

Table of Contents

Preface	5
Getting Started	6
The Sample Application	6
Starting a New Project:	6
Saving a Project:	7
Displays: Operator Password	8
Display 1: Enter ID no.	8
Creating Display 1	8
Creating a Field	9
Attaching a Variable	9
Formatting a Keypad-Entry Variable	10
Setting a Jump Condition	12
Display 2: Access Okayed/Denied	13
Editing Display 2	14
Formatting Variable 9:	14
Setting Jumps	15
Display 3: Welcome _____	16
Editing Display 3:	16
Formatting List Variable 7	17
Review	18
How to Build a Net	19
Building Net 1	19
Connecting Elements	22
Ladder: Operator Password	24
Approving the Password	24
Copying and Pasting Ladder Elements	24
Conditional Text—Access: Okayed/Denied	27
Enlarging a Net	27
Jump to Display 3: Timer	28
Starting a Timer	28
Using the Timer's Bit Value	29
Jump to Display 1: Timer	30
Review	31
Resetting Coils	31
Inserting New Nets in the Ladder	31
Resetting MB 10, 11, and 12	32
Initializing MI 4	33
Inserting a 'Comment'	34
Downloading a project	34
Testing Your Project: Debug	35
Displays: Entering Parameters	37
Display 4: Set Box Quantity	37
Editing Display 4	37
Creating a Field	37
Attaching a Variable	38
Formatting a Keypad-Entry Variable	38
Setting a Jump Condition	39
Display 5: Start Time	41
Editing Display 5	41

Programming the M90	
Creating a Field and Attaching a Variable	41
Formatting a Keypad-Entry Time Variable	42
Setting a Jump	43
Display 6: End Time	44
Editing Display 6	44
Creating a Field and Attaching a Variable	44
Formatting a Keypad Time Entry Variable	45
Setting a Jump	46
Review:	46
Displays: Displaying Run-Time Data	47
Display 7: Box Count	47
Editing Display 7	47
Creating a Field and Attaching a Variable	47
Formatting a Display Variable	48
Creating a Field and Attaching a Variable	48
Formatting a Display Variable	49
Setting Jumps	49
Display 8: Operator Messages	51
Editing Display 8	51
Creating a Field and Attaching a Variable	51
Formatting List Variable 8	52
Setting Jumps	53
Review:	54
Ladder: Maintenance Time	55
Net 11: Machine Cannot Run	55
Using Indirect Time Functions: Clock	55
Ladder: Starting the Bundling Machine	57
Starting the Machine	57
Direct Clock Functions: Day Of The Week	57
Counting the Boxes	58
Building the Counter	59
Initializing the Counter	60
Ladder: Operator Messages	61
Stuck Box: Timer 0	61
Conveyor Stopped: Timer 1	62
Activate Timer 1	62
Display Line 0: Bundle Complete	63
Display Line 1: Stuck Box	64
Display Line 2: Conveyor Stopped	64
Exiting Display 8	65
Exiting 'Bundle Complete'	65
Exiting 'Box Stuck!' and 'Conveyor Stopped'	66
Exit Box Stuck, Return to Box Count	67

Preface

Unitronics' M90 OPLC is a micro-controller with an on-board I/O configuration and an HMI operating panel. M90 OPLC automation projects are written on a PC using U90 Ladder software, and then downloaded into the M90.

Automation projects include the:

- Ladder application, which is the control program that enables the M90 to carry out its automation task. You write this application using the Ladder editor.
- HMI application, which customizes the M90-operator interface. You design the messages the M90 displays on its LCD screen and customize the keypad using the HMI editor.

This tutorial teaches the basics of U90 Ladder programming step-by-step. When you complete it, you will know how to create projects using:

- Displays
- Timers
- Math Functions
- Store Functions
- Variables
- Counters
- Compare Functions

To get the most from the tutorial, connect your PC to the M90 controller. This allows you to download and test the project.

M90 Features

The M90 offers a number of advanced features, including:

- **CANbus/RS232 Networking**
- **I/O Expansion**
- **Modem Communication**
- **Remote Programming and Trouble-shooting**
- **SMS messaging**

To learn more about these and other features, refer to the M90's on-line help system.

M90 Sample Programs

You can learn more about M90 programming by referring to the sample U90 Ladder applications installed along with U90 Ladder. These are located in the Unitronics folder in the Examples directory.

Programming the M90

Getting Started

The Sample Application

In this application, you write an application that automates a box-counting machine.

This machine counts boxes before they are packaged into bundles. A photocell* is installed at the machine's entrance. The boxes are counted as they pass the photocell. The photocell also detects when a box is stuck, and detects when there are no boxes in the system.

Machine operators use their ID numbers as passwords to access the system.

Approved operators can then use the M90's keypad to set:

- The number of boxes per bundle
- 1 hour each day when the system will not be able to run

When the machine is running, the M90's LCD screen will display:

- A running box count
- A message when the set number of boxes per bundle is reached
- Error messages

Your program will also prevent the machine from running over the weekend.

*Note that the function of the 'photocell' in this application is filled by the +/- key on the M90 keypad. This allows you to download the tutorial into your M90 controller and run it without connecting the M90 to anything other than your PC.

Starting a New Project:

1. Open U90 Ladder.
2. Click the **New** icon on the toolbar.



Figure 1. New Project

A new project opens, showing the M90 Hardware Configuration window. You can have only one U90 project open at a time. Before a new project will open, you will be prompted to save any changes to the currently open project.

3. Select your M90 OPLC model from the list. The selected model name appears above the M90 picture as shown below.

U90 Ladder Tutorial

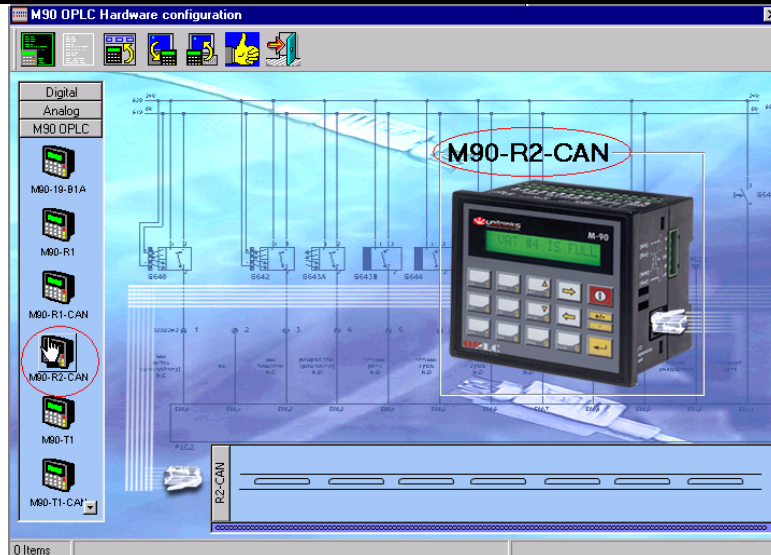


Figure 2. Hardware Configuration Window

This project does not include I/O expansion modules.

4. Close the Hardware Configuration window.

Before you begin programming, save your new project.

Saving a Project:

1. Select **Save** from the Project drop-down menu.
2. The **Save As** dialog box opens.
3. Select the desired folder; then enter **Factory Tutorial** as the file name as shown below. The file extension for U90 Ladder projects is **.U90**.

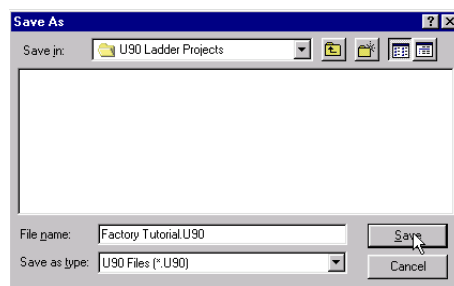


Figure 3. Save As Dialog Box

4. Click **Save**.

You are now ready to begin writing your project.

Programming the M90

Displays: Operator Password

In this section, you create a series of Displays. These displays will lead the machine operators through the process of entering a 2-digit-long password.

Display 1 is the display that will be shown on the M90's LCD screen after the project is downloaded into the M90. This Display instructs the operator to enter an ID number. The operator enters the number using the M90's keypad.

Display 1: Enter ID no.

Display 1 contains:

- **Fixed text.**
- **A Keypad-Entry Variable.**

Creating Display 1

1. Click the **Displays** button on the toolbar. Display 1 opens in the HMI editor.
2. Name the Display **Enter Password** by typing this title in the title bar and then pressing **Enter**. The Display name appears in the Project Navigation tree as shown below.

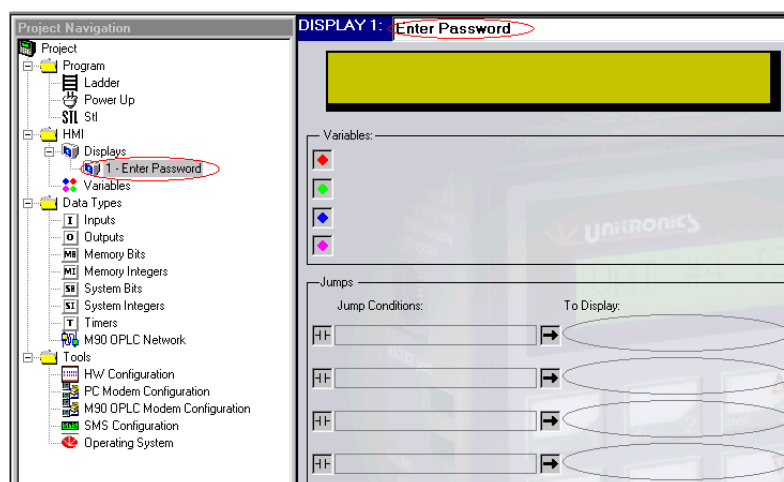


Figure 4. Initial Display

3. Click on the left side of the green Display field to place the cursor.
4. Enter the Display text **Enter User ID no.** in the green Display field as shown below.



Figure 5. Enter ID Number

Enter ID no. is fixed text. To enable the operator to enter an ID number you must:

- Create a field within the display that is long enough to hold the ID number.
- Attach a **Keypad Entry Variable** to the field.

Creating a Field

1. Click your cursor in the display after the fixed text. This is the starting point of the field.
2. To create the field, hold the left mouse button down and drag the cursor across the display as shown below. The field you create is highlighted in blue.

In Figure 6, the display contains a field two spaces long.

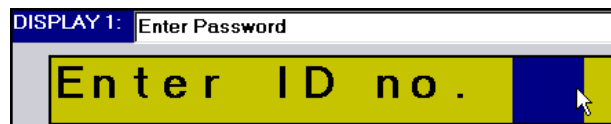


Figure 6. Variable Display Field

Attaching a Variable

1. Click **Attach Variable** on the toolbar as shown in the figure below.

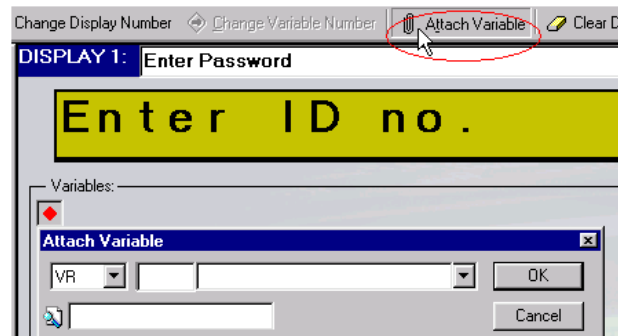


Figure 7. Attaching a Variable

2. The Attach Variable dialog box opens as shown below.
3. Enter **VR 6 Worker ID no.** and press **OK**. If you do not enter a number, the program assigns a default number.

Programming the M90

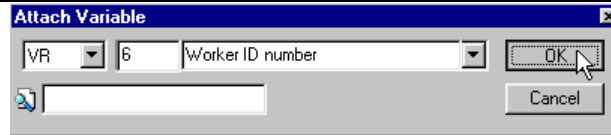


Figure 8. Enter Variable Number and Address

- 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.

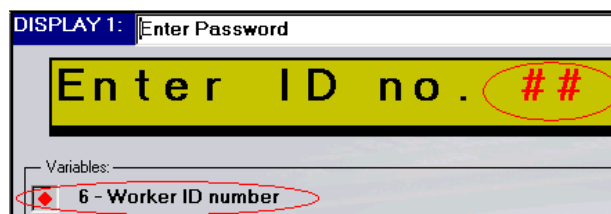


Figure 9. Display 1 with Attached Variable

You have attached a Variable to a Display. Now you need to format the Variable.

Formatting a Keypad-Entry Variable

This Variable will accept a two-digit number between one and ninety, because there are 90 workers in the factory. Since the operator enters an ID number using the M90 keypad, you will define this Variable as a **Keypad Entry Variable**.

- Click on **Variable 6** in the Project Navigation tree. It opens in the Variable editor as shown below.

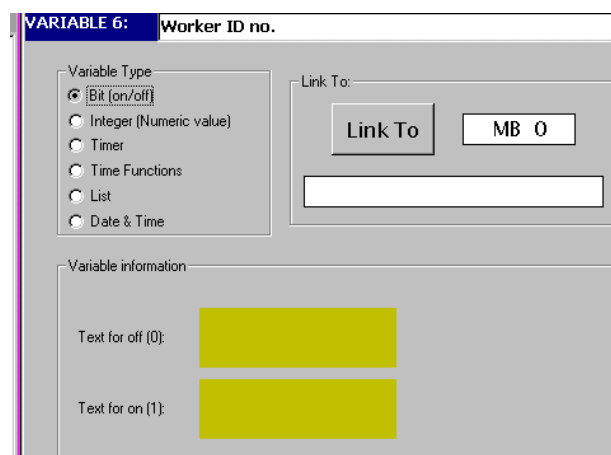


Figure 10. Variable 6

- Select **Integer** from the Variable Type list. The **Set Link to Int** box opens as shown below.

U90 Ladder Tutorial

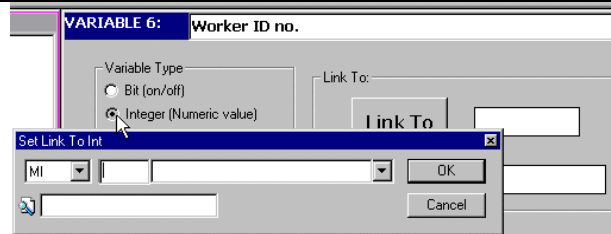


Figure 11. Linking an MI to a Variable

3. Enter **MI 4 Worker Name List** as shown below. Click **OK**. MI 4 appears in the Link To field as shown in Figure 13.

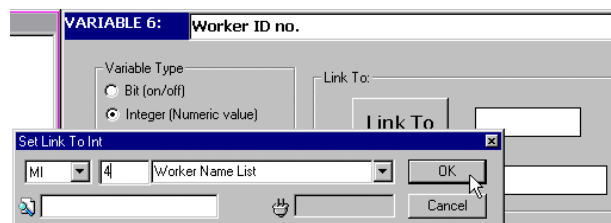


Figure 12. Assigning Operand + Description

4. Select **Keypad Entry** from the Variable Information list.
5. Select **Start with Clear Field**. This will “erase” any previous ID numbers that have been entered, and prevent them from being viewed on the M90’s display screen. If you do not select **Start with Clear Field**, the last ID number entered will enable system entry.
6. Select **Enable Limits**. In the **Min** box, enter 1; enter 90 in the **Max** box. When you are finished formatting Variable 5, the screen will look like the figure below.

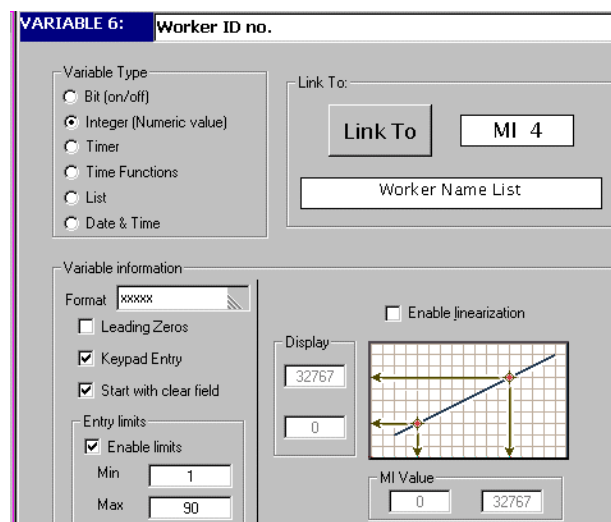


Figure 13. Formatting an Entry Variable

Programming the M90

Display 1 now contains fixed text, **Enter ID no.**, and a Keypad Entry Variable to hold the ID number.

The ID number acts as a password. The next Display, **Display 2 Password Access**, informs the operator if the password that has been entered is 'okayed', allowing system access, or 'denied', blocking system access.

To cause the M90 to change the Display currently shown on the LCD screen, you create **Jumps**. A Jump contains a Jump Condition and a destination Display.

Setting a Jump Condition

After an operator enters an ID number (s)he presses the **Enter** key. Use this key press as the Jump condition.

1. Select **Display 1** from the Project Navigation tree as shown below. Display 1 opens.



Figure 14. Opening a Display via the Project Navigation tree

2. Click on the first **Jump Condition**. The **Define Jump to Condition** box opens.

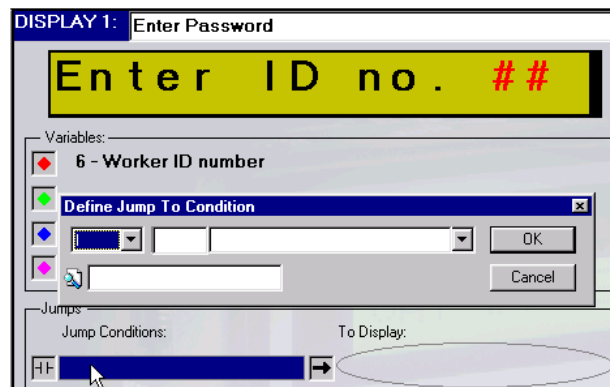


Figure 15. Define Jump To Condition box

3. Select the operand type **SB** from the drop-down list as shown below.

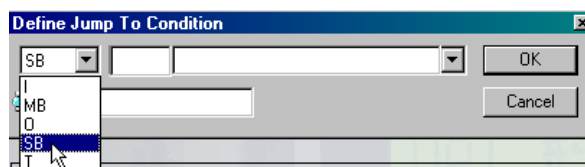


Figure 16. Define Jump To Condition box

U90 Ladder Tutorial

- Enter **30**. The Operand description **Keypad entries complete** appears automatically. Click **OK**. The **Define to Display Jump** box opens.



Figure 17. Defining a Jump Condition

- Enter **DS 2 A** e as shown below. Click **OK**.



Figure 18. Defining the Jump Destination

The Display now shows the Jump condition and the destination Display. Display 1 is complete as shown below. When an operator enters an ID number and presses **Enter**, the M90 will show Display 2 on its LCD screen.

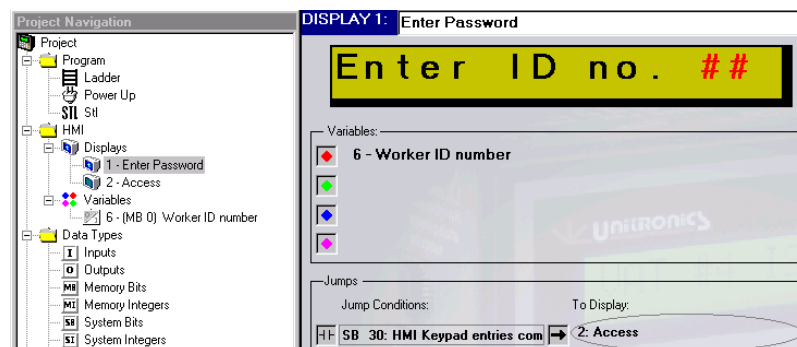


Figure 19. Completed Display

Display 2: Access Okayed/Denied

Display 2 contains:

- **Fixed** text.
- **Bit Variable** text.

Remember that although there are 90 workers in the factory, only 3 operators have ID numbers that may be used to access the system: 10, 11, and 12. When these numbers are entered, Display 2 will read: **Access okayed**. When any other number is entered, Display 2 will read: **Access denied**. **Access** is fixed text. Okayed/Denied is conditional text that depends on the status of a Bit Variable.

Programming the M90

The bit status of this Variable will also be used as a Jump condition from Display 2.

Editing Display 2

1. Open **Display 2 Access**: by clicking it in the Project Navigation tree.
2. Enter the fixed text **Access**: in the green Display field.
3. Next to the word **Access**:, click and drag your cursor to create a Variable field 6 spaces long.
4. Click the **Attach Variable** icon on the HMI toolbar. The **Define Variable** box opens.
5. Enter **Variable 9 Denied / Okayed** as shown below. Click **OK**.

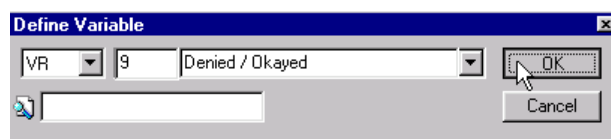


Figure 20. Attaching a Variable

The Variable field appears as red number signs as shown below. The Variable text appears in this field.

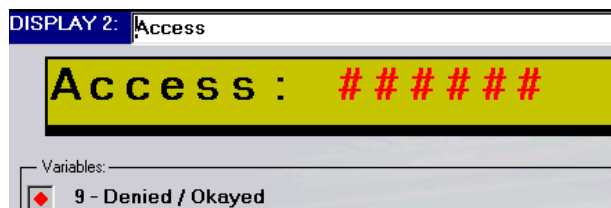


Figure 21. Linked Variable

Formatting Variable 9:

1. Open Variable 9 by clicking it in the Project Navigation tree.
2. Variable 9 opens. Leave the default Variable Type, Bit.
3. Click the **Link To** button. The **Set Link to Bit** box opens.
4. Enter **MB 20 System can work**. Click **OK**.

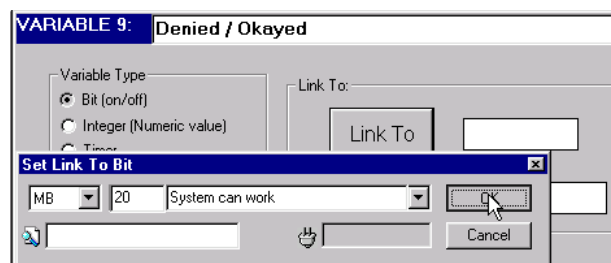


Figure 22. Link to Bit Variable

U90 Ladder Tutorial

5. Under Variable information, enter **Denied** in the **Text for off (0)** field.
6. Enter **Okayed** in the **Text for on (1)** field.

The complete Variable appears as shown below.

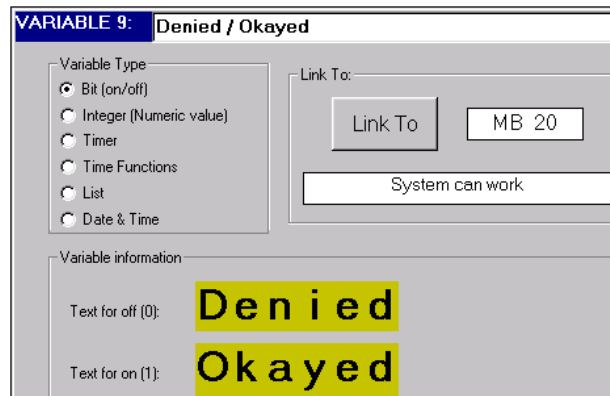


Figure 23. Variable 9 Complete

Setting Jumps

Next, set the Display's **Jumps**. The **Jump** conditions from Display 2 are not linked to the M90 keypad. The conditions are set within your Ladder in the Ladder project.

1. Open **Display 2 Access**. Click on the first Jump Condition. The **Define Jump to Condition** box opens.
2. Enter **MB 7 Time to jump to DS 3**. Click **OK** as shown below. The **Define to Display Jump** box opens.

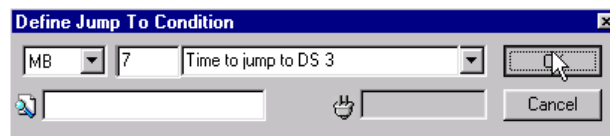


Figure 24. Jump Condition

3. Enter **DS 3 Present the workers name**. Click **OK**.

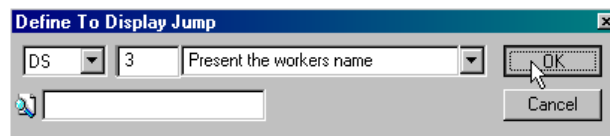


Figure 25. Jump Destination

4. Click on the second Jump Condition. The **Define Jump to Condition** box opens.
5. Enter **MB 8 Time to jump to DS 1**. Click **OK**.

Programming the M90

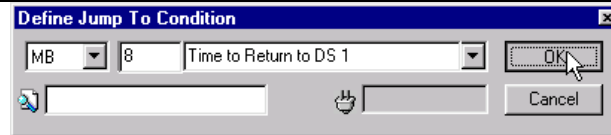


Figure 26. Jump Condition

6. The **Define to Display Jump** box opens.
7. Enter **DS1 Enter Password**. Click **OK**.

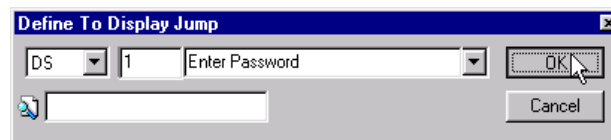


Figure 27. Jump Destination

Completed Display 2 appears as shown below.

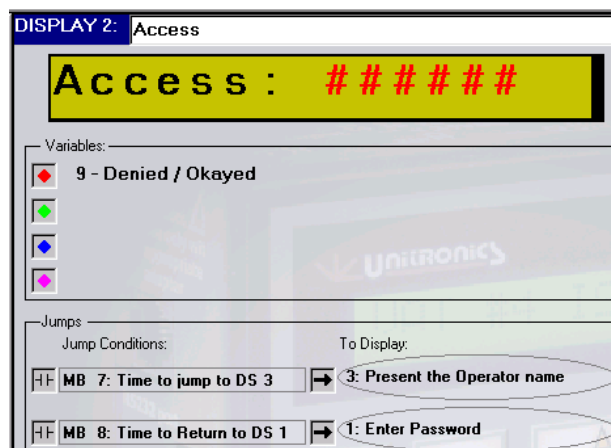


Figure 28. Display 2 Complete

Display 3: Welcome _____

This is the last Display in this section. Display 3 contains the text '**Welcome _____**', showing the operator's name. The operator's name will be contained in a List Variable show.

Editing Display 3:

1. Open Display 3 **Present the workers name**.
2. Enter the fixed text **Welcome**.
3. Select eight spaces for the variable text and attach **Variable 7 Operator name**.

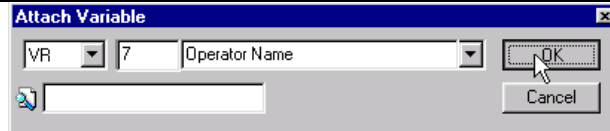


Figure 29. Attaching a Variable

- Set one Jump Condition: **SB 6 Keyboard is Active** to Display 4 as shown below.

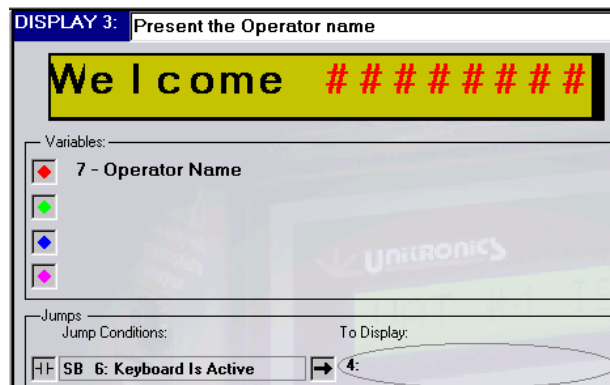


Figure 30. Display 3

Now format Variable 7 as a List Variable that can display any one of **three** names. The text of a List Variable changes **according** to the value of the MI to which it is linked.

Formatting List Variable 7

- Open **Variable 7** from the Project Navigation tree.
- Select **List** from the Variable Type list. The **Set Link to List** box opens.
- Enter **MI 4 Worker Name List**. MI 4 is also used in Variable 6

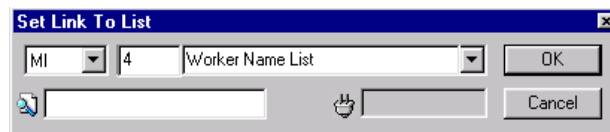


Figure 31. Link Variable

- Enter **90** in the **Variable Information: Lines** box. This allots one line for each worker's ID number and name. The line number corresponds to the worker's ID number.
- Click **Apply**. The Variable now contains 90 lines.
- Scroll down to lines 10, 11 and 12. These are the ID numbers of the three workers allowed to operate the conveyor belt.
- Enter names in lines 10, 11 and 12 as shown below.

Programming the M90

Variable information	
#	Data
8	
9	
10	S a r a h
11	D a n i
12	R u t h
13	

Lines: 90
Apply
Reset

Figure 32. List Variable

Remember that MI 4 contains the operator ID number entered via the M90 keypad. The ID number that is entered into MI 4 acts as a pointer; it corresponds to the number of the line containing the name. For example, if ID number **11** is entered, Display 3 will read “**Welcome Dani**”, since line 11 contains that name.



Figure 33. List Variable Displays

Review

In this section, you created 3 Displays containing the following text:

- Display 1: **Enter ID no. __**
The operator enters an ID number. The number is stored in MI 4. When the operator presses **Enter**, the system jumps to Display 2.
- Display 2: **Access:**
This Display contains conditional text (**Okayed/Denied**) based on the status of MB 20. If the operator enters ID numbers 10, 11, or 12, MB 20 will be ON and the Display will show **Access: Okayed**. Any other number results in **Access: Denied**. If MB 7 is ON, the system jumps to Display 3. If MB 8 is ON, the system jumps to Display 1.
- Display 3: **Welcome _____**
When numbers 10, 11, or 12 are entered, the names of the operators are displayed. When the operator presses any key, the system jumps to Display 4.

If you download your project at this point, the text in Display 1: **Enter ID no. _** will be shown on the M90 screen. Any number you enter will result in: **Access denied**. In the next section, you write a Ladder application that:

- Checks whether the operator ID number entered into MI 4 is 10, 11, or 12.
- Can turn MB 20 ON
- Can turn MB 7 or MB 8 ON.

How to Build a Net

In this section, you learn how to select Ladder elements and place them within a net. The Ladder is a diagram that shows power flow through the elements you place in the diagram. Power flows from left to right. To learn about Ladder principles, as well as specific Ladder elements and their functions, refer to U90 Ladder's on-line help.

The Ladder net in this example contains:

- Two **Equal function blocks**.
- One **Set coil**.

Building Net 1

1. Start the Ladder editor by clicking the **Ladder** button.
2. Click on the **Compare** menu, and then click on **Equal** as shown below. Your cursor becomes a hand holding the **Equal** function block.

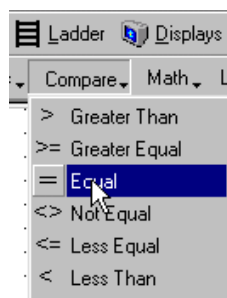


Figure 30. Compare Menu

3. Place the function block on the left rail of the Ladder as shown below. Note that in order to allow power to flow from the rail, the function block must **touch** the left rail.

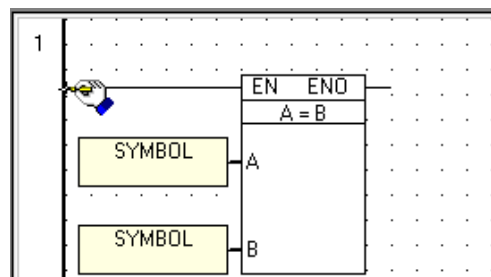


Figure 31. Placing an Element in a Net

4. Click on the rail. The **Equal** function block drops into place. The **Select Operand and Address** box opens as shown below.

Programming the M90

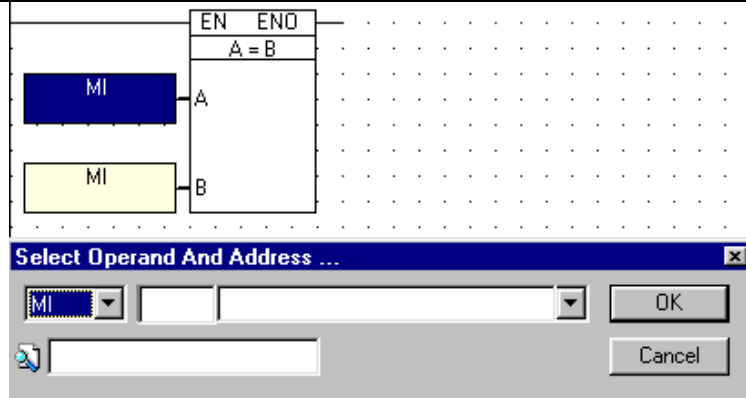


Figure 32. Assigning an Operand and Address: A Value

5. Enter **SI 2 Current HMI Display** for the 'A' integer value as shown below, then click **OK**. The **Select Operand and Address** box opens.

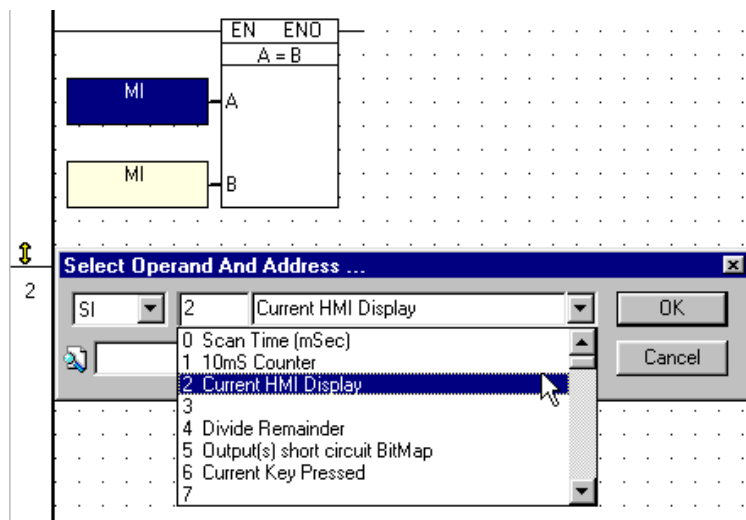
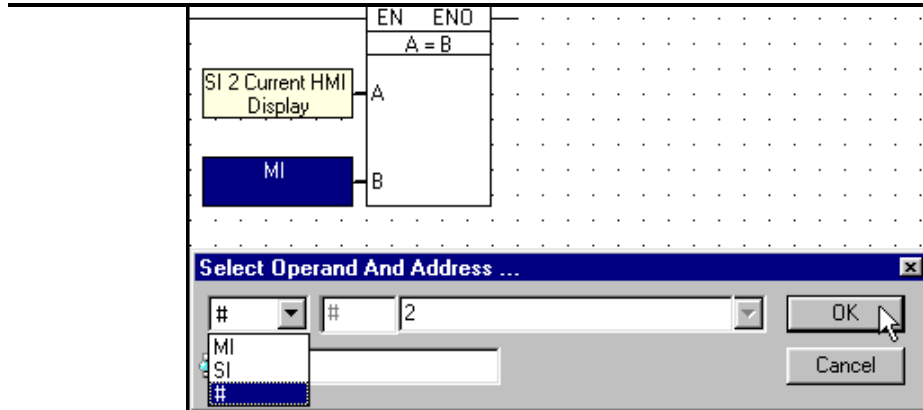


Figure 33. Assigning an Operand Description: A Value

6. Select **#** as the 'B' operand type. The **#** represents a constant value that you enter when you create your project. Constant values are not affected by your application.
7. Enter the constant value by typing **'2'**; then click **OK** as shown below.

U90 Ladder Tutorial

Figure 34. Assigning a Constant: **B** Value

The **Equal** function block now appears with both **A** and **B** values in place as shown below.

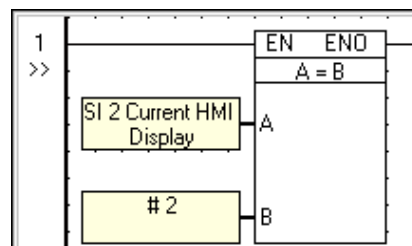


Figure 35. Complete Function Block

Now add another Equal function block.

1. Click on the **Compare** menu; then click on **Equal**. The **Equal** function block is attached to your cursor.
2. Place this function block so that it touches the first one as shown below. Note that in order to allow power to flow between them, the function blocks must touch

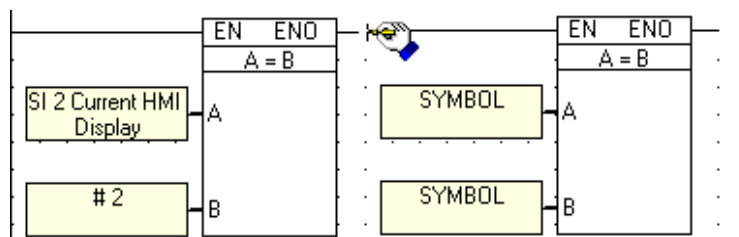


Figure 36. Elements Must Touch

3. Enter **MI 4 Worker Name List** for the '**A**' integer value; then click **OK**. The **Select Operand and Address** box opens.

Programming the M90

4. Select '#' as the 'B' operand type. Enter the constant value by typing '10'; then click **OK**. The net now appears as shown below.

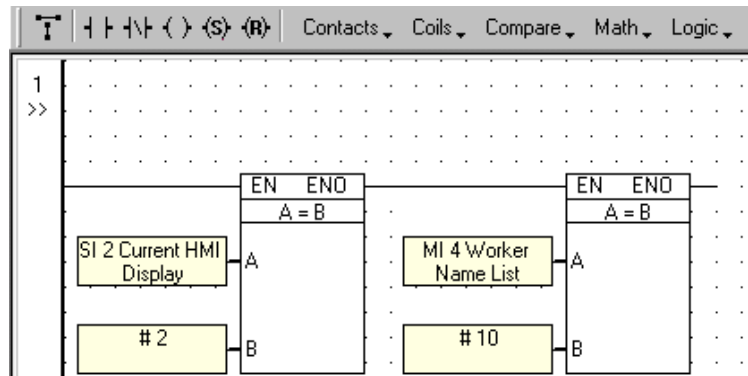


Figure 37. Completed Function Blocks

Now, place a Set Coil in the net. When an element attached to a Set Coil turns ON, it remains ON until it is reset to OFF.

1. Click on the **Set Coil** button shown below. The element is now attached to your cursor.

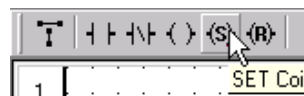


Figure 38. SET Coil Button

2. Place the coil in the net as shown below. The **Select Operand and Address** box opens.
3. Enter **MB 10 Worker number 10 is in**.

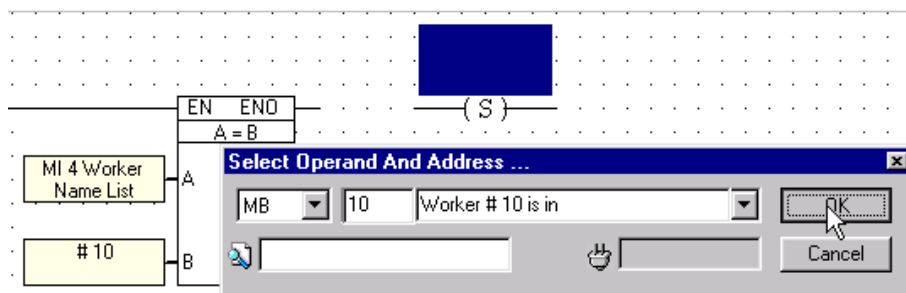


Figure 39. Assigning a Description

4. Click **OK**. The **Set Coil** now appears with its operand and address.

Note the space between the Set Coil and the function block. If the elements do not touch, power flow will not reach the coil. Connect them using the Draw Line tool.

Connecting Elements

U90 Ladder Tutorial

1. Click on the **Draw Line** button as shown below. Your cursor becomes a hand holding a pencil, and your arrow cursor remains on the button.

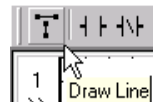


Figure 40. Draw Line Tool

2. Click on the end of the function block to anchor the line, then hold the right mouse button down and draw a line to the coil as shown below.

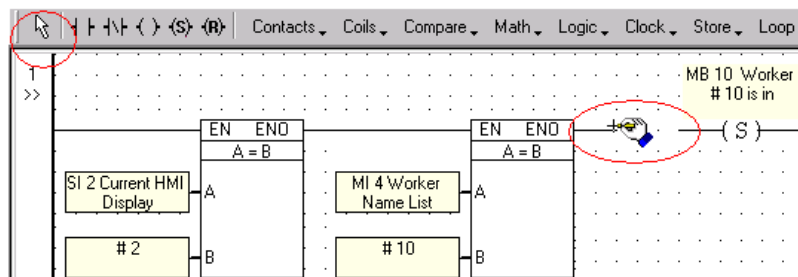


Figure 41. Drawing a Line to Connect Elements

3. When you are finished, click on the button holding your arrow cursor. The **Draw Line** tool returns to the toolbar.

Note that you can also use the **Draw Line** tool to use one condition to drive a number of coils by connecting parallel elements within a net.

Net 1, shown below, is now complete. Net 1 reads:

WHEN the Current HMI Display equals 2, AND MI 4 equals 10, THEN turn MB 10 ON.

This means that when an operator enters ID number 10, MB 10 turns ON.

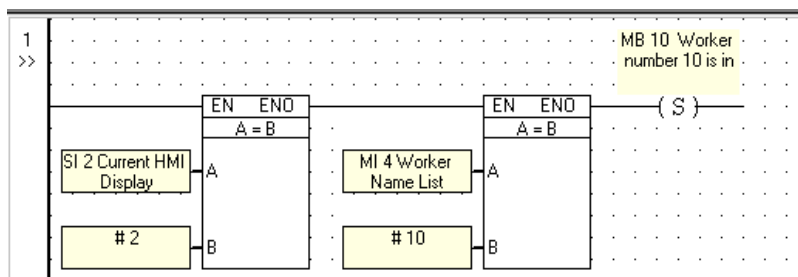


Figure 36. Net 1 Complete

This net is the first net used in the Ladder: Operator Password section of this tutorial.

Programming the M90

Ladder: Operator Password

When you download the project to the M90, the text **Enter ID no.** is displayed on the M90's screen. When any number is entered via the M90's keypad, pressing **Enter** on the M90 keypad will cause the system to jump to Display 2.

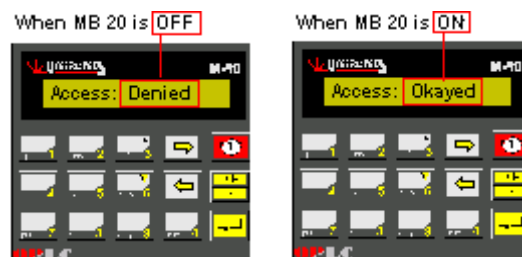


Figure 37. Display 2: Bit Conditional Text

Okayed/Denied is conditional text linked to MB 20. Now you create Ladder nets that can turn MB 20 **ON** to display **Access: Okayed** when an operator enters numbers 10, 11, or 12.

Approving the Password

The first 3 nets in your program will read:

WHEN the **Current HMI Display** equals 2, **AND** MI 4 equals 10, 11 or 12, **THEN** turn MB 10, 11, or 12 **ON**.

Net 1, which you built in the previous section turns MB 10 on when an operator enters ID number 10. Now, create similar nets for ID numbers 11 and 12.

Use the **Copy** and **Paste** functions to build Ladder nets for ID numbers 11 and 12. Remember that Copy and Paste operate differently in U90 Ladder.

Copying and Pasting Ladder Elements

1. Select the elements in the net by clicking and dragging the mouse across the net.

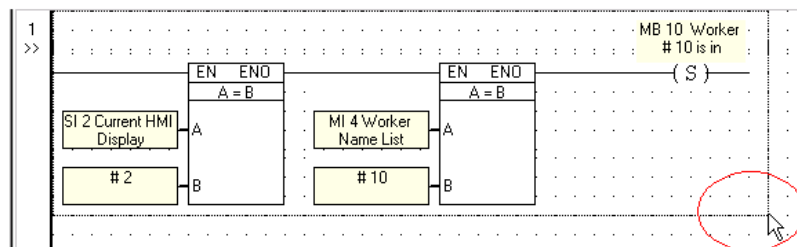


Figure 38. Selecting Elements

The selected elements are highlighted in grey.

U90 Ladder Tutorial

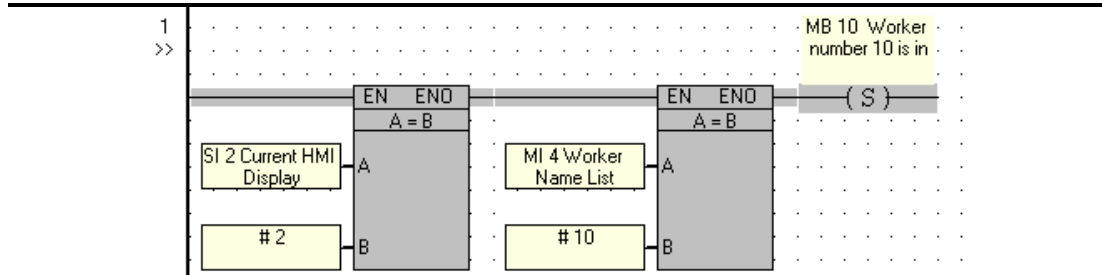


Figure 39. Selected Elements

2. Click **Copy** on the standard toolbar; then click **Paste**.
3. Move the cursor to Net 2; click as shown below.

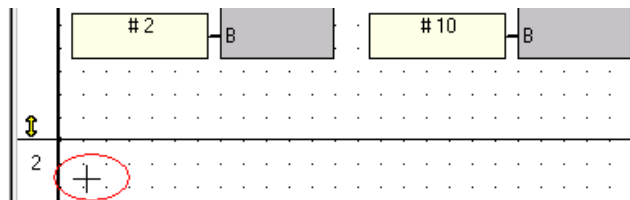


Figure 40. Click to Paste the Elements in Net 2

The elements are pasted into Net 2.

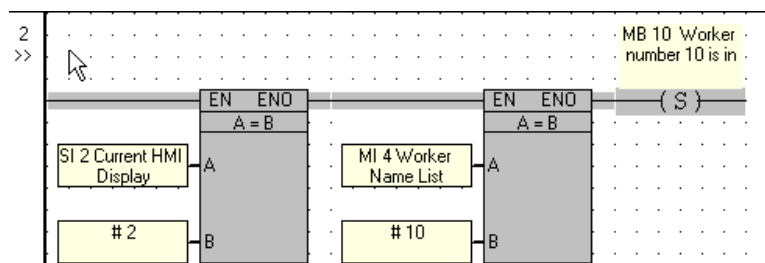


Figure 41. Pasted Elements

Now edit the operands to suit ID number 11.

4. Click on the '**B**' value, **#10**, in the second function block as shown below. The Operand is highlighted in blue, and the **Select Operand and Address** box opens. Now change 10 to 11.

Programming the M90

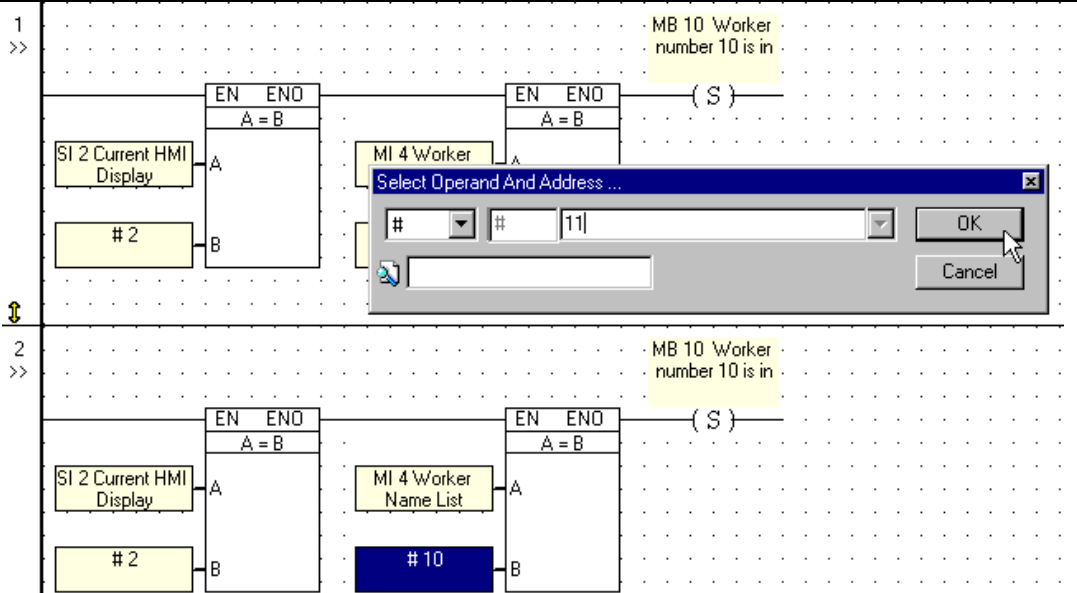


Figure 42. Changing #10 to #11

5. Click on the **SET Coil** to open the **Select Operand and Address** box. Enter **MB 11 Worker number 11 is in**.

The completed net is shown below.

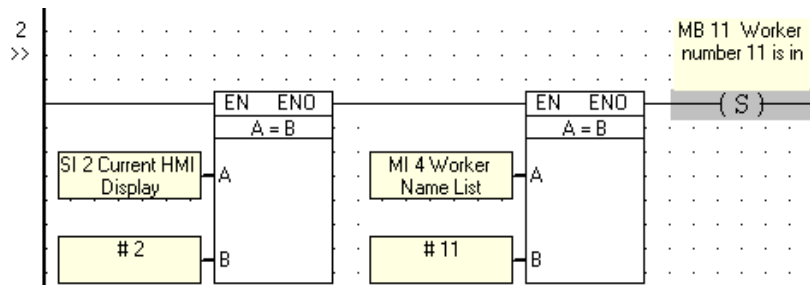


Figure 43. Net 2 Complete

Copy and paste the net again. Edit the net to suit ID number 12. The completed nets look like the figure below.

U90 Ladder Tutorial

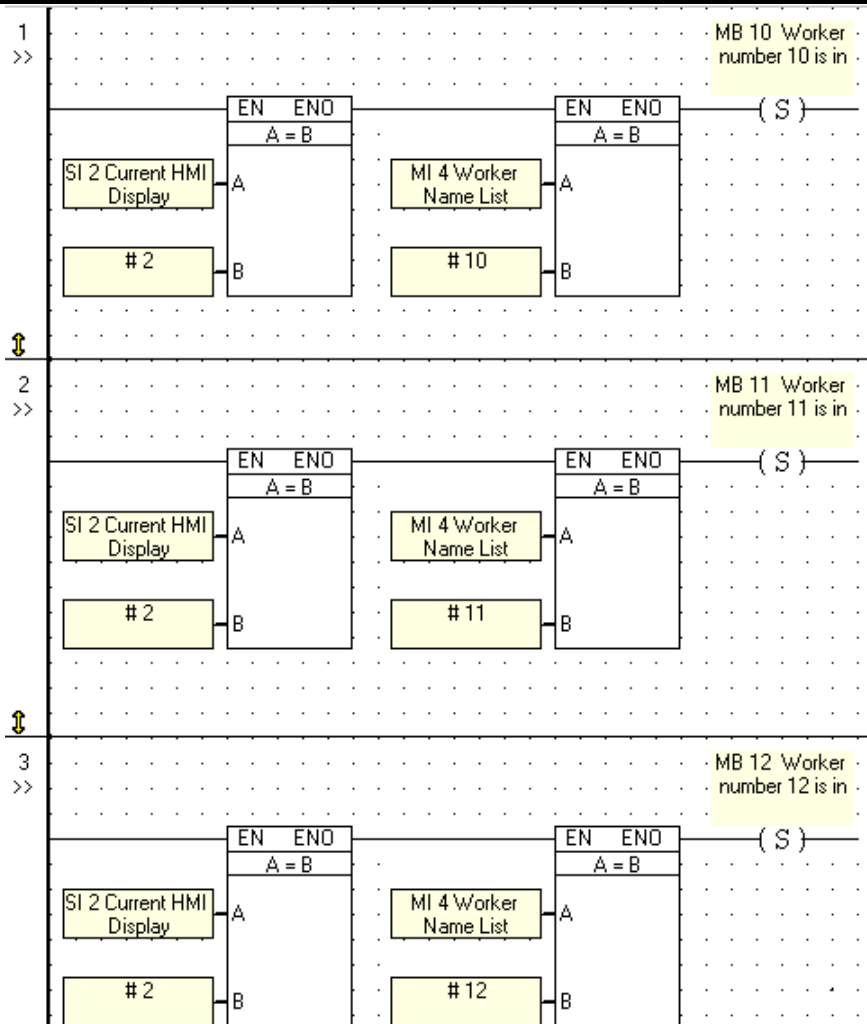


Figure 44. Nets: ID numbers 10, 11 and 12

Conditional Text—Access: Okayed/Denied

This net will read:

WHEN MB 10, MB 11 or MB 12 is ON, THEN turn MB 20 ON.

Remember that MB 20 controls the conditional text Okayed/Denied. Net 4 contains:

- Three **Direct contacts**.
- One **Direct coil**.

Enlarging a Net

To make room for the 3 contacts, you must enlarge the net.

Programming the M90

1. Click on the yellow arrow at the bottom of Net 4. The net border changes.
2. Drag the border down to enlarge the net.

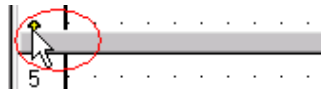


Figure 45. Enlarging a Net

3. Place the contacts and define them as shown below.
4. Connect them using the Line Draw tool.
5. Place the coil as shown below.

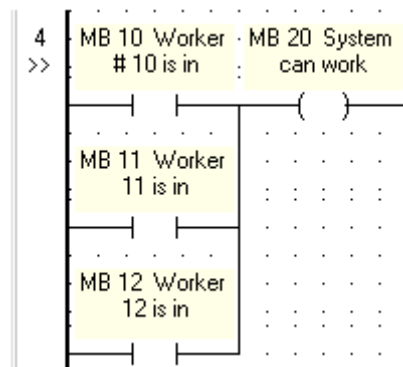


Figure 46. Net 4: turn MB 20 ON WHEN 10, 11, or 12 is Entered

Net 4 is complete. Note that in Net 1, 2, and 3 MB 10, 11, and 12 were each linked to a Set Coil; in Net 4 they are linked to Direct Contacts.

Jump to Display 3: Timer

This section controls the status of MB 7, which is used as a Jump Condition set in Display 2

2. MB 7 is driven by a 4-second Timer. U90 Timers have a:

- Preset value: In this case, the timer value will be preset to 4 seconds. U90 timers count **down**: 4, 3, 2, 1, 0.
- Current value: This is whatever time is left in the counter at a given moment.
- Bit value: A Timer is linked to a bit. This bit turns ON when the Timer reaches 0.

Starting a Timer

The Net 5 reads:

WHEN Display 2 is on the M90 screen, AND MB 20 is ON, start Timer 7.

The next net contains:

- One **Equal function block**.
- One **Direct contact**.

U90 Ladder Tutorial

- One **Direct coil**, linked to a **Timer**.
1. Add a new net by clicking in the grey area below Net 4. Net 5 appears.
 2. Place and define the Equal function block and Direct Contact into the net as shown in Figure 47 below.
 3. Place the Direct Coil and define it as Timer 7: **T 7 Time to Jump to Display 3**.
Note that when you enter the Timer's address, 7, the **Select Operand and Address** box changes. A new field opens, allowing you to assign a preset Timer value.
 4. Click in the new field; then highlight the seconds place.
 5. Enter 4 in the second's field as shown below. Click **OK**.

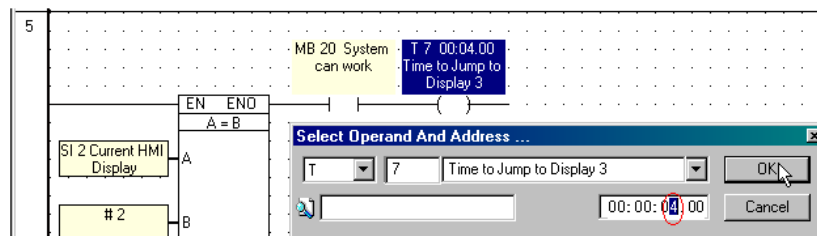


Figure 47. Setting Timer 7

Using the Timer's Bit Value

Net 6 reads:

WHEN T 7 is ON THEN turn MB 7 ON.

This net includes:

- One **Positive Rise contact**.
- One **Direct coil**.

A Positive Transition Contact gives a single one-shot pulse when the linked element rises from OFF to ON. A Positive Transition Contact registers the **change** in status from OFF to ON. The length of the ON status is not relevant.

1. Select the **Positive Rise Contact** from the **Contact** menu as shown below.
2. Place it on the left Ladder rail; then link it to **T 7 Time to Jump to Display 3**.

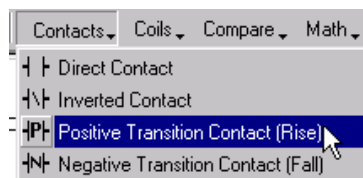


Figure 48. Positive Contact

3. Place and define the Direct Coil in the net as shown in Figure 49.

Programming the M90

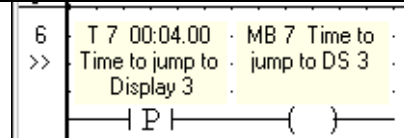


Figure 49. Using a Timer

The completed nets appear as shown below.

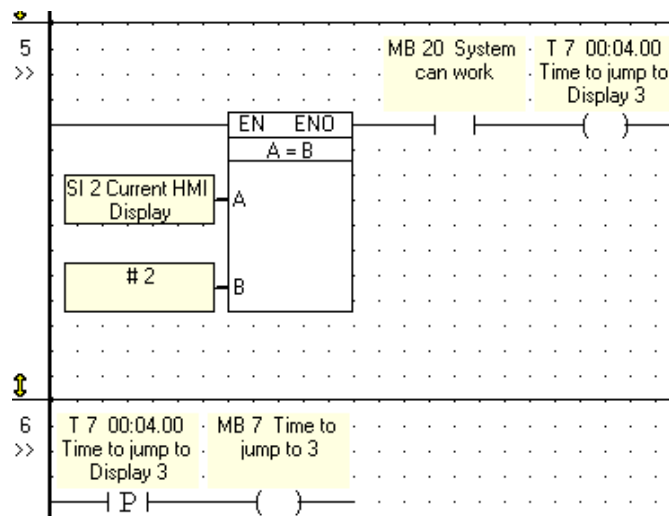


Figure 50. Using a Timer to Jump to Display

Now, when operator ID numbers 10, 11, or 12 are entered, Display 2 will read **Access: Okayed**. The text will be displayed on the M90 screen for 4 seconds; the screen will then change to show Display 3: **Welcome _____**.

Jump to Display 1: Timer

If the ID number entered is **not** valid, the system will jump back to **Display 1 Enter Password**. This section controls the status of MB 8, which is a Jump Condition set in Display 2. Like MB 7, MB 8 is driven by a 4-second Timer. Net 7 reads:

WHEN Display 2 is on the M90 screen **AND** MB 20 is not **ON**
THEN turn MB 8 **ON** **AND** start Timer 8.

Net 7 contains:

- One **Equal function block**.
- One **Inverted contact** (Normally OFF).
- One **Direct coil**, linked to a **Timer**.

1. Add a new net by clicking in the grey area below Net 6.
2. Place and define the Ladder elements in Net 7 as shown below.

U90 Ladder Tutorial

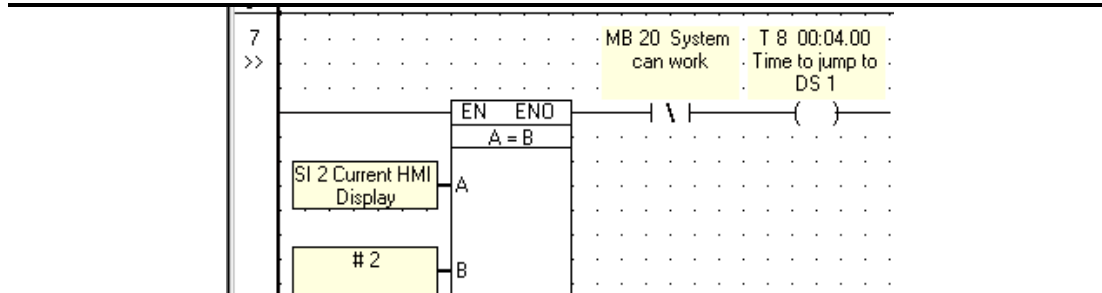


Figure 51. Jump to Display Timer

Net 8 reads:

WHEN MB 8 is ON THEN jump to Display 1.

Net 8 contains:

- One **Positive Rise contact**.
- One **Direct coil**.

1. Place and define the Ladder elements in Net 8 as shown below.

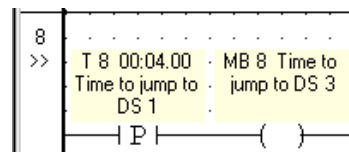


Figure 52. Timer: Return to Display 1

Review

You have written an HMI application that allows system entry via password. You have also written a Ladder application that supports the Jump Conditions between the HMI Displays. You must now:

- Reset the **SET Coils** you used to confirm password entry: MB 10, 11, and 12. The coils must be reset to allow the program to function the next time it is run.
- Clear MI 4., which contains the operator ID that is entered via the M90 keypad. You will use a **Store Direct** function block to enter a '0' value into MI any time the system restarts.

Resetting Coils

Reset conditions should be placed at the beginning of a Ladder application. To do this, you must first insert new nets at the top of the Ladder.

Inserting New Nets in the Ladder

1. Click the **Insert New Net** button on the Ladder toolbar as shown below. The cursor changes into cross-hairs.

Programming the M90



Figure 53. Insert New Net button

- Place the cross-hairs in Net 1; then click. A new net appears.

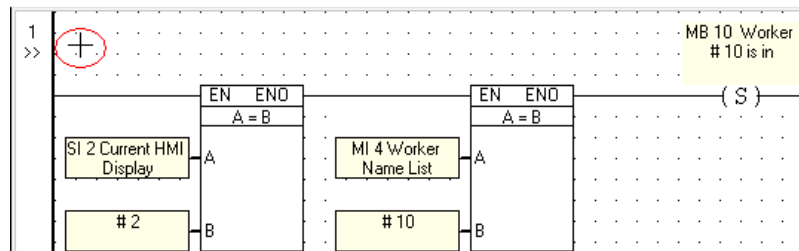


Figure 54. Inserting a Net

- Repeat, inserting another net for a total of 2 new nets. What **was** Net 1 is **now** Net 3. Nets 1 and 2 are blank nets.

Resetting MB 10, 11, and 12

Two nets will be used to reset the MB s. Together, these nets read

WHEN Display1 is on the M90 screen, **THEN** turn MB 30 **ON**.
WHEN MB 30 is **ON**, **THEN** turn **ON** Reset Coils MB 10, 11, and 12.

New Net 1 contains:

- One **Equal function block**.
- One **Direct coil**.

- Place and define the Ladder elements in new Net One as shown in the figure below.

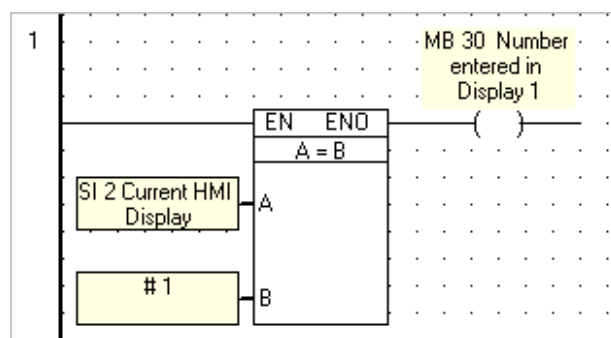


Figure 55. Reset Conditions

New Net 2 contains:

- One **Positive Transition contact**.
- Three **Reset coils**.

U90 Ladder Tutorial

1. Enlarge the net as shown on page 28, Figure 45. Enlarging a Net.
2. Place Ladder elements into Net Two as shown in the figure below. To allow the single, one-shot connection to reset the parallel series of coils, you must connect them.
3. Click on the **Line Draw** icon. Connect the contact to the Reset coils.

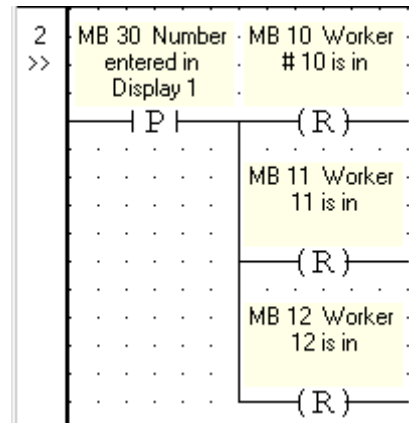


Figure 56. Reset Conditions

Initializing MI 4

The entered ID number is stored in **MI 4 Worker Name List**, where it remains until MI 4 is initialized. If the next worker pushes **Enter** on the M90 keypad without entering a number, the system will grant access based on the previous worker's ID number.

To avoid this, initialize MI 4 by storing a zero value (0) into it, using:

- One **Store Direct** function block.

You can include this function block in Net 2, together with the Reset Coils,.

1. Select the **Store Direct** function block from the **Store** menu as shown below.



Figure 57. Store Direct

2. Place the function block as shown in Figure 58. The **Select Operand and Address** box opens.
3. Enter a value of '0' for the 'A' value, and MI 4 for the 'B' value. The complete net appears as shown below.

Programming the M90

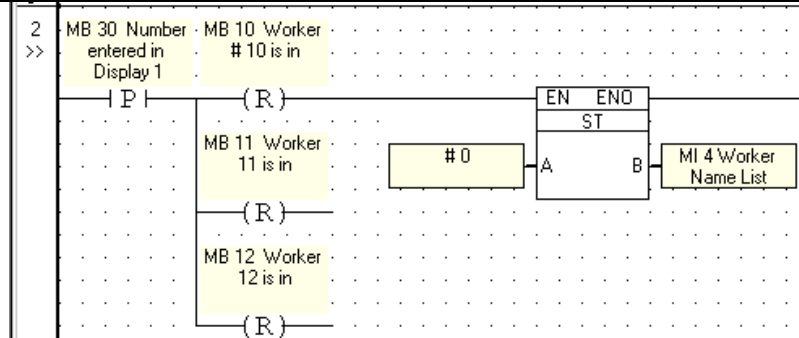


Figure 58. Initializing the Counter

Net 2 now reads:

WHEN MB 30 is ON, THEN turn ON Reset Coils MB 10, 11, and 12, AND store 0 into MI 4.

Inserting a 'Comment'

U90 Ladder offers a Comments feature that allows you to store notes in your program.

1. Click on the **Insert Comment** button. Your cursor turns into a cross-hairs.

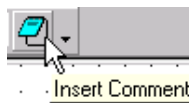


Figure 59. Insert Comment

2. Click in Net 1. A Comments field opens at the top of the net, allowing you to type text.

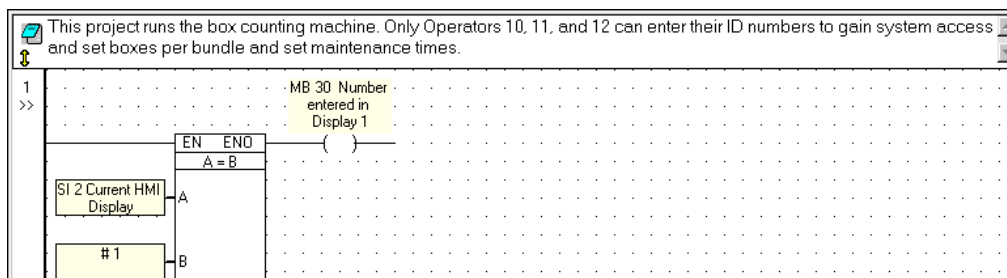


Figure 60. Enter Comment

You can download and test your project. Keep in mind that, because you have not yet formatted Display 4, pressing **enter** after Display 3 **Welcome _____** will bring up a blank screen. Use the **Debug** feature to reset **SI 2 Current HMI Display** to 1.

Downloading a project

Before you can download a project, the M90 must be connected to a power supply and to your PC. Refer to the M90 User Guide for instructions.

U90 Ladder Tutorial

1. Click the **Download** button as shown below. The **Download** box opens.

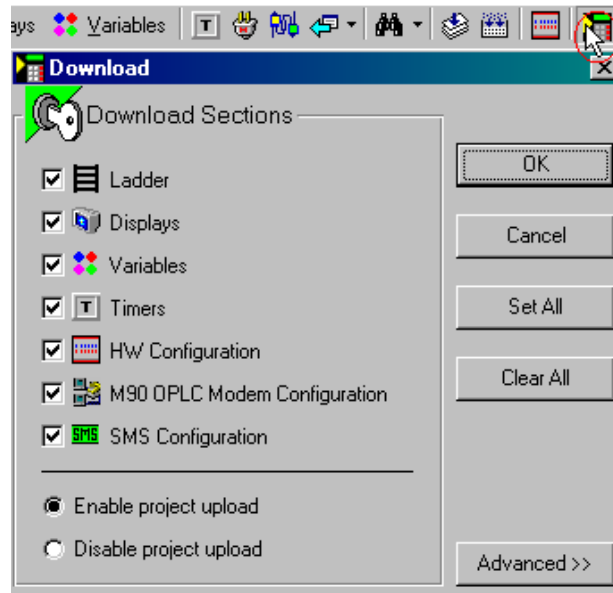


Figure 61. Debug

2. Click **OK**. The Download process begins. When it is complete, **Enter ID no. __** is displayed on the M90 screen—providing you have followed directions exactly as given.. To learn more about downloading and related features, check U90 Ladder’s help.

Testing Your Project: Debug

If you test your project now, the Jump to Display 4 will show a blank screen. You can reset the program “on-line” using the **Debug** mode.

1. Click the arrow next to the **Debug** button; then select **Full M90 OPLC View**.



Figure 62. Debug

2. The net power flow appears in red and a live representation of the M90 appears on your screen. The current value of activated Ladder elements are displayed over the yellow Operand fields.
3. In Net 1, click on the function block’s ‘A’ Operand field, the **Send Value** box opens as shown below.

Programming the M90

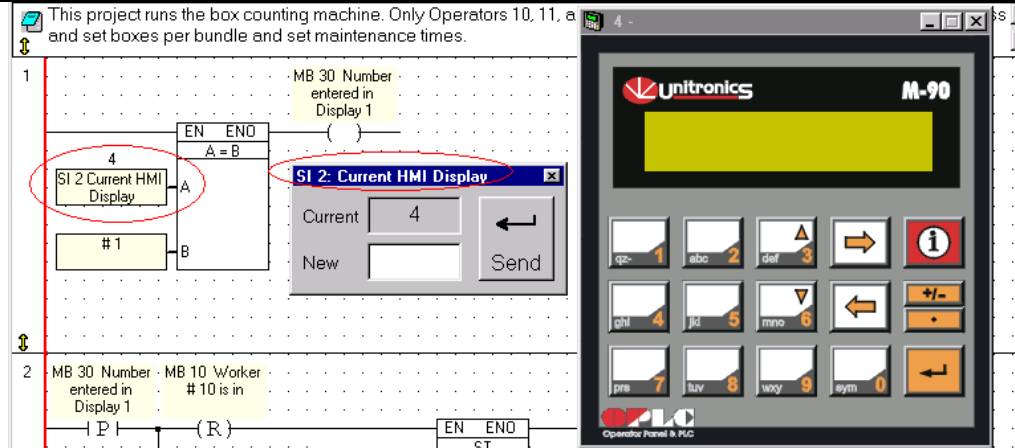


Figure 63. Using Debug

4. Enter 1 in the **New** box and click **Send**.

The new value '1' appears above the Operand field, the power flow through the net changes, and **Display 1 Enter ID no.** is shown both on the connected M90 and the graphical M90 representation on screen as shown below.

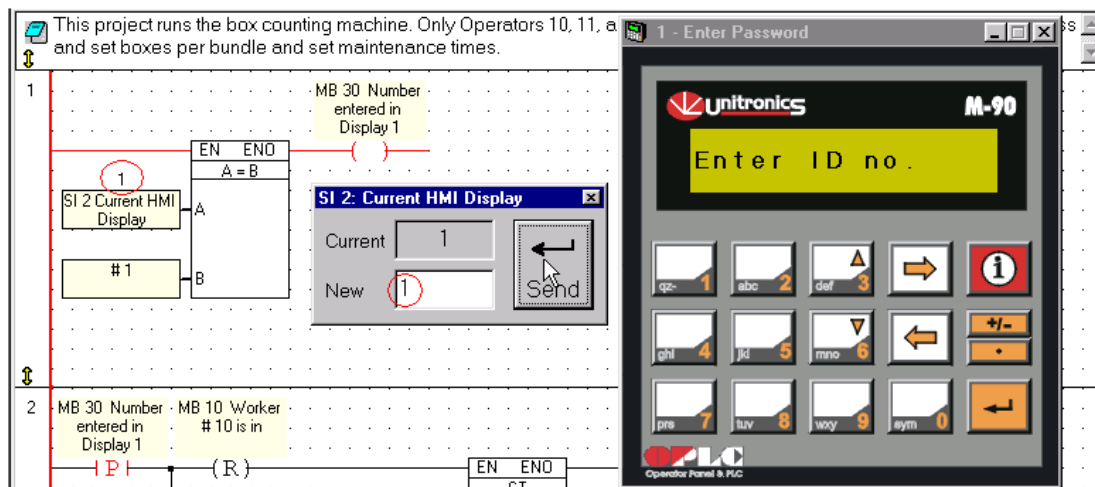


Figure 64. Send Value

5. Click the **Debug** button to exit Debug mode.

Displays: Entering Parameters

Once an operator's password is approved, the operator sets system parameters using the M90 keypad. In this section, you create a series of Displays. These displays lead the machine operators through the process of:

- Setting the number of boxes per bundle. The maximum number of boxes per bundle is 99.
- Setting a start time and an end time for system maintenance, during which the bundling machine cannot run.

Display 4: Set Box Quantity

Display 1 contains:

- **Fixed** text.
- A **Keypad-Entry Variable**.

Editing Display 4

1. Open the HMI editor; then open **Display 4** by clicking it in the Project Navigation tree.
2. Name it **Set Box Quantity**, by typing the name in the title bar, then pressing **Enter**. The title appears in the Project Navigation tree as shown in Figure 67.

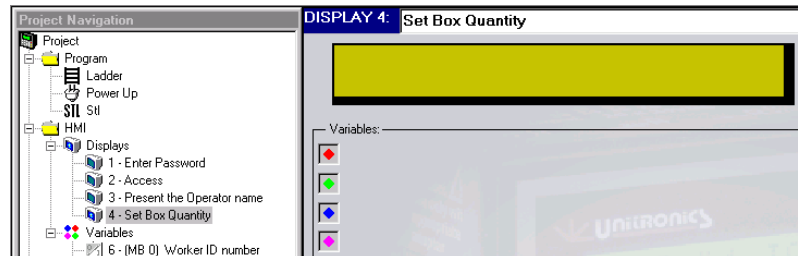


Figure 67. Naming a Display

3. Enter the fixed text **Set Box Q'ty.** in the green Display field as shown below.

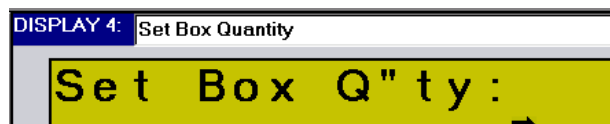


Figure 68. Creating a Text Message

To allow the operator to set the number of boxes per bundle, you link a Variable to the Display. The Variable will contain a number entered from the M90 keypad. Since the maximum number of boxes per bundle is 99, create a field that can hold two digits.

Creating a Field

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

Programming the M90

2. Create the field by dragging the cursor across the display. The field is highlighted in blue.

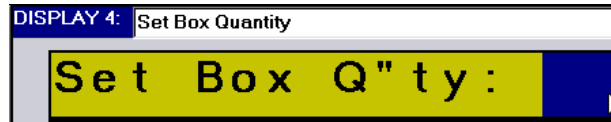


Figure 69. Selecting Variable Space

Attaching a Variable

1. Click **Attach Variable** on the toolbar. The **Attach Variable** dialog box opens.
2. Enter **VR 5 Set Box Quantity**; then press **OK** as shown in Figure 70.

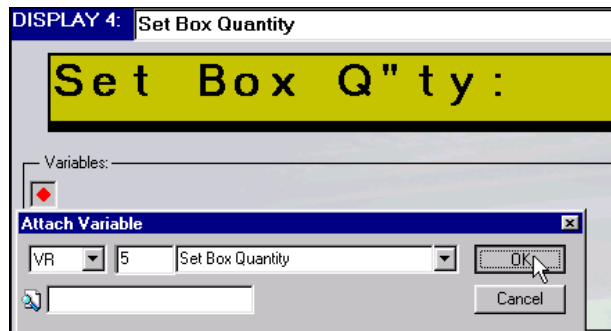


Figure 70. Enter Variable Number and Address

Display 4 shows the Variable-linked spaces as red pound signs. You have attached a Variable to the Display. Now format the Variable to accept a number that the operator enters from the M90 keypad.

Formatting a Keypad-Entry Variable

This Variable will accept a two-digit number between 1 and 99.

1. Open **Variable 5** by clicking it in the Project Navigation tree.
2. Select **Integer** from the **Variable Type** list; the **Set Link to Int** box opens.
3. Enter **MI 11 Set Box Quantity** as shown below; then click **OK**.

U90 Ladder Tutorial

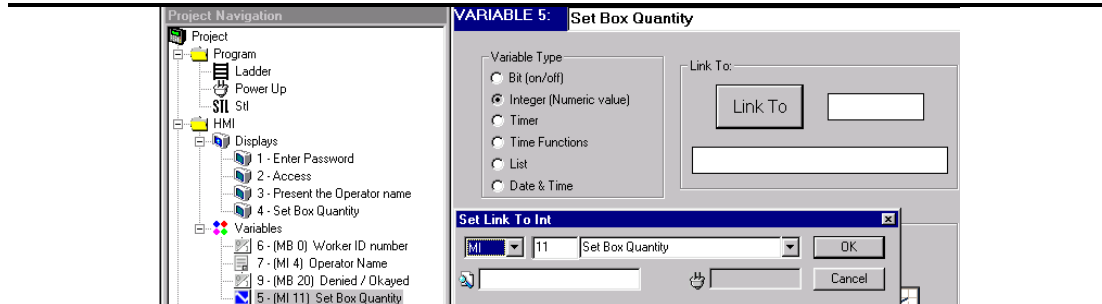


Figure 71. Linking an MI to a Variable

The Variable is now linked to MI 11. You will format MI 11 later.

4. Select **Keypad Entry** from the Variable Information list.
5. Select **Start with Clear Field**. If you do not select **Start with Clear Field**, the last number entered in MI 11 will be displayed.
6. Select **Enable Limits**. In the **Min** box, enter 1; enter 99 in the **Max** box. When you are finished formatting Variable 5, the screen looks like the figure below.

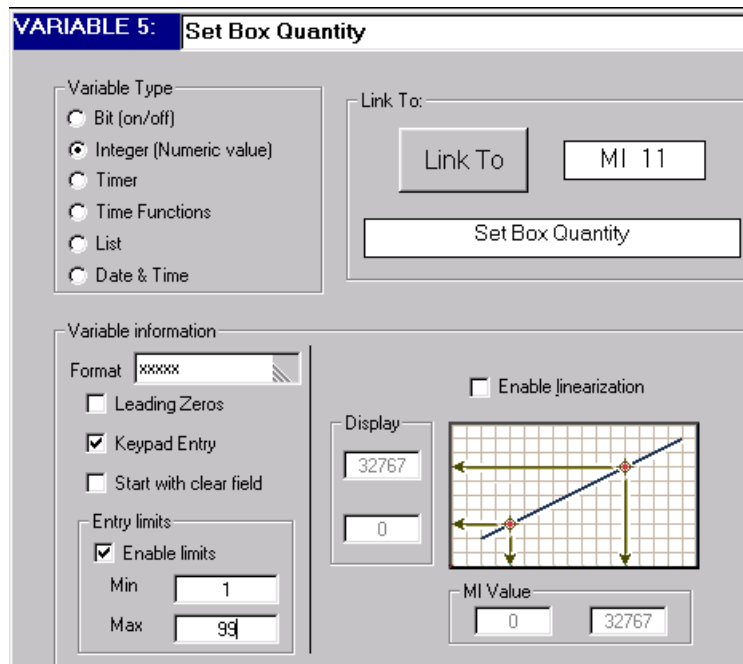


Figure 72. Formatting an Entry Variable

Setting a Jump Condition

After an operator enters the number of boxes per bundle (s)he presses the **Enter** key. Use this as the Jump condition.

Programming the M90

1. Open Display 4 by clicking it in the Project Navigation tree.
2. Click on the first **Jump** condition. The **Define Jump to Condition** box opens.
3. Enter **SB30 Keypad entries complete**, as shown in Figure 73.

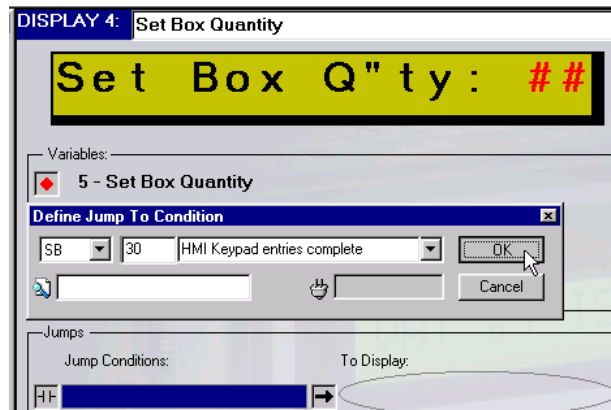


Figure 73. Defining a Jump Condition

4. Click **OK**. The **Define to Display Jump** box opens.
5. Enter **DS 5 Enter Start Time** as shown below.

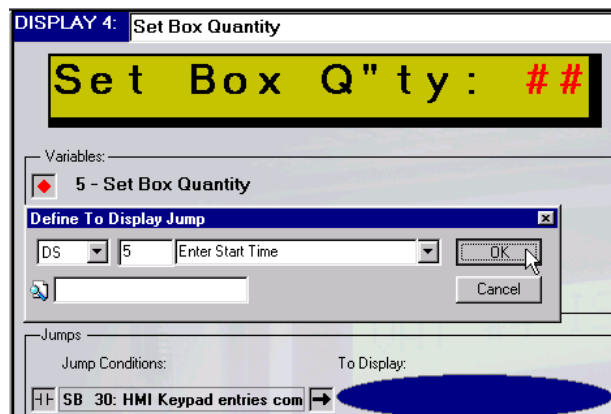


Figure 74. Defining the Jump Destination

6. Click **OK**. The Display now contains the linked Variable and Jump condition as shown below. **Display 5 Enter Start Time** appears in the Project Navigation tree.

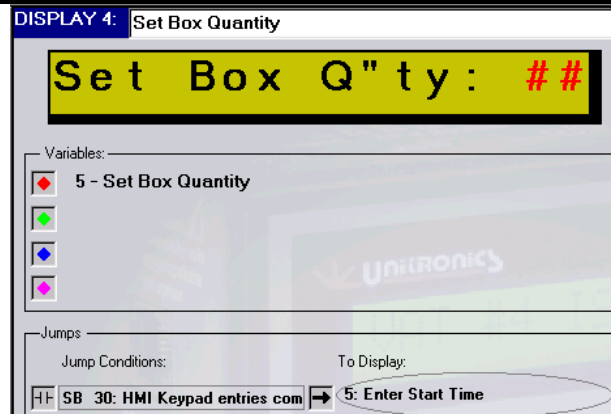


Figure 75. Completed Display

The complete Display shows the Jump Condition and the destination Display. When an operator enters a number and presses **Enter**, the M90 will show Display 5 on its screen.

Display 5: Start Time

Display 5 contains:

- Fixed text.
- A Keypad-Entry Time Variable

Editing Display 5

1. Open Display 5 by clicking it in the Project Navigation tree.
2. Enter the text **Start Time:___** in the green Display field, as shown below.

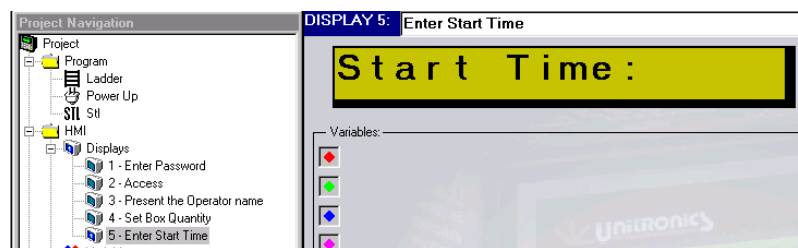


Figure 76 Display 5: Start Time

Creating a Field and Attaching a Variable

1. Select 5 spaces in the Display text.
2. Click **Attach Variable**. The **Attach Variable** box opens.
3. Enter **VR 2 Start Time**; then press **OK**. Display 5 shows the Variable-linked spaces as red pound signs as shown in Figure 77 below. Now, format the Variable.

Programming the M90



Figure 77. Display 5 with Attached Variable

Formatting a Keypad-Entry Time Variable

This Variable will hold the Start Time that is entered by the operator via the M90 keypad.

1. Open **Variable 2** by clicking it in the Project Navigation tree.
2. Select **Time Functions** from the **Variable Type** list. The **Set Link to Time Function** box opens.
3. Enter **MI 2 Start Time**; then click **OK** as shown below. Variable 2 is now linked to MI 2. You will define MI 2 when you write the Ladder program for Maintenance Time.

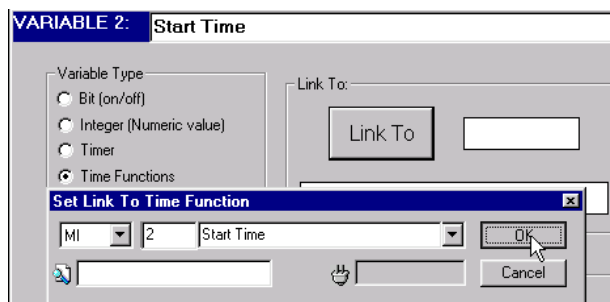


Figure 78 Linking a Variable

4. Select **Hour (CT)** and **Keypad Entry** from the **Variable Information** list as shown below.

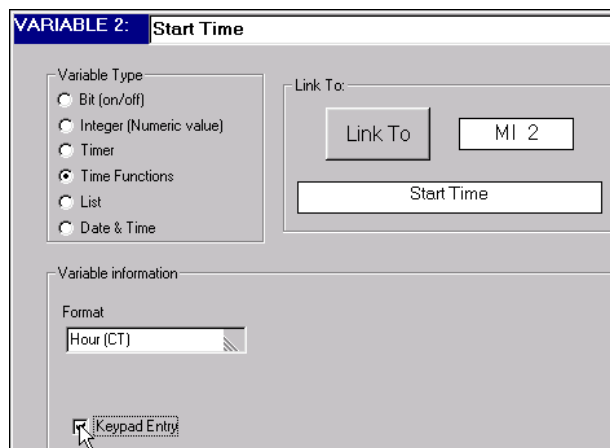


Figure 79. Defining a Time Variable

U90 Ladder Tutorial

Display 5 is complete. The operator must both set a Start Time and an End Time for maintenance. Now, set a Jump Condition that will show **Display 6 End Time**.

Setting a Jump

After an operator enters the Start Time (s)he presses the **Enter** key. Use this for the Jump Condition.

1. Open Display 5 by clicking it in the Project Navigation tree.
2. Click on the first **Jump Condition** in the **Jumps** box. The **Define Jump to Condition** box opens. Now enter **SB30 Keypad entries complete** as shown below.

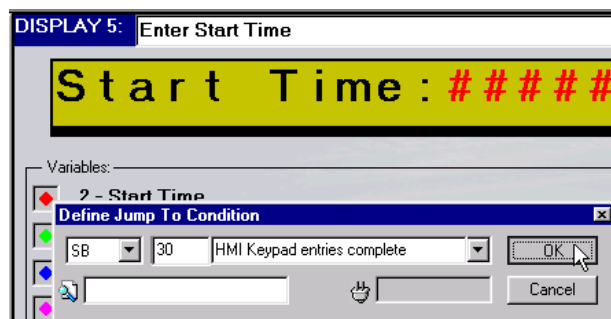


Figure 80. Defining a Jump Condition

3. Click **OK**. The **Define to Display Jump** box opens
4. Enter **DS 6 Enter End Time** as shown below.

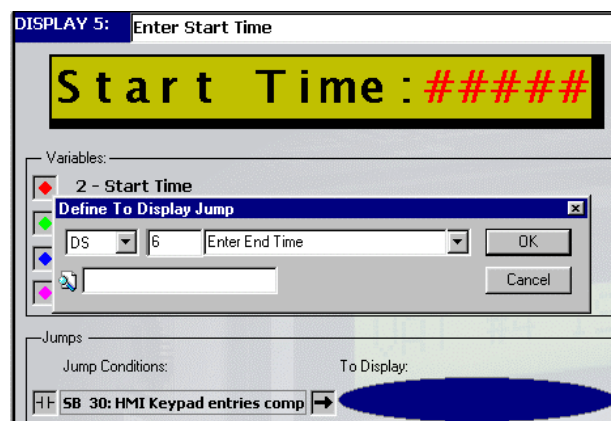


Figure 81. Defining the Jump Destination

5. Click **OK**. The Display appears together with the linked Variable and Jump condition as shown below. **Display 6 Enter End Time** appears in the Project Navigation tree.

Programming the M90

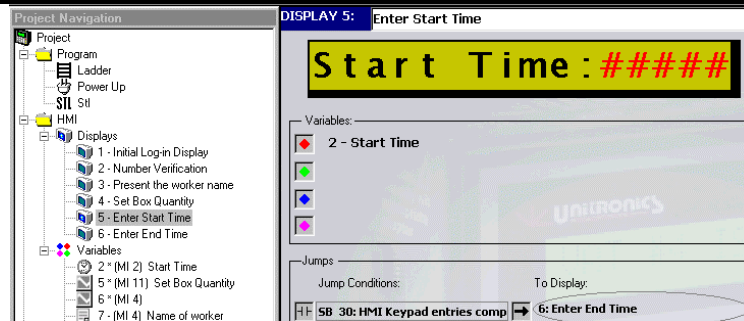


Figure 82. Completed Display

Display 5 is complete. After an operator enters the Start Time and presses **Enter**, **Display 6 Enter End Time** will be displayed on the M90's screen.

Display 6: End Time

Display 6 contains:

- **Fixed text.**
- **A Keypad-Entry Time Variable.**

Editing Display 6

1. Open Display 6 by clicking it in the Project Navigation tree.
2. Enter the text **End Time: ____** in the green Display field as shown below.



Figure 83. Display 6: Jump Destination Display

Creating a Field and Attaching a Variable

1. Select 5 spaces in the Display text.
2. Click **Attach Variable**. The **Attach Variable** box opens.
3. Enter **VR 3 End Time**; then press **OK**. Display 6 shows the Variable-linked spaces as red pound signs as shown in Figure 77 below. Now, format the Variable.



Figure 84. Display 5 with Attached Variable

Formatting a Keypad Time Entry Variable

This Variable will hold the End Time that is entered by the operator via the M90 keypad.

1. Open **Variable 3** by clicking it in the Project Navigation tree.
2. Select **Time Functions** from the **Variable Type** list. The **Set Link to Time Function** box opens.
3. Enter **MI 3 End Time**; then click **OK** as shown below. Variable 3 is now linked to MI 3. You will define MI 3 when you write the Ladder program for Maintenance Time.

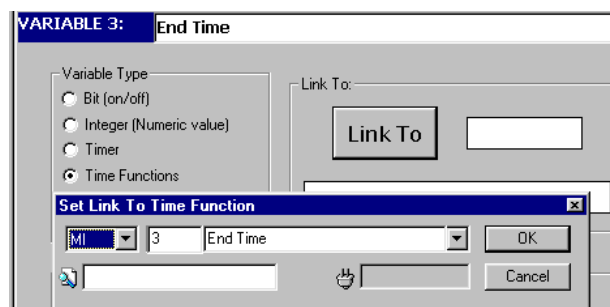


Figure 85. Linking a Variable

4. Select **Hour (CT)** and **Keypad Entry** from the **Variable Information** list as shown below.

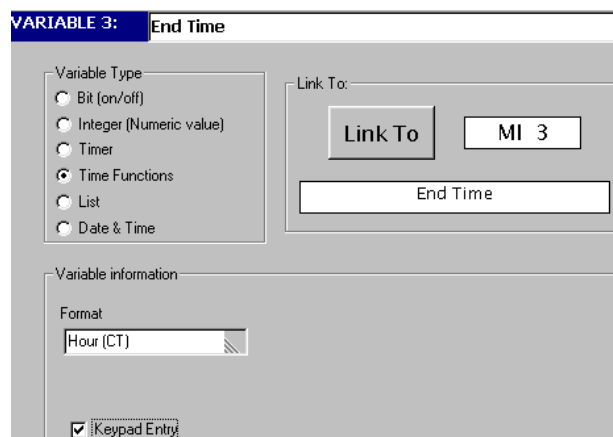


Figure 86. Selecting a Variable Type

Programming the M90

Setting a Jump

After an operator enters the End Time (s)he presses the **Enter** key. Use this for the Jump condition.

1. Open Display 6 by clicking it in the Project Navigation tree.
2. Click on the first **Jump Condition**. The **Define Jump to Condition** box opens.
3. Enter **SB30 Keypad entries complete**; then click **OK**. The **Define to Display Jump** box opens.
4. Enter **DS 7**; then click **OK**. The complete Display is shown below.

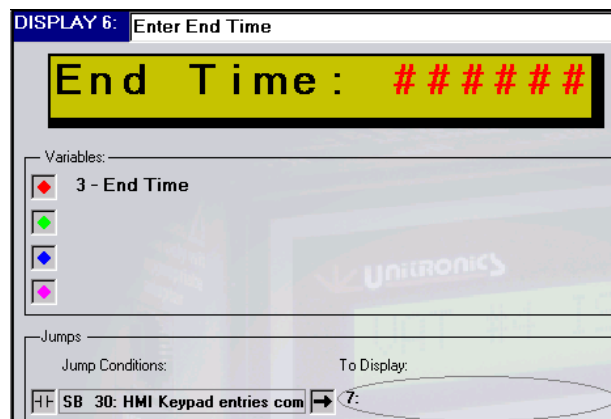


Figure 87. Display 6 Complete

Review:

In this section, you created 3 Displays that enable the operator to use the M90 keypad to set system parameters:

- Display 4: **Set Box Quantity**__
The operator enters the amount of boxes per bundle. The number is stored in MI 11. When the operator presses **Enter**, the system jumps to Display 5.
- Display 5: **Enter Start Time:**__
The operator sets the starting time for system maintenance. The time is stored in MI 2. When the operator presses **Enter**, the system jumps to Display 6.
- Display 6: **Enter End Time:**__
The operator sets the end time for system maintenance. The time is stored in MI 3. When the operator presses **Enter**, the system jumps to Display 7, which you define in the next section.

Displays: Displaying Run-Time Data

At this point, your application allows the operator to:

- Be identified by the M90 according to an ID number.
- Set the number of boxes per bundle.
- Set aside a time period for system maintenance, during which the system cannot run.

In this section, you create 2 Displays that show run-time system data on the M90's screen:

- A Display that shows a running box count and the number of boxes set per bundle.
- A Display that allows the operator to track events or errors within the system.

Display 7: Box Count

Display 6 contains:

- **Fixed** text.
- **2 Display Variables.**
 - The first Variable shows the running box count on screen. The boxes are counted as they pass a 'photocell'. You will link this Variable to an MI that acts as a counter in your Ladder program.
 - The second Variable shows the number of boxes set per bundle. This number has been set by the operator in **Display 4, Set Box Quantity.**

Editing Display 7

1. Open **Display 7** by clicking it in the Project Navigation tree.
2. Name it **Box Count**, by typing the name in the title bar and pressing **Enter**. The title appears in the Project Navigation tree.
3. Enter the fixed text **Box ___ out of ___** in the green Display field, as shown below. The spaces in the text will contain the Variable values.

Creating a Field and Attaching a Variable

1. Click after the word 'Box'. Select 2 spaces in the Display text as shown below.



Figure 88. Selecting Variable Space

2. Click **Attach Variable**. The **Attach Variable** box opens.
3. Enter **VR 4 Boxes Counted** as shown below; then press **OK**.

Programming the M90

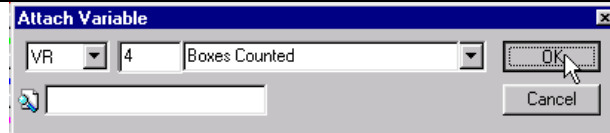


Figure 89. Enter Variable Number and Address

Display 7 shows the Variable-linked spaces as red pound signs. Now, format the Variable.

Formatting a Display Variable

This Variable will hold the number of boxes counted as they pass a 'photocell'.

1. Open **Variable 4** by clicking it in the Project Navigation tree.
2. Select **Integer** from the **Variable Type** list. The **Set Link to Int** box opens.
3. Enter **MI 10 Current Number of Boxes**; then click **OK** as shown below. Variable 4 is now linked to MI 10. You will use MI 10 as the box counter in your Ladder application.

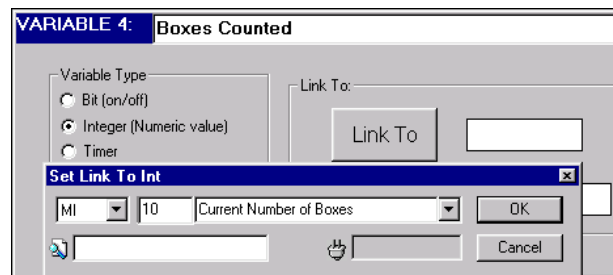


Figure 90. Formatting a Variable

Now, return to Display 7 and attach the second variable, which contains the preset number of boxes per bundle.

Creating a Field and Attaching a Variable

1. Open Display 7.
2. Click after the words 'out of'. Select 2 spaces in the Display text as shown below.

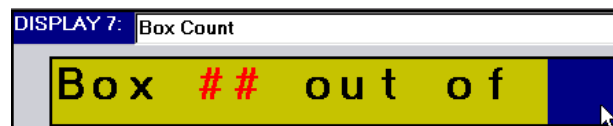


Figure 91. Selecting Variable Space

3. Click **Attach Variable**. The **Attach Variable** box opens.
4. Enter **VR 1 Amount of Boxes per Bundle**; then press **OK**.

Display 7 appears with the Variable-linked spaces as green pound signs as shown below.

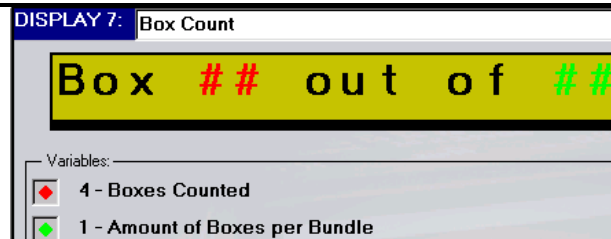


Figure 92. Display 7 with Attached Variables

Now, format Variable 1.

Formatting a Display Variable

This Variable will hold the number of boxes counted as they pass a 'photocell'.

1. Open **Variable 1** by clicking it in the Project Navigation tree.
2. Select **Integer** from the **Variable Type** list. The **Set Link to Int** box opens.
3. Enter **MI 11 Set Box Quantity**; then click **OK**. Variable 1 is now linked to MI 11 as shown below. MI 11 contains the number of boxes per bundle entered by the operator via the M90 keypad.

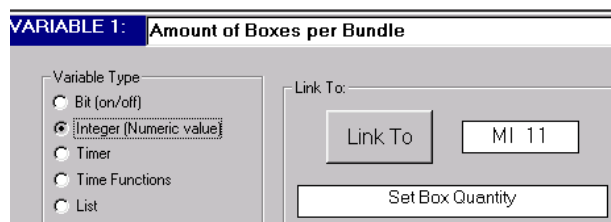


Figure 93. Formatting a Variable

Setting Jumps

Although you will set 3 different Jump Conditions for this Display, note that each condition will jump to the same destination Display.

1. Open Display 7 by clicking it in the Project Navigation tree.
2. Click on the first **Jump Condition**. The **Define Jump to Condition** box opens.
3. Enter **MB 41 Error Message 1**; click **OK** as shown below. The **Define to Display Jump** box opens.

Programming the M90

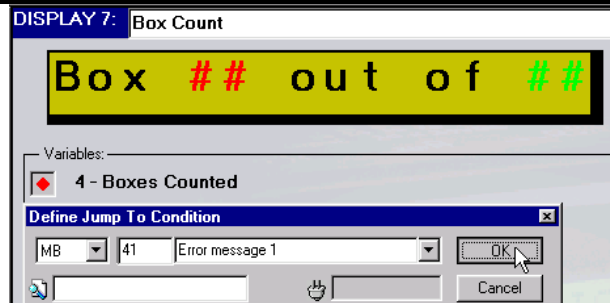


Figure 94. Defining a Jump Condition

4. Enter **DS 8 Operator Messages** as shown below; then click **OK**.

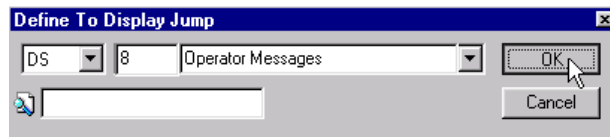


Figure 95. Defining the Jump Destination

The Display now appears together with the linked Variable and Jump Condition as shown below. **Display 8, Operator Messages** opens in the Project Navigation tree.

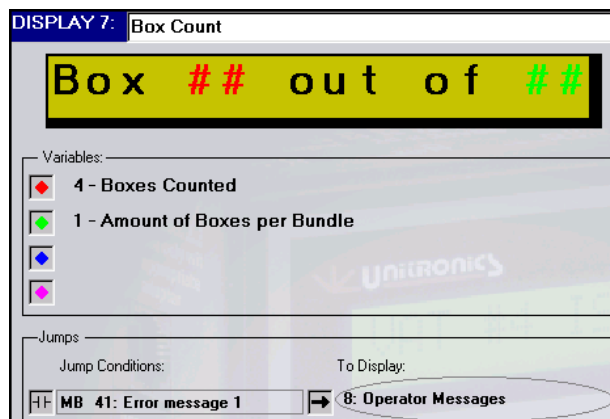


Figure 96. Display and Jump

Now, set two additional Jump Conditions.

5. Click on the second **Jump Condition**. The **Define Jump to Condition** box opens.
6. Enter **MB 43 Error message 2**. Click **OK**. The **Define to Display Jump** box opens.
7. Enter **DS 8 Operator Messages** as shown below; then click **OK**.
8. Click on the third **Jump Condition**. The **Define Jump to Condition** box opens. Enter **MB 2 Bundle Complete**, as shown below.



Figure 97. Defining a Jump Condition

9. Click **OK**. The **Define to Display Jump** box opens.
10. Enter **DS 8 Operator Messages**; then click **OK**. Display 7 appears as shown below.

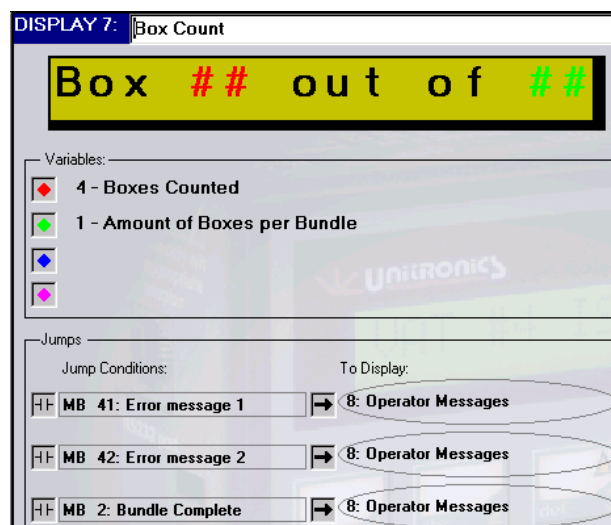


Figure 98. Completed Display

Display 7 is complete. Now, create the operator messages.

Display 8: Operator Messages

Unlike other Displays in your application, Display 8 contains no fixed text. It contains:

- **One List Variable**
This Variable displays any one of **3** messages **according** to the value of the linked MI.

Editing Display 8

1. Open Display 8 by clicking it in the Project Navigation tree.

Creating a Field and Attaching a Variable

1. Click in the green Display field and select the **entire** field.
2. Click **Attach Variable**. The **Attach Variable** box opens.
3. Enter **VR 8 Operator Messages** as shown below; then press **OK**.

Programming the M90

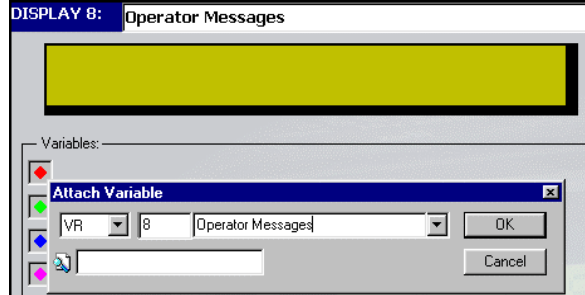


Figure 99. Attaching a Variable

4. Click **OK**. Display 8 appears with red pound signs as shown below.

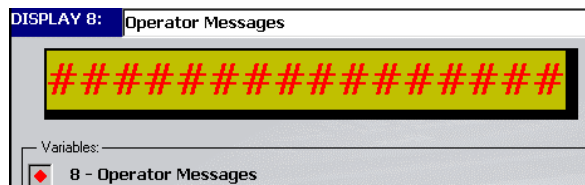


Figure 100. Attached Variable

Now, format the Variable.

Formatting List Variable 8

1. Open **Variable 8** from the Project Navigation tree.
2. Select **List** from the Variable Type list. The **Set Link to List** box opens.
3. Enter **MI 5 Operator Message List** as shown below; then click **OK**.

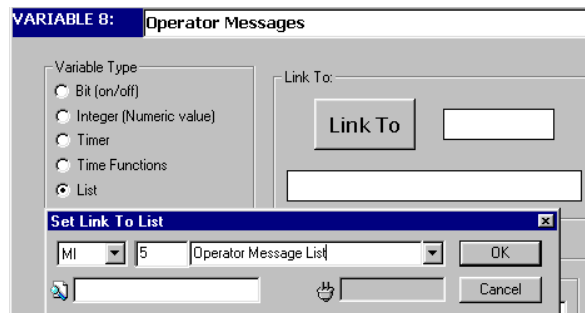


Figure 101. Linking a List Variable

4. In the Data field, enter the text on lines 0, 1, and 2 as shown below.

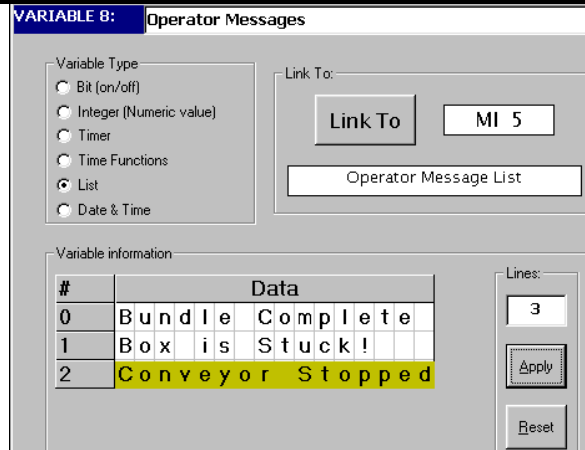


Figure 102. Defining a List Variable

The final Display in your HMI is complete—except for Jump conditions. The Jump conditions will cause Display 8 to change if:

- The bundle of boxes is complete.
- A timer turns ON.

Setting Jumps

You set 2 Jump Conditions for this Display.

1. Open Display 8 by clicking it in the Project Navigation tree.
2. Click on the first **Jump Condition**. The **Define Jump to Condition** box opens.
3. Enter **MB 4 Return to DS 1: Enter ID** as shown below; then click **OK**.

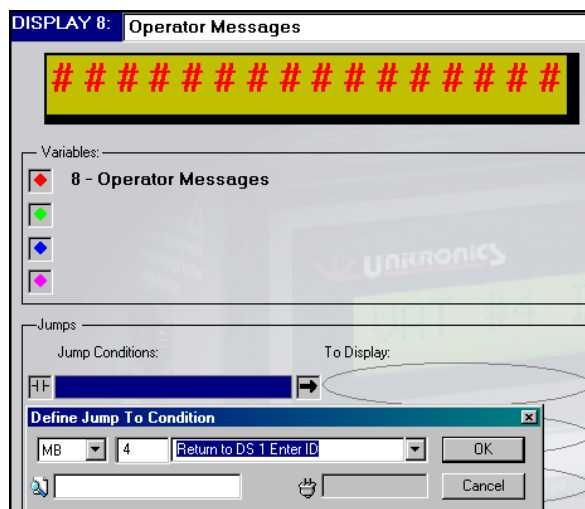


Figure 103. Defining a Jump Condition

Programming the M90

The **Define to Display Jump** box opens.

- Enter **DS 1 Enter Password** as shown below; then click **OK**.

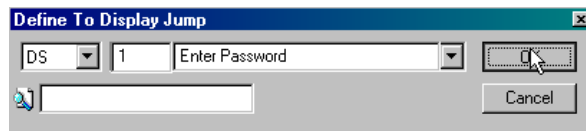


Figure 104. Defining a Jump Condition

- Click on the second **Jump Condition**. The **Define Jump to Condition** box opens.
- Enter **MB 5 End Message Display Time**. Click **OK**. The **Define to Display Jump** box opens.
- Enter **Display 7 Box Count**. Click **OK**.

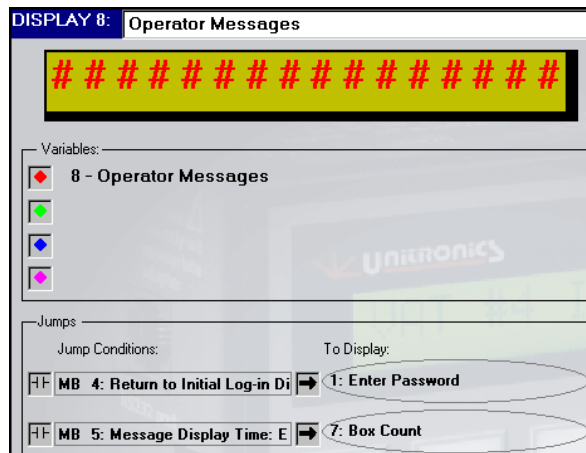


Figure 105. Final Display Complete

Review:

In this section, you created 2 Displays:

- Display 7: **Box __ out of __**
This shows a running box count that allows the operator to track production. The Display contains 3 Jump Conditions, all of which lead to Display 8.
- Display 8: _____
This Display contains a List Variable. Different conditions cause different Variable lines to be displayed on the M90's screen:
 - Bundle Complete.
 - Box is Stuck!
 - Conveyor stopped.

Your HMI application is now complete. Now, write the supporting Ladder application.

Ladder: Maintenance Time

In the previous section, you created two Displays that enable the operator to set a time period for system maintenance. These Displays use Variables to accept time values that are entered by the operator via the M90 keypad. In Display 5, **Variable 2 Start Time** was linked to **MI 2 Start Time**. In Display 6, **Variable 3 End Time** was linked to **MI 3 End Time**.

In this section, you use these values to build a net that will prevent the machine from running or accidentally being turned on during maintenance.

Net 11: Machine Cannot Run

This net reads:

WHEN the RTC time is between the times entered into MI 2 and MI3, THEN turn MB 6 ON.

Net 11 contains:

- An **Indirect Time Clock function block**.
- A **Direct coil**.

MI 2 and MI 3 define the time range for this Indirect Time function. When the current RTC¹ time is within this range, power cannot flow through the function block. The power flow drives a Direct Coil, linked to MB 6. This condition prevents the machine from running during maintenance time.

Using Indirect Time Functions: Clock

1. Select the **Time** function block from the **Clock** menu shown below, then place the function block on the left Ladder rail. The **Select Operand and Address** box opens.

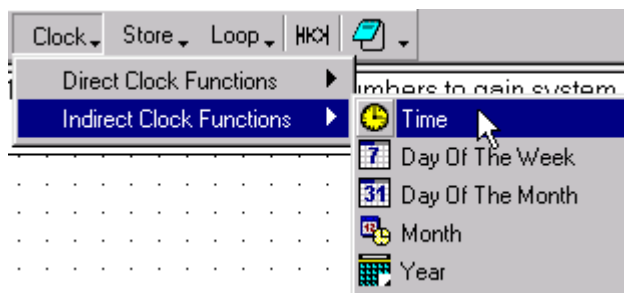


Figure 106. Net 11 Select Time Function

2. Enter **MI2 Start Time**. Click **OK**. The Time function **automatically** includes the next consecutive MI, which is **MI 3 End Time**, as the second time value.
3. Place a Direct Coil next to the Time function. The **Select Operand and Address** box opens.

¹ RTC: Real Time Clock. The M90 has an internal RTC that is used to handle time and date functions.

Programming the M90

4. Enter **MB 6 Machine cannot run**. Click **OK**. The finished net appears as shown below.

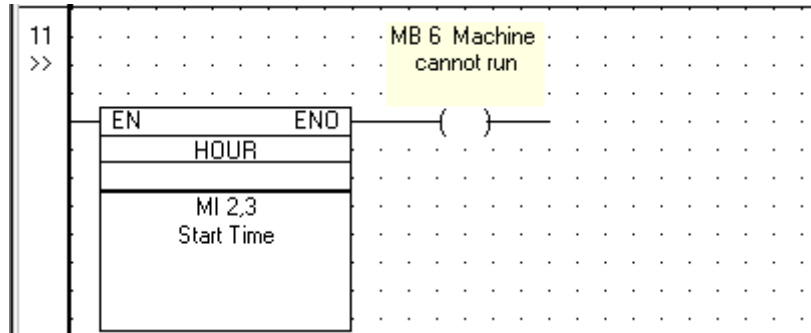


Figure 107. Net 11 Prevent the Machine from Running

Ladder: Starting the Bundling Machine

Net 12 actually starts the machine. Before the machine can start, the system checks:

- If ID numbers 10, 11, or 12 have been entered, turning **MB 20 System can work ON**.
- The day, using a function block set to enable power flow on weekdays.
- The Current HMI Display number; if it is higher than 6, the machine can start.

Net 12 reads:

When MB 20 is ON, AND it is a weekday, AND MB 6 is OFF, AND the Current HMI Display is 6, turn O 0 ON.

Net 12 contains:

- A **Direct contact**.
- A **Direct Clock function block: Day Of The Week**.
- An **Inverted contact**.
- An **Greater Than function block**.
- A **Direct coil**.

Starting the Machine

1. Place a Direct Contact on the left rail; the **Select Operand and Address** box opens.
2. Enter **MB 20 System can work**; then click **OK**.

Direct Clock Functions: Day Of The Week

Direct Time function block parameters are set by the programmer.

3. From the **Clock Menu**, select **Direct Clock Functions**, then **Day Of The Week**.
4. Place the function block next to the Direct Contact; the **Day Of The Week** box opens.
5. Select the days on which the application will run as shown below.

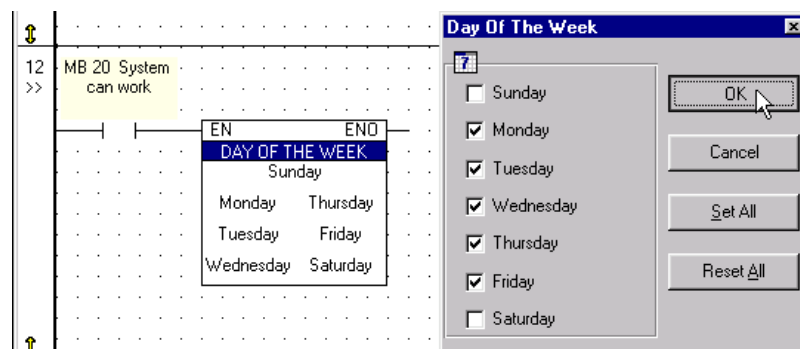


Figure 108. Net 12 Day Of The Week

The function block appears with the days of the week marked as shown below. Now the machine cannot run on weekends.

Programming the M90

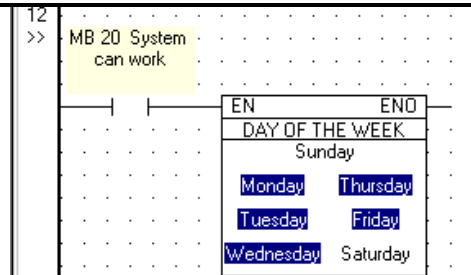


Figure 109. Net 12—Day of the Week

6. Place an Inverted Contact next to the function block. The **Select Operand and Address** box opens.
7. Enter **MB 6 Machine cannot run**; then click **OK**. Now the machine cannot run during the time period set for system maintenance.
8. Select **Greater Than** from the **Compare** menu, and place it next to the Inverted Contact. The **Select Operand and Address** box opens.
9. Enter **SI 2** for the 'A' value and **# 6** for the 'B' value; then click **OK**.

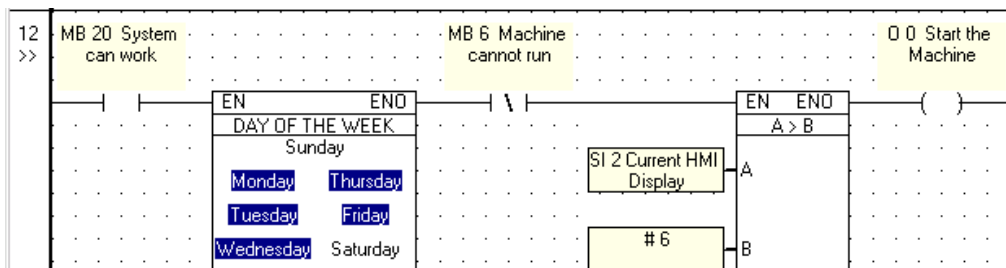


Figure 110. Net 12, Start Machine

Note that the current Display can be higher than 6 only after:

- A valid ID number has been entered, **and**
- The operator has set the number of boxes per bundle and system maintenance time.

Counting the Boxes

You used the conditions in Net 12 to start the machine. You can also use them to drive the box counter. The counter is connected to a photocell. Each time the photocell 'sees' a box, the counter increments by one. Note that the function of the 'photocell' in this application is filled by the +/- key on the M90 keypad. When this key is pressed, the M90 counts a single pulse. Add the 'photocell' and the counter to Net 12. This part of the net reads:

WHEN SB 50 turns ON, ADD 1 to the value in MI 4.

To build the counter, use:

- A **Positive Transition contact**.
- An **Add function block**.

U90 Ladder Tutorial

Building the Counter

Before you begin, enlarge Net 12 as explained on page 27.

First, ensure that the counter value cannot exceed the number of boxes per bundle. Do this by using a Less Than function block to compare **MI 11 Set Box Quantity** to **MI 10 Current Number of Boxes**.

1. Select **Less Than** from the **Compare** menu; place it as shown in Figure 111. The **Select Operand and Address** box opens.
2. Enter **MI 10 Current Number of Boxes** for the 'A' value, **MI 10 Set Box Quantity** for the 'B' value.

Now, build the 'photocell' and counter.

3. Select **Positive Transition Contact** from the **Contact** menu, and place it as shown in Figure 111. The **Select Operand and Address** box opens.
4. Enter **SB 50 +/- Key is pressed**, then click **OK**.
5. Select **Add** from the **Math** menu; place the function block as shown in Figure 111. The **Select Operand and Address** box opens.
6. Enter **MI 10 Current Number of Boxes** for the 'A' value, **# 1** for the 'B' value. The 'A' and 'B' values will be added together; then stored in the 'C' value.
7. Enter **MI 10 Current Number of Boxes** for the 'C' value.
8. Use the **Line Draw** tool to connect the elements as shown below.

Now each time you press the M90's +/- key, 1 is added to the number currently in MI 10; the sum is stored in MI 10. Net 12 is complete as shown below.

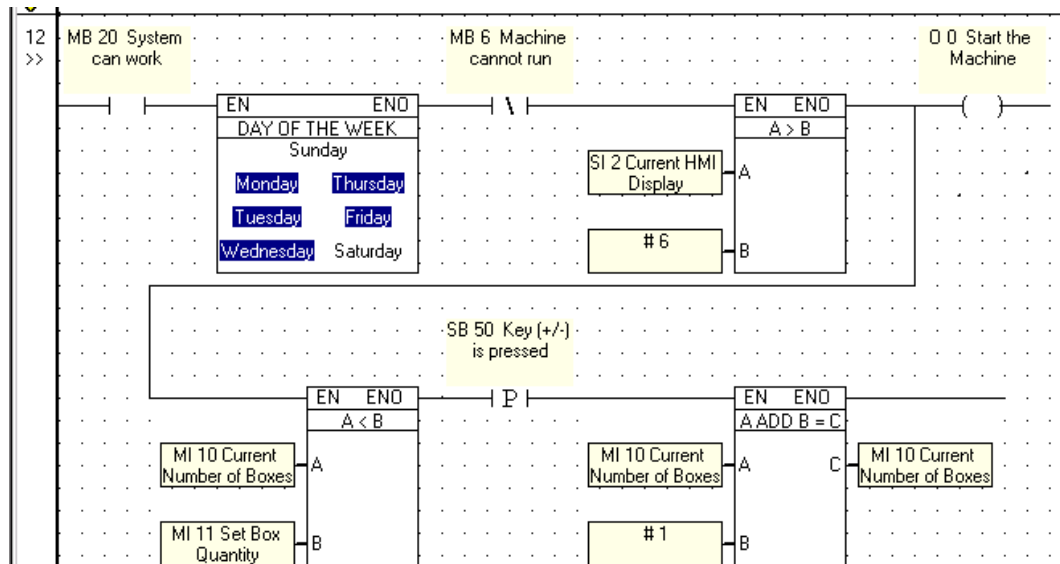


Figure 111. Net 12, Counter Complete

Programming the M90

Before the counter in Net 12 can work, you must initialize ('zero') the counter value.

Initializing the Counter

This net reads:

WHEN MB 20 is ON, STORE '0' into MI 10.

This net contains:

- A **Positive Transition contact**.
- A **Store function block**.
- A **Reset coil**

1. Insert a new net in front of Net 12 as explained on page 31. Net 12 becomes Net 13.
2. Select a Positive Transition contact and place it on the left Ladder rail. The **Select Operand and Address** box opens.
3. Enter **MB 20 System can work** and click **OK**.
4. Select **Store Direct** from the **Store** menu. Place the function block as shown below.
5. Enter **# 0** as the '**A**' value; enter **MI 10 Current Number of Boxes** as the '**B**' value.

Now, add a Reset coil. The state of the coil will be used to alert the system when the first box passes the 'photocell'.

6. Select a Reset coil and place it as shown below. The **Select Operand and Address** box opens.
7. Enter **MB 31 First Box Passes Eye**; then click **OK**.
8. Use the Line Draw tool to connect the Reset coil as shown below.

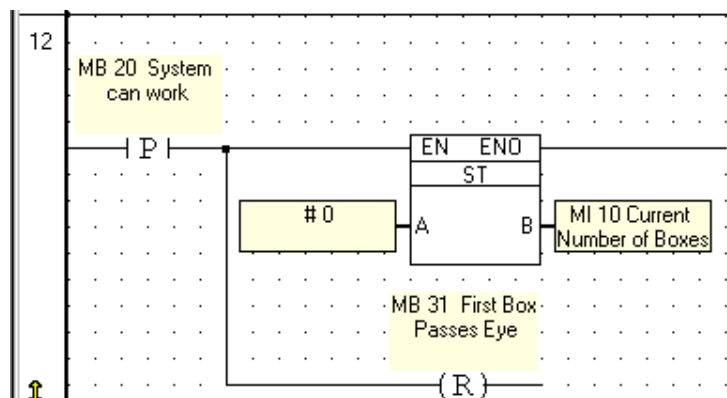


Figure 112. Initializing the Counter

This net is complete. The box counter will be initialized whenever a valid password is entered into the system.

Ladder: Operator Messages

Display 7 Box Count contains the 3 Jump Conditions shown below. All lead to **Display 8 Operator Messages**. Display 8 contains **List Variable 8**.

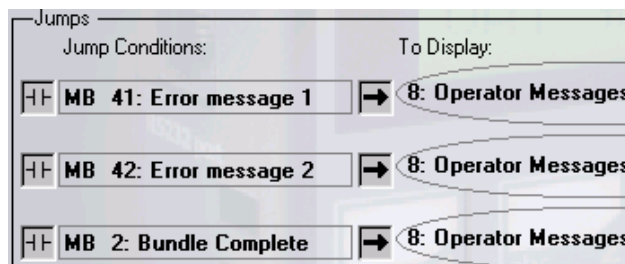


Figure 113. Jumps: Error Messages

Variable 8 is linked to **MI 5 Operator Message List**. The Jump Condition MB determines what value will be stored in MI 5. The value in MI 5 points to a line in **List Variable 8**; that message is then displayed on the M90's screen as shown below.

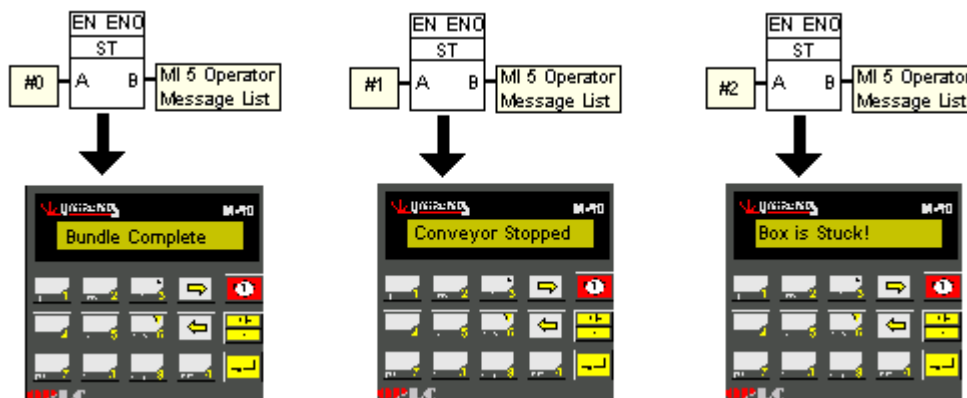


Figure 114. List Variable: Error Messages

Stuck Box: Timer 0

Timer 0 is used to detect when a box is stuck. Timer 0 starts when a box 'passes' the 'photocell'—when the M90's +/- key is pressed. Later in the application, the timer value will be used to turn MB 41 **ON**, displaying **Box Stuck** on the M90's screen. This net reads:

WHEN SB 50 turns ON, AND O 0 is ON, start Timer 0

This net contains:

- Two **Direct contacts**.

Programming the M90

- A **Direct coil**.

1. Build Net 14 by selecting the elements and placing them according to the figure below.

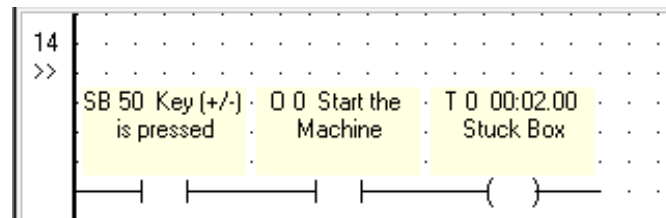


Figure 115. Stuck Box

Conveyor Stopped: Timer 1

Timer 1 is used to check whether boxes are being delivered into the system. Later in the application, the timer value will be used to turn MB 42 **ON** and display **Conveyor Stopped** on the M90's screen. Two nets control Timer 1. Net 15 reads:

WHEN SB 50 is ON, SET MB 31.

Net 15 contains:

- A **Positive Transition contact**.
- A **Set coil**.

Because you have used a Set Coil, MB 31 remains **ON**. This condition will be used in the next net to start Timer 1.

1. Build Net 15 by selecting the elements and placing them according to the figure below.

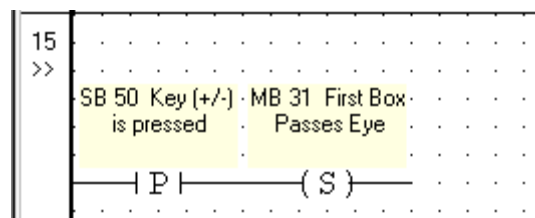


Figure 116. First Box Detected

Activate Timer 1

The net shown below uses three contacts to activate Timer 1, Conveyor Stopped.

Note that SB 50, the 'photocell' is now linked to an Inverted Contact. This means that power can flow to the other side only when the M90's +/- button is not pushed--in other words, when the 'photocell' does **not** detect a box. The net reads:

WHEN MB 31 is ON, AND SB 50 is OFF, AND O0 is ON, start Timer 1.

1. Build Net 16 by selecting the elements and placing them according to the figure below.

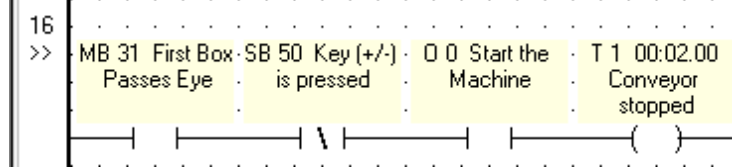


Figure 117. Conveyor Stopped—Timer

Display Line 0: Bundle Complete

There are 2 nets in this section:

- Net 17 causes the system to jump to Display 8.
- Net 18 causes Message 0, **Bundle Complete** to be displayed on the M90's screen.

Net 17 reads:

WHEN MI 10 is GREATER THAN OR EQUAL TO MI 11, turn MB 2 ON.

1. Build Net 17 by selecting the elements and placing them according to the figure below.

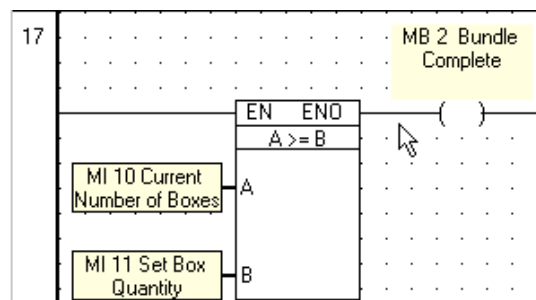


Figure 118. Jump to Operator Message

Net 18 reads:

WHEN MB 2 turns ON, STORE 0 in MI 5.

When **MI 5 Operator Message List** contains 0, Line 0 in **List Variable 8 Operator Messages** is displayed on the M90's screen: **Bundle Complete**.

1. Build Net 18 by selecting the elements and placing them according to the figure below.

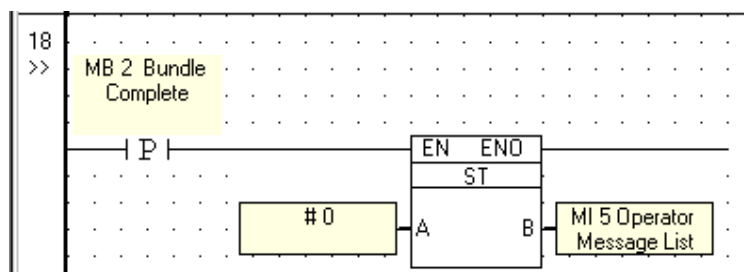


Figure 119. Display Bundle Complete

Programming the M90

Display Line 1: Stuck Box

- Net 19 causes the system to jump to Display 8 when Timer 0 finishes.
- Net 20 causes Message 1, **Stuck Box!** to be displayed on the M90's screen.

Net 19 reads:

WHEN T 0 is ON, AND MB 2 is OFF, turn MB 41 ON.

1. Build Net 19 by selecting the elements and placing them according to the figure below.

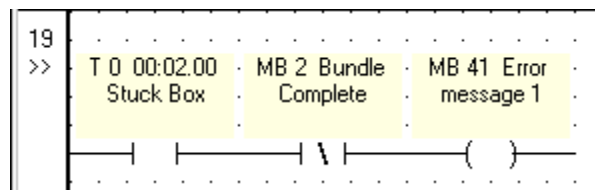


Figure 120. Jump to Display Box is Stuck!

Net 20 reads:

WHEN MB 41 turns On, STORE 1 in MI 5.

When **MI 5 Operator Message List** contains 1, Line 1 in **List Variable 8 Operator Messages** is displayed on the M90's screen: **Box Stuck!**

1. Build Net 20 by selecting the elements and placing them according to the figure below.

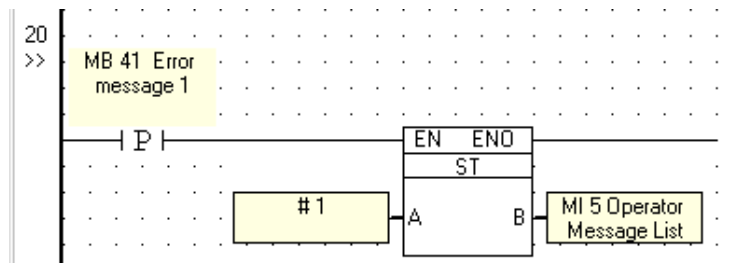


Figure 121. Display Box is Stuck!

Display Line 2: Conveyor Stopped

- Net 21 causes the system to jump to Display 8 when Timer 1 finishes.
- Net 22 causes Message 2, **Conveyor Stopped** to be displayed on the M90's screen.

Net 21 reads:

WHEN T 1 is ON, AND MB 2 is OFF, turn MB 42 ON.

1. Build Net 21 by selecting the elements and placing them according to the figure below.

U90 Ladder Tutorial

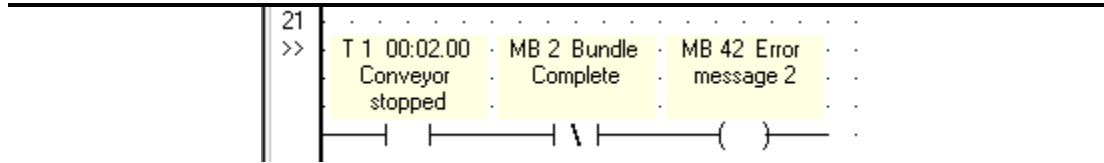


Figure 122. Jump to Display Conveyor Stopped

WHEN MB 42 turns On, STORE 2 in MI 5.

When **MI 5 Operator Message List** contains **2**, Line 2 in **List Variable 8 Operator Messages** is displayed on the M90's screen: **Conveyor Stopped**.

1. Build Net 22 by selecting the elements and placing them according to the figure below.

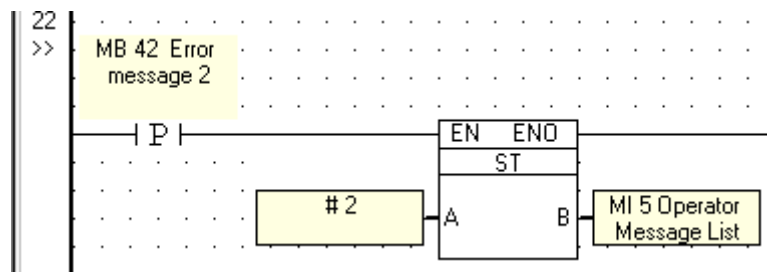


Figure 123. Conveyor Stopped

Exiting Display 8

The Jump Conditions that cause the system to exit Display 8 activate Timers.

Exiting 'Bundle Complete'

The net shown below activates a timer that:

- Determines the length of time **Bundle Complete** is displayed on the M90's screen.
- Is used to exit **Display 8 Operator Messages**.

This net reads:

WHEN the Current Display is 8, and MI 5 is EQUAL to 0, start Timer 3

When the **Bundle Complete** message is on the M90's screen, Timer 3 starts.

1. Build Net 23 by selecting the elements and placing them according to the figure below.

Programming the M90

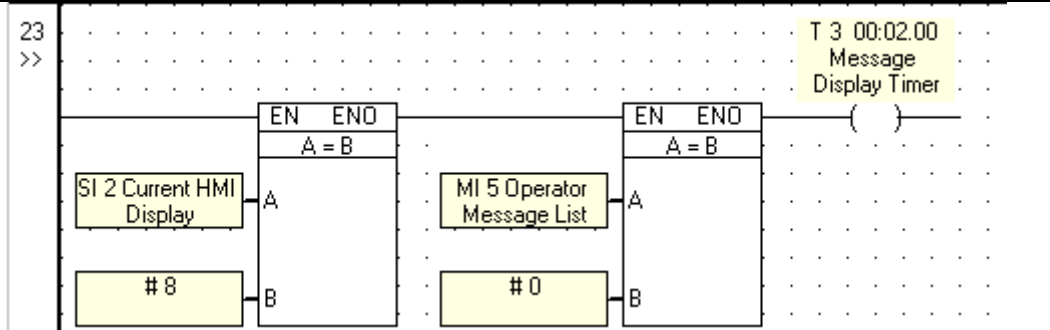


Figure 124. Display Timer

The net below causes the display screen to change when Timer 3 finishes. The net reads:

WHEN Timer 3 is ON, turn MB 4 ON.

This causes **Bundle Complete** to be displayed on the M90's screen for 2 seconds. MB 4 then turns **ON**, causing the system to return to **Display 1 Enter ID**. When this happens, the application has run successfully.

1. Build Net 24 by selecting the elements and placing them according to the figure below.

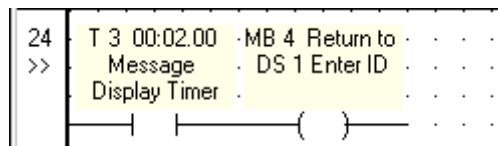


Figure 125. Application Complete

Exiting 'Box Stuck!' and 'Conveyor Stopped'

The error messages are displayed when MB 41 and MB 42 turn **ON**. When the errors have been fixed, these MBs will turn **OFF**, starting a timer. The net below reads:

WHEN MB 41 and MB 42 are OFF, and the Current Display is 8, turn on Timer 4.

1. Build Net 25 by selecting the elements and placing them according to the figure below.

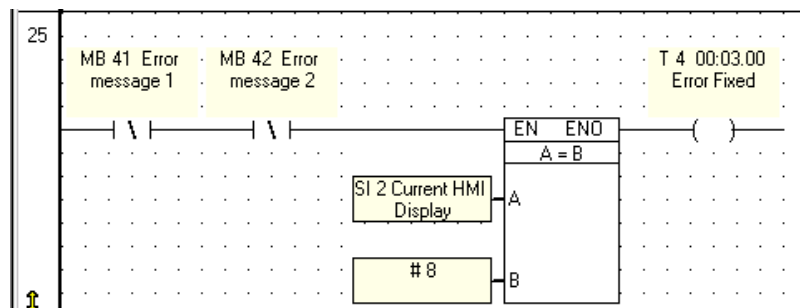


Figure 126. Error Fixed

Exit Box Stuck, Return to Box Count

The net below supports the Jump Condition from **Display 8 Operator Messages: Stuck Box**. This net reads:

WHEN Timer 4 is finished, AND SB 50 turns ON, AND MI 10 is Less Than MI 11, turn MB5 ON.

MB 5 is used as a Jump Condition in Display 8. When MB 5 turns ON, the Jump Condition will be fulfilled and **Display 7 Box Count** will appear on the M90's screen.

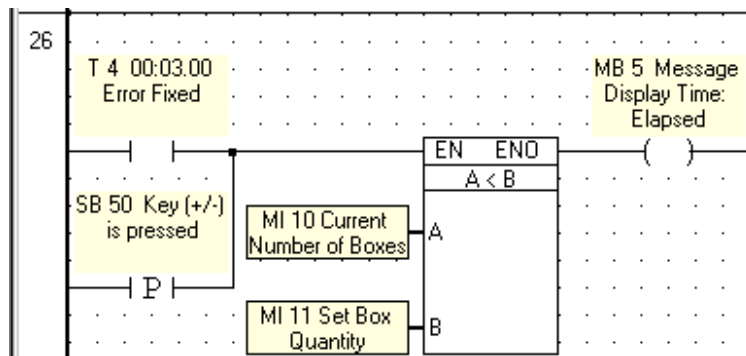


Figure 127. Error Fixed

Your application is complete. You may download it to the M90 and run it as a self-contained application.

You can learn more about M90 programming by referring to the sample U90 Ladder applications installed along with U90 Ladder. These are located in the Unitronics folder in the Examples directory.