

PLC Based Motor Coil Winding Measurement

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ABSTRACT

Using PLC we can measure the coil windings for the motor. In which the PLC is used to give the command for the desired winding count. Coil winding is the difficult part of the motor when it gets affected and to repair that the count of the coil windings plays an important role. To Solve that solve that problem, PLC are used which will take the wing counts and then it will start the motor and when it will reach to that desired winding count it will stop. With that its used to find or calculate the RPM of motor also.

INTRODUCTION

PLC technology are most essential part of the Industrial Automation. As there are motor which are used for the various purpose in the industry or in work such as (EV) electrical cars or bikes. So motor is important factor to maintain in the cars or in bikes. If that motor get busted or get damaged. Basically the winding get affected of that motor. We need to change the windings or the reassemble the winding. In that the winding count plays an important role. In this We are using PLC to count that winding from the desired winding input. So the winding count or the measurement becomes easy to implement. PLC technology are getting new developments in the Industrial Automation [1]. For this purpose we using the ladder programming. Motor coil are hard to replace and we need to count that coil for the armature winding. To make it easier PLC is implemented with the proxy sensor.

PLC is the platform of Industrial Automation in which the Input Module need Digital data only. PLC is the gamechanger in the Industrial automation but it can't take the Analog data as input that the only drawback of PLC. In the Modern Era the PLC has the wide range of the flow in the technology where the most of the thing can be automated from By the PLC. Through PLC we can achieve the highly Stable Industrial Automation. There are wide uses of PLC in the industry where it is also used in the Robotics as a controller.

PLC are implementing new way of Automation in the industry. PLC has a ability to handle more number of inputs and outputs than a normal microcontroller.

LITERATURE REVIEW

Objective

This project is based on the measuring the coil winding of the motor to replace it or to repair it. This project involves the PLC as the main controller and Proxy sensor to determine the rounds or the counts which has been completed by the motor.

PLC has the input parameters as the input of proxy sensor and input if motor function also. While performing the operation the input is taken by the Proxy sensor and it is than counted in the counter of PLC.

PLC has to take a input form the Sensor and the counter will count the input function which will given by the Proxy sensor. Before that we need to provide the desired winding count in the counter so that the when it will reach to that desired winding count the motor will stop to rotate.

The main objective of this project is to coil winding count easier. By using PLC we can make it more easier than manual counts.

For this Programming we are using Ladder programming.

Ststem Development

To Implement this System the there are parameters:

A. *Motor Control through the PLC Platform*

The control of motor is based on the input desired winding counts. When it will reach to that winding count the motor get the signal to stop the motor.

The motor will start when the desired input winding counts are given as the motor starts while the sensor will count the rounds or the rotation of the motor, based on that when it will reach to that desired winding count motor will stop.

The motor can be either controlled by the sensor or from the switch also. In some cases where we need to stop the motor for the emergency condition. In that case we need a switch to stop the motor at that position.

The Diagram is below in fig.1.

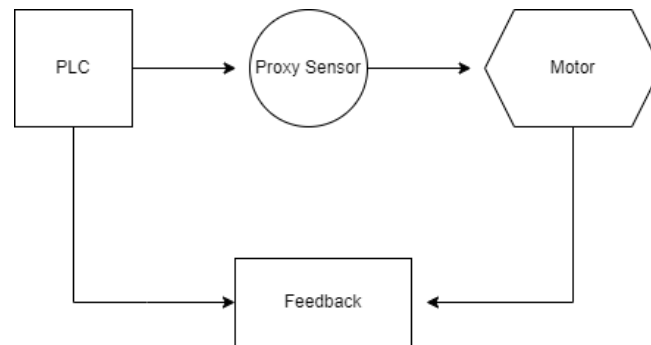


Figure 1. Motor Control through the PLC Platform

B. PLC platform

The main controller for this project is PLC (programmable Logic Controller). For this Project MicroLogic1400 PLC is used. The PLC has inbuilt ADC (Analog to digital converter) which convert the analog input into digital input and in the output side there is DAC (digital to Analog converter) which convert the digital input which is given from processor and convert it into Analog output as per the requirement.



Figure 2. PLC Platform

The components of the PLC platforms:

□ Input devices:

In the PLC platform the different types of input devices are connected such as Sensor, push button, normal switch, limit switch and selector Switch.

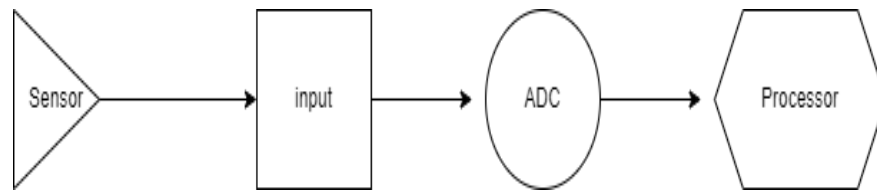


Figure 3. Input devices

□ *PLC power:*

The main power supply of is either AC or DC power supply. There is rectifier in the Ac converter to convert ac supply in dc supply. In Dc converter there is current limiting resistor. So that the their should be no damage to the processor.

• *AC supply module:*

It has Rectifier to convert Ac supply into Dc supply. with that there is optoisolator which is used to prevent the damage to process from the voltage.

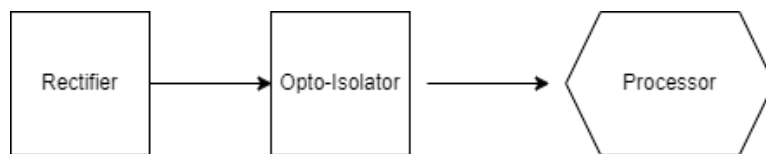


Figure 4. Supply Module

DC Supply Module:

It has current limiting resistor and Optoisolator to prevent the damage to processor from the voltage from the source.

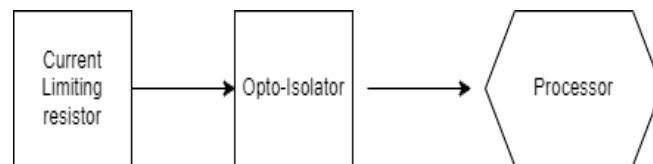


Figure 5. DC Supply Module

□ *Programming the PLC*

For the programming of the PLC I have used Ladder programming. Which is the most efficient one and simple to understand. In ladder programming there are basically NC and NO switches which are used to provide the input to the Processor. Output devices can be Motor, Solenoid, Contactors and alarms. Based on the requirement of the user they can put any thing

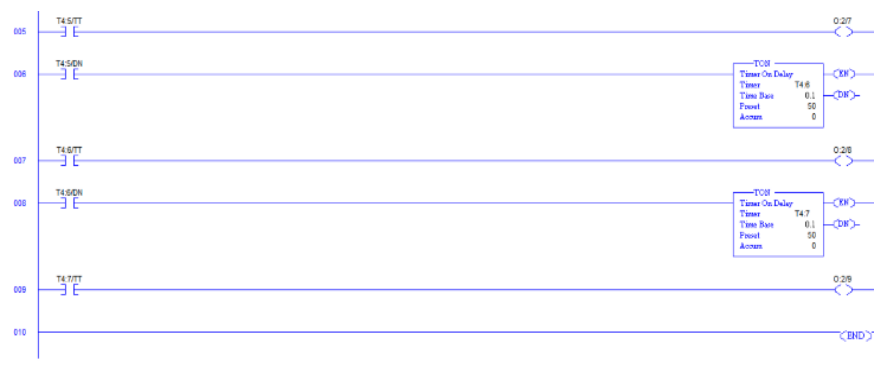


Figure 6. Programming the PLC

□ *Output Devices:*

As the motor is the Output Device in this project, motor is connected to the output module of the PLC. Which the function of DAC it converts the digital signal which is coming from processor and converts it into Analog signal.

It has Two types of output Devices. Based on the Supply voltage it can be either AC or DC.

DC output Wiring:

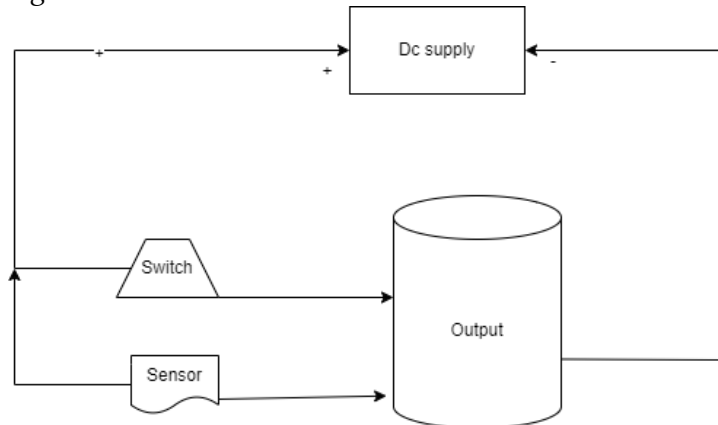


Figure 7. DC output Wiring

□ *Ac output wiring:*

In Ac Output wiring the same Connection is used and the wiring is also same. The main change is in the supply voltage in this case.

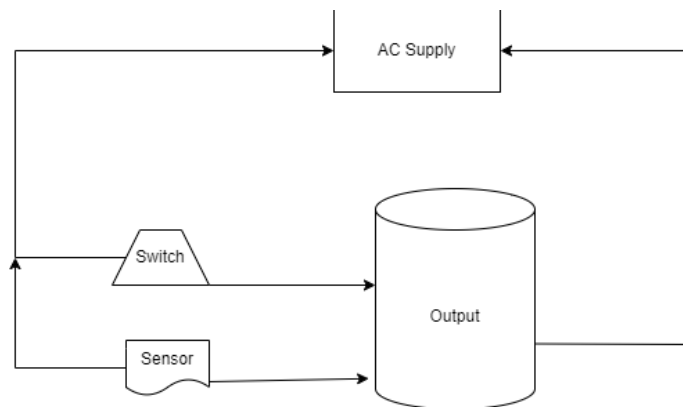


Figure 8. Ac output wiring

□ *Motor And Feedback Unit:*

a. *Motor:*

A 12 volt Dc motor is used in this project. And the feedback is provided through the Proxy sensor. If it reaches to the desired Winding count then the feedback will send to the controller and the PLC will stop the motor.

In case the motor is not stopped then there is switch, which is used to turn off the motor in an any accident condition or to manually stop the motor.

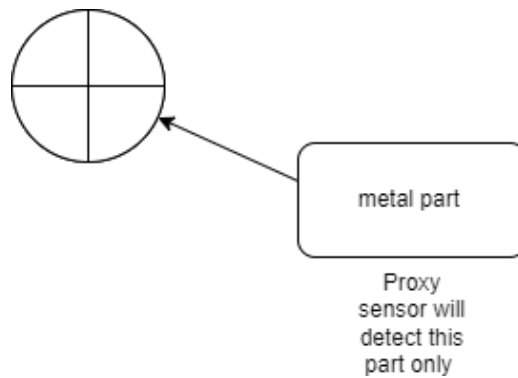


Figure 9. Motor

□ Proxy Sensor:

It is used to detect the rotation of the Motor. Basically it will detect the metal part while the motor is rotating.

When there will no metal part then it will not detect then rotation or the part. M18 Inductive Proximity Sensor with 3 wire is used in this project its model number is: N8GS1.

It is used to measure the high speed metal detection. For this project this sensor is a perfect fit. For some cases they want to count the winding counts very fast so they will increase the RPM of motor, so to overcome this problem a high speed proxy sensor is necessary.



Figure 10. Proxy Sensor

□ Feedback Mechanism:

The rotation of motor is sensed by the proxy sensor which is mounted in front of motor. When it will detect the metal it will send the pulses to the counter. Then the counter will count those pulses and when it will reach to Desired or the given winding count the counter will high its Done bit so that the motor will stop rotating in fig 11.

In the Counter there are two outputs in fig.12:

- counting bit (CU) : which become high when the counter is counting manually by the switch or by the sensor
- Done bit (DN) : it will become high when the counter will complete its counting to the desired preset value or the given value.

As the counter plays an Important role in the counting of the coil winding count, its main function which will provide the feedback to the motor that the desired winding counts are completed.

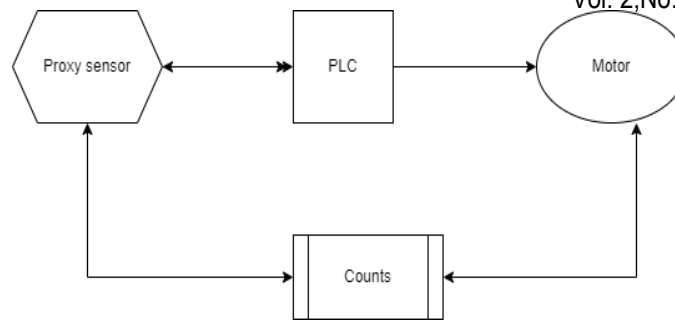


Figure 11. Feedback Mechanism

There are two different types of Counters used in the PLC:

- CTU: counter up means when the preset value is provide then then the input switch or the sensor will provide the counts. As the sensor will detect the the metal it will increment the value of accumulator. At a certain count the accumulator value is equal to the preset value then the (DN) done bit will high. The CTU counter is displayed in fig.12.
- CTD: counter down which is used for the counting only but in this counter the accumulator value and the preset value are same for the initial stage. So basically this counter counts the value in the reverse order. But there is drawback that it started as accumulator==preset but when it reaches to zero it goes into the negative values like (-1,-2,-3,-4) etc. that the reason this counter is not used in the Industrial automation. Only the CTU or the counter up is used. In this project the up counter is used only. The down counter is displayed in fig.13.

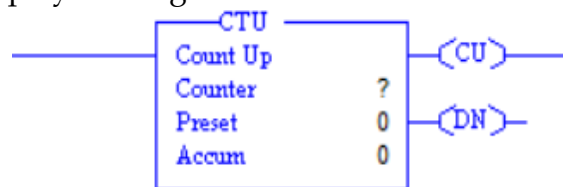


Figure 12. CTU

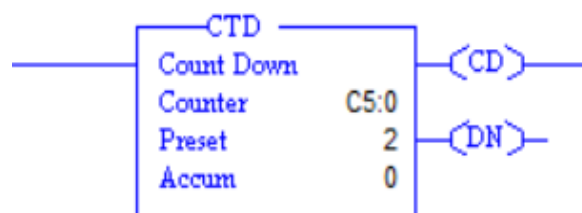


Figure 13. CTD

In this project the input for the desired Coil winding or the user input coil winding is provided in the counter itself only. Thus the values is provided in the preset so that the accumulator can start from the zero to the preset value.

Block Diagram:

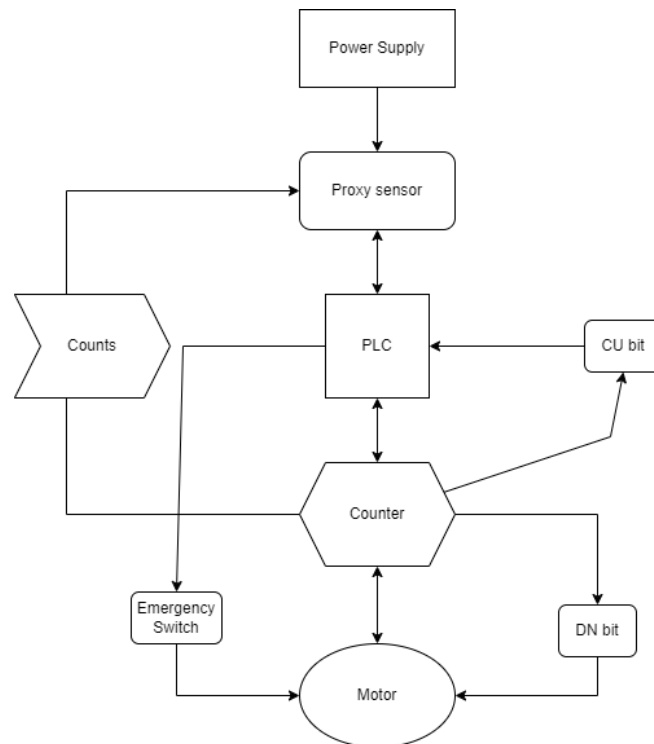


Figure 14. Block Diagram

As mentioned in the above fig.14. this is the complete process of this project. In the given system there is one switch which is used in the emergency purpose to stop the motor.

□ *Working Mechanism:*

- a) The first thing to do in the project is the source voltage. Which will be either Ac or Dc based on the user input.
- b) After completing the source voltage now the proxy sensor has to implement in front of the motor at the specific distance. To measure the rounds or the counts which the motor is taking. As the sensor will start counting the value of accumulator will increase from 0 to the preset value. The main function of the Proxy sensor is to detect the rounds of the motor to get the proper coil winding measurement. As the input is sensor so the count value should be accurate so that the user doesn't require to the counts once again. To ensure the accuracy the high speed proxy sensor is used to measure the rounds or the counts of the motor.

In the above mentioned figure.15 the detailed view of the sensor input attached with the counter is given in the Ladder programming.

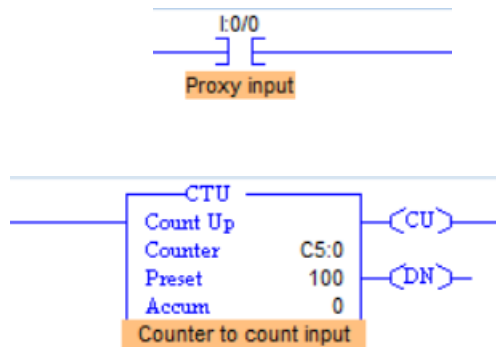


Figure 15. Proxi Input and Counter to Count Input

From the counter the the enable bit will be hidgh fromm that bit will get to know how amny rounds or the has completed or are going on. This is the manual process if you want to see the exact count then the it is visible in the counter accumulator value.

In fig.15 the preset value is 100 and accumulator value is zero(0) when the sensor will start sensing the metal from the rotaing plate of the motor the accumulator value will start increasing or incrementing by one. The main function of the counter that it counts the valur manually means when the switch will high or the sensor will detect the metal then only the counter will start counting and then I will start incrementing the value of accumulator.

After certain counts or the rotations the (DN) bit will high so it will confirm that the counts has reched to the desired counts or to the given counts.

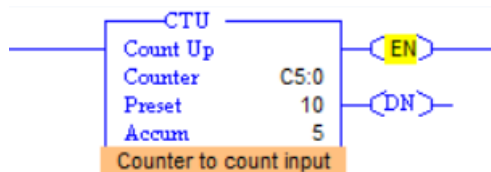


Fig .16 Counter to Count Input (EN, DN)

In the above fig.16 as you can see that the accumulator value is 5 and the preset value is 10 so the (DN) done bit is low or 0.

But the (EN) enable bit or the counting bit is high. It means that the sensor is counting the input form the surrounding. The input is prosy sensor so the proxy sensor is detecting the metal from the rotating motor.

When the accumulator== preset then the (DN) done bit will high.

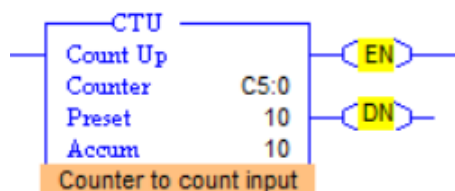


Figure 17. CTU (EN, DN)

In the above fig.17 it is visible that the (Dn) done bit is high when the accumulator==preset is true.

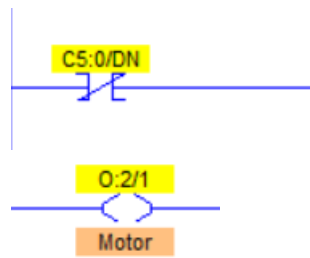


Figure 18. Motor

As displayed in the Figure.18 the NC switch is used to turn off the motor. When the (dn) done bit is high the NC (normally closed) switch will convert it into low (0). so the motor will stop rotating.

To reset the counter accumulator value it required an extra switch to make the accumulator value as zero (0). When the counts are completed and its time for the next count so for that the accumulator value should be zero. To make it zero the reset (RES) function is used with a switch attached with it.

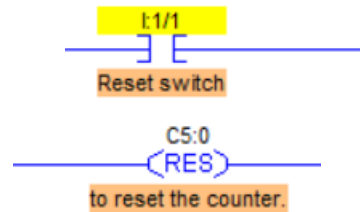


Figure 19. Reset Switch and To Reset the Counter

In the above Figure.19 the connection of the reset switch is given. So that the counter or the accumulator value will be get reset.

As the complete logic is designed in the ladder programming the it displays all the things in form of switch and the output.

The main function of the reset switch is to reset the accumulator value for the next coil winding measurement. to get the desired count of the coil to make the motor functioning the value of the counter must get resetted from that seich when the first counts is completed.

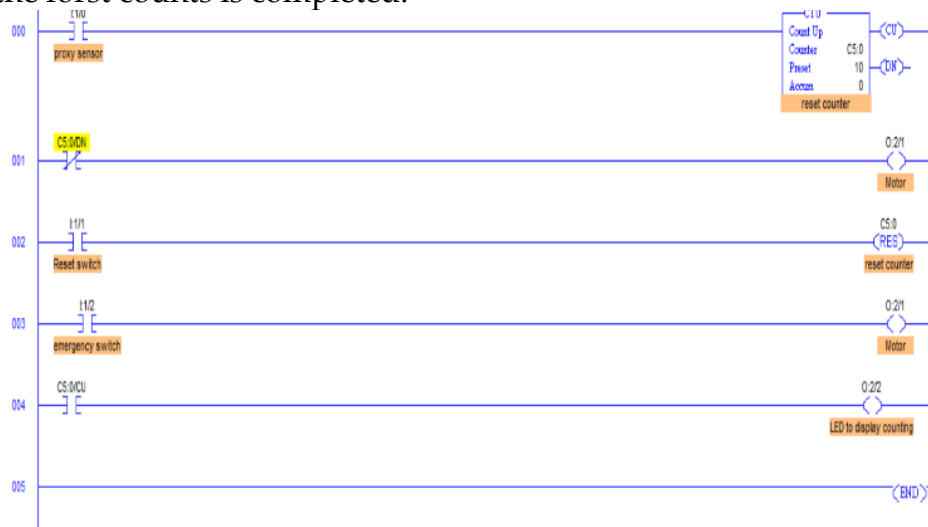


Figure 20. Complete Program

In the above figure.20 the complete code of the pfoject is provided. In this there are emergency stop switch which is atatched to rung:0003 it is used to stop the motor in the emergency purpose. In Rung:0004 there is switch which ha sthe address of the (cu) countinf bit of the counter and it is atatched to a

led indicator. Which will provide the counting of the rotationg by making the LED as high and low as the Led will turn on and off by the sensor will sense the metal from the rotation. This is just t indicate that the sensor is sensing the metal and the counter is counting the counts.

As the input sensor will sense the metal from *the rotation when it will reacht to a desired count the done bit will geyt high and the motor will get a signal to stop rotating.*

METHODOLOGY

The system design involves using several key components: a Programmable Logic Controller (PLC), a proxy sensor, a motor, a counter module, and an emergency stop switch. The proxy sensor is connected to the input module of the PLC, while the motor is connected to the output module. An emergency stop switch is included for safety.

The process begins with the initialization of the ladder programming. The desired winding count is set in the PLC counter, and the PLC is configured to receive inputs from the proxy sensor. The proxy sensor detects each rotation of the motor and sends a signal to the PLC, which increments the count for each signal received.

The control logic is simple: when the count matches the desired winding count, the PLC stops the motor. Additionally, logic is included to handle emergency stop signals from the switch to ensure safety.

For testing and calibration, initial tests are conducted by running the motor and monitoring the winding count. The placement or sensitivity of the sensor is adjusted if necessary. Calibration involves comparing the PLC count with manual counts to verify accuracy, and adjustments are made to the ladder program to correct any discrepancies.

In the implementation phase, the PLC-controlled winding system is tested in a real-world scenario. The system's performance is monitored to ensure consistency. Data on winding counts and motor performance is collected and analyzed to identify any patterns or issues, allowing for further refinement of the system. This methodology ensures accurate measurement of motor coil windings, making the process simpler and more efficient compared to manual methods.

RESEARCH RESULT AND DISCUSSION

As per the Working Mechanism the coil winding measurement. System work very efficiently with the Proxy sensor. To ensure the Emergency switch the motor can be turn off by a single switch Only. This project helps to measure the coil windings with accurate Position or proper count.

- *Accuracy:*
the project or the system provides the precise Measurement of coil windings diameters, and their Turns to ensure the consistent winding process.
- *Efficiency:*
Automation of coil winding process has gain To improve the efficiency of the manual labor by reducing their work.
- *Reliability:*
through the PLC control, the system makes the Performance reliable and convenient, which contribute the Enhancement of the product quality and the customer Satisfaction.

Advantages of this System:

- *Real time monitoring:*
The process can closely monitored through HMI system. And there is Led which is connected to the (CU) counting pin it will glow when the counter will start counting.
- *Flexibility:*
The PLC Program can be easily modified as per the client requirement. So the PLC has more flexibility than other controller.
- *Improved the Quality Control:*
By using this system the automating of the coil wing measurement processes, the system reduces the effort of the human beings. It will also reduce the human error while counting the windings coils. This system will ensure that the each and every coil will get specified Standards.

CONCLUSIONS AND RECOMMENDATIONS

The PLC-based motor coil winding measurement system gives a coinvent and a robust solution to ensuring the quality and efficiency in the manufacturing field. By implementing the sensors, Actuators (motor) , precise control, the overall system provides an accurate measure, and proper control on PLC. The Real time monitoring system can contribute to the improvement of the product quality and efficiency.

ADVANCED RESEARCH

In writing this article the researcher realizes that there are still many shortcomings in terms of language, writing, and form of presentation considering the limited knowledge and abilities of the researchers themselves. Therefore, for the perfection of the article, the researcher expects constructive criticism and suggestions from various parties.

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