Development of Proposed ATE of Digital Stethoscope

[1]Sayali Shinde, [2]Om Patel, [3]Mr. Adarsha K, [4] Dr. Surendra Bhosale
[1]Student of M. Tech. Electronics, [2]Student of M. Tech. Electronics, [3]Associate Professor, [4] CEO of Ayu Devices
Department of Electrical Engineering, VJTI, Mumbai, Maharashtra, India

Abstract: Stethoscope is one of the critical tool used to assess a patient's health by performing auscultation. The addition of electronic circuit in the acoustic stethoscope is called Digital stethoscope. Digital stethoscope utilizes a microphone, amplifier and electronic circuit as modifiers of the acoustic signal into digital. Device test is required to test its functionalities and reliabilities. The device which is to be tested is digital stethoscope called as AYU lynk .This Paper includes hardware and software designing of ICT and Acoustic test that will be used for automated testing of Digital stethoscope. It will verify the device functionality and its behavior at circuit and functional level .The test procedure includes generating test cases through NI virtual bench. These test cases will verify the functionality of various components of PCB and determine the test as pass or fail. This product has inbuilt capability to locate and diagnosis the faults. These will reduce time, efforts & errors in testing and evaluating circuit parameters of Digital stethoscope.

Keywords **- Automated test equipment (ATE), NI Virtual Bench, Digital stethoscope, Device under test (DUT), JIG, In Circuit Test (ICT)**

I. INTRODUCTION

An automated test equipment system (ATE) is composed of test instruments that are capable of applying stimuli and taking accurate measurement under the control of computer that is used to test device, known as the Device under Test (DUT) or Unit under Test (UUT) [2]. ATE can be used to test simple electronics components like resistor, capacitor to very complex Integrated Circuits and PCB [2].ATE is divided into two test ICT and acoustic test.
ICT consist of jig for testing of the particular stethoscope PCB [7]. It tests for working of each component of the PCB. The GUI of the application is completed with the help of Pyqt5. All the data from the jig is forwarded to NI Virtual Bench. The purpose of testing is to detect defective PCB, to find out which part of PCB is not functioning properly, to avoid defective PCB assembly at Production Line, to avoid Field failure and reloading of finish product, to collect data of faults for analysis purpose [2]. There is Several PCB test strategies to choose from including boundary scan and manufacturing defects analyzers [5]. Acoustic test will test the device at functional level [8].

II. PRELIMINARIES

This section provides the description of how planning of the design of jig is carried out. The basic of the Digital stethoscope is to be studied to design Jig.

A. Working of Digital stethoscope PCB

It consists of battery, LDO, mic, filter and headphone and mono amplifier. LDO is use to give accurate low voltage of 3.3V from battery. Heart beat sound is received by mic circuit which is given to filter section. It will filter out all unwanted signal/frequency and pass only heart sound .filter sound is given to headphone and mono amplifier to amplify signal. The supply for all IC is given from LDO output.

Fig. (1).Ayu lynk attached to normal stethoscope

B. Methodology

1. In Circuit Test (ICT)

Digital stethoscope ICT ATE is designed to check battery output and charging circuit, Low drop out voltage section, Filter section, and Amplifier section. The power supply from NI is given to Digital stethoscope and Logic circuit and digital I/O inputs from NI are given to logic circuit to control select line of Demux IC. JIG is device which contains PCB that is design according to required test point and pogo pins are mounted on these test points [4][7]. On this pogo pins device to be test are kept [7]. Pogo pins which directly get contact with Digital stethoscope PCB through via points of which voltage value need to check and output of pogo pins are given to Demux channel in logic circuit. Depending upon select line, logic circuit will provide appropriate output at specific interval and it is measured by digital Multimeter of NI.

The automation of all input and output is done with the help of python language and all input ,output and details of pass and fail criteria is display on GUI.NI Virtual Bench application requires zero installation and can load automatically via Windows Auto play when connected through USB. Virtual Bench is an all-in-one instrument that integrates with PC .It combines a mixed-signal oscilloscope, a function generator, a digital Multimeter, a DC power supply, and digital I/O into a single device [11].

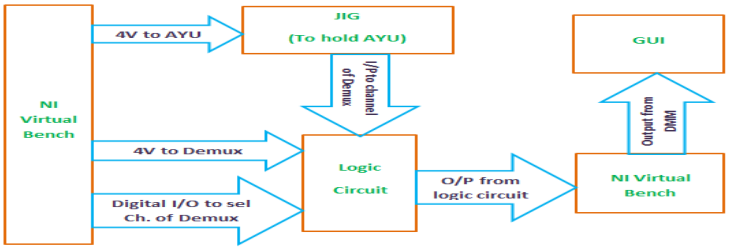

Fig.(2). Block diagram of ICT ATE

2. Acoustic Test

The power supply from NI of 12V is given to Power Amplifier and 3.3V to Mic circuit and frequency of range 100 - 1KHz from function generator is given to Stereo Amplifier Left channel input. Stereo amplifier produce amplified frequency which is given to speaker where chest piece is attached and output of chest piece is given as input to AYU device which produce amplified and filter sound. This sound is given to mic circuit. Output voltage of mic is taken by CRO and with the help python language it will plot graph of voltage versus frequency. The automation of all input and output will be done with the help of python. GUI is created with the help of PyQt5 where we need to put device ID and click on start to start testing and automatically it will store result in particular folder.

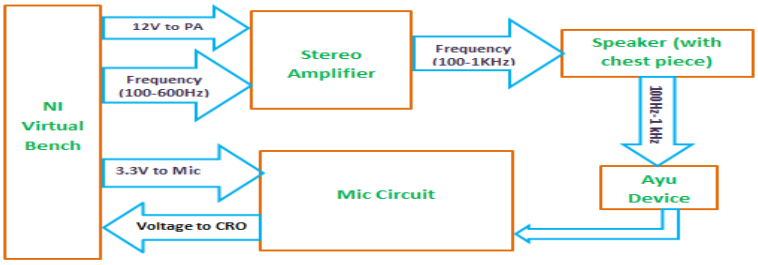

Fig.(3). Block diagram of Acoustic ATE

III. IMPLEMENTATION

A. In Circuit Test

1. Hardware

In this experiment JIG is used to hold DUT for test and logic circuit to link jig and NI Virtual bench.

1.1 PCB of JIG and Logic Circuit

Jig PCB is used to hold assembled PCB [6].It consist of pogo pins which will be directly get connected to PCB through via points and it will give appropriate voltage of particular point.[7] The circuit designing of jig is completed using multisim. PCB layout is done with the help of Altium. Logic circuit consist of 16:1 De-multiplexer IC .All voltage value from pogo pins are given to 16 channels of Demux and depending on select line of Demux ,particular channel voltage will be present at Demux output at fixed interval of time through python coding with NI virtual bench. Supply to logic circuit is given from NI Virtual Bench

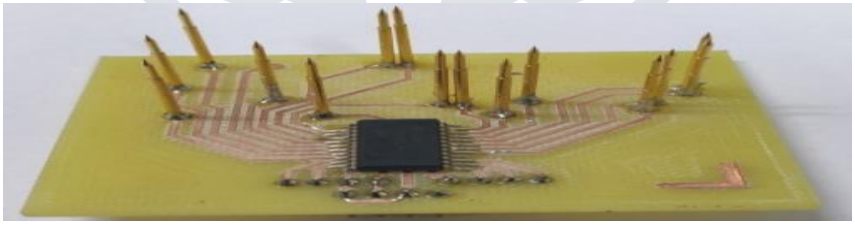

Fig. (4). Logic circuit

1.2 Experimental setup

Below connection consist of PCB JIG, Logic circuit, assembled PCB to test and NI virtual bench. Assembled PCB is placed on JIG which contains pogo pins whose output is given to logic circuit. Logic circuit contain Demux IC, depending on channel of Demux selected via NI virtual bench I/O pins, the output of IC is given to digital Multimeter of NI virtual bench. The supply to digital stethoscope and logic circuit is given by NI Virtual bench.

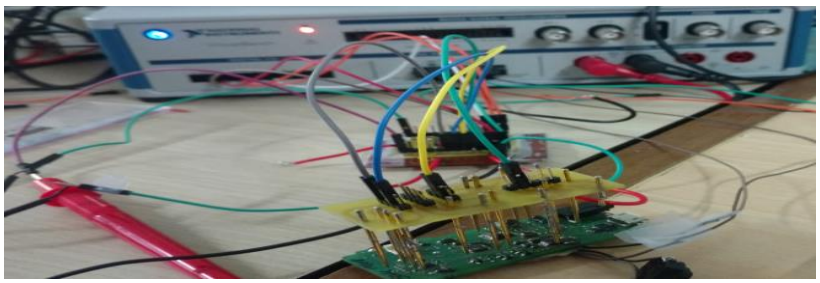

Fig. (5). Experimental setup of ICT

B.Acoustic Test

1. Hardware-MIC

Sound is a type of energy vibrating through a medium (such as air or water); this energy at particular specific range of frequencies, is recognized by the human ear as sound [9]. It is made up of three basic elements: Frequency, Intensity, and Timbre [9]. The microphone is responsible for converting sound signal to electric signal [10]. The intensity of the changes in sound pressure corresponds to the AC voltage amplitude generated by the microphone. Likewise, the frequency of the changes in sound pressure corresponds to the frequency of the AC voltage [9].

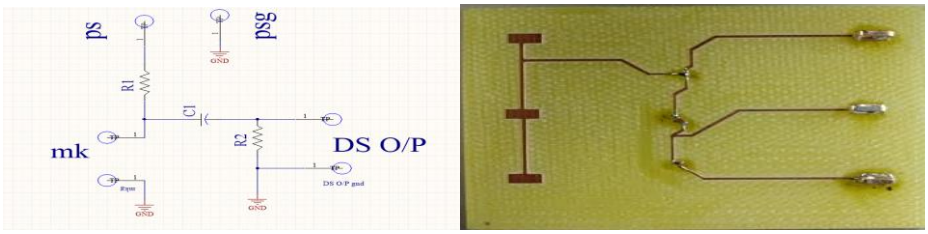

Fig.(6). MIC PCB for acoustic test

1.2 Experimental setup

The below connection is made according to block diagram of acoustic test which consist of stereo amplifier, Ayu Lynk, Speaker, chest piece, mic and NI Virtual bench. Frequency of range 100Hz to 1kHz is given to input of Ayu lynk and after processing from filter, amplifier section it produce graph of frequency versus amplitude .If amplitude at heart frequency i.e. 300 - 400Hz is maximum than other then device is Ok otherwise it will decided as faulty device.

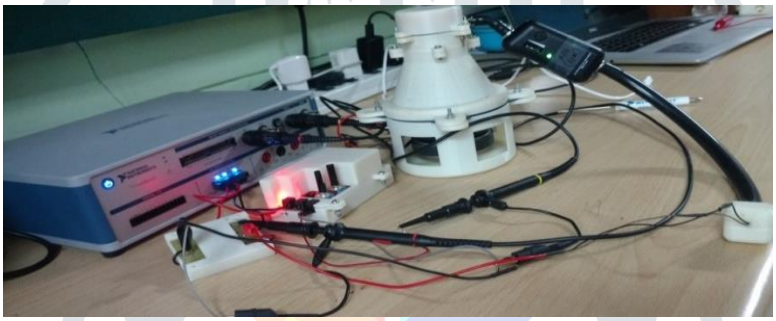

Fig.(7). Final hardware setup of ICT test:

2. Software- Software PyQt5 and Python is used in this project

The Selection of Python code is due to its compatibility with NI Virtual Bench [11].It is used to integrate NI virtual bench with JIG and to automate whole setup. Latest version is python 3.7 is used for showing final output. To develop Graphical user interface (GUI), PyQT5 is use to display all input, output detail and also pass and fail criteria

IV. RESULTS

Following step need to perform to obtain result

1. Open GUI of ICT and Acoustic test respectively which will look like below
2. Enter Device ID and model type on either ICT or Acoustic test and click on start.
3. After clicking on start of ICT, the main code will run at backend which will take voltage reading from PCB and compare with pre-defined values and after completion it will pop up result window with all pass and fail comments.

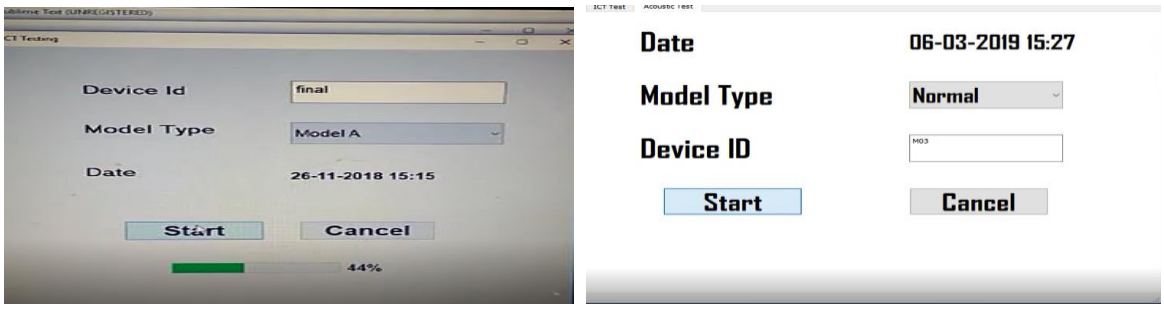

Fig.6. GUI of a) ICT ATE b)Acoustic ATE

4. After clicking on start on Acoustic test, the main code will run at backend and after completion it will pop result which will show graph of voltage versus frequency

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          Ayu ICT Testing Report
Date - Time : 27-11-2018 15:38
Model_type = Bluetooth Device
Charger IC VCC:   3.3641   True
Headphone I/P:    3.2822   True
Red Led:          1.6010   True
Stat:             1.6734   True
VO Postive:       1.5543   True
VO negative:      1.5584   True
V positive:       3.2823   True
LDO T1:           1.2033   True
Final Result : PASS
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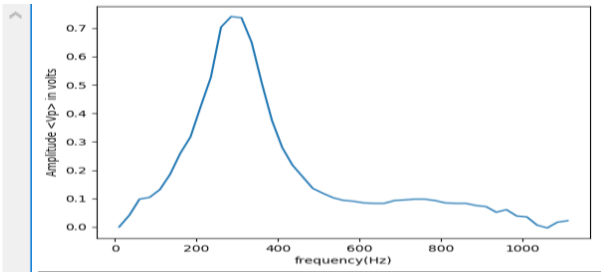

Fig.7. Final results a) ICT test result b) Acoustic test result

V. CONCLUSION

Product Test equipment of digital stethoscope with given specification is developed successfully. This product has inbuilt capability to locate and diagnosis the faults and automatic store result in define path. The circuit has components with large tolerance but when using components with less tolerance shall give better results. More features like current test, continuity test and combine GUI of ICT and acoustics test can be added on future development on which I will work further during my dissertation

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