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MULTI OPERATIONAL FUNCTIONS INTERLOCK SYSTEM USING PLC

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Abstract: The scope of this project is to implement some ideas for Multi operational functions Interlock system based on Programmable Logic Controller (PLC) technology. Industry is having different sections with different machinery process and controlling these all in one loop interlock system , when you turn on that interlock system then only particular operation in the industry will run , if you call that sections we need to use a interlock controller and we have to implement in the PLC Programming and some other cases we need to skip the machinery operations is also very critical to run the machine while using this project we can control the multiple operational system with some Programming interlock system and we have to implement in the PLC Programming For these programming controlling we use CALL function , Jump function , master control relay , Programming interlocks ,if you turn the call function input in the PLC the only particular operations in the Machine will run and in the same way if we use jump function all Machinery will not execute the PLC system

1. INTRODUCTION

1.1 INDUSTRIAL AUTOMATION

Automation is the use of control systems such as computers to control industrial machinery and processes, replacing human operators. In the scope of industrialization, it is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the physical requirements of work, automation greatly reduces the need for human sensory and mental requirements as well.

1.2 ADVANTAGES OF AUTOMATION

The purpose of automation has shifted from increasing productivity and reducing costs, to broader issues, such as increasing quality and flexibility in the manufacturing process.

Automation is now often applied primarily to increase quality in the manufacturing process, where automation can increase quality substantially.

For example, automobile and truck pistons used to be installed into engines manually. This is rapidly being transitioned to automated machine installation, because the error rate for manual instalment was around 1-1.5%, but has been reduced to 0.00001% with automation. Hazardous operations, such as oil refining, the manufacturing of industrial chemicals, and all forms of metal working, were always early contenders for automation.

2. INTRODUCTION TO PLC

2.1 Programmable logic controller

A programmable logic controller (PLC) is a specialized computer used to control machines and process. It uses a programmable memory to store instructions and specific functions that include ON/OFF control, timing, counting, sequencing, arithmetic, and data handling.

The First Programmable Logic Controllers (PLCs)

- PLC was introduced in late 1960's
- The First Commercial and successfully PLC was Design and developed by launched in 1969 by Modicon as relay replacer for general motor
- Earlier it was called acronym PC
- Late 1970's it is greatly controlling device with Microprocessor based equipment to control industrial equipments.
- Developed to offer the same functionality as the existing relay logic systems
- Programmable, reusable and reliable
  - Could withstand a harsh industrial environment
  - They had no hard drive, they had battery backup
  - Could start in seconds
  - Used Ladder Logic for programming.
- Programmable logic controllers are used throughout industry to control and monitor a wide range of machines and other movable components and systems. PLC is used to monitor input signals from a variety of inputs (input sensors) which report events and conditions occurring in a controlled process. Programmable logic controllers are typically found in factory type settings. PLCs are used to control robots, assembly lines and various other applications that require a large amount of data monitoring and control.

3.DELTA PLC INTRODUCTION

3.1 DELTA PLC

DELTA

- Delta is an **THIVAN** Based Company
- The head quarter is in Cambodia
- Delta has established in 1973 as the delta microfinance PLC and all finance of delta PLC is coming from bank of Cambodia
- Delta is now multi branches in Australia and all Asian countries

SERIES OF PLC'S IN DELTA

- **S -Series for low end Type of PLC'S(0-100 I/O'S)**
- **ES2,EA2,EX2 Series PLC's are middle end type of PLC'S(0-1000 I/O'S)**
- **EH EC PM Series PLC's are high End type of PLC'S(>1000 I/O'S)**

Figure: 3.1.1 Series Of PLC's In Delta

ADDRESSING IN DELTA

INPUT ADDRESSING :---
(X0 X1---X7)
(X10 X11--X17) UP TO (X370,X371,X372—X377)
OUTPUT ADDRESSING :---
(Y0 Y1 ---Y7)
(Y10 Y11 ---Y17) UP TO (Y370,Y371---Y377)
MEMORY ADDRESSING :---
M0 M1 M2 M3------M4087
INTEGER ADDRESSING :- D0 D1 D2---D900
CONSTANT VALUE: k0,k1,k2-- -

SHORTCUT KEYS

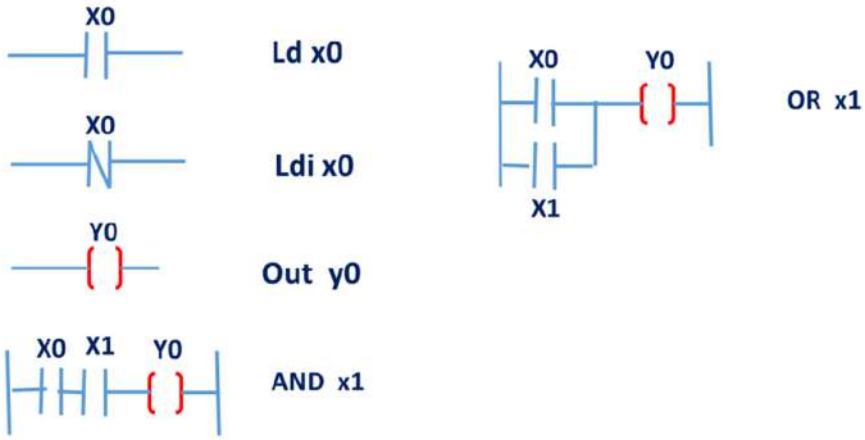
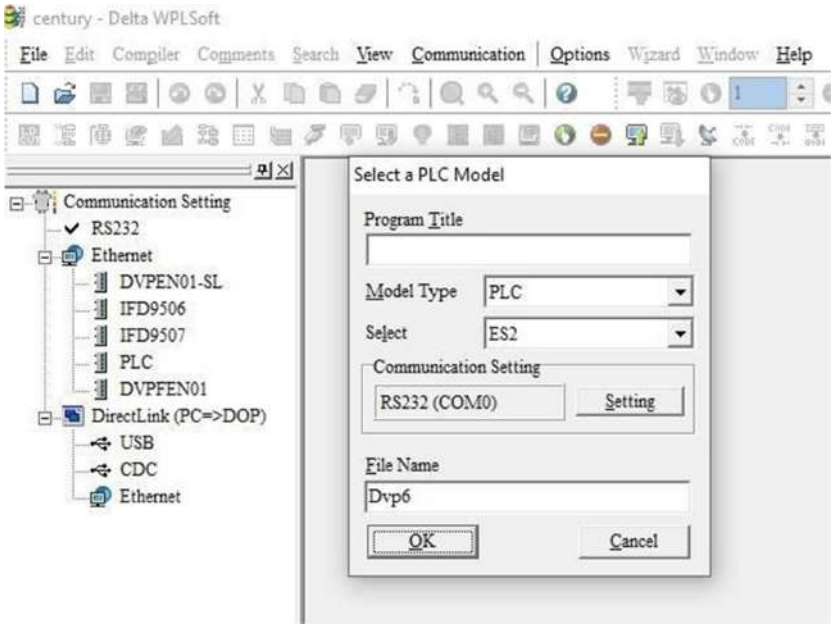


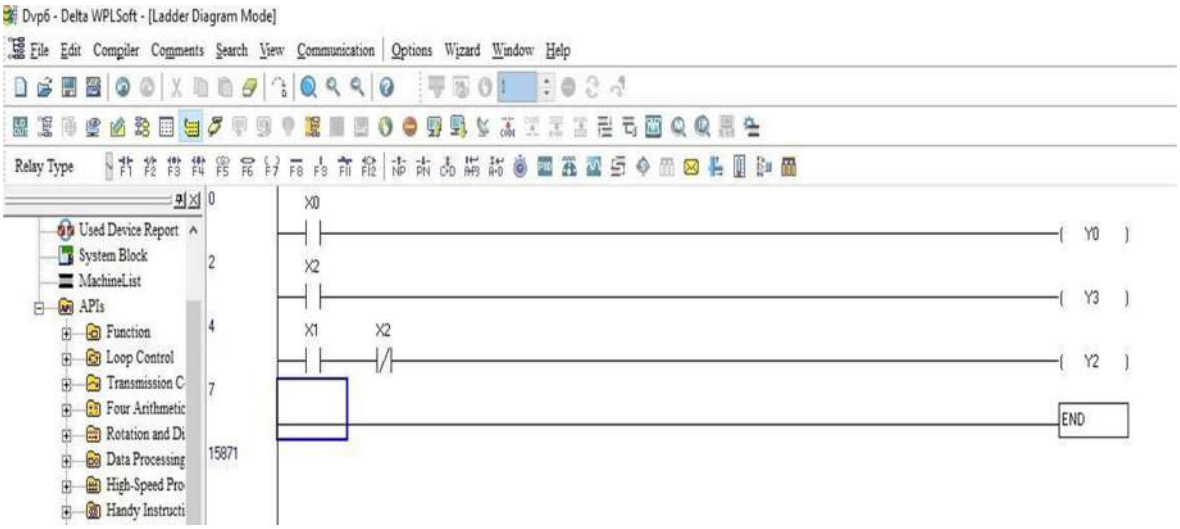
Figure: 3.1.2 Shortcut Keys

3.2 SOFTWARE EXECUTION

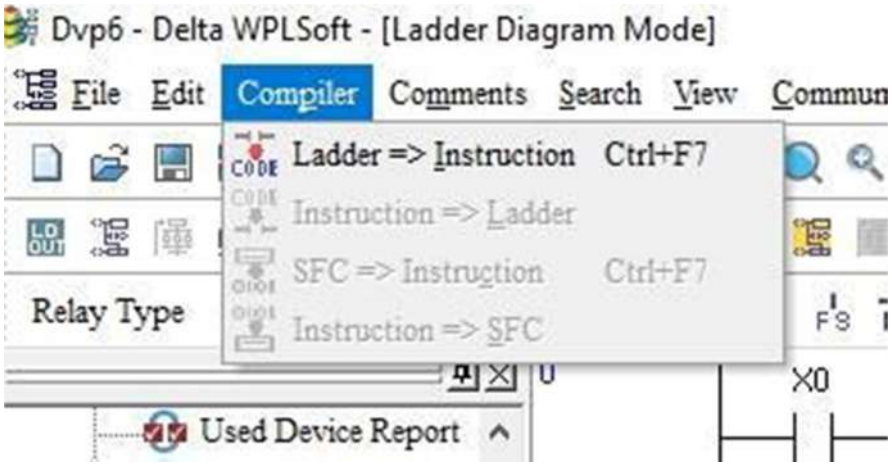
- Open WPL software and go to file option on tool bar and create a new program with ES2 series PLC and assign name for Project



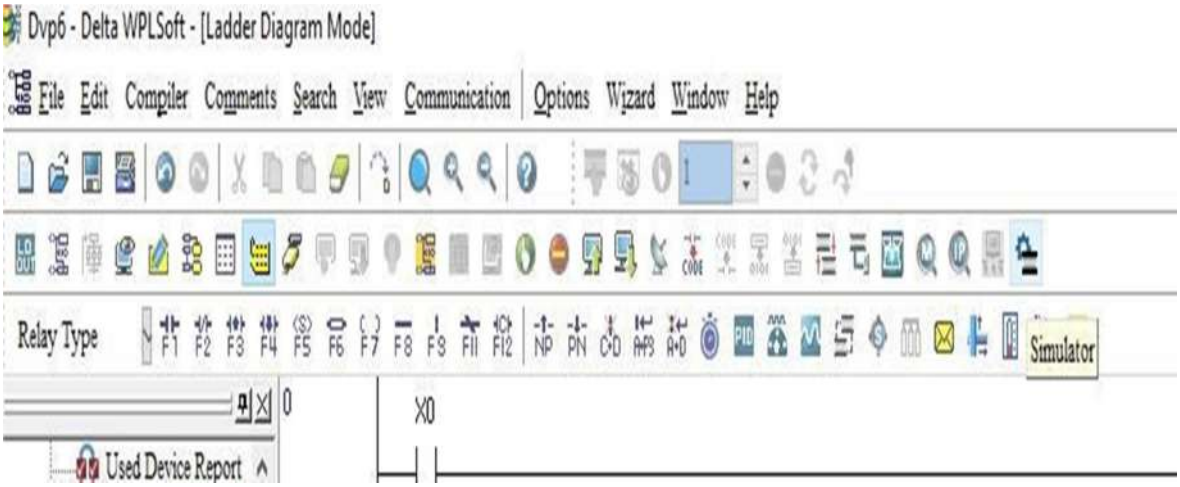
- Write a Program according to instructions



- Go to compiler Option and click on ladder instruction option



- Click on simulator Option



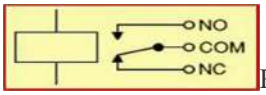
- Click on Online mode and next click on run mode for offline execution not on the kit
- Set on/off inputs and check ur Program

4.RELAY

A relay is an electromagnetic switch operated by a relatively small electric current that can turn on or off a much larger electric current. The heart of a relay is an electromagnet (a coil of wire that becomes a temporary magnet when electricity flows through it). You can think of a relay as a kind of electric lever: switch it on with a tiny current and it switches on ("leverages") another appliance using a much bigger current. Why is that useful? As the name suggests, many sensors are incredibly sensitive pieces of electronic equipment and produce only small electric currents. But often we need them to drive bigger pieces of apparatus that use bigger currents. Relays bridge the gap,

making it possible for small currents to activate larger ones. That means relays can work either as switches (turning things on and off) or as amplifiers (converting small currents into large currents).

What is Relay?



Relay

A relay can be termed as different type of switch which can be operated electrically. Generally, relays are mechanically operated as switch using an electromagnet and these types of relays are termed as solid-state relays. There are various types of relays and are classified based on various criteria such as based on operating voltage, based on operating technology, and so on. Various types of relays can be listed as latching relay, mercury relay, reed relay, Buchholz relay, vacuum relay, solid state relay, and so on. Before discussing in detail about types of relays, let us discuss how relay works.

Relay Working

To discuss about working of relay, we must consider any one type of relay and here in this article, consider solid state relay to easily understand about relay working. Solid state relay can be defined as relay, which utilizes the solid state semiconductor devices for performing switching operation. If we compare electromagnetic relay and solid state relay, then we can observe that the solid state relay offers high power gain. These solid state relays are again classified into various types such as transformer-coupled, photo-coupled, reed relay-coupled solid state relay.

The solid state relay working is similar to electromechanical relay, but the solid state relay doesn't contain any moving parts. Hence, offer increased long term reliability compared to relays with moving contacts. The power MOSFET transistors are used as switching devices in solid state relay working. The electrical isolation between the low power input circuit and the high power output circuit can be provided using an Opto-coupling. Let us consider a practical example of solid state relay as shown in the figure below. If the output switch is opened or MOSFET is off, then it is said to have infinite resistance. Similarly, if the output switch is closed or MOSFET conducts, then it is said to have a very low resistance. We can use these solid state relays for switching both AC and DC currents.

5 INTRODUCTION TO PLC COMPNENTS IN THE PROJECT

5.1 SMPS

Switched Mode Power Supply (SMPS) Like a linear power supply, the switched mode power supply too converts the available unregulated ac or dc input voltage to a regulated dc output voltage. However,in case of SMPS with input supply drawn from the ac mains, the input voltage is first rectified and filtered using a capacitor at the rectifier output. The unregulated dc voltage across the capacitor is then fed to a high frequency dc-to-dc converter.

Most of the dc-to-dc converters used in SMPS circuits have an intermediate high frequency ac conversion stage to facilitate the use of a high frequency transformer for voltage scaling and isolation. In contrast, in linear power supplies with input voltage drawn from ac mains, the mains voltage is first stepped down (and isolated) to the desired magnitude using a mains frequency transformer, followed by rectification and filtering. The high frequency transformer used in a SMPS circuit is much smaller in size and weight compared to the low frequency transformer of the linear power supply circuit. The 'Switched Mode Power Supply' owes its name to the dc-to-dc switching converter for conversion from unregulated dc input voltage to regulated dc output voltage.

The switch employed is turned 'ON' and 'OFF' (referred as switching) at a high frequency. During 'ON' mode the switch is in saturation mode with negligible voltage drop across the collector and emitter terminals of the switch where as in 'OFF' mode the switch is in cut-off mode with negligible current through the collector and emitter terminals. On the contrary the voltage regulating switch, in a linear regulator circuit, always remains in the active region. Details of some popular SMPS circuits, with provisions for incorporating high frequency transformer for voltage scaling and isolation, have been discussed in next few lessons.

In this lesson a simplified schematic switching arrangement is described that omits the transformer action. In fact, there are several other switched mode dc-to-dc converter circuits that do not use a high frequency transformer. In such SMPS circuits the unregulated input dc voltage is fed to a high frequency voltage chopping circuit such that when the chopping circuit (often called dc to dc chopper) is in ON state, the unregulated voltage is applied to the output circuit that includes the load and some filtering circuit.

When the chopper is in OFF state, zero magnitude of voltage is applied to the output side. The ON and OFF durations are suitably controlled such that the average dc voltage applied to
the output circuit equals the desired magnitude of output voltage. The ratio of ON time to cycle time (ON + OFF time) is known as duty ratio of the chopper circuit. A high switching frequency (of the order of 100 KHZ) and a fast control over the duty ratio results in application of the desired mean voltage along with ripple voltage of a very high frequency to the output side, consisting of a low pass filter circuit followed by the load.

The high Version 2 EE IIT, Kharagpur 6 frequency ripple in voltage is effectively filtered using small values of filter capacitors and inductors. A schematic chopper circuit along with the output filter is shown in Fig.21.3. Some other switched mode power supply circuits work in a slightly different manner than the dc-to-dc chopper circuit discussed above. Details of some of these circuits have been discussed in following lessons.

6 PLC WIRING

- Before going to discuss about plc wiring we need to know about the types of inputs
- Types of inputs coming from field/site/ application
    1. Sink (24-)
    2. source (24+)
        a) If 24- signal coming from one device the it consider has a sink signal
        b) If 24 + signal coming from one field device then the signal called source signal
- Usually PLC input voltage either 230V AC or 24 DC
- For 24V DC we use SMPS
- PLC having the option as S/ S means sink /sours
- Suppose if your giving 24+ in S/S the we need to give 24- in the input terminals common
- Suppose if your giving 24- in S/S the we need to give 24+ in the input terminals common
- Types of Outputs coming from PLC also two Types
    1. Transistor (24-)
    2. Relay (24+)
        a) If 24 – signal coming from PLC then it consider has a transistor output
        b) If 24 + output signal coming from PLC then it consider has a Relay output
- In our delta PLC we are using transistor outputs
- Suppose if we are getting 24 – signal coming from PLC the we need to connect 24+ in the common terminals of output devices
- Suppose if we are getting 24 – signal coming from PLC the we need to connect 24+ in the common terminals of output devices

- Out PLC is transistor output that's why we need to use 24+ has common in the output of PLC
- In inputs (buzzer siren ,relay, limit switches ,emergency etc…) of PLC we have given 24- and we need to give 24+ in the S/S terminal of PLC
- Base these signals coming from PLC then it will turn off and protect the devices from the critical situations coming from the site

6.1 PLC WIRING DIAGRAM FOR THE PROJECT

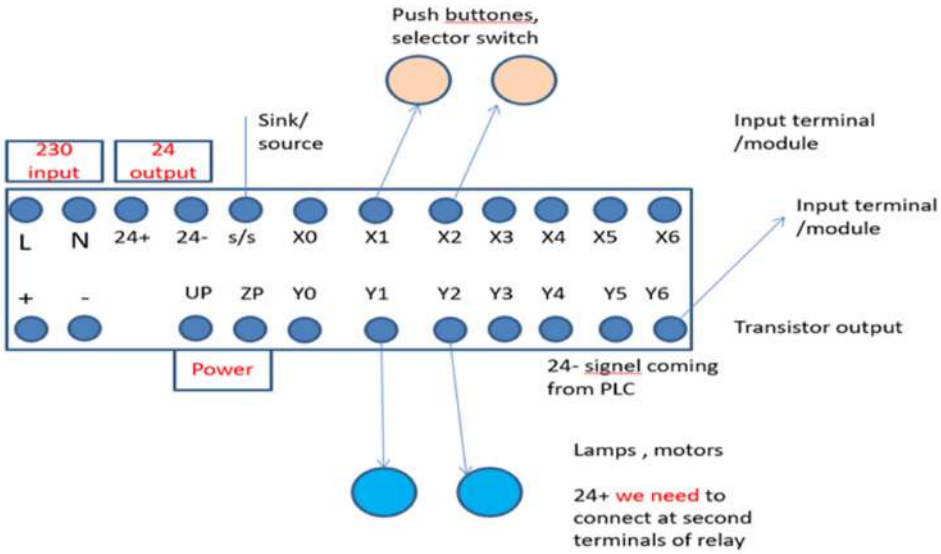


Figure: 6.1.1PLC Project circuit diagram

6.2 PLC software operations

- In this project we are using delta plc and we use software has WPL software
- Emergency is having behind NC contact that we need to connect with PLC as input
- Limit switch is having NC and NO contact that we have to connect either the PLC and it has inputs to PLC
- Siren is having supply and one coil feed back and it has inputs to the PLC
- 2 change over relay is also having relay feedback to the PLC
- Area sensor or any sensing object has inputs to the PLC
- When tank reach to high level it will give signal to the plc and it has input to the plc
- All feed back from all above has input tot the plc and we can do the program in the plc and we can turn off the output procedure based on the condition from field

CONNECTION PROCEDURE:

- Open device manger and check the port number [Comp 8]
- Open WPL Software
    1. Open options on tools pad
    2. Next, communication setting
    3. Assign same comport number [Comp 8]
    4. Open communication option on tools bar
    5. Communication transfer setup
        - [PC => PLC]
        - [PC <= PLC]
    6. Click on ONLINE mode

6.3 Project Program

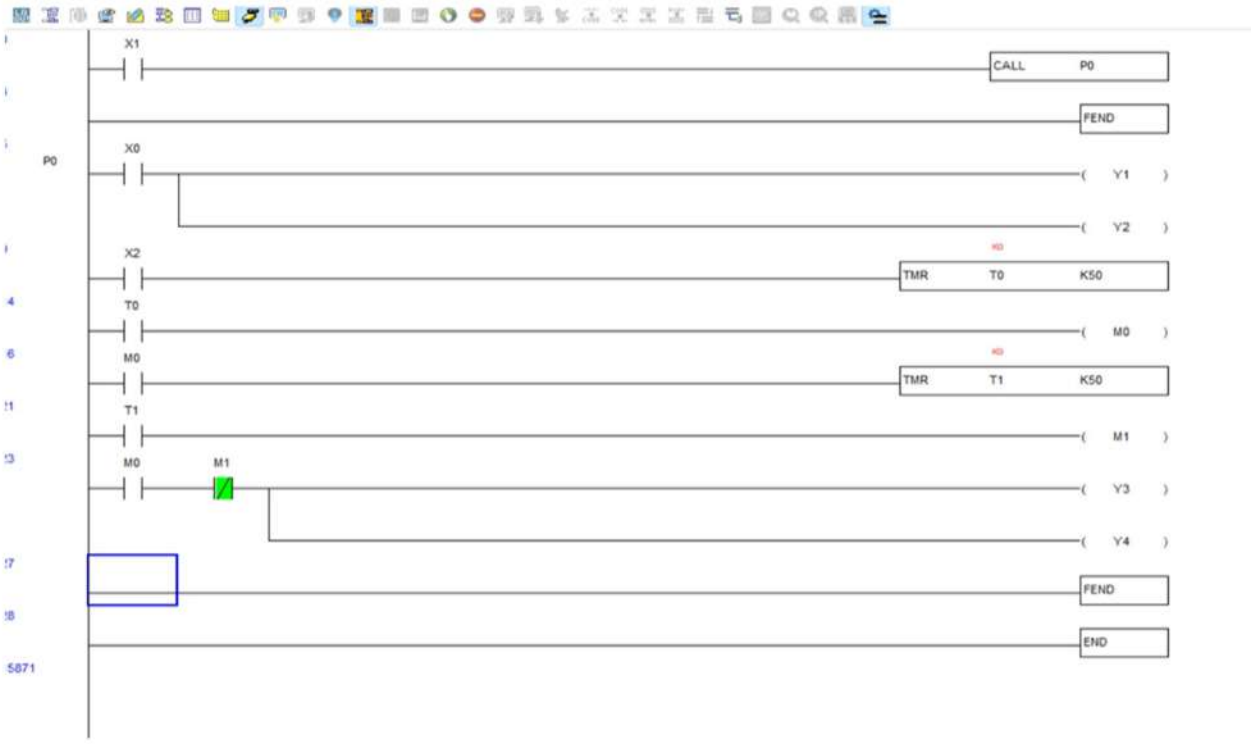


Figure: 6.3.1 Program

- X0 Sensor ON After 5 Seconds, Y0 ON
- After 5 Secs Y1 ON and Y0 OFF
- Repeat this process
- When M0 ON and OFF Count will Increase
- Count Reach to 3 Y2 ON
- Count Reach to 5 Y3 ON and Y2 OFF
- When X2, X3, X4, X5 ON all Process is Going to Trip

All inputs signals of emergency, limit switch , proximity sensor , buzzer , siren a we need to assign in ladder logic diagram as off conditions to thee outputs of field

7. CONCLUSION

The development and implementation of the multi-operation interlock system using PLC technology have been successfully achieved. The primary objective of this project was to design a robust and efficient system that ensures safe and controlled operation in a multi process industrial environment. Through the utilization of Programmable Logic Controllers (PLCs), various sensors, actuators, and interlocking logic, we have created a comprehensive system capable of managing multiple operations concurrently while prioritizing safety and preventing hazardous conditions. The multi-operation interlock system using PLC technology represents a significant advancement in industrial automation, offering a reliable solution for managing complex operations while prioritizing safety and efficiency. The successful completion of this project underscores the potential of PLCs in enhancing industrial processes and underscores the importance of thorough design, testing, and implementation methodologies in ensuring system reliability and effectiveness. Moving forward, further enhancements and refinements can be explored to continually improve system performance and address emerging industrial challenges.

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