

Design of Reliable SoCs with BIST Hardware and Machine Learning

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ABSTRACT- Built in self testing circuits are one the most efficient circuit testing methodology compared to other testing equipments like the ATE's. These BIST type of technology can be used in embedded systems to check whether there is any malfunction in the IC'S pins where it would be very difficult and time consuming if we use ATE'S and other alternative .By using BIST'S it will be very easy and efficient to determine whether the circuit is functioning well (or) not. Generally these BIST are being used in conglomerated circuits in the world these are also used in the developing technologies like the AI and IOT'S which is more efficient compared to other testing forms. Since embedded systems are being into act and are been used in various divisions in the globe right from alarm clock to electronic parking meters and parking pay stations in malls and other areas. so it would be a very useful technology to combine both embedded system and the BIST technology for a cost efficient and most reliable technology to which the circuits can be trusted upon and the circuits could be pushed to further limits. The BIST circuits represents an opportunity for the industries to deliver testing solutions that are ubiquitous across a broad range of systems and devices in the world.

Keywords-BIST[1],ATE[2],IOT[3]AND EMBEDED SYSTEM[4]

I. INTRODUCTION

In today's accelerating world there are lots of new technical advancement undergoing in a very flashing and in a swifiting speed where the circuits are been designed in such a manner in which it could perform any kind of activity with a great amount of speed, and the size of the chipset is really small compared to the work which it is capable of doing. Since the circuits are being designed to perform more complex and tiring activities the construction of these versatile circuits are so much conglomerate. When these circuits are being used there are lots of chance for the circuit to get malfunctioned due to various technical reasons. So to overcome this flaw in the circuits we use the built in self testing circuits which

uses the pseudo random number generator and cyclic redundancy checker in the circuit and the components present inside it. This bist actually does one or more internal scans in the registers of the ic or at the particular components present in the internal circuits. During this internal scans the components generate a particular crc signatures in which the components store's the particular crc signature and will compare it with the large enough inputs of the random crc set from the prng. Then the circuit compares the actual crc produced and the stored crc's analog signature wave. when these two waves are same then there is no flaw in the circuit and if there is any variation's observed in the analog signature wave then there is a flaw in that particular register of the ic.

The main purpose of using this bist technology type of circuits over other testing methodology's like ATE's, UUT, ATGP and EUT's. In the above mentioned testing methodology's an external testing device (or) an equipment is needed to check the patterns in the circuit and to identify the flaw's present in the circuit we should use an external probe for testing where the probe should be connected to the terminals of the ic registers and then the analog signatures are been generated and then it is compared with the ic registers and then the circuit impairment is been diagnosed. Then the necessary steps are undertaken to repair the issues which is really difficult process where it's really a tiring process to identify the flaw in the circuit and even time consuming in nature. By using bist kind of circuits this problem is run-overed and the flaw is been identified and is redundant and an alternative circuit is been used and the particular function is processed. Then the desired output is been obtained. Where this process is done totally internally without using any external equipment's like the connecting probes, etc and its purely based on internal scan's using analog signatures, prng's and crc's.

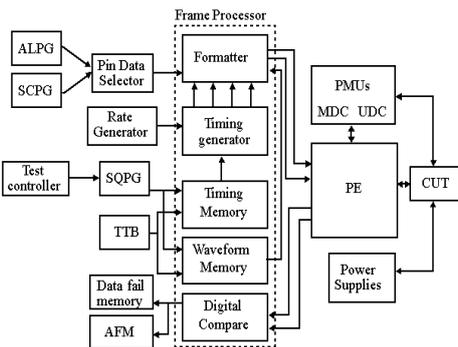
The main boon of using a built in self testing circuits is that these circuits are really cost efficient in nature and time consuming where these circuits perform a periodic

test's and if there is any flaw detected then that particular component is redundant and later on the component or the ic registers are been replaced and the circuit is been repaired. The main advantages of incorporating a bist technology is that the customer they themselves can test the chip after they are fabricated and once they are in use, and the need for external testing equipments is limited or can completely be eliminated. And the test time could be further reduced if the bist's are designed in parallel mode where it could access more number of components at a time.

II. METHODOLOGY

In order to uphold the circuits it is very useful to introduce the built in self testing circuit methodology as an alternative to the conventional engineering testing approach. As embossed in the figure 1(a) the ATE testing circuit is very large and complicated as compared to the bist type of circuits which is shown under figure1 (b).

a.



b.

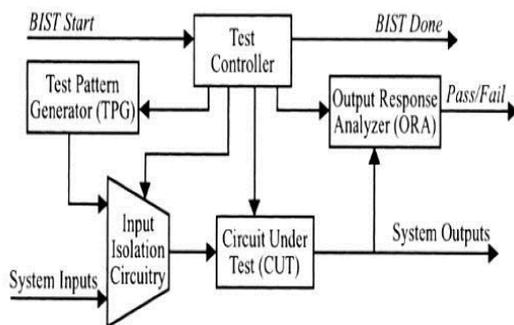


Figure 1

(a) Conventional engineering design flow of an ATE circuit; and (b) block diagram of BIST circuit.

These BIST circuits are the type of circuits which works under the principle of analog signature waves. Where the

bist circuit firstly scans internally inside the circuit components. During this scan the components produces the signature waves of crc's of the components and this particular wave patterns are been compared with the stored wave patterns of the prng's and crc's during this process of comparison if the circuit finds any type of variations in the produced wave forms then the bist circuit comes into the action where it indicates the user regarding the flaw present and it also identifies the ic register (or) the particular pin number of the circuit. So the flaw after detection could be redundant (or) could be repaired. By this flawless circuits could be designed and checked where these could be maintained.

Its not only used in electronics field it is also used in many other applications in varying field of study. The taxonomy of BIST type of circuits are as follows below:-

- (i) Medicine
- (ii) Military
- (iii) Unattended machineries
- (iv) Automotives
- (v) Aviation and
- (vi) Electronics

III. Medicine

In today's world there are lots of health issues which are emerging in a rapid phase. So these health issue are been diagnosed using various tools which actually work using at-least one electronic components and uses computer technologies. So its very important to make sure that these equipments are under condition.

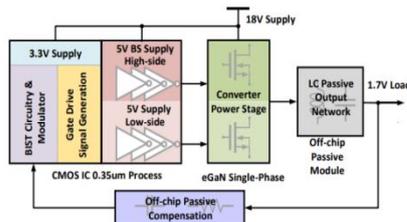
So to make sure that these equipments are been periodically checked and maintained to serve the user with proper and accurate results we implement the BIST technology. Where these equipments are been incorporated with self testing circuits which undergoes two kinds of tests.

- (i) power-on self test and
- (ii) periodic test.

During the power on self test the circuit performs a comprehensive test to ensure the safety of the equipments. After this pos test it performs a periodic tests in the circuit at a particular period of time. This periodic test are been performed to ensure that the circuit is not been unsafe to use since the power on self test is performed.

By this the safety of the medical devices are achieved.

2.



Figure(2) Hybrid GaN and CMOS Integrated Module Radiation Hard DC-to-DC Converter

IV. Aviation

Almost all the aviation systems are been incorporated with BIST circuits. The keen advantages of implementing these bist circuits to these aviation systems are to isolate the failing line of the system. Where in today's worlds there are lots of aviation machineries been fabricated and are generally very advanced with high tech technologies inbuilt inside them. So to keep an eye on the safety line of these technologies, the aviation companies uses the bist where the major role of the bist is to prevent accidents due to failure in the electronic components. So these periodic tests are been undertaken by these bist circuits and if it is observed that there is any failure in the systems then it will immediately indicate the operator and that particular system will be replaced (or) redundanted with an alternative system and this isolated the failing system could be replaced easily after landing.

v. ELECTRONICS

The main purpose to implement these bist circuits in electronics filed is to manufacture less inexpensive ic's and even faster computing capacities of ic's and other electronics components. Wherein these bist's actually reduces the cost of manufacturing the ic's and other electronic components. The main reason is that these bist identifies the flaw in the components at the stage of manufacturing itself. So the fabrication of flawless electronic components are been produced easily, could also be highly reliable to the customers.

These bist are also been incorporated in computers and other unattended machineries where they themselves could check for flaws and could be rectified by themselves. In computers these test's are been performed during the booting process.

VI. MACHINE LEARNING TECHNOLOGY IN BIST

The upcoming development of the bist circuit is a very great leap towards the technologies where the developing technologies ML is been collaborated with the existing BIST technologies. In this a ML model is been

developed and various signature wave patterns are been feed to the model as data and this bist tech identifies the flaw within few seconds of the first scan and will indicate immediately to the operator. The main advantages of this model is that even though it is a small flaw the ML model could easily identify it. This is due to the trained data set which is been incorporated inside the circuit as a result the user could obtain highly accurate outputs from the circuits.

VII. MILITARY

Even the military is using various bist tools in their missiles where the US military force uses bist in every missile they use. The Minuteman was one of the first major weapons systems to field a permanently installed computer-controlled self-test.

VIII. SPECIALIZATION

- Continuous built-in self-test (CBIST, C-BIT)
- Event-driven built-in self-test, such as the BIST done to aviation systems after the aircraft lands.
- Periodic built-in self-test (C-BIT/P-BIT)
- Interrupt-driven built-in self-test (IBIST) or user/operator-initiated built-in self-test (I-BIT, or O-BIT)
- Power-up built-in self-test (PupBIST, P-BIT)
- Automatic built-in self-test (ABIST)
- Embedded system
- System engineering
- Safety engineering
- Watchdog timer

IX. CONCLUDING REMARKS

In the presence of built in self testing circuit it would be easy to debug the flaw which is been present in the various domains as specified above. It could leverage the accuracy of the circuit in almost all the modern technologies and could also reduce the time in repair work as specified earlier. This also improves the hinges of redundancy of the circuits in the aviation domains, military, unattended machineries and even in electronics field. This is actually a great leap towards the modern world which is running in a very fast phase. So this could lead to more reliable and even high standard tools in use.

By incorporating bist circuits in our daily lives equipments like ups, elevators, computes and many other appliances it will be a very great advantageous and even beneficial to the consumer. The reason is that if these bist are been installed in these various appliance the future technology will able to send the flaw notification directly to the company rather than the consumer scheduling a flaw complaint to the company. This will be very useful and time efficient to the user to

take care of their machines and the industries will also be able to attend the customer and provide an advance service support to their customers. More over this a very cost efficient and time managing technology and is really a great hinge to solve all the conglomerate circuit problem's and easily to analyze the circuit and provide the necessary solutions to the circuit's and use them to their highest efficiency.

As a final note this paper is focused in providing a profound knowledge regarding the evolving technology so called built in self testing circuits which could and is serving as an alternative to many other testing methodologies which are present in the world. In these systems the learning's are been performed by analog signature waves using crc's and prng's. BIST reduces (or) even eliminates the use of probe and other kind of external testing machine and also provides a more accuracy in the results.

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