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Scrutiny of IGBT under the Ordeal Controlled Environment

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Abstract: This paper describes the scope of evaluating the test behaviour of IGBT (Insulated gate bi-polar transistor) under the controlled test set-up environment subjected to various temperature. The thermal imbalance is highly maintained in order to compare the variations in the parameters of the IGBT while testing. Controlled temperature plays a vital role while testing IGBTs for parallel operation in high power applications. The implementation of such system in a production environment leads to increase in output yield, superior quality and reliability. The evaluation of IGBTs static behaviour is done using Compact real time input output module (NI-CRIO).

Keywords: Controlled temperature, IGBT, NI-CRIO, static.

I. INTRODUCTION

The insulated gate bipolar transistor is a three terminal power semiconductor device. It play a vital role in industrial application as they include the both the features of BJT and MOSFET. Since they find the application in high power devices paralleling of IGBT's are needed such that the output power is enhanced, even it is desirable for the heavy loads. The two major problems are faced when the IGBTs are connected in parallel i.e.., current de-rating and current imbalance.Current imbalancecontributes to the reduction of static current on the other hand while parallel operating, the overall current gets contributed to the IGBT which has lowest Vce such hard conditions leads to de-rating. In order to check the test parameters the operator choose the IGBT from the production batch place in the test setup which is pneumatically controlled and placed in the temperature controlled room. The parallel connected modules operates at different junction temperature. [1][3].
The key parameter measurements like the Vce,Uth and Ud for parallel operations is obtained via the C-RIO which is briefly described in the later section. From physics we know that the parameter of semiconductor are temperature dependent mostly for the higher ambient variation. Here we are testing the IGBT for various ambient temperature which may reduce the cause of failure when used in the production line while designing high power applications such as UPS, inverters etc. Generally the power devices performance and properties of the unit under test will degrade and lead to failure of the test circuit or the entire set-up. Even though the high temperature is considered while manufacturing one can see a significance change in static parameters if the temperature is not been considered as a critical factor.

II. C-RIO BASED MEASUREMENT SYSTEM

A NI based C-RIO system is used for measuring the IGBT parameter. The hardware of the compact real time input output system has a FPGA, I/O modules, chassis and an embedded controller which is used for the real time data measurements in the test set-up. The Labview software for real time data acquisition system makes it easy for the static and dynamic analysis for various parameters.

A. Implementation of the C-RIO

Because of the superior performance characteristics of a Compact Real Time system, it was proposed to implement this high end rugged platform in realising the IGBT characteristics evaluation test.

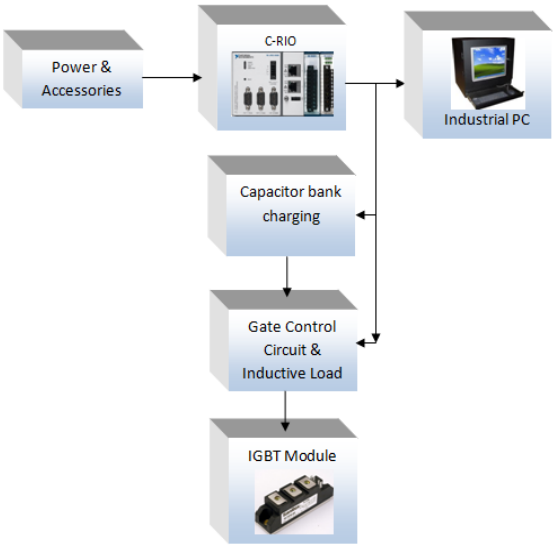

Figure 1:Implementation of C-RIO

Proposed C-RIO Configuration:

1) Controller (NI cRIO-9068): Here in 9068 within one platform of chassis we can find a dual core processor, FPGA and 8 slots of input output which are reprogrammable. It is very useful when the operating device temperature plays a vital role providing -40 degree Celsius to -70 degree Celsius of operating temperature range along with input power supply of 9-30Vdc. The NI-9068 controller is the brain of the system featuring the capabilities of standalone system. Higher processing rate and greater data throughput

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ensures an ideal reliable system for use in a production line. It has been featured with the Linux Real time OS and an Artix- 7 FPGA. It has a greater option of connectivity for the 2 GB Ethernet, one USB Hi-speed and 3 serial ports for various measurement

2) 4-Channel Analogue input module (NI -9222): It is a high speed analogue input module, having high sampling rate up to 500Ksamples/sec/channel and having resolution of 16 bits/channel. Such a high speed data acquisition module very accurately captures dynamic signals with a high degree of accuracy and greater precision at faster rate.
3) 8-Channel 24V Digital I/O module (NI-9474): It is an eight-channel, 1 µs high-speed sourcing digital output module. It is compatible with the signal strength from about 3-5V and can be used in many industrial applications such as motors and drives.

B. Block diagram of the experimental set-up

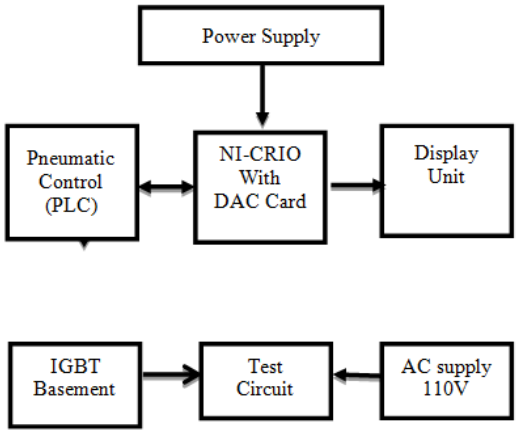


Figure 2:Block diagram of the measurement flow of the entire set-up

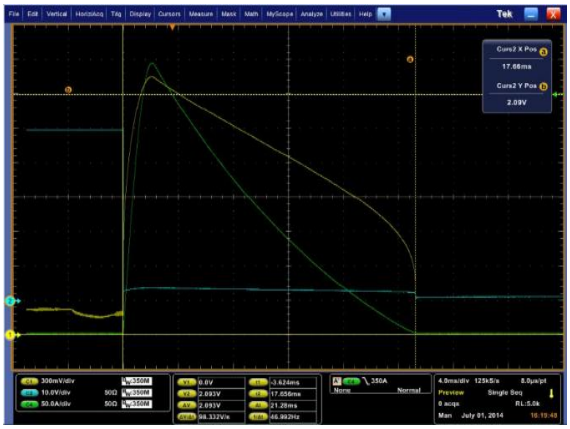
The fig 2 represents the testing set up of the C-RIO based IGBT set up mechanism .The placement of the IGBT in the test circuit plays a major role in this circuit. Therefore a PLC is used as a part of the test circuit which provides the contact establishment between the IGBT and the test circuit. A jig with a sense probes and a power probes are used for a contact establishment. The movement of a jig is automated with the PLC automation provided with a suitable precautions and safety measures since an high current is applied in the circuit i.e.., 350A.The movement of the Jig iscontrolled by the C-RIO i.e.., the controlling signals along with the acknowledgement signals are generated by PLC via C-RIO.Once the contact establishment is done the static parameters are measured by the real time data acquisition system all these three parameters are measured based on the relay switching designed in the test circuit. The switching instant of the relay is initiated by the C-RIO programmed by the graphical tool Lab View. As the test is completed the test results via the $V_{ce,}$ $V_{d,}$ and $_{Vth}$ are recorded in the display unit is used to display the test results. The results are compared with the pre standard values and there relevant sorting box number is displayed. Once the box no is known the placement of the IGBT to the relevant box is done manually.

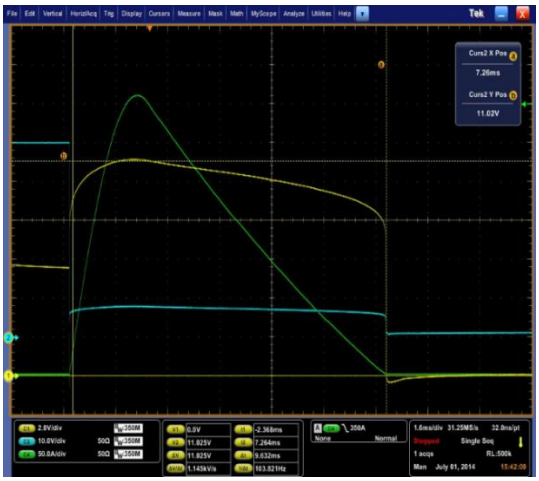
III. EXPERIMENTAL RESULTS

There are few key Static characteristics which has vital role determining the performance of IGBT modules with regards to current sharing in parallel operation mode.
Static Parameters such as:

1. Collector-Emitter voltage(Vce)
2. Gate threshold voltage(Uth)
3. Freewheeling Diode ON-State voltage drop(Ud)

are shown in the below figures respectively





IV. THERMAL ANALYSIS

The IGBT module is usually mounted on the heat sink in order to keep the device in the safe operation mode. The thermal behaviour of the system is determined by the thermal impendence of the IGBT and diode from junction to case (the data is given by the IGBT module

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manufacture), the thermal interface between the IGBT and heat sink and the geometrical distribution of the heat sink. Specific methods of cooling such as natural air, fan in the experimental set-up have been mounted in order to maintain the temperature.

During the experimental analysis various readings have been recorded at different temperature and the parameters showed variation resulting temperature imbalance.

The behaviour of IGBT characteristics are compared and analysed at different junction temperature and by placing the IGBT at different interval with respect to the ambient change. With the rise in the junction temperature the static behaviour of IGBT also increases leading to the current imbalance and change in its Vce, Ud and Uth value which may cause failure during parallel operations, The static and dynamic characteristics of the IGBT is as shown below

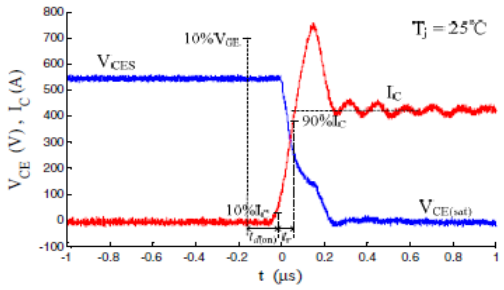

Figure 3: Characteristics parameter of IGBT

V. TABULATION OF EXPERIMENT RESULTS

Table 1: Parameter measurement result

Test by using Measurement System:			
	VEC (unit: V)	VCE(sat) (unit: V)	VGE(th) (unit: V)
AVE	1.61671869	1.60360867	9.6062892
MIN	1.556499	1.545081	9.480639
MAX	1.655108	1.666573	9.737033
MAX-MIN	0.098609	0.121492	0.256394
Deviation	0.02550708	0.01930063	0.083024067

Table 2: Parameter measurement result under controlled environment with repetitive result of IGBT

Sl No.	Vce	Ud	Uth
1	1.940	2.011	8.222
2	1.943	2.034	8.230
3	1.935	1.989	8.205
4	1.942	1.981	8.228
5	1.912	1.984	8.221
6	1.939	1.987	8.219

VI. CONCLUSIONS

A simple experimental set-up fixture is been designed to study the parallel connected IGBT and its impact with the temperature. This value is veryhelpful in high power applications where one can reduce the failure of IGBT if proper thermal balance is maintained. The CRIO being economical provides accurate result which ensures reliability and high productivity in the industry.

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BIOGRAPHIES

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