

Interim Report

by Christopher Milner

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Interim Report

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1 Proposal

1.1 Summary

This project is focusing on a device produced by Aber Instruments called a probe tester. Currently when our devices are used in a manufacturing environment by a biotech or pharmaceutical company they perform three tests on our equipment as part of their due diligence process as required by local regulations. These three tests are a signal simulator test of the instrumentation which ensures it is reading within given tolerances, a standard conductivity test comprising of the measurement of a known value solution with the instrumentation and the probe ensuring that both are within tolerance and finally a probe test which tests the internal circuitry of the probe for liquid ingress, board corrosion and electrical continuity from the connector to the electrodes.



Figure 1 Current Probe Tester

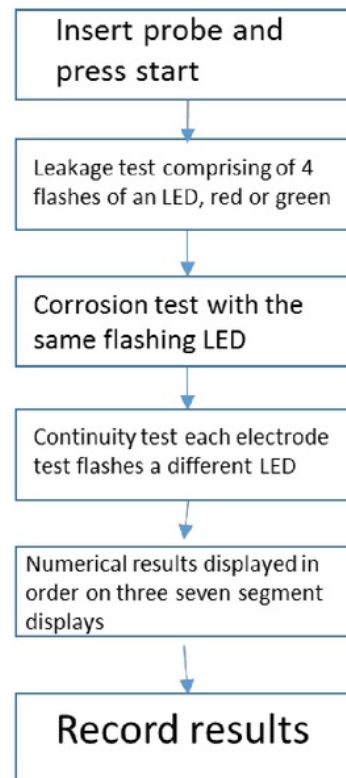


Figure 2 Flow Chart

This final test will ensure the reliability of the probe throughout the application which could be a fermentation or bioreaction of several thousand gallons, lasting days or weeks and costing hundreds of thousands of dollars. Our customers regard these tests as very important not only from a compliance point of view but also financially.

The consensus is that the current device is diligent but not convenient in so far as the readings it gives are quite accurate but they are somewhat difficult for the less technically minded to first acquire then also interpret. The results must also be recorded by hand leaving the process open to human error from writing down incorrect readings to, in some instances not recording them at all. This is an issue when the Federal Drugs Administration conducts an audit of the due diligence process and documentation, or in the event of a catastrophic failure of the fermentation or hardware, claims on liability insurances.

1.2 Objectives

A redevelopment of the current tester is long overdue and this will give the company the opportunity to rectify most if not all the issues fed back from the customers. These will include a way of storing the data on the device and exporting it electronically in a commonly used format, and a more intuitive user interface. This will mean that most of the project will involve writing code of one language or another dependent upon the final solution chosen.

The design work will be carried out in work time to the point of having a working prototype completed ready for testing.

I will be joined on the project by Peter Twiddy who will oversee progress on the project, Tim Pryce the R&D director who will approve any purchases and work carried out in stages and Tomas Chapot who will give advice on and approve any programming carried out.

1.3 Tasks and Time Scales

Roles and Responsibilities

My role in this project is to design a circuit and create a program to collect store and export data. I will be responsible for the design fulfilling the specification and being completed on time. The R&D project manager will oversee the project and ensure that deadlines are being met and the budget is adhered to. The R&D director will fill the role of technical mentor, answering questions and helping solve any problems that may arise.

Health and safety

Any work undertaken in any department must be done whilst adhering to Aber Instruments Health and Safety policy. This follows guidelines and legislation laid out in the Health And Safety At Work Act 1974. Whilst there will not be any requirements to use any heavy machinery, there are risks involved with using computer display equipment which must be correctly adjusted. Also in the build phase of the project it will be necessary to use soldering irons, scalpels and equipment driven by compressed air. All these items have risk assessments carried out on them on a regular basis and are a guide on their safe use.

2 Research

The current probe tester carries out three tests on the probe to ascertain its health. The first is a corrosion test. The probe is made from a stainless steel tube with a PCB running down its length. When in use the probes are subjected to extremes in temperature. This can cause condensation to form inside the probe, corroding any copper tracks that the moisture lands on.



Figure 4 Probe Internals

Figure 4 shows a 220mm long probe in its finished state, alongside the internal PCB assembly. The PCB is double sided with 5 tracks and a ground plane running its entire length. According to (Tong, 2016) the anodic index of copper, either solid or plated is 0.35 and the index of stainless steel is 0.50. This means that when the two metals are in contact with each other either physically or through a conductive medium they will produce an electrochemical voltage of 0.15V. This figure is the absolute maximum limit for bimetallic applications in environments subjected to high humidity or salt water. Any more than 0.15V and a significant amount of galvanic corrosion will take place.

The design of the probe is such that the steel and copper never come into contact under normal conditions so any voltage present in the PCB tracks is an indication that there is a problem. The current probe tester has a pass criteria of >50mV and will fail if any of the connected plug pins has a greater voltage than this. The accuracy of this measurement can be increased by altering the gain value of an IN114 precision instrumentation amplifier. This component is used in the current device but only has a gain of 1 meaning that a 50mV signal is being read by an analogue pin with a 0-5V range. A gain of 10 or 20 would increase the threshold voltage seen by the processor and subsequently increase the resolution of the measurement.

The second test performed detects whether there has been any liquid ingress into the probe. The probe tip screws into the end of the stainless steel body and is sealed using a silicon o ring and Loctite 542 thread sealant. This seal can be subjected to the pressure of tens of thousands of litres of whatever medium is being measured and is a potential failure point. Also the probes are usually cleaned by autoclave subjecting the seals at both ends of the probe to steam at a temperature of 120°C and a pressure of 2.2Bar. This can cause failure of the seal o ring between the plug and the body and the o ring in the plug cap.

To test if any liquid has got inside the probe, the impedance between each track and the ground plane is measured. In the current probe tester this is done by calculating the resistance from the centre tap of a voltage divider with a known resistance on one side and the resistance of the probe on the other. A regulated 5 volts is applied across the divider, allowing the dynamic measurement range to fill the 0-5v analogue to digital converter.

The final test is a simple test of signal continuity from the pins in the plug through to the electrode rings in the tip. This is done in a similar fashion to the leakage test with the output being measured from the centre of a voltage divider.

3 Specification

3.1 Technical Specification

The accuracy of the new probe tester must be equal to or greater than that of the original device.

The new probe tester must have a method of digitally storing the test results.

The test results must be able to be exported digitally.

3.3 Budget

The work for the development of the device will consist mostly of writing code and therefore the cost will be made up mostly of man hours. This means that a figure will can't be accurately predicted. A starting budget of £1000 has been agreed which can change as the project progresses.

5 Project Plan

6 Design Requirements

7 Discussion and Conclusion

7.1 Three Potential Solutions

7.1.1 Solution One

The first solution uses a plain enclosure with no user interface apart from a pilot light to show the device is active. The connectors for the probes and a USB-B socket will be the only external details. This enclosure will connect via USB to a computer or laptop running the companies own software that is already in use in the vast majority of installations. By modifying the software, the probe test can be easily integrated along with electronic data export options, with the ability to write data to the probe memory already included. The device will use USB bus power, negating the need for a portable power solution.

7.1.2 Solution Two

The second solution will be a stand-alone desktop device with a large display showing a step by step guide on the use of the tester to 'fool proof' its operation. This display will also allow the switching between user level modes and drive the exporting of the data via USB pen drive.

7.1.3 Solution Three

The third solution retains the portability of the current device, being hand held and battery powered. It is similar to solution two in that it will have a display for instructions all be it smaller and lower powered.

8 References

Tong, X. C. (2016). *Advanced Materials and Design for Electromagnetic Interference Shielding*. CRC Press.

Interim Report

GRADEMARK REPORT

FINAL GRADE

GENERAL COMMENTS

Instructor

40/100

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GRADING FORM: CSG-RUBIC

CHRISTOPHER MILNER

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RESEARCH-INFORMED LITERATURE



Research is good but must use refs - 9/25

9/25

KNOWLEDGE AND UNDERSTANDING



Reasonable proposal.- 5.5/10 Good spec. 3/5
Design requirements needs work.- 4.5/10

13/25

ANALYSIS



Testing plan needs more work.- 4/10 Good start
with conclusion. 5/10

11/20

PRACTICAL APPLICATION AND DEP.



Good chart. 3.5/5 Quality is good, but lacks
content. 2.5/5

6/10

SKILLS FOR PROFESSIONAL PRAC.



Reasonable, but needs more work. - 5.5/10
Presentation - 5.5/10

11/20