK.



5. Open the modem's Properties box by clicking on the Properties button, then open ASCII Setup.



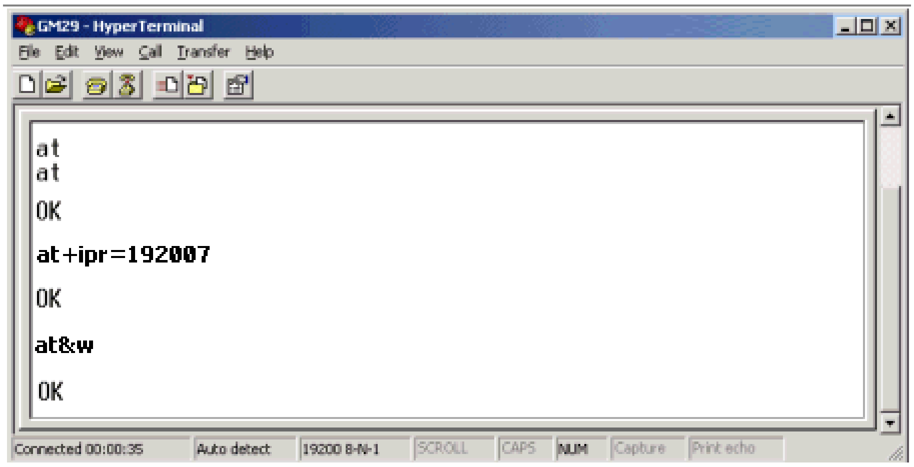
6. Select the options shown below, and then click OK.



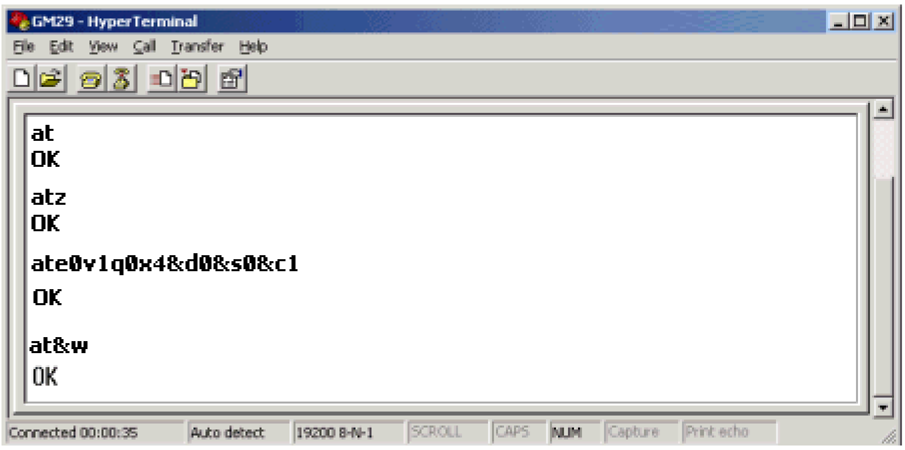
Hyperterminal is now connected to your PC via Com 1; the ASCII settings now enable you to enter commands via the PC keyboard and see the replies from the modem within the Hyperterminal window.

To test the connection, type AT; if the connection is valid the modem will respond 'OK'.

To change the modem's baud rate, type AT+IPR=19200&W; the command '&W' burns the new baud rate into the modem's non-volatile memory.



Typical initialization strings used with an Siemens M20-type modem are shown below.



Modem Commands

Note □ The modem must reply with either OK or READY to each command entered. If the modem fails to answer, the command has not been processed.

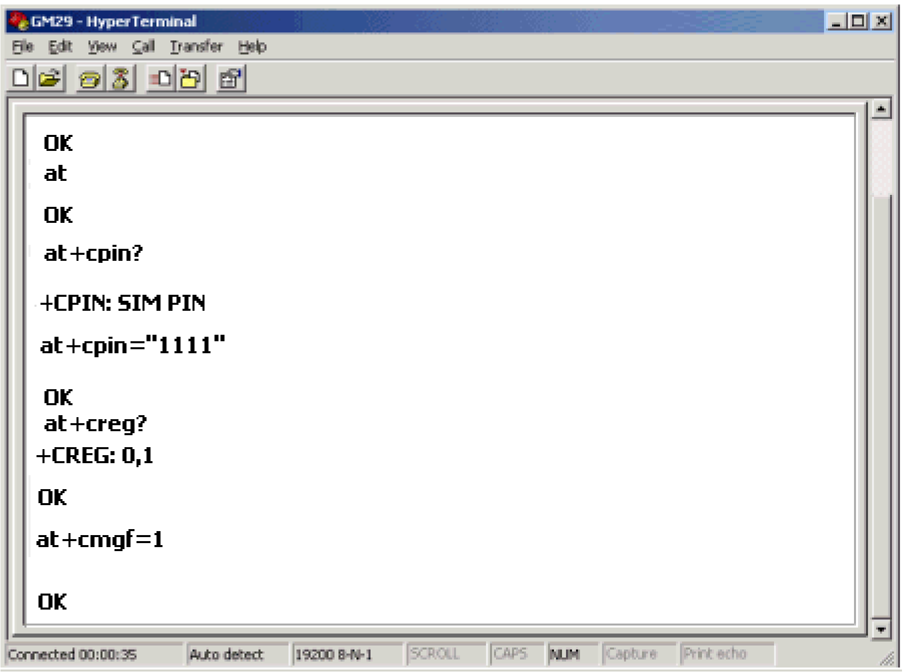
+++	Escape Sequence. This causes the modem to close connections and go back to command mode
AT	This command means Attention; and is used to begin a session
AT&F	Restores factory default settings
ATZ	Resets the modem. This command may take time to implement, so the response from the modem may be delayed
ATE0	No Echo
V1	Enable Verbose (long) response
Q0	Respond
X4	Detailed answers
&D0	Ignore DTR
&D2	Once DTR falls, disconnect and go to command mode
&D1	Once DTR falls, disconnect
&S0	DSR always ON. Since the DSR can be permanently set to ON, connecting it to the RTS causes the terminal always be ready to transmit\receive data
&S1	DSR OFF in command and test modes

&C1	Give the user a signal for the DCD
&C0	Don't give the user a signal for the DCD (refers to LED indications where relevant)
ATS0=1	Auto-Answer after 1 ring
S0=0	Modem doesn't answer. Forces PLC to answer with ATA (pickup)
S10=15	Sets the time (in units of 0.1 sec) from the time when CD is not detected, until the string NO CARRIER is shown. If the value is 255, then the CD signal will not fall—even if the modems are no longer connected
S7=30	TimeOut: If this time is exceeded, the modem notifies that dial has failed
S12	The modem register that defines the time interval during which the line must remain clear, before and after the +++ command. **Note** □ In the M90, this value is fixed on the M90 side and is not entered into the modem. If the controller cannot hang up, register S12 should be checked to ensure that the pause =1.2 sec
&W	Burn the configuration into the modem's non-volatile memory

Initializing the modem to SMS mode via Hyperterminal

Once the modem is successfully initialized, you can use Hyperterminal to initialize the modem to SMS mode.

Command	Description	Notes
at+cpin=?	Is a pin number required?	
at+pin="xxxx"	Is the pin number set in the application?	XXXX is the PIN number coming from the U90 application.
at+creg?	Has the SIM card been registered with the local cellular provider?	Should return one of two answers: • +CREG: 0,1 The SIM is registered with its local provider. • +CREG: 0,5 The SIM is in **roaming** mode.
at+cmgf=1	Go to text mode	



Notes • Commands including question marks are run for verification **twice.** If the command is not verified during the second attempt, the attempts stop.

- If the SIM requests the PUK number, the SIM must be taken out of the modem and installed into a phone to enable the number to be entered.
- If the SIM is full, the SIM must be taken out of the modem and installed into a phone to enable the SIM to be cleared.
- The modem must be able to support Text mode. P.D.U. mode is not supported.

When a controller sends an SMS text message

- The controller uses the Send command, containing the number to be called: AT+CMGS= ”phone number”.
- The controller then waits for the reply '>'.
- When the '>' is received, the controller sends the message, ending the line with CTRL_Z
- If the message is successfully sent, the controller will receive a message of confirmation,+CMGS:xx. When this message is received by the controller, SB 184 turns ON. The confirmation message is acknowledged by OK.
- If :
  the message of confirmation is not received within 15 seconds, or
  the '>' is not received within 3 seconds, SB 185 turns ON.

When the controller receives an SMS text message:

- It receives the command: +CMTI: “SM” ,xx. Xx is a number in the controller's memory, 1 to 20.
- When the message is received, the controller asks the modem for the text via the command AT+CMGR=xx
- The modem replies with +CMGR, including the phone number, status, text, and concluding with OK.

Note • When a Com port has been successfully initialized, the relevant bit turns ON: SB 80 , 82, 83 or 84.
If initialization fails, SB 81, 83, 85, or 87 will turn ON.

'The Sniffer'--Viewing communication strings

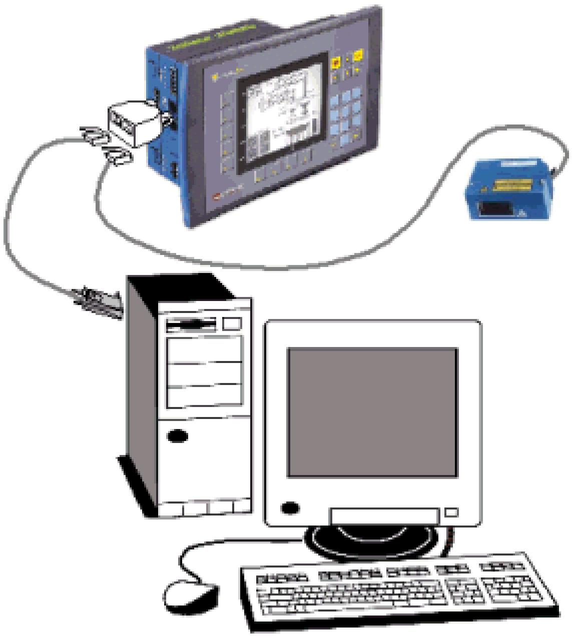
The instructions below show you how to construct a communications 'Sniffer'. This device enables you to use Hyperterminal to view communication strings flowing between a PLC and an external, connected device such as a bar code reader.

‘Sniffer’ is connected to the external device.

‘COM’ is connected to the PLC.

The completed Sniffer is connected to a PLC communication port, PC and external device.

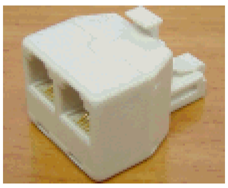
Note that communication cables are the programming cable provided by Unitronics.

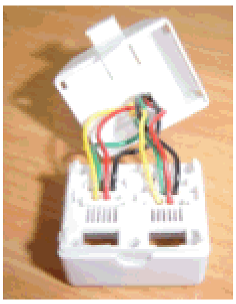


To make a Sniffer, you need:

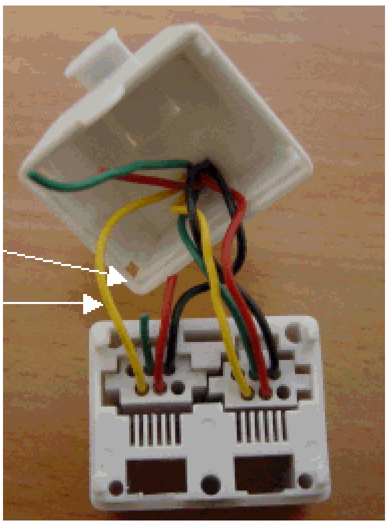
- An adapter.
- Two 1N4148 or 1N914 diodes.

1. Open the adapter carefully via the 4 snaps in its sides.

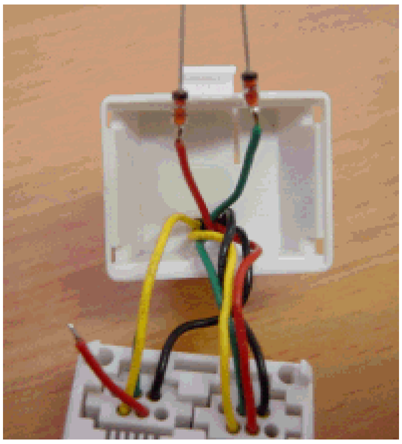




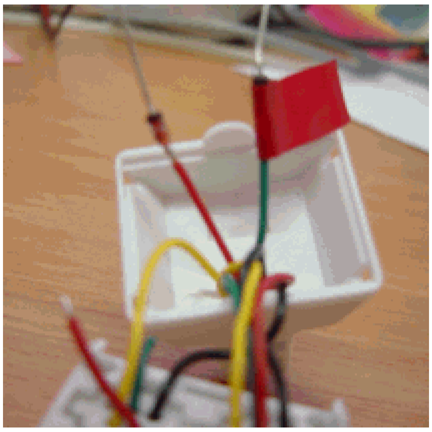
2. Cut the red and green wires as shown below.



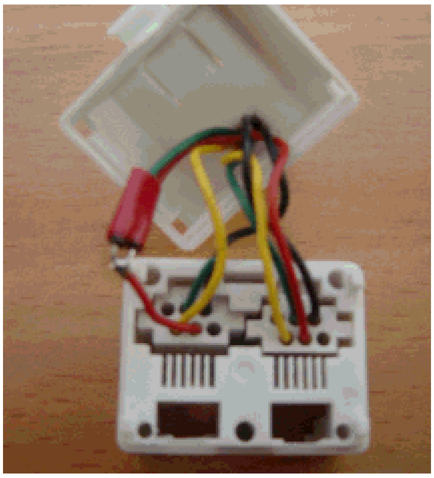
3. Solder one diode to the red wire, and one diode to the green wire.
   The soldered point provides the anode.



4. Put isolating material on the soldered points.



5. Solder both diodes' cathodes to the red wire.



6. Put isolating material on the solder.
7. Close the Sniffer.
8. Label the connectors as shown.

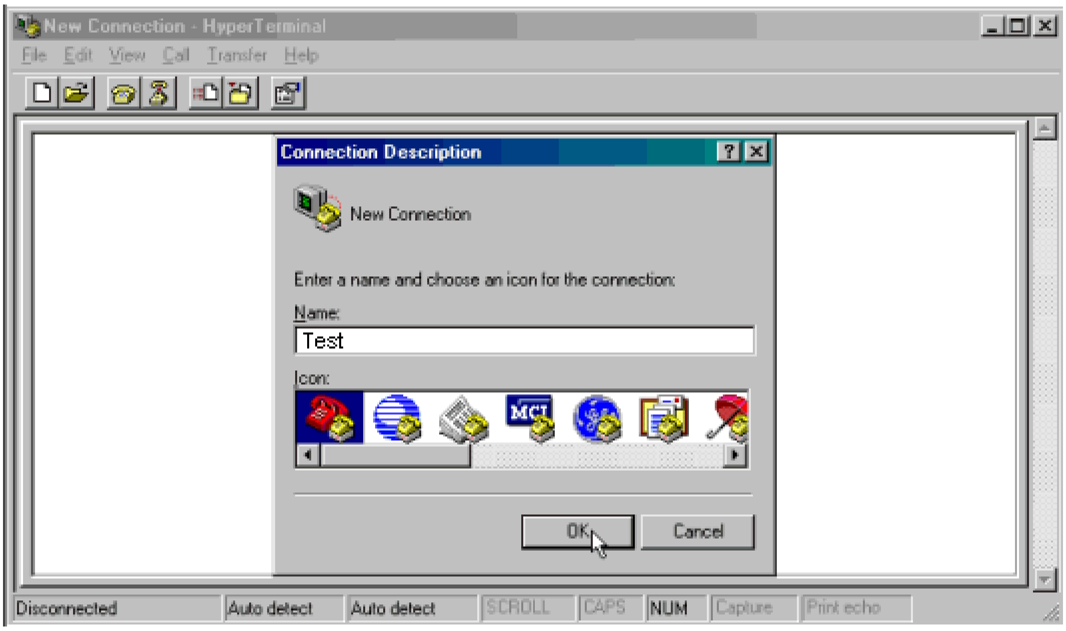
Note □ In order to run view the strings in Hyperterminal, you must set the program to display ASCII strings as described above in Using Hyperterminal.

Using Hyperterminal to check PC-PLC direct communications

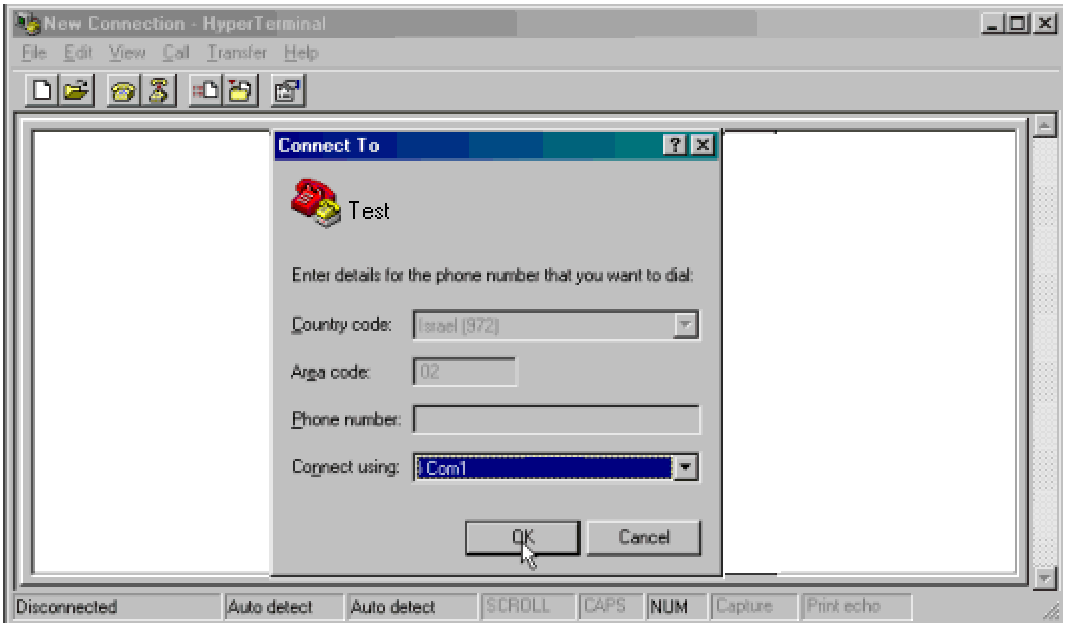
If the PC port is defective or in use by another application, you may be unable to access a directly connected controller with your PC.

Via Hyperterminal, you can check the PLC-PC communication connection by sending a simple text command, Get ID. If the connection is in order, the controller replies with its ID; if the connection is faulty, the controller will not reply.

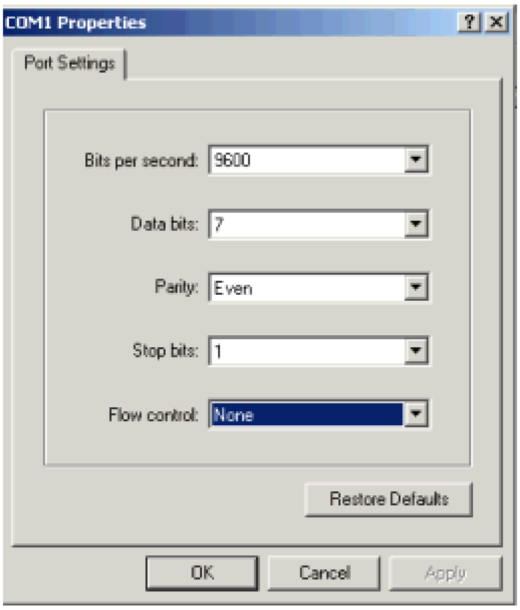
1. Open Hyperterminal.



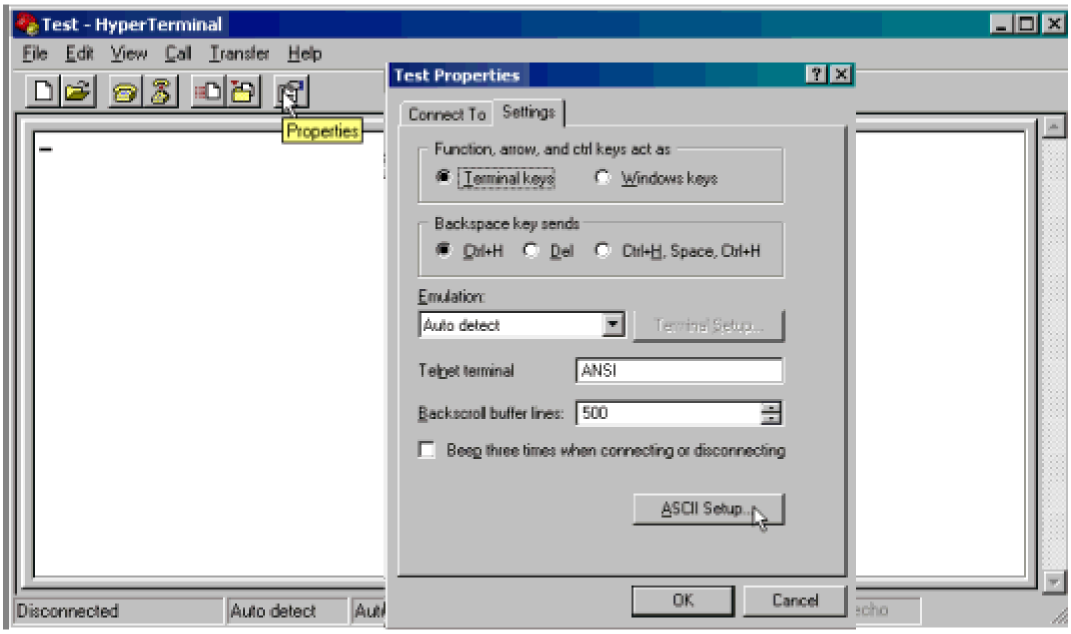
2. Enter a name for the new connection and select an icon, and then click OK. The Connect To box opens.
3. Select the PC COM port that connects the PC to the controller, and then click OK.



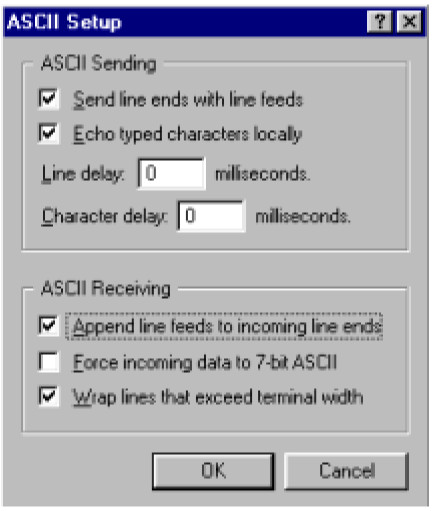
4. The Port Settings box opens as shown below. To enable your PC to communicate with the controller, set the COM port parameters to the M90 default settings:BPS 9600, Data bits=7, Parity=N, Stop bits=1, Flow control=None, and then click OK.



5. Open the Properties box by clicking on the Properties button, then open ASCII Setup.

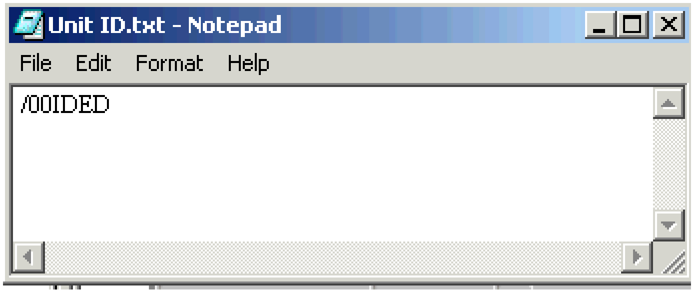


6. Select the options shown below, and then click OK.



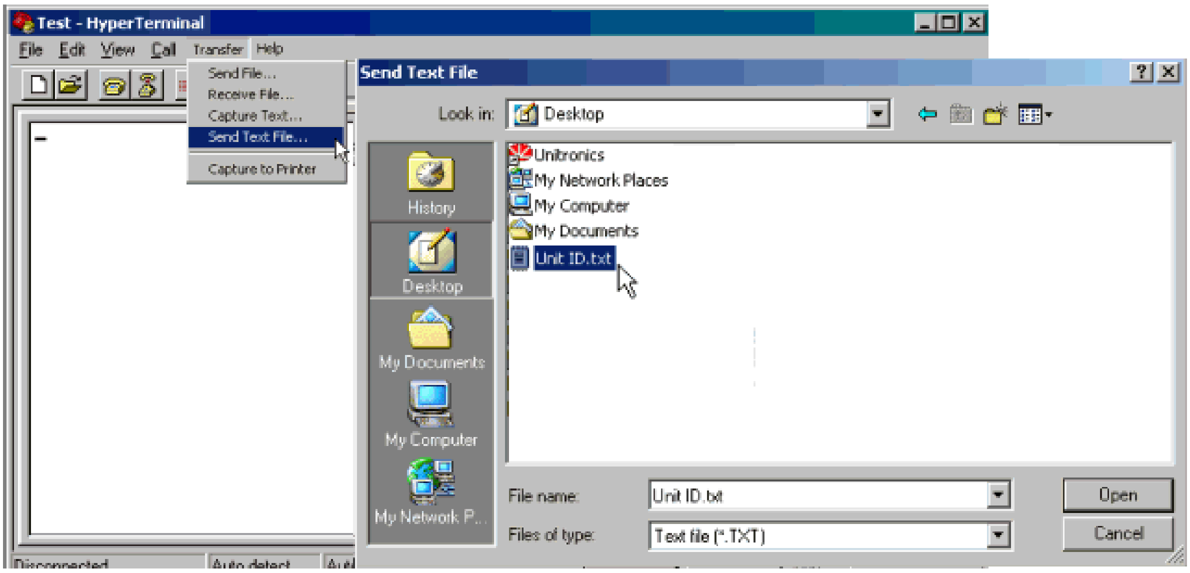
7. To synchronize the controller's communication settings, enter Info mode. Navigate to System>RS232>Restore Defaults, and then press the Enter key.
8. Open Notepad, enter the text **/00IDED**, press Enter, and save the file. This is the Get ID command, where 00 is the 'placeholder' for the controller's Unit ID number. 00 enables any directly controller to answer, no matter what it's actual ID number is. ED is the command's checksum.

Note • Pressing Enter places a Carriage Return command at the end of the text. Although the Carriage Return is not visible, the command will not be processed without it.

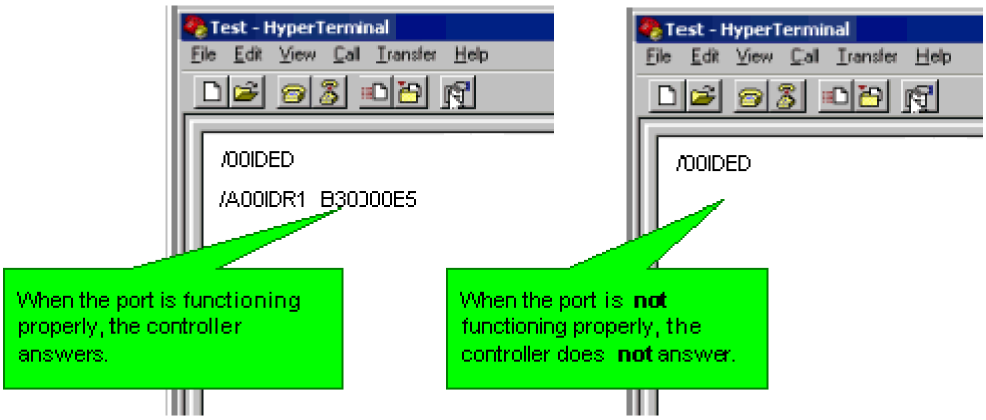


9. Select Send Text file from the Transfer menu, and open the text file

.



10. If you have configured everything according to the instructions above, and the port is functioning properly, the controller with its ID number. If the port is out of order, the controller will not reply.



In the figure above, the characters in the string that is returned by the controller, /A00IDR1 B30000E5 may be interpreted as follows:

A	00	ID (PLC model)	B (Hardware Version)	E5	CR (ETX)
Answer	Requested number	M90-R1	OS V3.00 (00)	Checksum	Not visible

Compatibility: HW, OS, SW

Both the OS that runs the PLC and your current software version must support the hardware, such as I/O Expansion Modules, that you use in your applications.

Hardware	Supported by OS Version	Supported by U90Ladder Version
M91-2-R34	3.72 B00	3.94.43

M90/91 and Jazz, Memory and Features

	Ladder program size, Maximum	Application download size, Maximum	Displays, Maximum	Variables, Maximum	List Vars Size, Maximum
M90	3K	32K (1)	80	50	2K
M91 (single line)	3K	32K	80	50	2K
M91 (2 lines, English only)	3K	32K	80	64	2K
M91 (2 lines multilingual)	3K	32K(2)	80	64	2K
Jazz	2K	24K	60	64	1.5K

(1) M90-XX-B1A maximum Ladder program size is 1K

(2) Jazz memory is composed of Flash only. It is dynamic. Note that the 24K includes upload data. This means that in certain cases, if a program is too large to download, you may be able to download it after selecting Download: Disable program upload.

	PID loops, Maximum	Supports Data Tables	Supports Drum
M90	4	Y	N
M91 (single line)	4	Y	Y
M91 (2 lines, English only)	4	Y	Y
M91 (2 lines multilingual)	4	Y	Y
Jazz	0	N	Y

Download: Stop and Reset

Jazz controllers always Stop and Reset at project download.

M90/91 controller Stop/Reset under the following conditions

Reason	Stop PLC	Reset PLC
Hardware configuration is checked in download, even if no changes have been made.	YES	YES
HMI language in project differs from the language in PLC	YES	YES

The project's Drum configuration differs from the Drum in the PLC	YES	YES
The Project Password in the project differs from the Password in the PLC	NO	YES

Reducing Program Size

When downloading a project that exceeds the memory capacity of the controller, the program stops the download process and displays a warning.

There are several steps you can take to decrease program size:

- Delete Comments via the Edit menu.
- Select the Disable Upload option in Controller> Download.
- Delete unreferenced operands via View>Unused Operands.

Note • The memory capacity of M90/91 is 16K.
The capacity of Jazz controllers is 8K.

PLC does not turn on

When the PLC is turned on, the display screen is lit.

Note that the screen can display messages only after you download HMI displays to the PLC. If you have not downloaded displays, check the screen by pressing the 'i' button for a few seconds to enter Information Mode. If no text appears on the screen, the PLC may not be receiving turned on.

If your PLC does not turn on

- Check that the power supply's voltage is in the permissible range in accordance to the technical specifications for your model.
- Check the PLC's connections. The +24VDC must be connected to the + V terminal, and the ground connected to the 0V terminal.
- Make sure that the 24VDC output power supply is connected to a functioning AC power source.
- Check your fuses or circuit breakers. These must allow power flow.
- Make certain that the power is ON.

If you have checked all of the above, and the PLC does not turn on, contact your local distributor.

Replacing or Removing the battery

After replacing the PLC battery, initialize the PLC via Info Mode Info>System>Working Mode> Init.

Note • When you replace the battery, you lose RAM values.

Backing up the PLC RAM

Unitronics Remote Access PC utility offers the tool 'Backup PLC RAM'. Using this tool, you can read all PLC RAM values such as Data Tables and register values into an Excel file on your PC, and later write these Excel values back into the PLC's RAM.

Remote Access may be installed from the Setup CD, or downloaded from
http://www.unitronics.com/download.htm

Power-up Modes

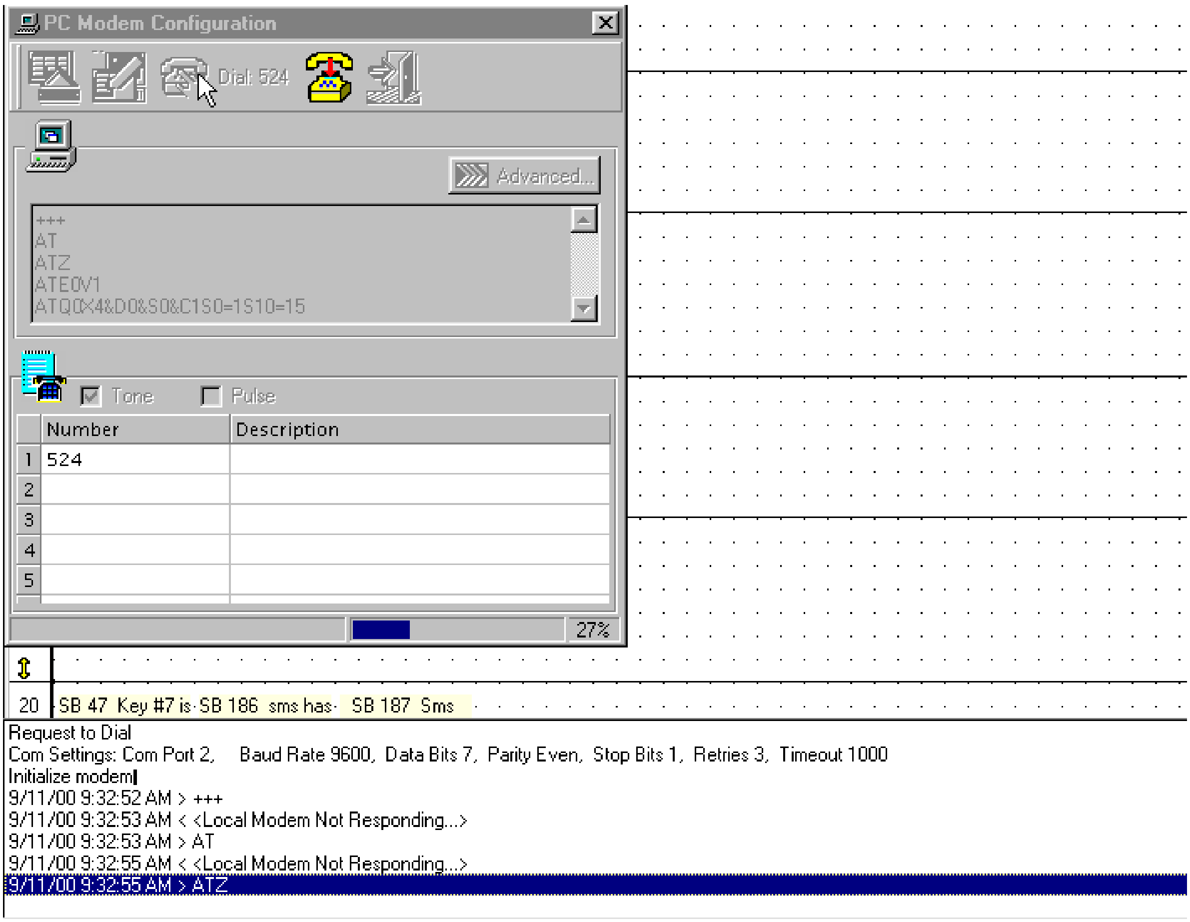
You can force the controller to enter Bootstrap or Stop mode by turning on the power supply while pressing specific keypad keys.

Mode	M90	M91
Bootstrap	< I > + < 7 >	< I > + < 7 >
Stop (O/S) Exit Stop Mode by entering Information Mode, and then selecting System> Reset.	< I >	< I >

Note • During Stop mode, timers continue to run.

Communication Log

When you dial a remote modem using U90 Ladder, a window opens up in the bottom of your screen. The log of events is quickly displayed in this window.



The log also appears during download and upload if there are communication problems.

This log is stored as a .txt file. You can view this log by navigating to Unitronics\U90_Ladder\U90Ldxxx and opening a file named ComLog.txt.

In this file, the most recent log of events appears **last**.

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