

Rockwell Software RSLogix500

MicroLogix 1400 Programming

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This document is a supplement to the “Lab 1.doc” lab exercise that introduces one to the basics of ladder logic programming. The following equipment is assumed:

A-B 1766-L32BXB MicroLogix 1400

24-volt power supply

This document is primarily for Rev 9 of the RSLogix500 software. A serial cable connection from the PC to the processor is also assumed.

In order to become familiar with basic ladder logic programming and addressing techniques on the Allen-Bradley equipment, the steps to accomplish the first part of the first lab exercise are outlined in sections A, B, and C. The remainder of the sections outline the steps to document your ladder, to print the ladder logic program, and to save your ladder logic diagram. The last section explain the differences when programming offline, accessing the programming software outside of the laboratory.

In an industrial setting, the initial PLC programming is done offline and then later downloaded to the PLC when ready for the final test and debug. In addition, there is usually only one project (program) for each PLC on the network. For these labs, the ladder programming will be done online so that changes can be immediately tested.

Rockwell Software RSLogix500 version 9.0 is used to program the Allen-Bradley MicroLogix 1400. Icons for these programs should already be on the desktop.

The PLC and the PC used to program it are connected directly through a serial RS-232 link.

For the casual user, the RSLogix software is best operated using the point-and-click approach. Towards the top of the screen, buttons for frequently-used commands are displayed in toolbars. One may click on the button, or access the function by selecting commands from the menu at the top of the screen. The various functions of the software may also be accessed by typing various letter mnemonic commands, but unless you use the software extensively, the learning curve is too steep for this laboratory.

A. STARTING A PROJECT WITH THE MICROLOGIX 1400

Power up the computer and external power supply.

For the most part, programming the MicroLogix series of PLC processors is identical to programming the SLC-500 processors. The only basic difference one will see is that the program cannot be edited on-line. One must edit the ladder logic off-line and download the changed program to the PLC.

If RSLinx is not already started, then start the program. If the RSLogix500 Programming Software main menu is not already displayed, click on the RSLogix500 icon. The main menu screen should appear with a list of selections. If the error message "Project file does not exist! OK to create it?", click on "Yes". The software will start up in the offline mode and a ladder may be displayed.

Communications should already be set up properly. To check that they are properly configured, select **C**omms | **S**ystem **C**omms.... Click on the "+" box next to "AB_DF1-1" since the MicroLogix is connected with a serial cable to the PC. A processor icon should appear with "MicroLogix xx" and maybe a name of the current program in the processor. Click on **OK**.

If your project is already in the PLC, click on the down arrow beside the small window in the upper left (should have "OFFLINE") and select **Go Online**. A ladder diagram should appear. Skip to the online programming functions.

When starting a project for the first time, it must initially be set up offline, and then go online. The initial setup consists of specifying the processor and configuring the discrete I/O modules.

1. Configuring the Processor

When starting a project for the first time, check and make sure the OFFLINE/ONLINE window displays OFFLINE. From the menu bar select **F**ile | **N**ew, or click on the white sheet icon. If you are prompted to close the current project, select **Y**es. A window titled "Select Project Name" is displayed. The processor model is:

Bul. 1766 MicroLogix 1400 Series B (Enhanced Password Security)
Type in a Processor (project) name and click on **OK**. The project data bases will be created. A project window and an empty ladder will appear. You are now ready to configure the I/O channels.

2. I/O Configuration

Using the RSLogix software, configuration of the inputs and outputs involves two steps:

1. specifying modules in the rack
2. assigning symbols to the I/O channels

The second step is not absolutely necessary, but it is easier to specify symbols now than when programming the ladder logic. The RSLogix programming software aids the programming of a PLC because one does not need to memorize the I/O addresses and file addresses, but can refer to them symbolically, as a label.

Since this processor does not have any expansion I/O, no modules need to be specified. All of the I/O channels for this lab exercise are built-in to the processor.

Now assign symbols to the input channels. Double-click on the Address/Symbol icon in the project tree window (toward the bottom of the tree). The Address/Symbol Editor window will appear. To assign symbols to the discrete input channels,

Click on **Add New Record**

A blank box will appear in the Address column of the table. Type in an address in the format (for START_PB switch) "I:0/0" and press <Tab>. A new row appears in the address table and columns labeled "Symbol" and "Description" will appear and the cursor will be in the "Symbol" column. You will only need to enter information in the "Symbol" column. The "Description" column is optional, though for a real program, you will generally place up to 75 characters of additional descriptive text in this field. If the cursor is not already in the "Symbol" column, click on the symbol column next to address I:0/00 (or use the cursor keys to place the box in this position).

Type your symbol name, in this case "START_PB" and press <Enter>.

Use the <Tab> or mouse to move the box to the description column and type in a description, for example, "Start push button switch" and then press <Enter> <Enter>.

Repeat the above 3 steps to specify the symbols and descriptions for the other input and output channels.

When finished, close the window by clicking on the "X" in the upper right corner of the window.

Now some of the data files need to be re-sized.

3. Sizing Data Files

It is good practice to properly size the data files before you start programming, since you will not be allowed to resize the data files when programming on-line. The default data files have only one element, which is not enough for the labs. The B3, T4, and C5 files will be sized to contain 11 elements, numbered from 0-10.

In the project tree window, right-click on the icon for "B3 - BINARY".

Click on **Properties**

Change the **Elements** field to "11" and press <Enter>.

Right-click on the icon for "T4 - TIMER".

Click on **Properties**, change the **Elements** field to "11" and press <Enter>.

Right-click on the icon for "C5 - COUNTER".

Click on **Properties**, change the **Elements** field to "11" and press <Enter>.

Now the processor channel information must be specified.

4. Processor Channel Configuration

The default baud rate of the serial port is okay. It can be accessed as follows.

Double-click on the Channel Configuration in the project tree window.

Select the **Chan. 0 - System** tab

Set the baud rate to 19200.

Select the **Chan. 0 - User** tab
Set the baud rate to 19200.
Click on **OK** when finished.

Now the processor needs to be downloaded with the blank ladder.

5. Processor Download

Select **Comms | Download....** A popup window will appear asking for a name you're your project. Change the folder as appropriate and the file name. Click on **Save**. A revision note window may pop up. Either type in a note, or just click on **OK**. If a window pops up indicating a mismatch in the processor revision letter, click on **Yes**. A confirmation window will pop up asking whether to proceed with the download. Click on **Yes**.

If a window pops up informing you that the communication configuration is different, click on **Don't Apply**. Repeat step 4 above. If the baud rates are okay, then start the download again and when a window pops up informing you that the communications configuration is different, click on **Apply**. If a Save Project window appears, click on **OK**.

When a windows pops up and asks if you want to go Online, click on **No**. Skip to the online editing functions, the next section.

B. LADDER LOGIC PROGRAMMING

The MicroLogix processors cannot be edited while on-line. One must edit the program while off-line and then the program downloaded to the processor.


The OFFLINE/ONLINE box should show "OFFLINE". If not, click on the arrow to the right of "REMOTE" box. The steps necessary to program the first part of the experiment, the series rung, will be explained in detail. For the other parts of the exercise, only the different steps required to do these parts are explained.


1. Two Contacts in Series (Logical AND)

The first ladder program to be implemented will be a simple series control rung. Two switches, SW3 and SW4, will be placed in series and will be used to control a single light, LA1.

Use the right mouse button to access editing functions whenever possible. Clicking on the right mouse button brings up the editing menu with available options. The menu is different depending on the (box) cursor location. If the box is on the left rail of a rung, **rung** editing functions: accept, cancel, cut, paste, append rung, insert rung, etc. If the box is on an instruction, then **instruction** editing functions are presented if the right mouse button is clicked: append/insert instruction, insert/append branches, change instruction type, cut, paste, etc. As you place the instructions into a ladder program, one can either *append* or *insert* the instruction. Append places the new instruction to the right of the current cursor position, and insert places the instruction to the left. If the cursor is on the left power rail, append or insert will append or insert a rung. *Appended* rungs are placed *below* the current rung, and *inserted* rungs are placed *above* the current rung.


If the ladder window is not displayed, double-click on "LAD 2" under "Program Files" in the project window. Place the cursor (red box) on the END rung. If not, click on the left rail of the bottom rung.

Click on the Insert Rung icon (... ). A new rung appears at the top of the screen with a red box on the left. The "e" in the box indicates this is an edit zone. Now the individual instructions for the new rung will be entered.

A normally open (NO) relay contact is needed at the input, so click on the appropriate contact symbol () above the ladder window.

Move the cursor arrow tip close to the left side of the rung and click the mouse. The NO contact will appear with a box around it and a question mark above it.

Switch SW3 will be used first, so type the symbol or address for that switch ("SW3" or "I:1/02") and press <Enter>. The symbolic and physical address of the relay that controls the contact will appear above the contact symbol on the ladder diagram.

Click on the  contact symbol above the ladder window and then click on the new rung to the right of the first contact and add a second NO relay in series with the first. Use the symbol or address for switch SW4 ("SW4" or "I:1/03") for this contact.

The output for this rung will be light LA1.

Click on the output coil symbol (-()-) above the ladder window.

Move the cursor to the right side of the rung and click the mouse. A normal output coil symbol will appear with a box above it.

Type the symbol or address for light LA1 ("LA1" or "O:2/00").

Since the output instruction has been entered, the rung edits may now be accepted.

Click on the left rail of the rung. A red box appears.

Click the right mouse button.

Click on **Accept Rung Edits**. Now the rung is loaded into the controller's memory. The "e" indications on the left side of the rung should disappear.

Now download the program and change the processor to the run mode:

Click on the arrow to the right of "OFFLINE" box

Click on **Download**

On the confirmation window, click on Yes

A windows pops up and asks if you want to go Online, click on Yes.

Click on the arrow to the right of "REMOTE PROG" box highlighted in blue. Select **Run**

On the confirmation, click on Yes

The controller is now set to respond to input conditions and perform appropriate output commands. The ladder power rails change to green, indicating the processor in the run mode.

Try the input switches in various combinations and observe the output. Also observe the changing status of ladder components on the screen. Energized or true conditions cause the elements to be highlighted on the ladder diagram.

2. Entering Branches (Logical OR)

Change the processor back to program mode and go offline:

Click on the arrow to the right of "REMOTE RUN" box. Select on **Program**

Click on the arrow to the right of "REMOTE PROG" box. Click on **Offline**

Either insert a new rung, or start rungs edits on an existing rung, placing the cursor on the instruction that will parallel the new branch. To start the branch:

Place the cursor on the contact that will parallel the new branch.

Right click the mouse.

Select **Insert New Branch**

A branch will appear before the cursor with a red box surrounding the right side of the branch

Place the mouse cursor on the red box and hold down the mouse button as you drag the branch to the desired location of the right side of the branch, usually on the other side of an instruction. The red rectangular box on the rung that changes to green indicates the location of the other leg of the branch. Release the mouse button and the program will place the branch.

Instructions are entered on branches just as if they were a separate rung.

To make a series of parallel branches that have parallel sides (instead of nesting, which looks like an inverted tree), the branch is extended down.

Place the cursor on the lower left corner of the branch.

Right click the mouse

Select ***Extend Branch Down***

A branch will appear below the existing branch and parallel with the existing branch

Now download the program and change the processor to the run mode:

Click on the arrow to the right of "OFFLINE" box

Click on ***Download***

On the confirmation window, click on ***Yes***

A windows pops up and asks if you want to go Online, click on ***Yes***.

Click on the arrow to the right of "REMOTE PROG" box highlighted in blue. Select ***Run***

On the confirmation, click on ***Yes***

3. Timers

To enter a timer into a rung, position the cursor on the right side of the rung, or to the left of where you want to place the instruction.

Click on the Timer/Counter tab above the ladder window and click on **TON**.

A timer instruction will appear at the right side of the rung. A box with a cursor will appear.

At this point, you have two options:

1. Type the timer address, e. g., "T4:1", and press <Enter>
2. Type a symbolic name, e. g., "TIMER1" and press <Enter>. If an address has not already been assigned to this symbol, then a warning message will appear at the bottom of the screen. You will have to use the database symbol/description to assign the symbol. **Your rung edits will not be accepted until you assign an address to that symbol.** Click on the symbolic name to highlight it. Now double click on Database-Address/Symbol in the project tree window. The record for the symbol will appear, allowing you to type in an address, followed by <Enter>. Click on the icon in the upper right to finish with the address/symbol editor.

Select the timer base, 0.01 or 1 second and press <Enter>

Type the preset value and press <Enter>

Type the initial accumulator value and press <Enter>

Other types of timer instructions are selected by clicking on the Timer/Counter tab and then the appropriate mnemonic (TON, TOF, RTO, or RES (reset timer)).

Note: to refer to the timer done bit in a contact address, use "symbol/DN" or "address/DN".

4. Counters

Counter blocks are placed in the ladder rung in much the same way as timers. To enter an up counter into a rung, first click on the **CTU** and position the arrow on the right side of the rung.

Click the mouse.

A CTU instruction will appear at the right side of the rung. A box with a cursor will appear.

At this point, you have two options:

1. Type the counter address, e. g., "C5:1" and press <Enter>
2. Type a symbolic name, e. g., "COUNTA" and press <Enter>. If an address has not already been assigned to this symbol, then a warning message will appear at the bottom of the screen. You will have to use the database symbol/description to assign the symbol. Your rung edits will not be accepted until you assign an address to that symbol. Click on the symbolic name to highlight it. Now double click on Database-Address/Symbol in the project tree window. The record for the symbol will appear, allowing you to type in an address, followed by <Enter>.

Click on the icon in the upper right to finish with the address/symbol editor.

Type the preset value and press <Enter>

Type the initial accumulator value and press <Enter>

For other types of counter instructions are selected by clicking on the Timer/Counter tab and then the appropriate mnemonic (CTU, CTD, or RES (reset timer)).

Note: to refer to the counter done bit in a contact address, use "symbol/DN" or "address/DN".

C. ADDING COMMENTS TO LADDER PROGRAM

Select the rung you wish to comment by placing the box cursor on the left power rail of the rung, or on any instruction in the rung.

Right-click on the left power rail for the rung

Select ***Edit Comment***

A window opens with a vertical cursor. Type descriptive text. Two consecutive <Enter> keys will terminate the comment.

To add a page title to a rung:

Right-click on the left power rail for the rung

Select ***Edit Title***

A window opens with a vertical cursor. Type descriptive text. Type <Enter> to terminate the title.

To change an existing rung comment or page title, double click on the comment or page title and A window opens with a one-line green field and a multi-line yellow window.

Make your changes.

Press <Enter> twice when done with comment.

Press <Enter> when done with title.

To display the rung comments on the ladder logic display, the "Display page titles/rung descriptions" must be enabled. From the main menu:

Select **View**

Select **Properties**

Select the **Comment Display** tab

Make sure "Show Page Titles" and "Show Rung Comments" are check marked

D. ASSIGNING SYMBOLS TO ADDRESSES

For a large project, it is much easier to enter the symbols into an external file in the format of comma separated variables and import them into the database. However, for the purposes of this lab, it is probably easier to manipulate the database directly. There are times when one will want to assign a specific address to a symbol, or to correct an incorrectly entered symbol. To access the symbol database, select Address/Symbol under the Database folder in the project tree window. A spreadsheet appears on the screen. The first column lists addresses, the second column lists symbol names and the other columns show scope, symbol group, and description.

To add a new symbol/address, click on **Add New Record**. A new row will appear and an address window appears. Type in the new address.

To modify the symbol and/or description for an address, use the mouse or cursor keys to highlight the appropriate box for the address and type in the correct information. To move to another field, use the mouse to select another field, press <Enter> or use a cursor key.

To delete an address/symbol from the database, use the mouse or cursor keys to select one of the fields in the record. Click on **Delete Record**.

When finished editing the database, close the window.

To define a new data file, one must first be OFFLINE.

Right-click the data files icon in the project tree.

Click **New**.

Type in a number for the data table in the **File** field.

Use the **Type** list box to select the type of data file

Type a **Name** and **Description** for the file.

Enter the number of **Elements** the file will contain

Make the file **Global**.

If one has not defined addresses in a particular file, or wants to increase the length of a file (for example, to add more timers), it also must be done OFFLINE:

Right click Double click on the appropriate file in the project tree

Click on **Properties**

Select appropriate number for file size (for bit files, specify the number of words, not the number of bits)

Close window.

E. DISPLAYING MEMORY LOCATIONS

To display the contents of a data file, double-click on the data file in the project tree.

Use the custom display features to build a display that shows the contents of multiple addresses (bit, integer, floating point, BCD, etc.) and allow one to modify them. This feature is very useful for debugging program operation and mathematical operations.

To **create** a custom display, do the following:

Right-click on Custom Data Monitor in the project tree

Select **New**

Type the number of new files to create, usually 1.

Click in the Name field and type a name for the CDM file.

Click in the Description field and type in a description.

Click on **OK**.

To **build** a custom display, do the following:

Double-click on appropriate CDM file under Custom Data Monitor in the project tree.

A window will be displayed with addresses/symbols in the fields.

Drag addresses from the data tables or ladder files to the CDM file, or click Insert from the right mouse menu and then enter the addresses into the CDM list. If you have trouble dragging addresses from the ladder to the CDM display, make sure the cursor is on the **address** not the mnemonic, instruction, or documentation.

Repeat the previous step for every address you want to monitor.

To **display** an already defined custom display, do the following:

Double-click on appropriate CDM file under Custom Data Monitor in the project tree.

To change the data at an address, first display the custom display. Use the cursor keys to highlight the appropriate entry, and type the new number, followed by <Enter>.

To exit from the custom display, close the window.

F. INPUT/OUTPUT FORCING

For inputs, the force function allows one to override the actual status of external inputs by forcing individual discrete inputs to be ON or OFF. Input forces are written to the input image table and have no effect on the actual input. The value in the force table overrides the actual input. For example, if I:01/13 is forced to 1 (ON), it will appear in the input image and ladder logic as 1, regardless of the actual status of the device.

For outputs, the force function allows one to override the processor logic and force individual discrete outputs to be ON or OFF. Output forces are written directly to the output device and do not appear in the output image table. The value in the force table overrides the

value in the output image. For example, if O:24/02 is forced to 1 (ON), the actual output will be ON, regardless of how it appears in the ladder and output image table.

Note: Enabling or disabling forces can result in sudden machine movement, possibly injuring personnel. Applying of removing forces while forces are enabled takes place immediately, with no prompt for confirmation. **USE EXTREME CAUTION WHEN USING FORCES!**

One can program forces in one of two ways:

- Position the cursor on an instruction in the ladder program which references a real I/O address and from the right-mouse menu select **Force On** or **Force Off**.
- Edit the input or output force table with a display similar to the monitor data file screen.

To access the output force table, double-click on O0 under the Force Files folder on the project tree. The force table for outputs is displayed in the window. The current state of the force table is indicated as:

- . there is no force for this address
- 1 address is forced ON
- 0 address is forced OFF

To display the input force table, double-click on I1 under the Force Files folder on the project tree. More than one I/O forcing window may be open at a time, and display different parts of the force table, or display the input and output force tables simultaneously.

To change the force status of the bit,
Double-click on the state (./0/1) of the address you want to force.
Edit the state of the bit and press <Enter>.

To enable forces, select **Enable All Forces** from the lower forces list box. A confirmation window will appear. Click on **Yes**.

To temporarily disable forces, select **Disable All Forces** from the lower forces list box. A confirmation window will appear. Click on **Yes**.

To remove all forces, select on **Remove All Forces** from the upper forces list box. You will be asked if you want to remove all forces. Click **Yes** to remove all forces.

G. IMPORTING

1. Importing Database from CSV files

To import an address/symbol/description database from a .CSV (comma separated variable) file:
From the main menu select Tools.

Select **Database / ASCII Import**

An ASCII Import window will appear. Select the following:

- Import Source Format - **CSV**
- Data to be imported - **Addr/Symbol Desc.**

On Collisions: - **Overwrite**
 Click on **OK**
 Select the appropriate file.
 The addresses and symbols are imported.
 A window showing the status of the import will be displayed. Click on **OK** when finished.

2. Importing PLC Program

Place the cursor on the left power rail of the instruction **before** which the imported code will go (the imported code will be **inserted** into the ladder):

Right-click the mouse.

Select **Paste From PC5 Library**

An Open/Import Program window will appear. Select File Type as "Library Files(*.PC5).

Select the "Project" subdirectory.

Select the appropriate program file ("Levdisp.pc5" for the level lab)

A window with import options will pop up. Select the following:

Import Rung Comments and Page Titles

Import Address Descriptions

Import NEW library descriptions only. Ignore duplicates.

Import Address Symbols

Import NEW library symbols only. Ignore duplicates.

Normal address load mode

Click on **OK**

If a warning window pops up with a message about the library being created for another PLC type, click on **OK**

The ladder is inserted into your program and is marked with "e".

To verify the rungs, select **Edit / Verify File**.

H. SAVING LADDER LOGIC PROGRAMS

Ladder logic programs (projects) may be saved for future use. By saving your ladder logic programs, you are able to resume your experiment, even though others have been using the same PLC. One usually saves the program to the default program directory on the hard disk and then saves the program to a flash drive for backup/transport to another computer.

To save the ladder logic currently in the PLC,

Select **File**

To save with the same project name, select **Save**

To save with a different project name, select **Save As...**

To save your project to another directory, use **Save As...** and select the proper drive and directory.

I. RESTORING LADDER LOGIC PROGRAMS

You may restore your ladder logic program from the files on the computer hard disk to the PLC either before going on-line, or while on-line. Before going on-line, do the following steps:

Select ***File***

Select ***Open***

The file selector window will appear.

Double-click on the appropriate project. The project is now loaded into the PC

Select ***Comms***

Select ***Download***

A window will pop up asking for confirmation. Select ***Yes***

If the processor is in the run mode, you will be asked if it is okay to switch to program mode before continuing. Select ***Yes***

The files will be downloaded

If the processor was in the run mode when you started, you will be asked if it is okay to switch to back to run mode before continuing. Select ***Yes***

While on-line, the steps to restore your ladder logic to the PLC are as follows (confirm that you are on-line first):

Select ***Comms***

Select ***Download***

A window will pop up asking for confirmation. Select ***Yes***

The system warns you that the program in the processor will be overwritten. Select ***Yes*** to continue. The system asks you to confirm that you want to load the current project from disk into the PLC-5 processor. Select ***Yes*** to load your project files into the processor.

J. PRINTING A LADDER LOGIC PROGRAM

You may print your program only while off-line. To print just the ladder, click on the printer icon on the menu bar. To print a full report that includes the cross-reference and the ladder logic, select ***File*** and then select ***Print Reports***. In either case, a printer window appears that basically only lets you specify the printer and its properties.

To change report options, select ***File*** and then select ***Report Options...*** A pop-up window will appear with check boxes for the various reports. Only the following should be checked:

Cross Reference

Program File List

Program Files

Select "Program Files" in the left window. Verify that the top box contains "ALL"

Select "Cross Reference" in the left window. Verify the following:

Sort by Address

Other options are available. You may print these other sections if you wish. The data base report can be quite lengthy.