
Lab #4: Programmable Logic Controllers (PLCs)

OBJECTIVES:

- Learn about programmable logic controllers and how to create programs for PLCs.
- Get familiar with PLC ladder logic programming methods.
- Use a panel interface with pushbuttons and lights to communicate with the PLC.
- Create basic programs that turn on and off several actuators based on the status of inputs connected to switches.

EQUIPMENT REQUIRED:

- Direct Logic 05 PLC
- PC with DirectSoft 32 software
- OP-406 Indicator Pushbutton Panel
- DC Motor
- 12V Fan
- 2 Switches
- Breadboard
- Digital Multimeter
- DC Power Source
- Miscellaneous wire

PRIOR TO LAB:

1.) Programmable Logic Controller (PLC)

A PLC is a very useful decision-making device in industrial applications. Serial communication is used between a PC and the PLC to download and upload programs to and from each other. A PLC has a built in memory storage device that allows for users to download a program and execute the program independently without having to be connected to the PC. For purposes of this lab, basic PLC programs will be discussed and executed to help students get familiar with ladder logic programming. Ladder logic refers to displaying graphically the layout of the logic between the PLC's inputs and outputs. Examples of ladder logic programming are presented below. Example programs will also be studied and students will recreate and gain experience with the PLC hardware and the programming software. A pushbutton panel will be connected to the DL05 PLC to provide the user with a physical interface with the PLC.

Please study the handouts about PLCs: "Logic Control Systems" before proceeding.

Let's begin with opening the program where the PLC programming takes place. The program is called DSLaunch4 and the desktop icon is shown below for reference.



DSLaunch 4.ink

- a) Open the program and double click on the icon labeled **DirectSoft32 Programming 4** under Applications on the upper left hand side of the window. A new window will open and you may begin your new program. You must make sure to click the icon on the toolbar at the top

of the screen labeled “**Edit Mode On**”. A toolbar will appear at the bottom of the window that allows you to add components to the ladder logic program.

- b) Make sure that you are in **Ladder View** by selecting the View button on the menu toolbar at the top of the window.
- c) You must also connect to the PLC to be able to write your program into it. Do this by clicking on PLC on the menu toolbar and selecting “**Connect to PLC**” from the drop down list.
- d) Your program should be in either Program or Run mode. Set this by clicking on the icon labeled “Mode” that looks like a “traffic light”. You can write your program to the PLC in either mode, however to execute the program, you must be in **Run mode**.

IN THE LAB:

Required Connections

Next, there is a simple example to help you get familiar with the programming language and panel interface. **Be Very Careful when Connecting anything to the PLC!!!!** First, you must connect the commons C0 and C2 of the PLC to ground on a breadboard.

- Connect the normally open, NO, terminal of a switch to input X0.
- Connect the normally closed, NC, terminal of another switch to input X1.
- The common of both switches goes to +12V.
- Connect a small DC Motor from output Y0 to +12V
- Connect a 12Vdc fan from output Y1 to +12V.
- Be sure that the User Interface Panel (Optimate) is connected to the PLC as well.

Note: The Op-406 panel has already been configured to function with the DL05 PLC; however, you must find in the next table and use the corresponding “Cxx” output coil for the lights L1-L6 and push-buttons B1-B4 as indicated in the table below.

The following example programs use a PLC base address of V40600. The table below shows the control relay correlation for an OP-406 panel configured for a PLC base address of V40600.

Device	Lamp/LED On/Off	Lamp/LED Flash	Button Status	Force
B1	C0	C20	C40	C60
B2	C1	C21	C41	C61
B3	C2	C22	C42	C62
B4	C3	C23	C43	C63
L1	C10	C30		
L2	C11	C31		
L3	C12	C32		
L4	C13	C33		
L5	C14	C34		
L6	C15	C35		C75 (F3)
				C76 (F2)
				C77 (F1)

Figure1: Table of C values to corresponding buttons and lamps on Panel

Example Program

To start, don't forget to be in "Edit Mode On". You can write and execute one rung at each time to see what the program is doing. Comments have been included to help you follow along. Another great feature that helps you view what is happening is the "Status" icon. Click on the "Status" icon so that it is pressed and it will highlight the elements in your program that are active. This is very helpful when getting into more complex programs. Also, some examples that show how to turn on a lamp on the panel, blink the light on the panel, and use a pushbutton, are shown below as well.

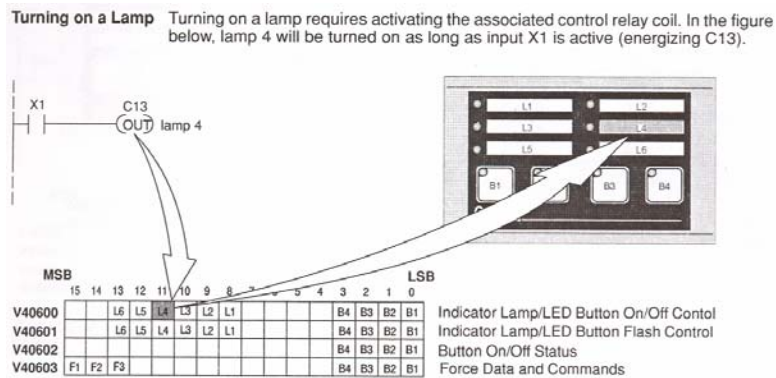


Figure2: Example of turning on a Lamp

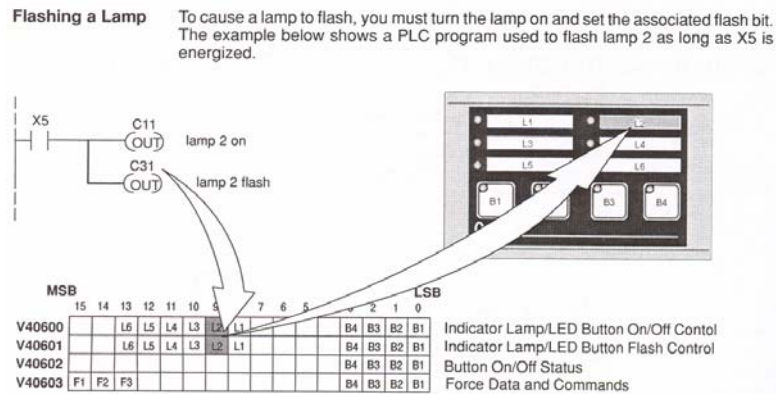


Figure3: Example of blinking a light

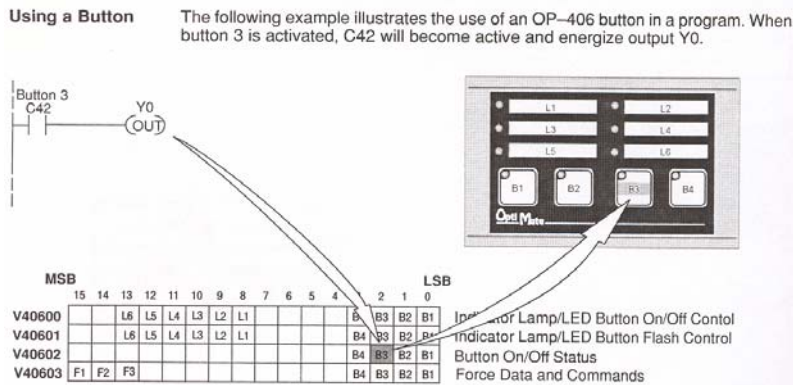
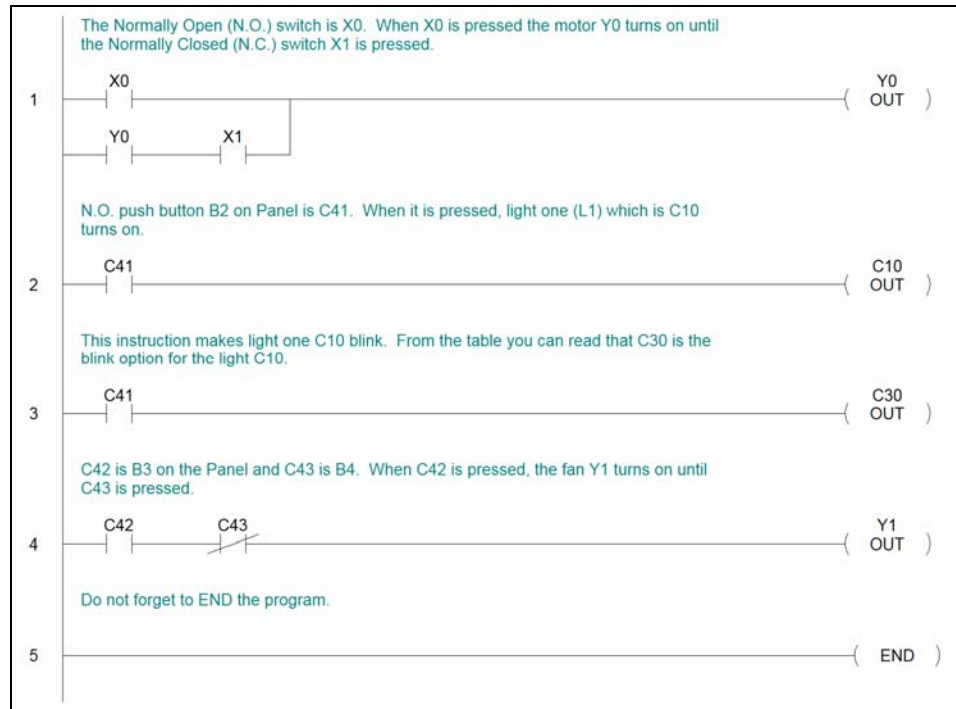


Figure4: Example of how to use a pushbutton on panel

Study in detail, write the following program, and save it. Be sure you understand what each rung is doing.



After making any changes to the program click on **“Accept Changes”** to update the program. Then, click on the “Write P” icon to write the program to the PLC. Make sure you are in Run mode and watch it work. Press the push buttons on the panel and the switches to see what happens. Remember to have the **“Status”** icon pressed. If you have any questions, please feel free to ask your instructor for clarification before you proceed.

1.) Program One

Study in detail, write the following program, and save it. Be sure you understand what each rung is doing.

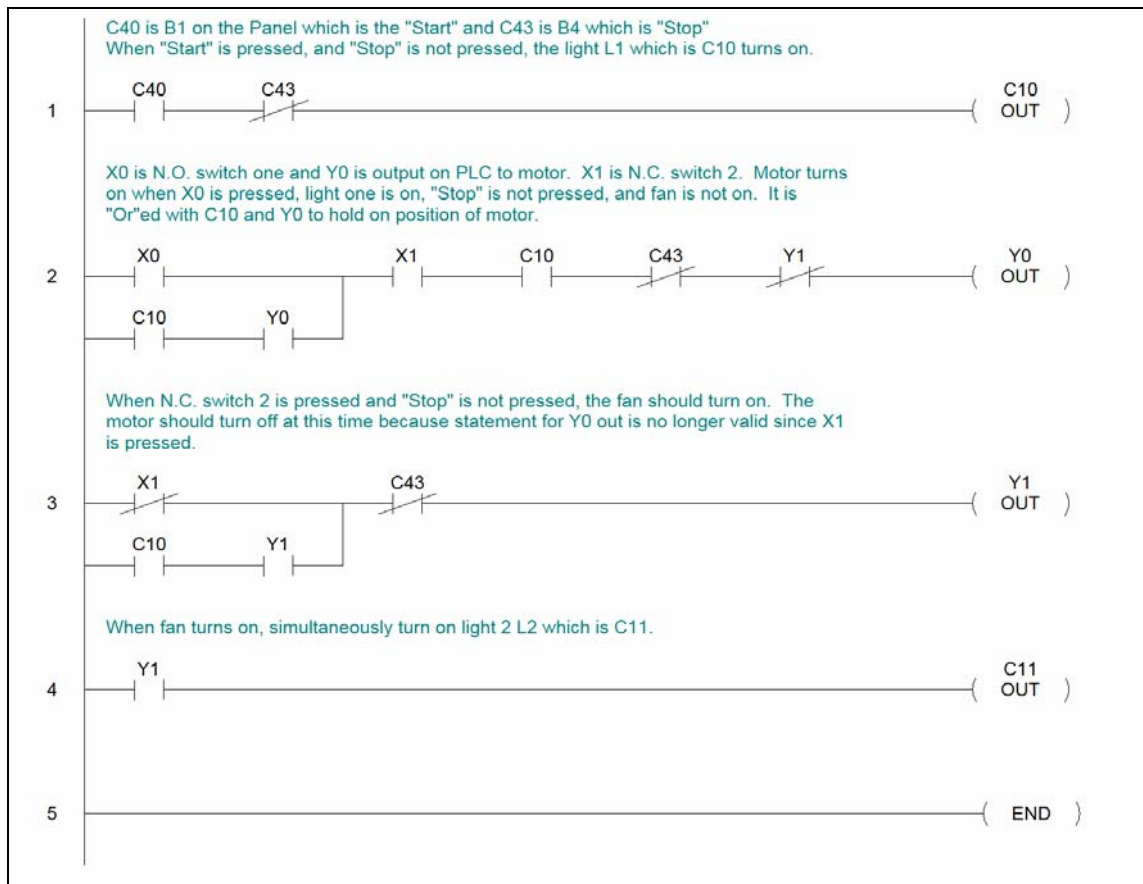
The first program (Program 1) that will be created should function as follows:

- Operator presses the Normally Open (N.O.) push button B1, we will call it the “Start” button, on the Panel.
- “Start” turns light L1 on Panel on (coil C10) .
- Motor connected to Y0 turns on once the normally open switch connected to X1 is pressed.
- When the normally closed switch connected to X2 is pressed, the motor at Y0 turns off and at the same time, the fan at Y1 and the light L2 on panel (coil C11) turns on.
- Operator presses the normally open pushbutton B4, which we call the “Stop” or “Emergency” button, on panel to stop fan and turn off lights. Notice in the program that Button B4 corresponds to coil C43 and it is almost in every rung of the program.

Shown below is the DSLaunch4 program that should execute the given instructions. Recreate this program and make sure you understand all comments. You may include your own comments by clicking on **Tools** on the menu toolbar and selecting **Comment Editor**. This will allow you to write comments for the rung that you have selected. The rows 1,2,3,4,5,etc... as shown are called rungs.

Note: This is not the only way to write the program to perform the indicated instructions. This is simply an example so that you get familiar with ladder programming for PLCs.

Program 1:



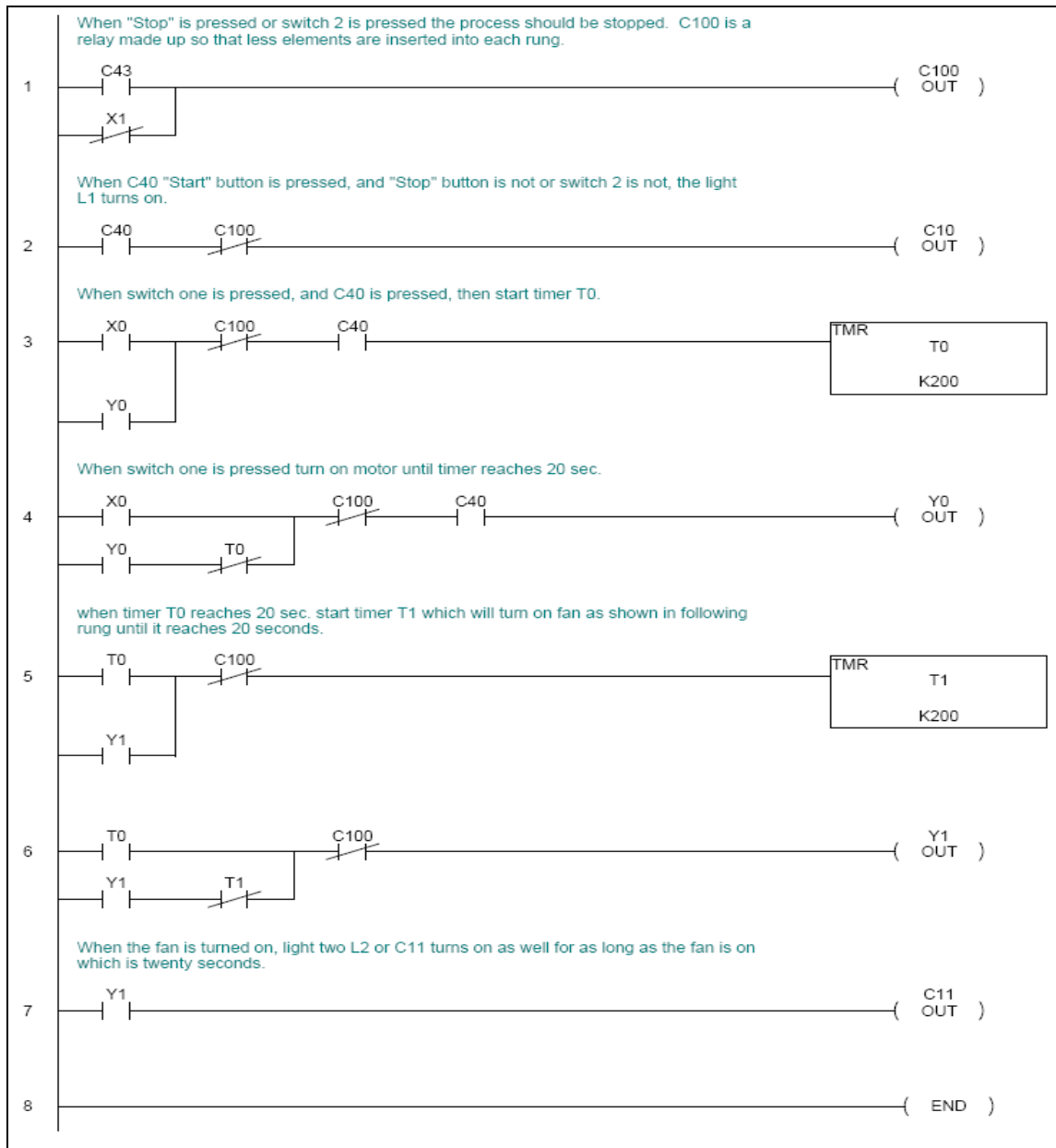
Once your program is complete, you must click on the **"Accept Changes"** icon that appears next to the "Edit Mode On" icon. Then, click on the "Write P" icon to write the program into the PLC. Click on the "Mode" icon and select run mode, then click on the "Status" icon to see the way your program operates. You are now able to execute your program.

2.) Program 2

Study in detail, write the following program, and save it. Be sure you understand what each rung is doing.

The instructions for your second program are as follows:

- Operator presses “Start” push button on Panel and light one (L1) turns on.
- When N.O. switch 1 is pressed:
 - Turn motor on for 20 seconds and then it should turn off.
 - Turn fan on and light 2 on at the same time for 20 seconds.
- At any time N.C. switch 2 or the “Stop” button is pressed, the process stops.



After completion of program, click on **“Accept Changes”**, write the program to PLC by clicking on “Write P”, put program in Run mode, and click on “Status” to see how the program is working.

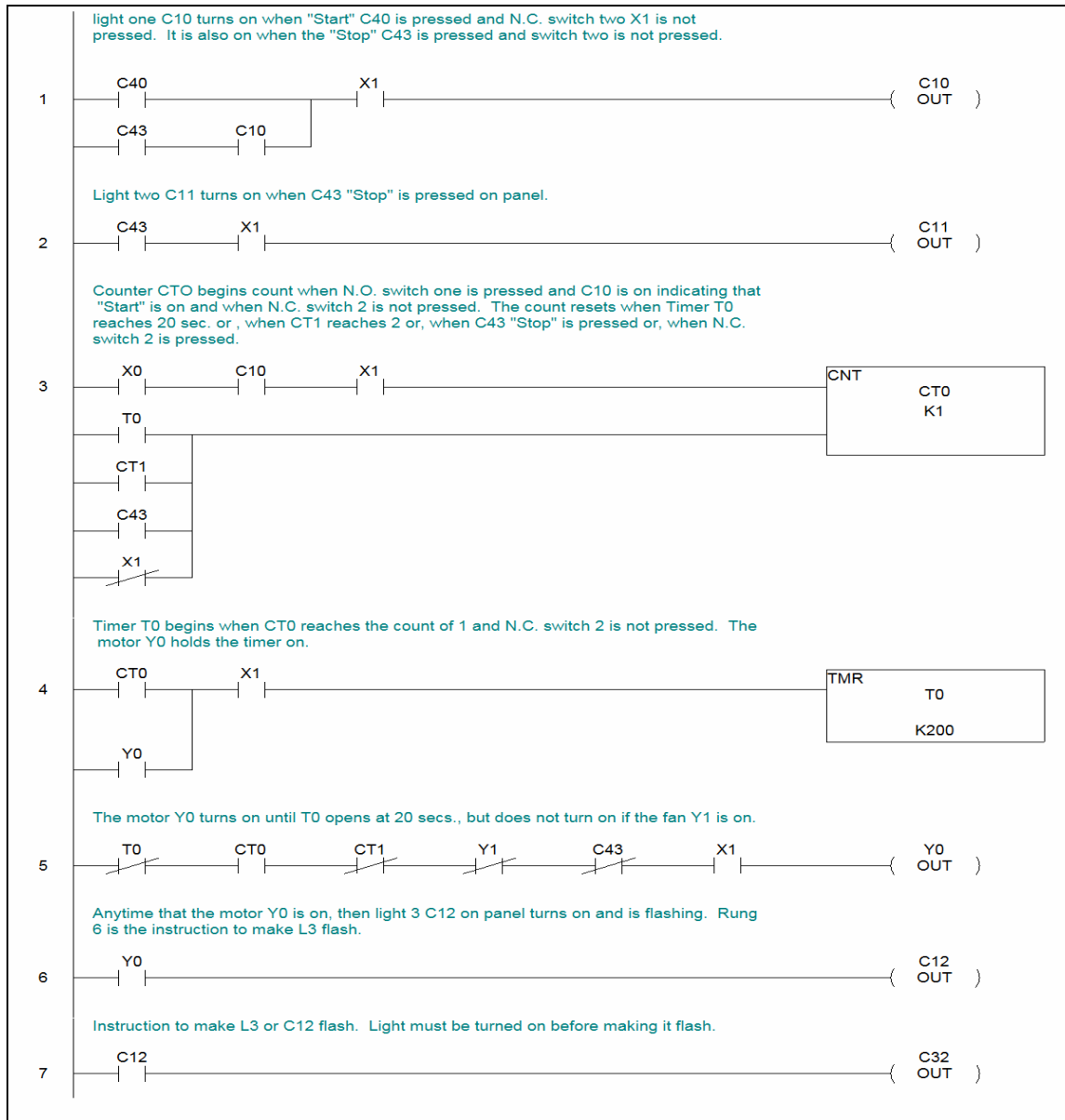
3.) Program 3

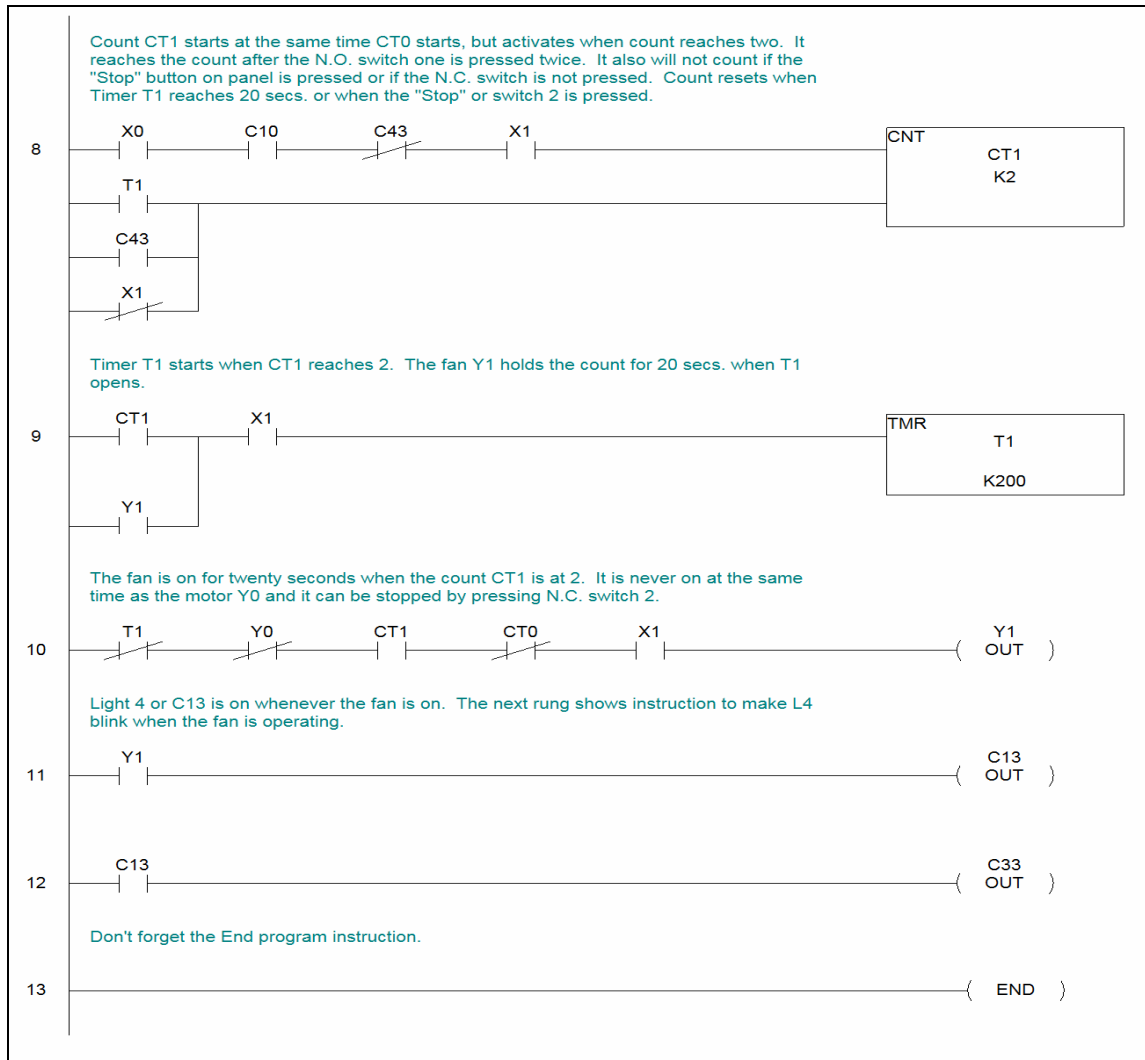
Study in detail, write the following program, and save it. Be sure you understand what each rung is doing.

The instructions for your third program are as follows:

- Operator presses “Start” button on Panel and light one (L1) turns on.
- When N.O. switch one is pressed once, the motor turns on as well as light 3 for twenty seconds. Light 3 should be blinking during this time.
- When N.O. switch one is pressed a second time, the fan turns on as well as light 4, which should be blinking, for 20 seconds. The fan and light 4 should never be on at the same time as the motor and light 3.
- If operator presses “Stop” push button at anytime, the process should stop, light one remains on, and light 2 comes on.
- If operator presses N.C. switch 2 at anytime, the process should stop and no lights should be on.
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Program 3





After completion of the program, accept the changes, write the program to the PLC, click status and set to Run