Cutler-Hammer

Eaton Logic Controller

Basic Training (1 Hour)

January 2006

Eaton Logic Controller
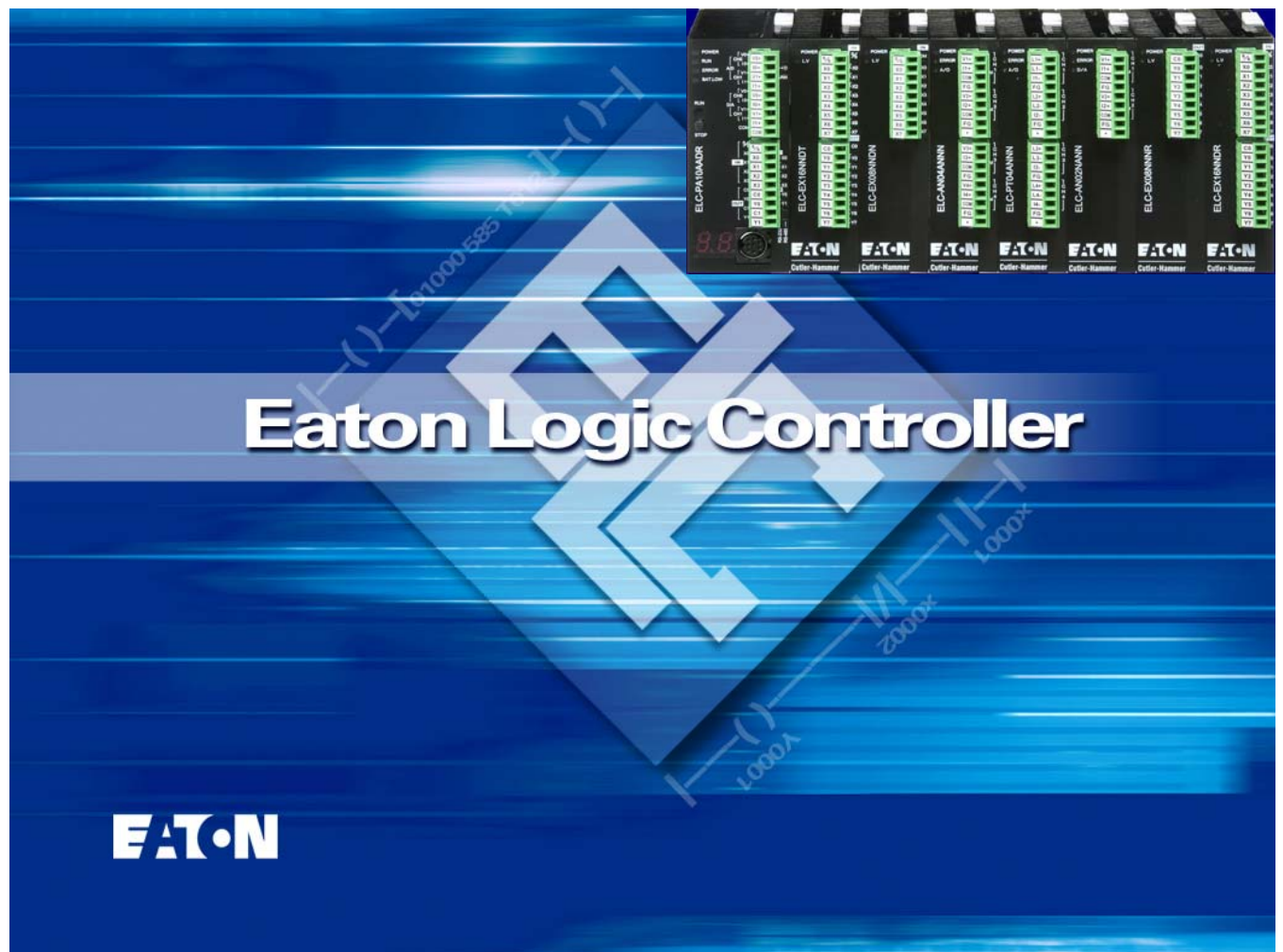
Preface

Intro:

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Basics:

- Hardware Overview
- Software Overview
- Connecting to the ELC

Exercises:

- Exercise 1: Ladder Logic
- Exercise 2: Logic Instructions

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Navigation in This Document

The cells to the left of the content on the even pages in this document are meant to show your progress through the training. The chapter which you are currently viewing is highlighted. For instance, on this page, the cells titled "Preface" and "Support Services" are highlighted to show what you are viewing on this page and the opposing page (in book format).

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Website Address	www.eatonelectrical.com

e-COM Support Center

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	FAX: 614-882-0417
	e-mail: CHATechSupport@eaton.com
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Go Chart

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Exercise 1: Ladder Logic

Exercise 2: Logic Instructions

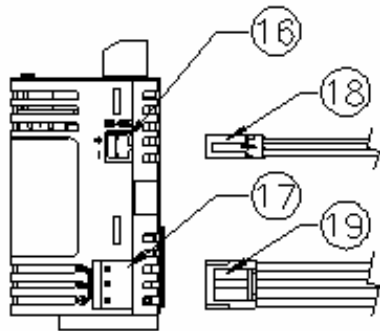**This document will take you through the following steps to learn the basics of the ELC:**

Basics

Hardware Overview

Software Overview

Connecting to the ELC

Exercises

Exercise 1: Basic Project Programming

Exercise 2: Basic Logic Instructions

Exercise 3: Timer & Math Instructions
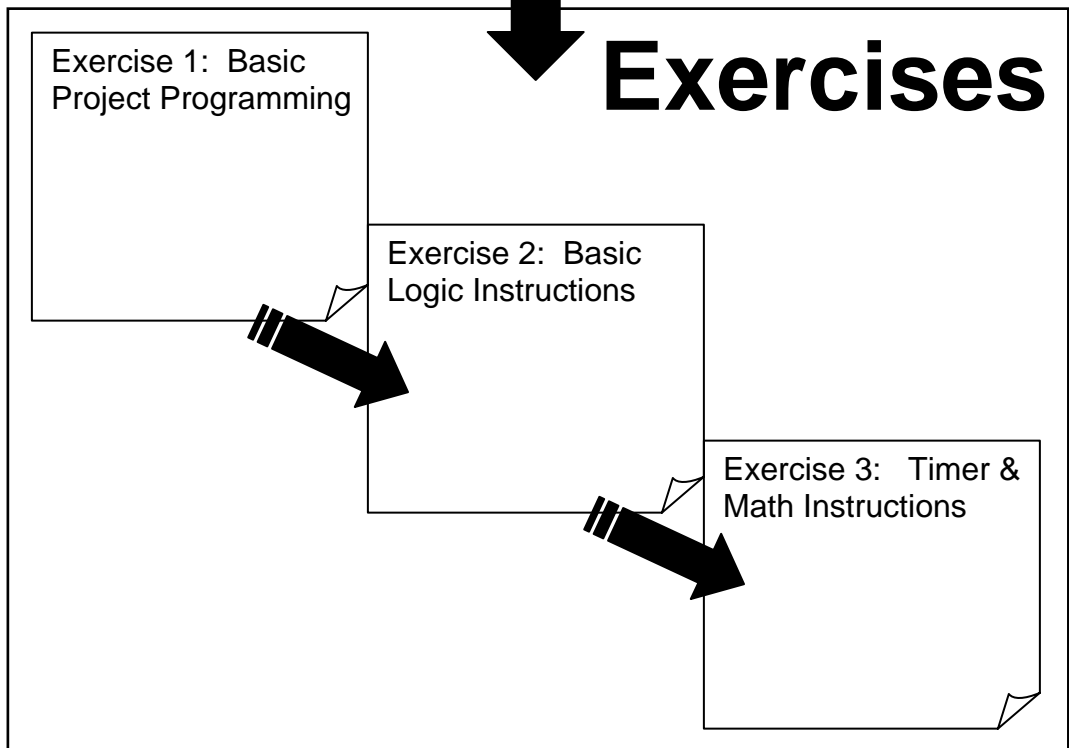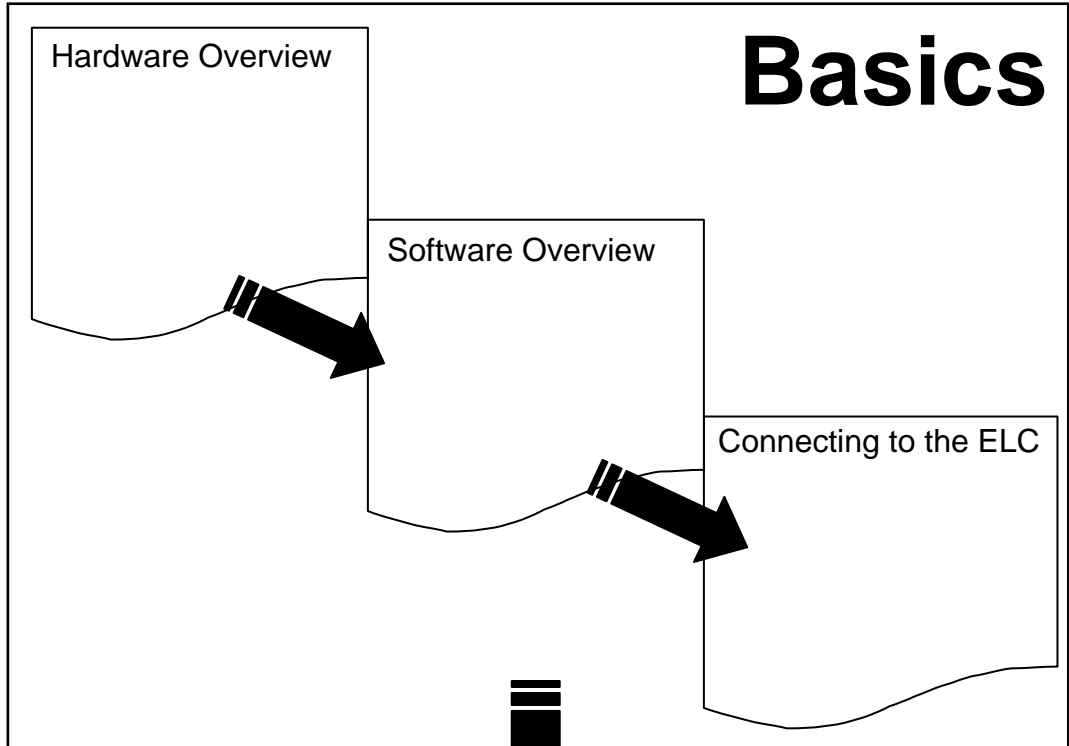
Hardware Overview
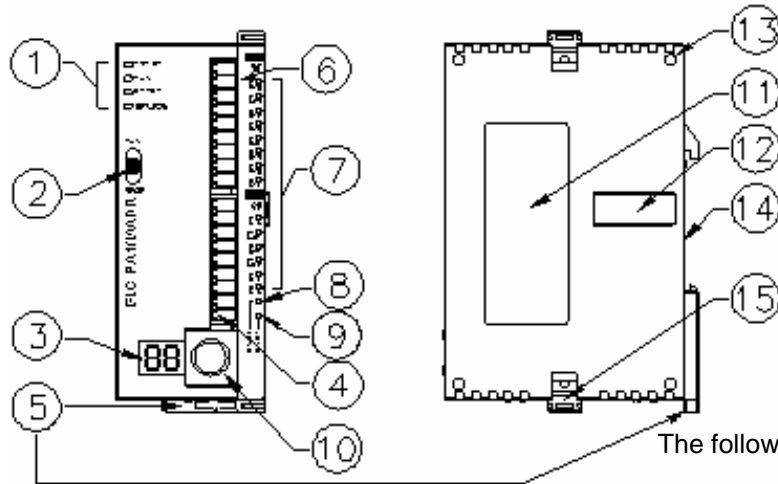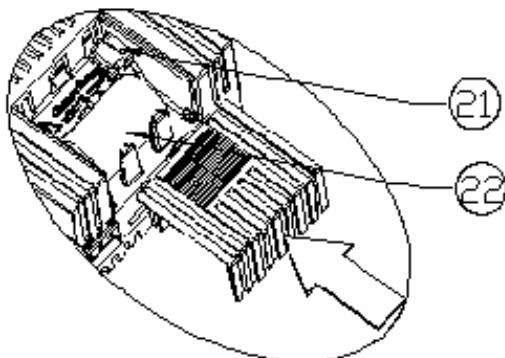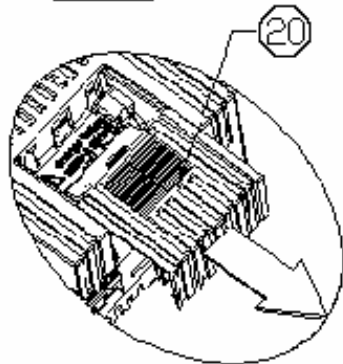
Item	Description
1	Status Indicators: • Power • Error • Run • Batt. Low (units with Clk/Calendar)
2	Run/Stop switch
3	(2) Digital 7-segment displays (on select models)
4	Digital I/O terminals
5	Din rail clip
6	Analog I/O terminals
7	I/O point indicators
8	COM 1 (RS-232) (Rx) indicator
9	COM 2 (RS-485) (Tx) indicator
10	COM 1 (RS-232) programming port
11	EATON nameplate
12	Extension port
13	Receptacle for expansion unit
14	DIN rail slot (35mm)
15	Expansion unit clip
16	COM 2 (RS-485) communication port
17	DC power input
18	RS-485 cable (included accessory)
19	Power input cable (included accessory)
20	Battery cover
21	Battery socket connection
22	Battery mount

Hardware Overview

Model Number Explanation

Use the following chart and tables to choose or identify your ELC components:

ELC - ☐☐☐☐☐☐☐☐

Module Type
AN: Analog
EX: Digital Expansion
PA: Processor with clock & analog
PB: Processor without clock
PC: Processor with clock
PT: Platinum Temperature

I/O Count

Digital Outputs
N: None
R: Relay
T: Transistor

Digital Inputs
A: AC
D: DC
N: None

Analog Outputs
A: Analog
N: None

Analog Inputs
A: AC
N: None
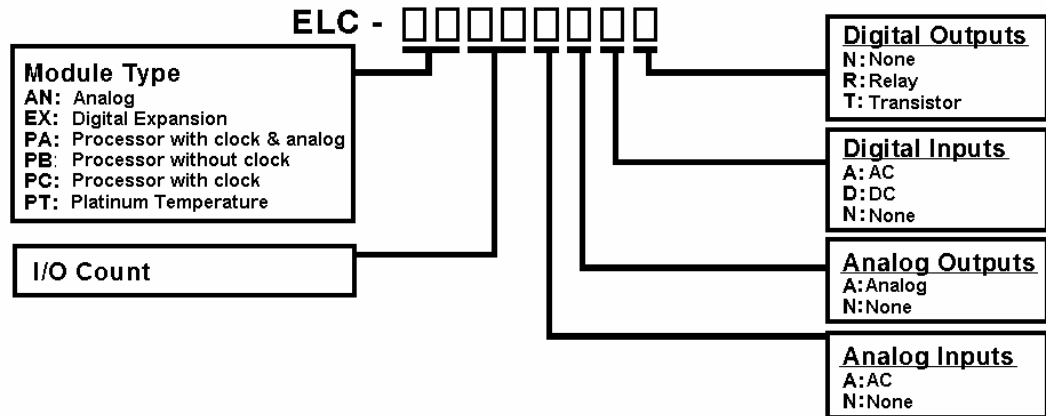
Processors

Description	Inputs			Outputs			Catalog Listing
Processor/no Clk	AC	DC	ALG	RY	TRN	ALG	
14 I/O PB Series		8		6			ELC-PB14NNDR
14 I/O PB Series		8			6		ELC-PB14NNDT
Processor With Clock							
12 I/O PC Series	8			4			ELC-PC12NNAR
12 I/O PC Series		8		4			ELC-PC12NNDR
12 I/O PC Series		8			4		ELC-PC12NNDT
10 I/O PA Series		4	2	2		2	ELC-PA10AADR
10 I/O PA Series		4	2		2	2	ELC-PA10AADT

Digital Expansion Modules

Description	Inputs		Outputs		Catalog Listing
	AC	DC	RY	TRN	
8 I/O Expansion	8				ELC-EX08NNAN
8 I/O Expansion		8			ELC-EX08NNDN
8 I/O Expansion			8		ELC-EX08NNNR
8 I/O Expansion				8	ELC-EX08NNNT
8 I/O Expansion		4	4		ELC-EX08NNDR
8 I/O Expansion		4		4	ELC-EX08NNDT
16 I/O Expansion		8	8		ELC-EX16NNDR
16 I/O Expansion		8		8	ELC-EX16NNDT

Analog Expansion Modules

Description	Inputs	Outputs	Catalog Listing
Analog In	Analog	Analog	
4 I/O Analog In	4		ELC-AN04ANNN
Analog Out			
2 I/O Analog Out		2	ELC-AN02NANN
4 I/O Analog Out		4	ELC-AN04NANN
Analog Combination			
6 I/O Analog In/Out	4	2	ELC-AN06AANN
Temperature			
4 I/O Thermocouple	4		ELC-TC04ANNN
4 I/O Platinum	4		ELC-PT04ANNN

Software Overview

PC Requirements

| Component	Requirement
Operating System	Windows 95/98/2000/NT/ME/XP
CPU	Pentium 90 and above
Memory	16MB and above (32MB and above is recommended)
Hard Disk	Capacity: 50MB and above CD-ROM (for installing ELCSoft)
Monitor Resolution	Minimum: 640×480, 16 colors and above Recommended: 800×600
Mouse	Serial or Windows compatible mouse
Printer	Printer with Windows driver
Comm Port	(1) RS-232, labelled COM1 - COM8
Compatible Products	All Eaton ELC series

Installing the software

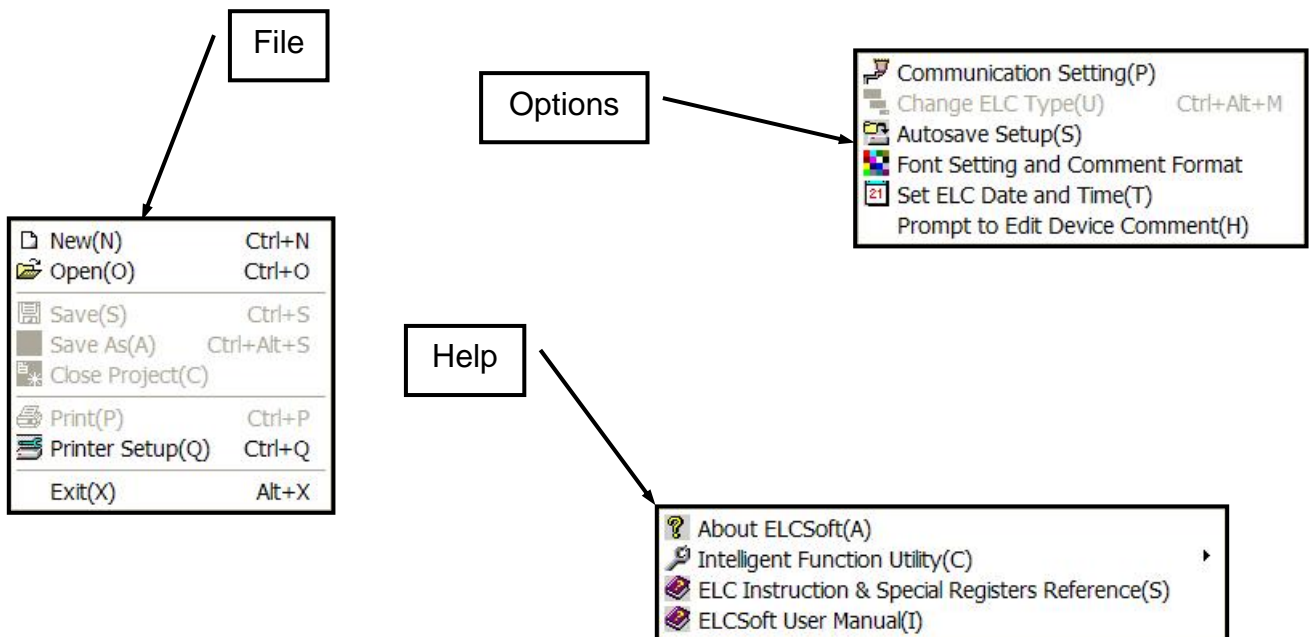Insert the provided CD-ROM into the proper drive on your PC. The install program should automatically run.
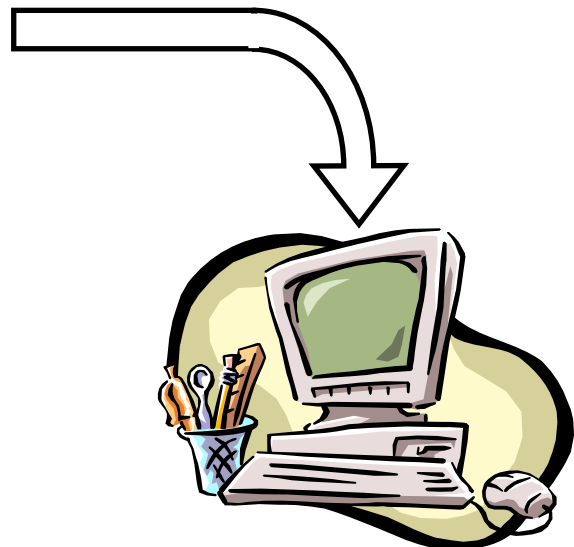
Software Overview

Software Features:

To open the software, select:
START>ALL PROGRAMS>ELCSOFT
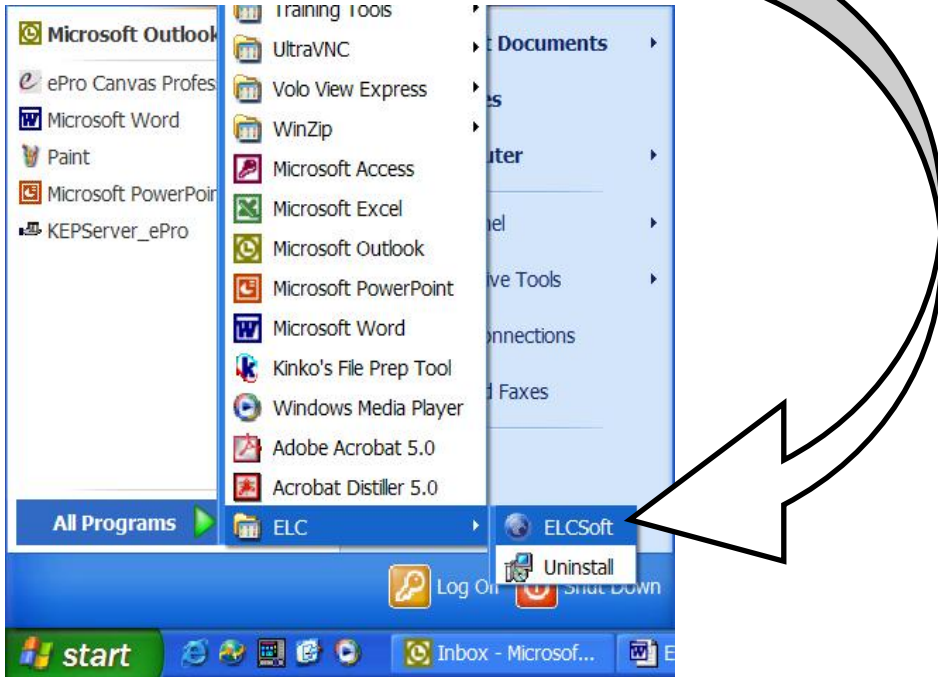
The following menus will be described here as a quick primer on just a few of the ELCSoft program features. Some of these features may be limited based on which ELC processor you are using.

File

Options

Communication Setting(P)	
Change ELC Type(U)	Ctrl+Alt+M
Autosave Setup(S)	
Font Setting and Comment Format	
Set ELC Date and Time(T)	
Prompt to Edit Device Comment(H)	

Help

New(N)	Ctrl+N
Open(O)	Ctrl+O
Save(S)	Ctrl+S
Save As(A)	Ctrl+Alt+S
Close Project(C)	
Print(P)	Ctrl+P
Printer Setup(Q)	Ctrl+Q
Exit(X)	Alt+X

About ELCSoft(A)	
Intelligent Function Utility(C)	►
ELC Instruction & Special Registers Reference(S)	
ELCSoft User Manual(I)	

Software Overview

File Menu

☐ New(N)	Ctrl+N
☞ Open(O)	Ctrl+O
▦ Save(S)	Ctrl+S
▦ Save As(A)	Ctrl+Alt+S
▦ Close Project(C)	
🖨 Print(P)	Ctrl+P
🖨 Printer Setup(Q)	Ctrl+Q
Exit(X)	Alt+X

NEW: Opens the window to the right. Allows you to give the new program a name (*Program Title*); choose what *ELC Type* you will be programming (you'll know this type as part of the ELC part number); and create a *File Name* that the new project will be saved under.

OPEN: Opens a window to browse to an already saved ELC project.

*SAVE: Saves an already open file to its current filename.

*SAVE AS: Saves an open project file as a name different than the one that is currently saved under.

*CLOSE PROJECT: Closes the currently open project and leaves the software open.

*PRINT: Opens the window to the right. Allows you to specify what you'd like to print and gives the option to preview the printed result.

PRINTER SETUP: Opens a standard printer setup window.

EXIT: Closes the ELCSoft software.

BELOW EXIT: Shortcuts to recently used projects will appear in rows below the Exit choice.

* Available only when a project is open.

ELC Type Setting

Program Title
[   ]

ELC Type [PB   ▼]

⦿ 4000 Steps
○ 8000 Steps
○ 16000 Steps

File Name
[Doc0   ]

[OK]   [Cancel]

Selection

Selection
⦿ Whole Range
○ Step Range Specification
Start [   ]
End [   ]
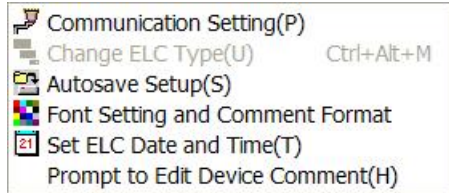
☐ Title
☐ Page
☐ Cover
☐ Frame

[Print Setup]

[Preview]   [Cancel]

Software Overview

Options Menu

COMMUNICATION SETTING: Opens the window to the right. Allows you to choose the COM Port, Baud Rate and Station Address for communications to the ELC, along with Retries and Retry Delay settings.

*CHANGE ELC TYPE: Opens the *ELC Type Setting* dialog shown on page 10. Allows you to set the type of ELC on which the currently open project will be used.

AUTOSAVE SETUP: Opens a window that allows you to set software auto save features to occur either at the beginning of a compile function or at a specific interval (minimum is 5 minutes). NOTE: By default, the *Auto Save* box is unchecked.

FONT SETTING AND COMMENT FORMAT: Opens a window to configure colors and fonts used in the program.

*SET ELC DATE AND TIME: If an ELC is connected, this opens the window to the right, which lets you synchronize the clock in the ELC.

PROMPT TO EDIT DEVICE COMMENT: When this option is checked, the software will automatically pop up a window that has a field for entering a device comment immediately after you enter an address by direct typing command in a programming window.
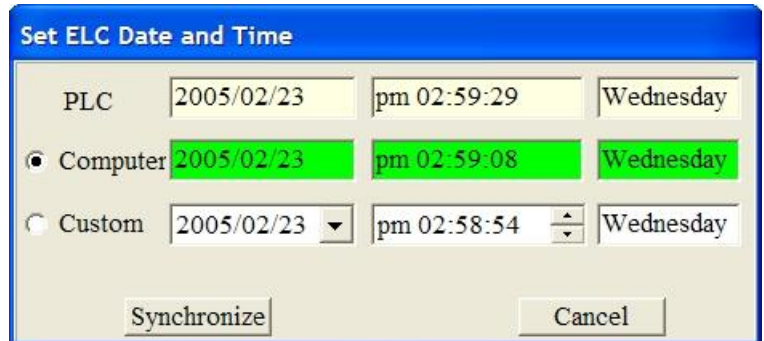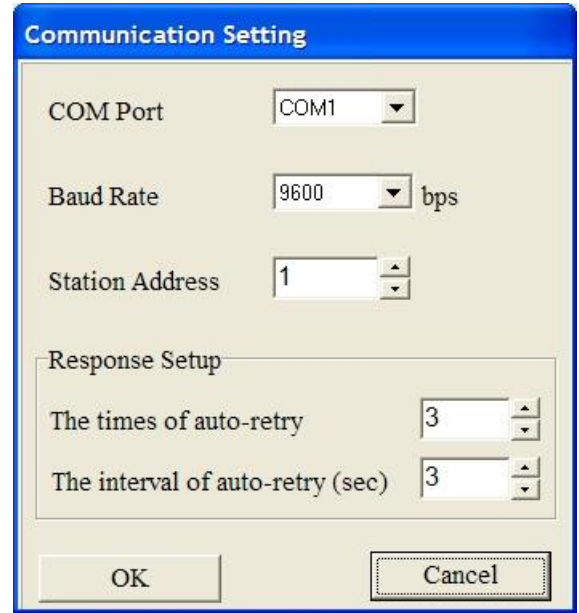
* Available only when a project is open.

Software Overview

Help Menu

About ELCSoft(A)
Intelligent Function Utility(C)
ELC Instruction & Special Registers Reference(S)
ELCSoft User Manual(I)
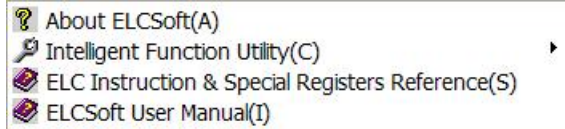
ABOUT ELCSOFT: Click here to view the version number of your ELCSoft software.

INTELLIGENT FUNCTION UTILITY: A submenu is available from this menu choice that assists in the setup of advanced ELC functionality.

ELC INSTRUCTION & SPECIAL REGISTERS REFERENCE: Opens a help file devoted that lists and defines all basic and advanced instructions and special function registers (D) and words (M).

ELCSOFT USER MANUAL: Opens the ELCSoft User Manual.

Other helpful menu commands:

VIEW>WORKSPACE: Opens a treeview representation of the currently open project to the left of the main programming window.

## SOME COMMANDS TO BE AWARE OF WHICH NEED LITTLE OR NO EXPLANATION:

- **VIEW MENU**
  - Instruction List
  - Ladder Diagram
  - SFC Diagram (*S*equence *F*unction *C*hart [similar to flow chart])
  - Edit Device Comments
  - List of Used Devices
  - Cross Reference List
  - Show Comments
  - Symbol Table

- **SEARCH MENU**
  - Go To
  - Search/Replace
 - Go To Start
  - Go To End

Connecting to the ELC

To connect to a new ELC:

- Open ELCSoft

- Use the ELC programming cable (part number *ELC-CBPCELC3*) to connect a serial port on your PC to the port on the front of the ELC processor.
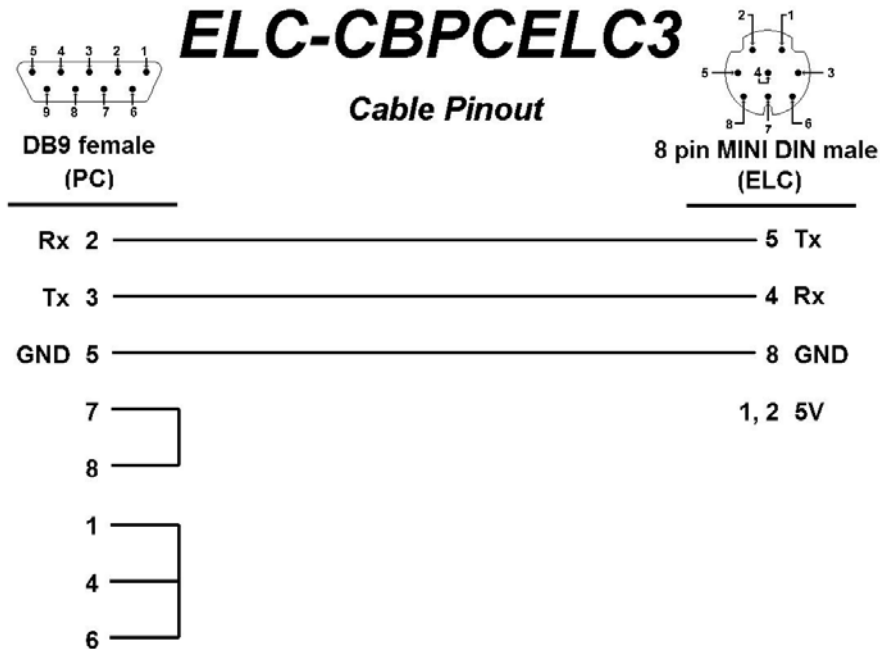
- Choose **OPTIONS>COMMUNICATION SETTING**, and choose the port to which the programming cable is connected in the window. *(NOTE: The Technical Support and Services team has had success using various USB to serial converters to communicate to the ELC product line as well.)*

- Set *Station Address* to 1.

- Select ***Communication>ELC Information***.
    - *The software will attempt to communicate to the ELC.*

- A window similar to the one shown here should appear relatively quickly.
    - *If this window does not appear, check the cable connection and be sure that you have the correct COM port and address chosen under the Options menu. The software should auto-detect the correct electrical settings for ELC communications.*
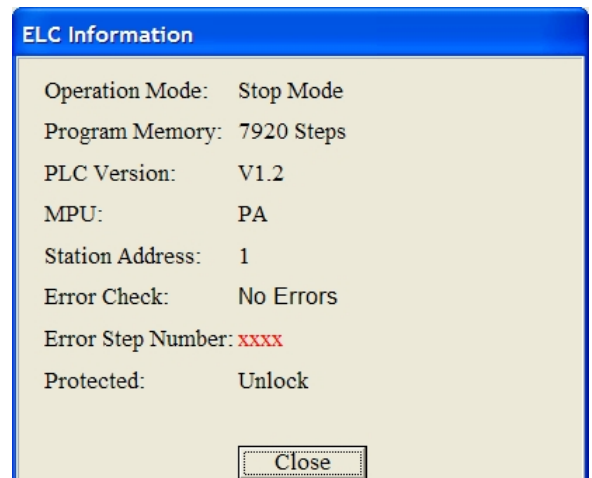
Connecting to the ELC

The Communication menu will be described here because many of the functions selectable in this menu are only available while connected to the ELC.

Communication Menu

TRANSFER SETUP: Opens the window to the right. Used not only to send the currently open project (or a portion of that project) to an ELC or a handheld programmer; but also to upload a project from an ELC that is connected to the PC.

VERIFY WITH ELC: Verifies that the currently open project is the same as the one stored in an ELC that is connected to the PC.

PASSWORD SETTING: Used to set the password in the ELC. The password is required for any communication to the ELC. Once a password is set, the only way to gain access to the ELC memory is to have that password. If you do not have the correct password, you can clear the memory in the ELC to gain access. If you are working with a PB model ELC and have forgotten the password, enter four spaces when requested for the password and a window will appear to confirm that you want to *delete the entire ELC program*. If you are working with a PC, PA or PH, remove the battery for 10 minutes or click **COMMUNICATION>FORMAT ELC MEMORY** to *delete the entire ELC program*. Once the program is deleted, you will have access to the ELC memory.

RUN & **STOP:** Change the run state of the ELC. Note that the current state of the ELC may be changed by the software no matter how the switch on the front of the processor is set.
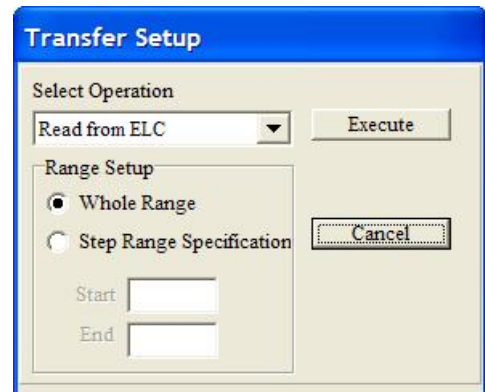
Connecting to the ELC

LADDER START MONITORING: While connected to an ELC, this starts monitoring the current state of the referenced bits in the ladder logic that is open in the software. This means that if the project in the ELC does not match the project currently open in the ELCSoft, it may seem that the software is not working properly. The best practice would be to use the **VERIFY WITH ELC** function first, then **LADDER START MONITORING**.

SFC START MONITORING: While connected to an ELC, this starts monitoring the current state of the referenced programs in the Sequential Function Chart. This is an advanced function that will be covered in future training materials.

DEVICES BATCH MONITORING: Opens a window that allows you to monitor a group of selected references in "spreadsheet" format.

*SET DEVICE ON/OFF: Opens the window to the right. Allows you to set the state of any bit reference.

*ENTER VALUE: Opens the window to the right. Allows value to be entered in a non-binary reference.
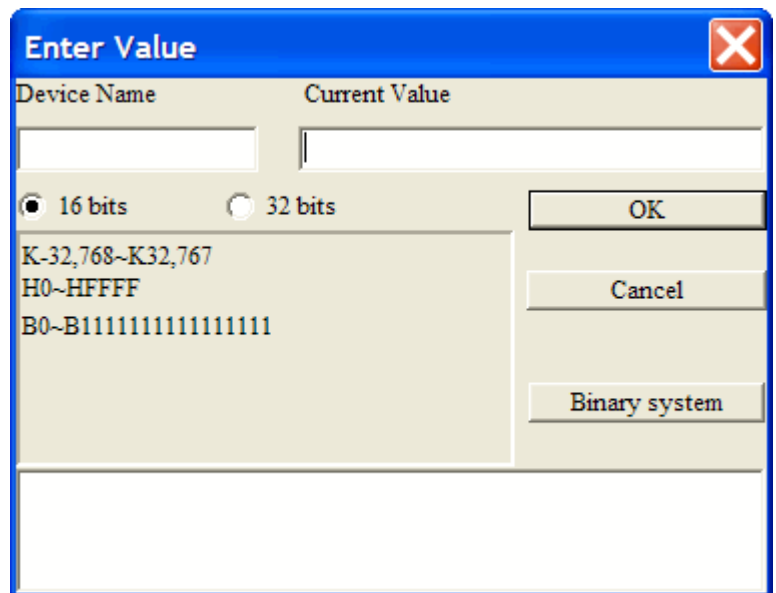
EDIT REGISTER MEMORY: Allows you to change the value of T, C, and D registers in table view format and send the values to the ELC.

EDIT BIT MEMORY: Allows you to change the state of bits in table view format and send the values to the ELC.

FORMAT ELC MEMORY: Gives options for clearing program memory or formatting ELC memory. Formatting ELC memory sets the processor back to factory defaults.

EDIT FILE REGISTER MEMORY:
Allows you to change the value of file registers in table view format and send the values to the ELC.

SEND CHANGES: After making changes to an ELC project, you can send the changes to the ELC without putting the processor into stop mode.

BAUD RATE AUTO-DETECT: Performs a check with the ELC that is connected to the selected port on the PC and pops up a window that gives details about the ELC model the baud rate, data bits, stop bits and parity of the communications that the ELCSoft package uses to communicate to the ELC processor, and the COM port from which the PC is communicating to the processor.

ELC INFORMATION: This calls up the window that you should have seen earlier when you verified communications between the PC and the ELC.

Exercise 1: Ladder Logic Programming

Intro:

Preface

Support Services

Go Chart

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Exercises:

Exercise 1: Ladder Logic

Exercise 2: Logic Instructions

In order to teach the basics of programming with ELCSoft, we will practice with basic ladder functions.

Getting Started

- Choose **FILE>NEW** and give your new project a *Program Title*. Choose the *Type* of ELC Processor you'll use and create a *File Name* under which the project will be saved.

  TIP: If you select **VIEW>WORKSPACE** once you have created the new file, an overview of the project in treeview format will appear on the left of the page. This is a great help in understanding the "big picture" as you program.

  TIP: All Exercises in this Basic Training will take place in *Ladder Diagram Mode*. Any screenshots you see will have that window maximized.
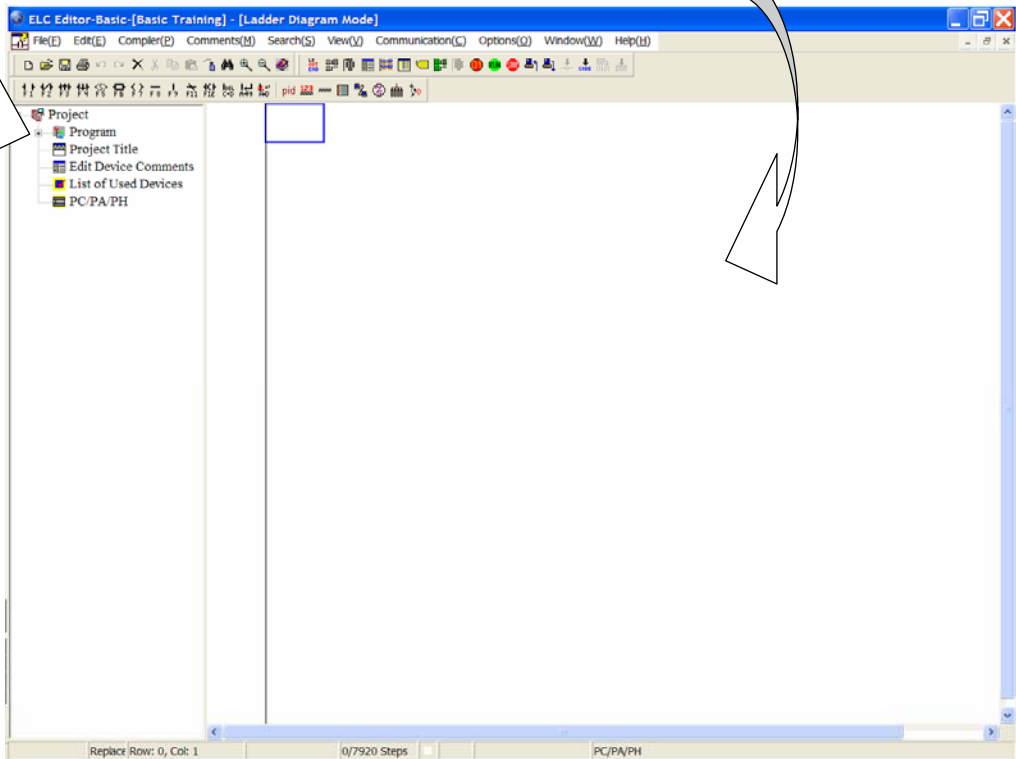
- There are multiple ways to add objects to the ladder diagram. You can click on the desired object in the Ladder Diagram Toolbar (see below); use the function key associated with the desired object; or start entering the instruction code on your keyboard when the *Ladder Diagram Mode* window is selected. To see a list of those instruction codes, select **HELP>ELC INSTRUCTION AND SPECIAL REGISTERS REFERENCE**.
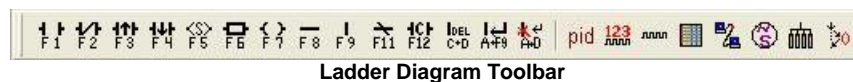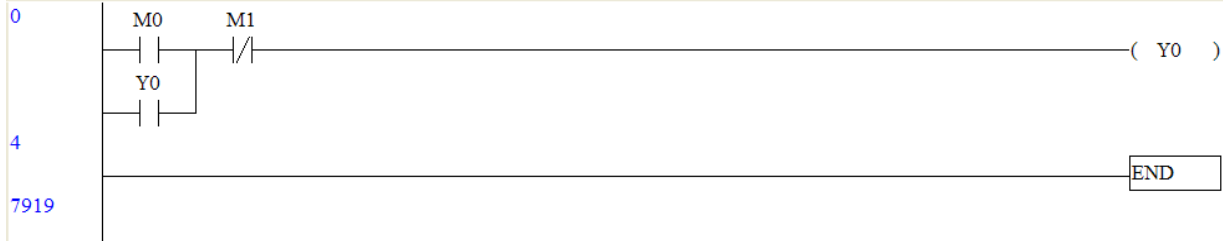

Ladder Diagram Toolbar

Input Instruction Popup Window

Exercise 1: Ladder Logic Programming

The finished result of this exercise will be this ladder running in the ELC:

- Click the icon that represents a normally open contact in the *Ladder Diagram Toolbar* (far left). The window to the right will appear with the type of contact you selected at the top.

- Select "M" from the *Device Name* pull down list. Note that the description of this type of reference changes to "Internal Relay."

- Leave the second window set for 0 and click "OK". A N.O. contact with the reference "M0" will appear in the window.

- Create a normally closed contact that references "M1" in the next available "cell".

- While the next cell is highlighted, press the F7 key on your keyboard. The device input window will appear with "Output coil" as the type of contact. Make this object reference "Y0". Y0 is the first digital output on the processor.

- With the first cell of line 2 highlighted, type *LD Y0* on your keyboard. *Case is not sensitive.* The Input instruction window will appear. "LD" is the command code for a normally open contact. (To see a list of those codes, select **HELP>ELC INSTRUCTION AND SPECIAL REGISTERS REFERENCE**.) "Y0" is the bit that we want to reference. Either click "OK" on that window or just press the enter key. The window will close and the contact will appear in the cell that was highlighted.

- When drawing vertical lines to connect rungs, the line draws from the lower left corner of the selected cell down to the rung below, so you will need to highlight the cell with the normally closed contact that references M1 and then either press F9 on your keyboard or click the vertical line tool on the toolbar.

- Highlight the first cell in the third line of the diagram and type the word *end* and press enter. Choose **COMPILER>LADDER => INSTRUCTION** to compile the project. This will complete your first simple latching circuit program.

- To download the program to the ELC, choose **COMMUNICATION>TRANSFER SETUP**. Be sure that the Selected Operation is "Write to ELC" and that Whole Range is selected in the range setup section. Click "Execute" and the program will be sent to the processor.
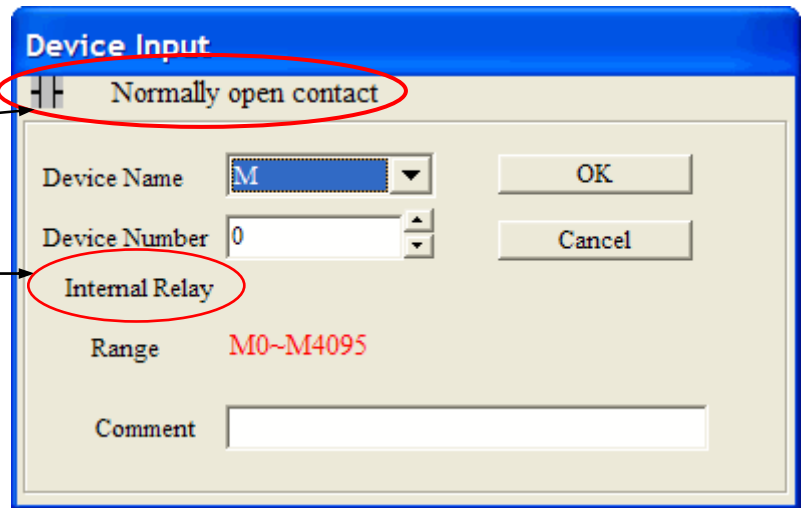
Exercise 1: Ladder Logic Programming

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Now that the program is downloaded…

- To put the ELC in RUN mode, click on the green *RUN* button in the toolbar or choose **COMMUNICATION>RUN** from the menu.

- To monitor the Ladder Logic, click the *Ladder Start Monitoring* button in the toolbar (there are popup tips that tell you what each button does when you mouse over them), or choose **COMMUNICATION>LADDER START MONITORING**.

- Once you are monitoring the ladder, you can select a contact and right click to change its state (see below).
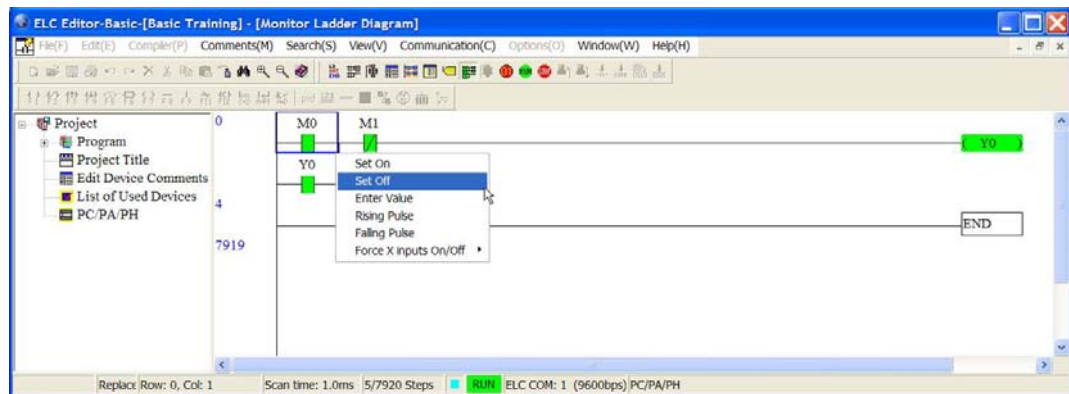
- Note the status line at the bottom of the program that shows the info on current programming mode (*Replace* or *Insert*), selected cell, scan time, number of steps used/total capacity, communication indicator (blinking when comms are present), ELC state, which port you're connected to, baud rate, and ELC processor type.
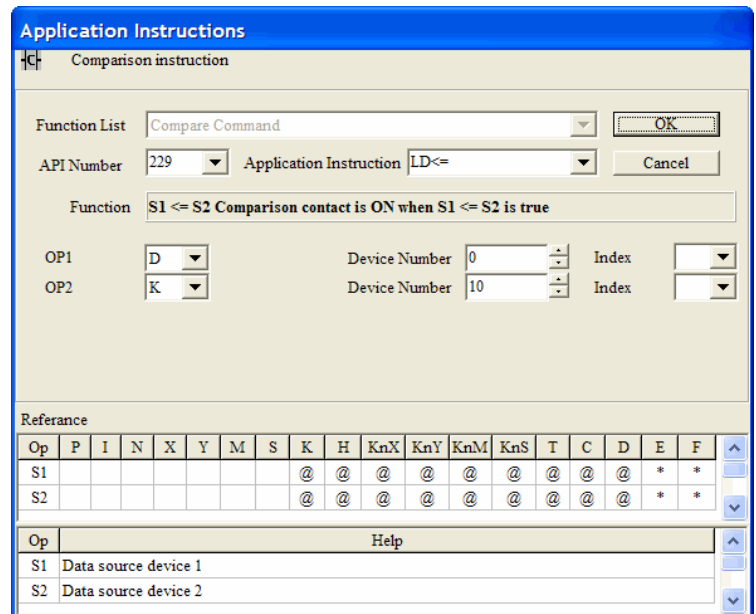
Exercise 2: More Logic Instructions

This exercise covers other basic functions like Set/Reset, MCS/MCR and Compare.

Use case: An injection mold machine has an automatic refiller for the plastic pellet reservoir. At the beginning of the shift, the operator approaches the machine and presses the start button. The filling mechanism automatically keeps the level in the reservoir between 10 and 100 lbs. If the filler is already running, the operator has the opportunity to press a button that engages the filler at a higher speed to fill the reservoir quicker.

- We've already created the cycle start command (M0); an output that will turn on a lamp that indicates the fact that the machine is running (Y0); and an e-stop reference (M1).

- We will be adding 4 rungs in this exercise. To insert rows, right click in the space between the first rung and the end statement and choose *Insert Row*.

TIP: If you can't choose *Insert Row*, you may still be in Ladder Monitoring Mode! You can toggle in and out of this mode by clicking the button in the toolbar.

- Just below the first rung and to the right of the M1 contact, either *type LD<= and click the ellipsis button on the Input Instruction Popup window* or *click the **Application Instruction** tool on the toolbar and choose **LD<=** from the pull down arrow next to **Application Instruction**. The window to the right will appear.

TIP: Get to know this window! The better you understand this window, the easier it will be for you to program your ELC. When you use an advanced function block in ELCSoft, this window is a big help in deciphering how the program works. For each Application Instruction that you choose in this window, there is a specific description of its function in the "Function" window.

- We will be storing the weight of the reservoir in word D0. Since we want the motor on when the weight is at or below 10, we'll set the *OP1* window to **D**, the corresponding *Device Number* to **0**, and leave the *Index* window blank. The *OP2* window will be **K** to represent a constant decimal value, the *Device Number* will be **10** (our minimum) and *Index* will again be blank.

- The output on this rung will be a SET instruction with Y1 as its reference (to turn on the "fill mechanism"). Either type **SET Y0** and press enter, or use the *Application Instruction* window, choose the SET instruction, and enter Y and 1 respectively.

- Repeat the last 3 steps just below the rung you've been working on to create a rung that resets (RST) Y1 when the value of D0 is equal to or greater than 100. These two rungs should look somewhat like this:
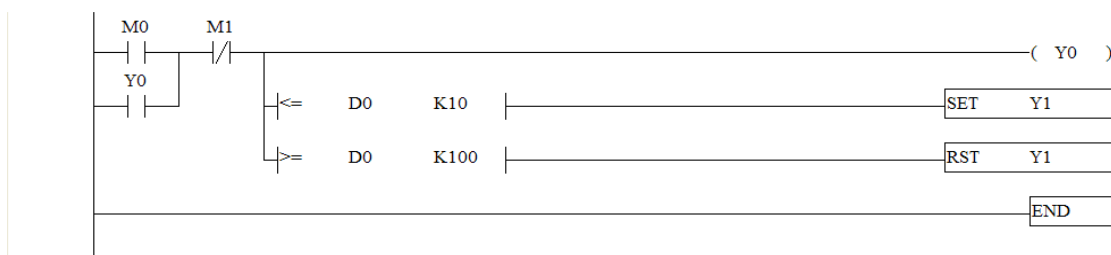
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- We now need to add a (very simple) Master Control Set and Reset to allow the operator (activating bit M2) to speed up the main filler mechanism (M3) when the main filler mechanism is running.

- At the beginning of the next rung, insert a normally open contact that references Y1.

- The output of this rung should be an *Application Instruction* MC with its operator being N0 (N is the layer of what is more or less an extremely basic subroutine that will function when Y1 is active).

- On the next rung, insert a normally open contact that references M2. This is just an internal bit, but in real life, it could be an X ("real world" input) reference. This would simulate the button that the operator can press that engages the filler at a higher speed. The output on this rung is internal bit M3 (the act of the filler engaged at the higher speed).

- On the next rung, there will be only an output that is an *Application Instruction* MCR with its operator being N0 (to complete the MC with operator N0 above).

- When this is complete, you have finished the programming portion of this exercise. Make sure your rungs look like this, then **TRANSFER SETUP** to the ELC.
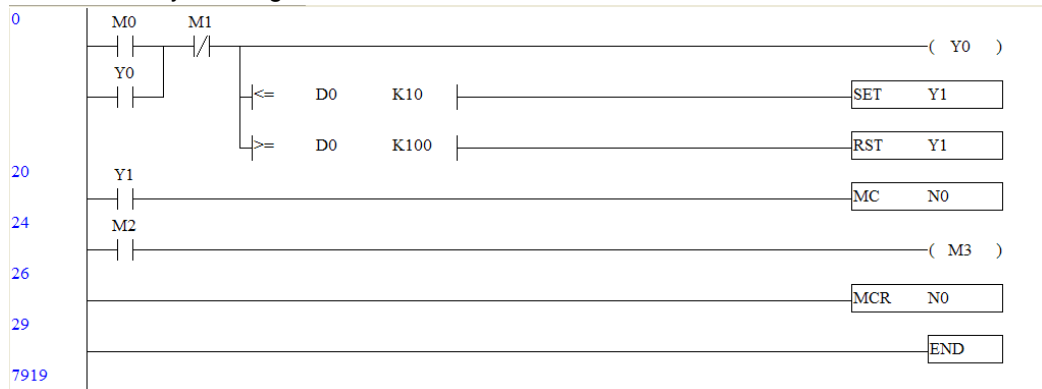
NOTES: When monitoring this program, notice that you can right click on an object with a numeric reference and choose Enter Value. When you do this, the window to the right appears. Enter D0 in *Device Name* and enter K100 or higher in *Current Value* to turn off Y1. Note that the state of Y1 remains the same between 10 and 100 so that the filler either continues to run as the weight rises from 10 to 100 or continues to be off as the weight falls from 100 to 10. When Y1 is on, you can activate M2 and see M3 turn on. If Y1 is not on, there is no way to turn M3 on. If M3 is on when Y1 is triggered off, it will turn off no matter what the state of M2.