Special Issue - 2018
International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
ICRTT - 2018 Conference Proceedings

Digital IC Characterization and Testing Using MSP430 Microcontroller

Varunkumar S K
Asst Proff
SDMIT,Ujire

Pallavi B J
SDMIT, Ujire

Tushar G N
SDMIT, Ujire

Prathiksha V
SDMIT, Ujire

Ramayshree
SDMIT, Ujire

***Abstract*:- The paper presents an efficient system for automated testing for IC's implemented in the single software platform. Here an overview of digital testing techniques with appropriate reference to material containing all details of the methodologies and algorithms. The IC testing is done by thorough understanding of datasheets of respective IC's and proper test plan. This is one of the cost effective system in which basic tests of IC's like continuity, power short etc. are performed. By giving necessary test conditions, buttons are used to select the type of test to be performed and microcontroller is used as logic analyzer to compare the obtained values with the datasheet. The IC (DUT) is tested for different inputs which cover all its functionalities.**

***Keywords:- MSP430 microcontroller, DUT, load board, datasheet, test program*.**

1. INTRODUCTION

For a new semiconductor product system engineers are responsible for defining and documenting the customer's requirements, design engineers develop the corresponding integrated circuit. Hopefully, the new design meets the technical requirements of the customer's application. Unfortunately integrated circuits sometimes fail to meet customer's needs. The failure may be due to the fabrication defect or it may be due to flaw or weakness in the circuit's design. These failures must be detected before the product is shift to the customer.

The test software detects the ATE tester to apply a variety of electrical stimuli (such as digital signals and sine waves) to the DUT. The ATE tester then observes the DUT's response to the various test stimuli to determine whether the device is good or bad. The testing is also responsible for developing hardware and software that modifies the structure of the semiconductor die to adjust parameters like DC offset and AC gain, or to compensate for grotesque manufacturing defects. Despite claims the production testing adds no value, this is one way in which the testing process can actually enhance the quality of the individual IC's.

Accuracy is a major concern for mixed-signal testing. Measurements made under incorrect test conditions can all lead to inaccurate test results. Repeatability is the ability of the test equipment and test program to give the same answer multiple times. The definition of a production test plan usually begins with the device datasheet or specification sheet, as it is often called. The test list must be comprehensive enough to guarantee that the manufactured devices meet the datasheet specification. The testing often detects datasheet mistakes and ambiguities while writing the test plan or developing the test plan.

Sometimes the datasheet lists a parameter with a note stating that it is "Guaranteed, not tested "or "Guaranteed by design". This is a formal way to notify the customer that the specification has been characterized and shown to be good by design, and is therefore not tested in production. There are several problems in this type of undisciplined approach. If a test plan is not clearly documented before coding begins, then the testing lacks the necessary overview of the test program that allows all the tests to fit together efficiently. Tester languages vary from low-level C routines to very sophisticated graphical user interface environments. Test programs typically consist of all or most of the following section: Continuity, DC parametric tests, digital patterns (also known as functional tests), test limits.

We ask that authors follow some simple guidelines. In essence, we ask you to make your paper look exactly like this document. The easiest way to do this is simply to download the template, and replace the content with your own material.

2. LITERATURE SURVEY

Time is money, especially when it comes to production test programs. A high performance tester may cost two million dollars or more, depending on its configuration. Probers and handlers may cost five hundred thousand dollars or more. If we also include the cost of providing floor space, electricity, and production personnel, it is easy to understand why testing is an expensive business.

One second of test time can cost a semiconductor manufacturer three to five cents. This may not seem expensive at first glance, but when test costs are multiplied by millions of devices a year the numbers add up quickly. For example a five-second test program costing four cents per second times one million devices per quarter costs a company $800,000 per year in bottom-line profit. Testing is perhaps the fastest-growing portion of the cost of manufacturing a mixed-signal device. Continuous process improvements and better photolithography allow the design engineer to add more function on a single semiconductor chip at little or no additional cost. Unfortunately, test time (especially data collection time) cannot be similarly reduce by simple photolithography. A 100-Hz sine wave takes 10 ms per cycle no matter how small we shrink a transistor. The only hope salvation from photolithography is the addition of test features into the design itself that aid in testing of the DUT.

3. METHODOLOGY

As the first step, test limits pertaining to DUT should be properly defined and dumped into MSP430 microcontroller. DUT is placed in the socket, necessary test setup and conditions are given based on the type of test that is to be performed. Push buttons are used to select the type of test. Once the push button is pressed, test program of that test is activated. By making use of the test setup and test condition, microcontroller analyses and based on the precision of ADC in the microcontroller, final results of the test is displayed in the serial window of the software.

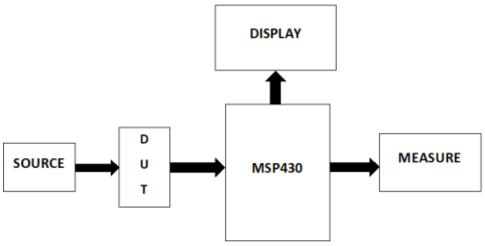


Fig.1 Test setup

3.1 *Continuity Test*

In electronics, a **continuity test** is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). Here test can identify the missing bond wire problem short between two pins. This is a simple test and can be done very faster which reduces the average test time of bad devices. This test is also called as power off test or open short test. This is typically the first test performed at package or wafer level.

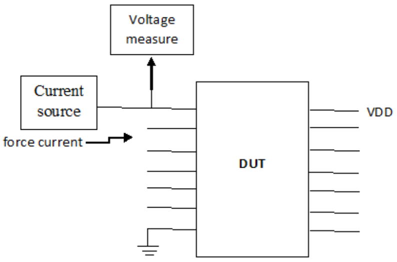


Fig.2 Continuity test setup

If voltage measured between the signal pin and ground is close to zero volt, then there are one or more short circuits between the signal pin and the ground pin through the VSS, VDD and/or another signal pin. If voltage measured between the signal pins rails or climbs to a potential that is higher than an acceptable forward-biased voltage drop, then there is an open circuit between the signal pin and ground. If measured voltage is forward-biased voltage drop, then the VDD protection diode is operating properly.

3.2 *Power Short Test*

The purpose of a power short-circuit test is to determine the short between VDD and ground pin of the IC. This test is the necessary test that is usually performed after the continuity test. This is the power off test since it may damage the DUT by performing the test in the power on condition.

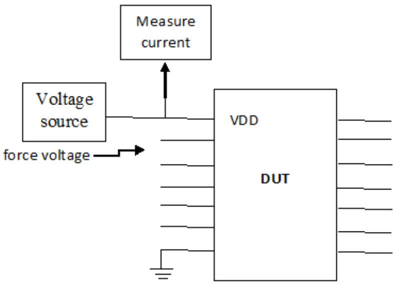


Fig.3 Power short test setup

Here the small amount of input voltage is forced such that it will not turn on the device. The current is measured, if the measured current hits the clamp value then it means there exist a short between VDD and ground.

3.3 *Leakage Test*

Purpose of leakage testing: Each input and output pin of a DUT exhibits a phenomenon called leakage. When a voltage is applied to a high impedance analog or digital input pin, a small amount of current will typically leak into or out of pin. This current is called leakage test, or simply a leakage. A good design and manufacturing process should result in a very low leakage currents. Typically, a leakage is less than 1µA, although this can vary from one device design to next. One of the main reason to measure the leakage is to detect improperly processed integrated circuits.

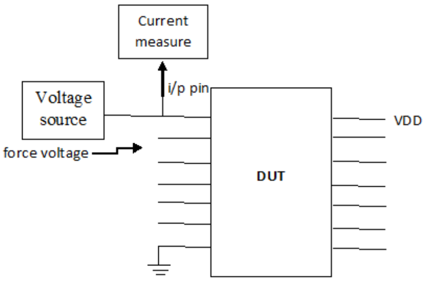


Fig.4 Leakage test setup

Leakage test techniques: Leakage is measured by simply forcing a DC voltage on the input or output pin of DUT and measuring the small current flowing into or out of the pin. There are two leakage currents that are referred to as I_{IH} (input current logic high) and I_{IL} (input current logic low respectively). These levels are tested at the valued input threshold voltages V_{IH} and V_{IL}. Since leakage is usually highest at one or both input voltage extremes, it is often measured at the maximum and minimum allowable input voltages. This leakage test can be done either in serial method or parallel method. From the testing time prospective parallel testing is desired where all pins are tested at once.

3.4 *Input Voltage Level Test (VIL, VIH)*

V_{IL} – Maximum input voltage level to still be considered as LOW. V_{IH} - Minimum input voltage level to still be considered as HIGH. The input high voltage (V_{IH}) and input low voltage (V_{IL}) specify the threshold voltage for digital inputs. If the device does not have adequate V_{IH} and V_{IL} thresholds, then the test program will fail one of the digital pattern tests that are used to verify the DUT's digital functionality.

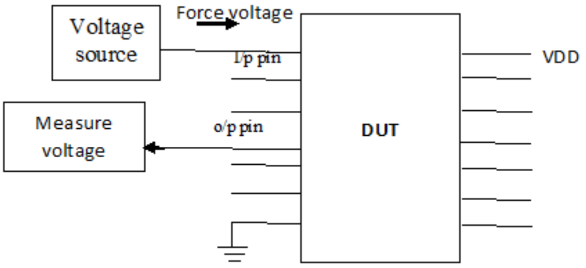


Fig.5 Input voltage level test setup

3.5 Output Voltage Level Test (VOL, VOH)

V_{OH} - Minimum output voltage level to be considered as HIGH. V_{OL} - Maximum input voltage level to still be considered as LOW. V_{OH} and V_{OL} are the output equivalent of V_{IH} and V_{IL}. V_{OH} is the minimum guaranteed voltage for an output when it is in the high state. V_{OL} is the maximum guaranteed voltage when the output is in the low state.

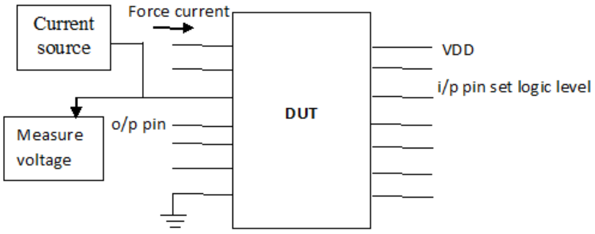
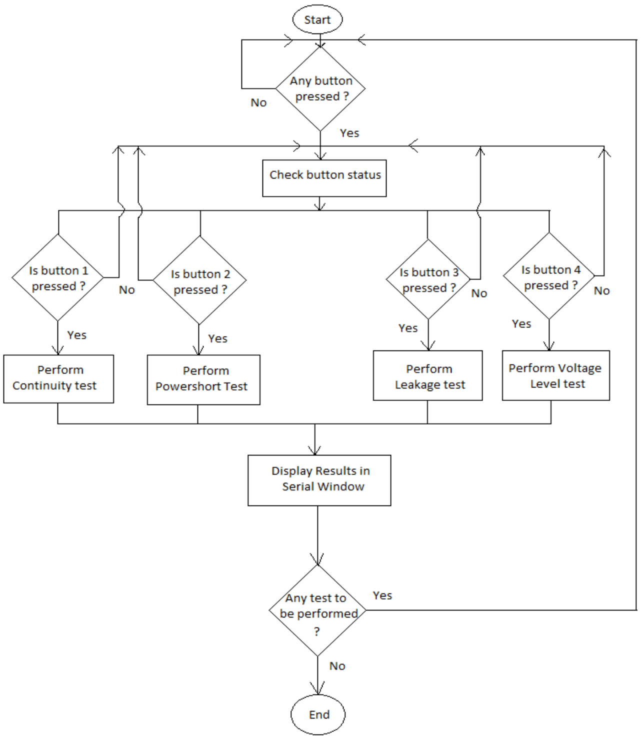


Fig.6 Output voltage level test setup

4. FLOWCHART

Below flowchart shows the step by step flow of the test program.



5. RESULTs

Table.1 Test results

Tests / Name of IC	Continuity Test	Leakage Test		Input Voltage Levels				Output voltage level	
		IIH(max)		VIL(max)		VIH(min)		VOL(max)	
		Expec-ted	Obtai-ned	Expec-ted	Obtai-ned	Expe-cted	Obtai-ned	Expec-ted	Obtai-ned
7404 NOT GATE	0.00V	20µA	10µA	1V	1.4V	2V	3.03V	0.5V	0.33V
7408 AND GATE	0.692 V	20µA	15µA	0.8V	0.0V	2V	2.11V	0.4V	0.57V
7432 OR GATE	0.00 V	20µA	10µA	0.8V	1.05V	2V	4.02V	0.4V	0.39V
7402 NOR GATE	0.00 V	20µA	20µA	0.8V	1.02V	2V	3.23V	0.5V	0.35V
7486 EXOR GATE	0.427 V	40µA	20µA	0.8V	0.15V	2V	1.75V	0.5V	0.32V
7400 NAND GATE	0.65 V	1 µA	(undetectable)	0.8V	0.17V	2V	2.46V	0.4V	0.32V

6. CONCLUSION

This paper is presented based on the available equipment in the college level. This system is a cost-effective system which allows to perform some of the necessary tests for the basic set of given digital IC's by defining proper test limits. The same procedure can also be used for the process of characterization of IC's. The precision of values depends upon the number of bits that ADC can handle. More the number of bits it can handle more will be the precision of the values. The whole circuit setup with push buttons built in the bread board can be replaced by the PCB board for the best efficiency of the system.

7. REFERENCES

[1] An introduction to mixed-signal IC test and measurement/Mark Burns, Gordon Roberts, 2001.

[2] Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits.