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Design and Automation of IGBT Test Fixture Using PLC

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Abstract— this paper describes about the construction of the IGBT test fixture for the analysis of various characteristics parameters. To accomplish with this we have implied the knowledge of PLC (Programmable logic controller) as automation for the real time processes. The choice of PLC is made as it provides the superior reliability and contribution towards the quality and performance for the test process. IGBT tester is designed in a controlled environment to maintain the performance and accuracy of the measurement system. This system is designed to provide a precise contact between the IGBT and Test Circuit for the different static parameters of IGBT.

Index Terms— PLC, IGBT, Real-Time Automation, Test Fixture, Static

1 INTRODUCTION

THE static and dynamic characterisitics of insulated gate bipolar transistor (IGBTs) play an important role in analyzing the behavoiur of parallel current IGBTs. Over the past few decades, developments in power semiconductor have led to fast advance of high power IGBTs [1]-[5]. Although the output current is very high it finds application in high power industrial application such as inverters, pulse regulators and frequency regulator drivers. In order to understand the characteristics parameters these IGBT have to be tested each time in a controlled environment. Traditional measurement system such as oscilloscopes and meters do provide a high resolution and accuracy, but when it comes to implement such a system in a production or industrial assembly line where harsh environment persist it leads to limitations such as stability, inaccuracy in measurements and high cost. Also manual testing of IGBTs was time consuming and tedious as it involved human resource and slowed the process. In order to reduce and remove such constraints posed by these system, we have designed an automated tester using PLC (programmable logic controller).

We have used PLC as a choice of automation as it was rugged enough to perform reliability in the plant floor environment with extreme temperature and humidity, airborne dust and particulates. Another significant feature involved its straight forward connection between the host and the computer. The tremendous success of PLC's is because of its programming language chosen i.e. relay ladder logic. The close correspondence of ladder logic to relay circuits was the main reason for the PLC to be chosen for the IGBT test fixture as it provided the pictorial programming interface with graphical representations with relay and switches.

Apart from the most complex PLC every other PLC have some common components:

1. It has dedicated electrical connections conform to INPUTS with exclusive INPUT number
2. It has dedicated electrical connections conform to OUTPUTS with exclusive OUTPUT number
3. A controller that is as simple as a computer.

2 BLOCK DIAGRAM

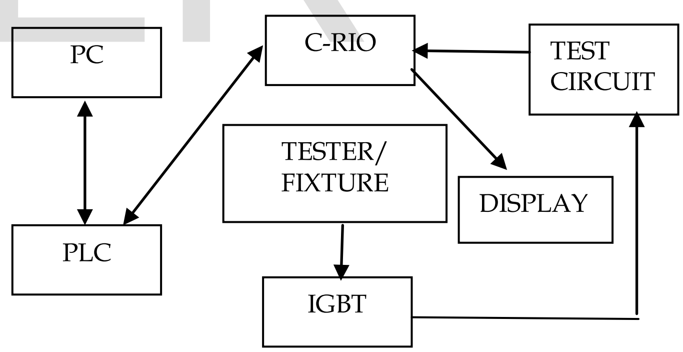

Figure 1- Block Diagram of IGBT Test Set-up

The above block diagram shows the entire test set-up fixture which consist of a PLC (Schneider PLC), National instrument's C-RIO, Fuji IGBT which has been used for the experimental purpose, Pc for displaying the measurement values.

In this set-up the IGBTs are tested by placing the IGBTs in the fixture which is pneumatically controlled by the PLC via the pressure signal and component detect sensor, while the measurement signal are measurement by the C-RIO based on the test circuit designed to measure the various parameter under the controlled environment .

- **C-RIO-** A Compact real I/O system (C-RIO) is rugged hardware architecture includes I/O modules, a

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reconfigurable FPGA chassis, and an embedded controller for communication and processing, and real time deterministic data acquisition. By the use of embedded controller good execution for the Real-Time application is possible. The user-programmable FPGA, hot –swapped I/O modules for data acquisition and control, and graphical Lab VIEW software for rapid Real-time, Windows and FPGA programming is mounted on the reconfigurable chassis.

- **IGBT Module-** the IGBT's used in the testing process is a Fuji V-series Module, having 1200V/600A/1 in one package. Having the feature of high speed switching, voltage driver and low inductance module structure.

3 Implementation of IGBT Tester

A. Pneumatic

Pneumatic controls are very common in industrial use, primarily for applications that require a fixed distance travel of or reciprocation of objects. Examples include transfer of materials between conveyors, clamping objects for assembly or testing, punch presses etc. Compressed air is used to generate the actuating action.

Manually placing the component on the sliding fixture and manually sliding the fixture under the pneumatic cylinder. The distance between the component and the pneumatic cylinder attached with the Derlin pad will be approximately 10mm. When the component is pressed to bottom which has spring loaded electric probes at the bottom touches the component and the signal is given to the PLC then the signal is received by NI from the PLC the test is performed. If the component is ok then the pneumatic cylinder moves up and the component comes up as it has spring loaded electric probes. And the component along with the sliding fixture moves back to the initial stage manually and the component is removed manually. If the part is not ok then the pneumatic cylinder does not move up at that point of view we need to click the acknowledgment switch and make the pneumatic cylinder move up. And then the component has to be placed in the rejection bin until and unless the rejected component is not placed in the rejected bin the machine does not allow testing the next component.

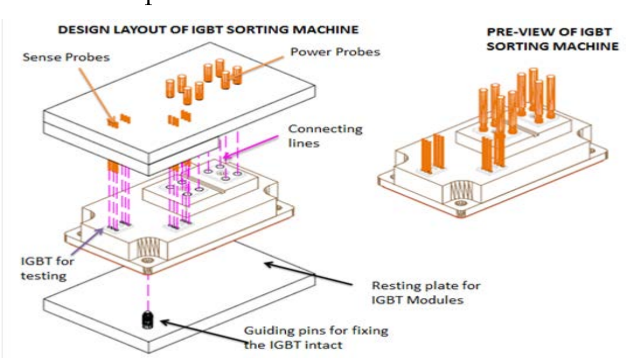

Figure 2- Design Layout of the IGBT Sorting Machine

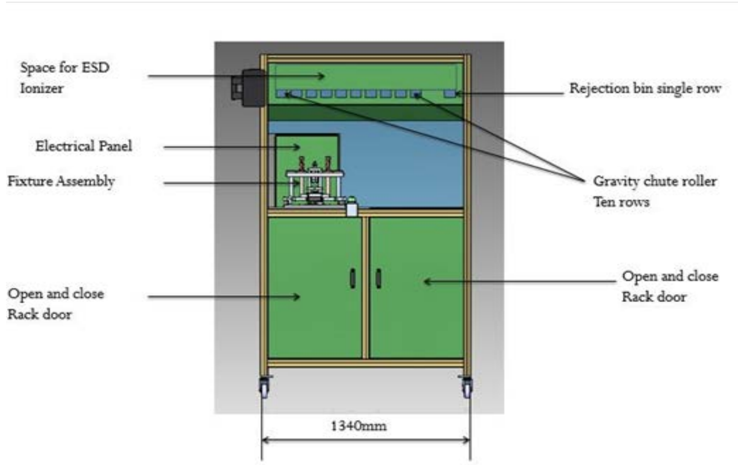

Figure 3 - Front view of the IGBT Tester

B. Process flow of controller

The Plc circuit is designed for the movement of the jig upwards and downwards such that it provides the connection establishment between the IGBT and the Test Circuit (Designed for the static Parameter Measurement of IGBT) with the help of pogo pins and power probes.The input and the output signals are shared between the plc and C-RIO.

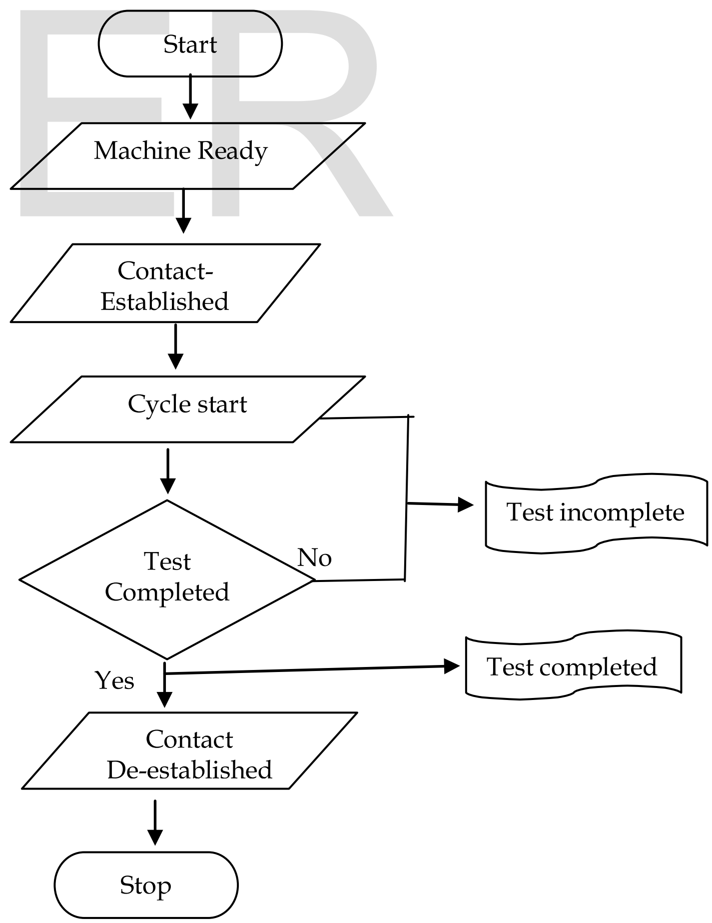

Figure 4- Flow process of controller with respect to C-RIO

The significant parameters of the PLC which plays a major role in the testing mechanism are discussed in this paper.

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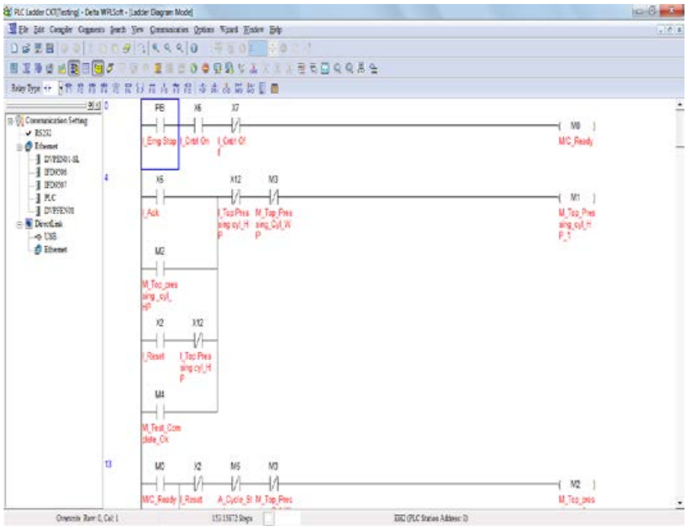
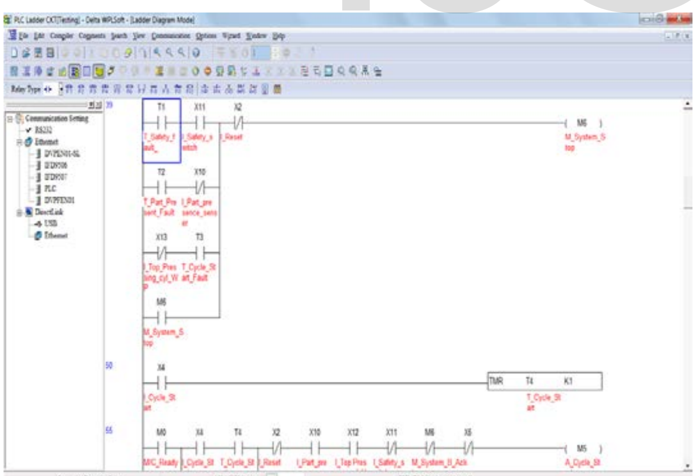
Step1: Machine ready I/O



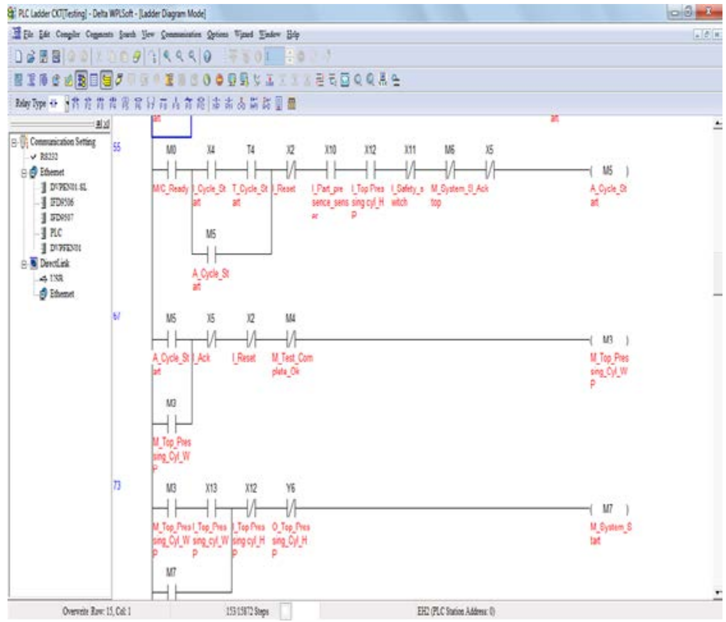
The Machine ready signal is set to initiate the system start, this signal is set when the control on signal is given from the C-RIO and there is no emergency stop is switched. Once the machine is ready with all the initial settings the position of the jig is monitored for its position (whether it is in top or in contact with IGBT) Top Position Sensor is set once the machine is ready and an acknowledgement signal is received from C-RIO and reset is not activated.

Step 2: System stop/start



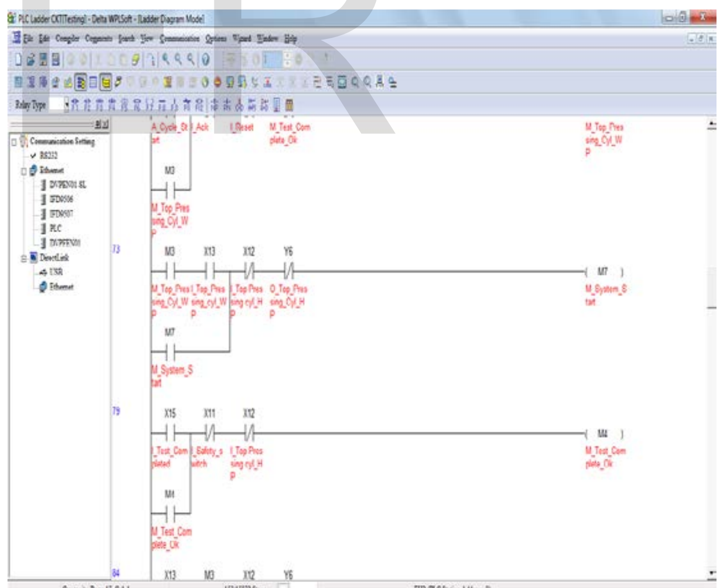
3 major Constraints are checked to stop the system operation i.e.., safety, part presence and cycle start.All the three are monitored by providing the time delay (ON DELAY TIMERS are used).If the safety switch input is not provided from the crio or If Igbt is not detected else the top position sensor is not set then the system is interrupted from the operation.

Step 3: Cycle start



Once the system is started i.e.., the connection is established the cycle start signal is sent so that the jig is not disturbed such that the static characteristic parameters of IGBT are measured. The safety switch is strictly monitored since a high current is flowing in the circuit.

Step 4: Test completed signal



Once the cycle has started and the results of parameters are drawn a signal is generated indicating whether the test is successful are not. If it is successful then the contact is released by making the higher position sensor to be on otherwise contact is not disturbed and a fresh cycle start is initiated on a manual demand.

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4 Comparison between Automation and Traditional Method of Testing

Table 1-Parameter Comparison

Sr.NO	Parameter	Semi-automated system	Traditional system
1.	Reliability	high	low
2.	Labor	low	high
3.	Process Time	low	high
4.	Amount of production	high	low
5.	safety	high	low

Table-2 Cost Comparison

Conventional Test platform	Cost in INR	C-RIO platform	Cost in INR	Difference
High End oscilloscope	9,21,000	NI-922 AI-Module	72,300.00	9,19,795
Switch Control Unit	2,25,540	NI 9774	19,500	2,06,040
FPGA Controller and multicore processor	NA	NI 9068	2,64,000	2,64,000

5 Conclusion

In this paper we have presented a complete designing of IGBT test fixture based on PLC and C-RIO platform. The automation system provided here enables maximum number of IGBT to be tested for its characteristics evaluation and gives an excellent performance within the controlled environment. The use of PLC for the controlling action of the system efficiently results in good production for the high power industrial application.

6 Future Scope

The application can be extended for testing the IGBTs using the IGBT Test Fixture under high controlled environment. Also the entire process can be made fully automated without the interruption of human.

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