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Automation Of Alternator Test Bench To Ensure Accurate Testing Using Plc And Hmi

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ABSTRACT Today's competitive environment has placed a very high demand on automating manufacturing firm for quantitative and qualitative production. Alternator performance test bench is one such system in which alternators are tested and validated after each process during production.

The purpose of the work is to implement an automated Alternator Test Bench using Siemens S7-300 along with Human Machine Interface. Alternators are associated with charge lamp test, part load test, full load test, regulator voltage test and W-frequency tests to ensure the performance without human intervention. It’s possible to achieve maximum types of testing alternators. Spares can be easily planned. Optimization of control is enhanced. Cycle time is reduced. Screening, data logging and reporting facilitates traceability of parts and further analysis. The selection of required test and parameters can be suitably performed as per the requirement without affecting functional efficiency.

Key words: *W-frequency, Human Machine Interface, Siemens S7-300, Alternator performance test, charge lamp test, regulator voltage test*

1. INTRODUCTION

Automation can be defined as “The technology that incorporates and integrates all the traditional engineering fields of Electrical, Mechanical and Electronics with the modern computer technology to operate and control the manufacturing process”. Today's competitive environment has placed a very high demand on automating manufacturing firm for quantitative and qualitative production.

Alternator test bench is one such system in which alternators are tested and validated after each process during production as the alternator is the major component of any automobile.

1.1 Objectives of the work

The objectives that are to be achived by this work are as follows:

- To enable maximum types of testing alternators.
- To reduce the cycle time.
- To eliminate the redundant tasks.
- To achieve an user friendly system by interfacing HMI.
- Optimization of control.
- To obtain a flexible and reliable system using Siemens S7-300.

2. SEQUENCE OF OPERATION

2.1 Component loading procedure

- Components are accurately positioned with the help of the locators provided.
- Check the status of the machine on the HMI panel.
- Press the emergency button immediately if anything goes wrong.
- Check for the display board for the OK or NOT OK component.

- After the operation is complete unload the component.

2.2 Operating sequence

- Loads the Alternator locating with the pins on the receiver ring.
- The slider unit takes the Alternator to the test area where the axis of alternator shaft and tool bit coincides with the aid of stopper pads.
- Proximity sensors sense the slider in the test area and send the signal to the PLC panel.
- On receiving the signal cylinder piston slides down and presses the alternators to engage with the tool bit.
- The motor rotates at a minimum search speed of 80rpm during which the Alternators shaft engages with the tool bit.
- Inductive proximity sensor located on the stopper block ensures the alternator shaft is engaged with the tool bit.
- Speed of the motor increases to the testing speed of 6000rpm after clamping the alternator completely.
- The speed of the spindle is measured using a sensor provided on the spindle support block and the signal is supplied to the drive panel.
- Test probe cylinder actuates and the test probes are brought in contact with the testing screws of the alternator.
- The performance test is conducted and the results are recorded and displayed on the HMI screen.
- The printer cylinder actuates and the print head prints the result on the alternator body and retracts.
- Test piston of probe cylinder slides up to its initial position.
- Speed of the servo motor reduces.
- The position of clamping cylinder slides up to its initial position.
- The slider along with the alternator slides back to the loading area.
- Unload the alternator from the slider.

2.3 Interruption and resetting

To interrupt the machine during the cycle, emergency stop may be pressed.
During the emergency stop condition the following operation take place.

- Power supply to the drive is removed by reenergizing the motor contactor.
- All cylinder movements are disabled.
- Motor set speed is made zero.

The reset operation of the machine can be done by pressing the RESET push button.

During the reset push button pressed condition,

- The machine will be back to its home condition.
- Motor set speed is made.
- Results of the previous auto cycle are cleared.

3. Automation with Sensors & PLC:

3.1 Sensors:

Sliding unit

- Reed switch have been provided at both end of the cylinder for ensuring the cylinder position.
- Two M12 proximity sensors have been provided in addition to reed switch at two end positions of slides to ensure its position.

Clamping unit

- Reed switch have been provided on both ends of the cylinder to trace the position of the piston.
- Two inductive proximity sensors have been provided to ensure the engaging of alternator shaft with tool bit.
- A retro reflexive sensor is provided to ensure the top position reached by slider; alternator shaft is disengaged from the tool bit.

Test probe actuation

- Reed switch have been provided at both ends to trace the position of the piston.

Drive unit

- A proximity sensor has been provided to sense the speed of spindle and to ensure the belt is driving the spindle.

Auto and manual mode:

Provision has been made for both auto and manual mode therefore operator can choose respective mode depending upon the requirement. Manual mode will be selected by the operator when breakdown occurs.

DAC (Digital to analog convertor):

An analog module at PLC itself acts as a DAC.

Which controls the voltage at the drive which in turn control the motor speed there by sleeve and coil insertion speed can be controlled. By varying the speed Cycle time can also be varied.

3.2 HMI Configuration

- HMI for this system is developed from WinCC Flexible. WinCC Flexible is application software belongs to Siemens.
- The PLC, motor drive and HMI are connected by profibus network.
- The HMI has a PCI adopter for the profibus communication the HMI configured for a data exchange of 128 tags.
- It provides a graphics-based visualization of an industrial control and monitoring system.

Human machine interface will give the following information's to the operator:

1) Indexing and wedging counts,

2) Errors,

3) Error descriptions,

4) Alarms,

5) Selection mode for the operator to edit.

Indication lamps:

Red, orange and green lamps are used as indication lamps to indicate the machine status. Red for emergency and breakdown occurs, orange indicates that component under processing, and green indicates process completed successfully.

3.4 Programmable Logic Controller:

Selection of a suitable PLC is very important. Depending upon the requirement suitable PLC will be selected.

Following are the considerations in selecting a PLC:

- Cost
- Number of inputs and outputs.
- Expandability.
- Flashcard.
- Availability of that PLC spares in the market.

By considering the above conditions and by surveying in the market finally we selected Siemens S7-300 plc was selected

Siemens S7-300 plc:

Design:

The S7-300 enables space-saving and modular configurations. In addition to the modules, only a DIN rail is required for hooking in the modules and screwing them into place. This results in a rugged and EMC-compatible design. The build-as-you-go backplane bus can be expanded by simply plugging in additional modules and bus connectors. The varied range of the S7-300 can also be used for central expansions or the construction of distributed structures with ET 200M; thereby producing very cost-effective spare parts handling.

Expansion options:

If the automation task requires more than 8 modules, the central controller (CC) of the S7-300 can be expanded using expansion units (EUs) Up to 32 modules can be used in the central rack and up to 8 per expansion unit. Interface modules (IMs) handle communication between the individual racks autonomously. In the case of plants covering wide areas, CCs/EUs can also be installed at greater distances from each other (up to 10 m). In a single-tiered configuration, this results in a maximum configuration of 256 I/O, and in multi-tiered configurations up to 1024 I/O. In distributed configurations with PROFIBUS DP, 65536 I/O connections are possible (up to 125 stations, such as ET 200M via IM 153). The slots are freely addressable, that is, there are no slot rules.

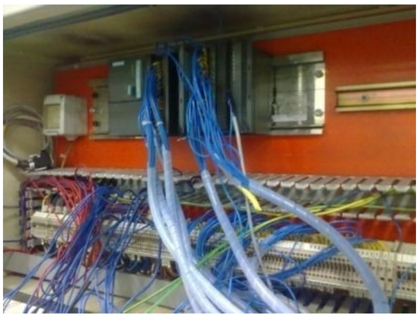
The extensive range of S7-300 modules is also used in distributed automation solutions. The ET 200M I/O system that has the same construction as the S7-300 can be connected via Interface modules not only to PROFIBUS but also to PROFINET.

3.5 Benefits:

- High processing speed, the CPUs enable short machine cycle times.
- The S7-300 can be set up in a modular configuration without the need for slot rules for I/O modules.
- There is a wide range of modules available both for the centralized and the distributed configuration with ET 200M.
- Integral PROFINET interfaces enable simple networking of the controllers, and simple data exchange with the operations management level.
- The narrow module width results in a compact controller design or a small control cabinet.
- The ability to integrate powerful CPUs with Industrial Ethernet/PROFINET interface, integrated technological functions, or fail-safe designs makes additional investments unnecessary.

3.6 Powerful, compact and cost effective:

The SIMATIC S7-300 universal controller saves on installation space and features a modular design. A wide range of modules can be used to expand the system centrally or to create decentralized structures according to the task at hand, and facilitates a cost-effective stock of spare parts. With its impressive array of innovations, the SIMATIC S7-300 universal controller is an integrated system that will save you additional investment and maintenance costs. In the selected PLC we utilized 32 inputs, 24 outputs and 1 analog I/O. The program was written in Ladder logic. Complete operations are made automatic by taking feedback from each sensor and from each operation.

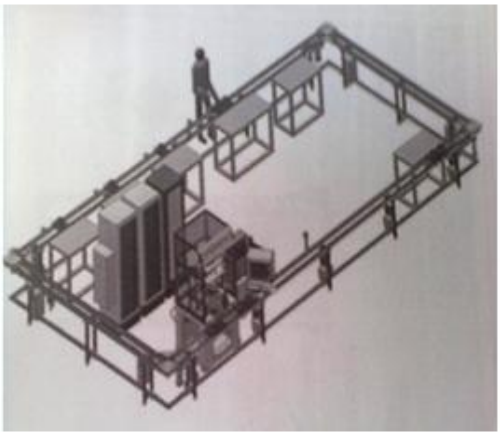


PLC installation

3.7 Cycle time flexibility:

A DAC can control the voltage at the drive therefore the speed of the coil and sleeve insertion can be controlled.

Therefore the speed during forward traverse and reverse traverse can be varied depending upon the requirement. In the system during forward traverse the voltage will vary in the range 4.81v-3.90v-0v and in reverse traverse voltage ranges 5.95v-0v.By increasing the voltage value traverse speed can be increased and hence the cycle time.



Overall view of the machine with conveyor

Conclusion:

A PLC with a HMI will increase the flexibility to operate the machine by operator, reduce the cycle time, minimizes Mean Time To Repair, increases the productivity, and possible to expand the system i.e. operations. A Flexible manufacturing system can be developed by a PLC.A PLC can be used to automate two or more machines. A PLC can easily communicate with the HMI. If any product type change occurs just by changing the program same PLC can be used. Screening, data logging and reporting facilitates traceability of parts and further analysis with the aid of HMI. Selection of required parameters and tests can be suitably performed without affecting the functional efficiency. Automated testing of alternator ensures accuracy. There by, it is possible to achieve qualitative and quantitative production.

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