DESIGN INTERFACING CIRCUIT OF MEASURING ELECTRIC PROPERTIES

Aliaa S. Al- Jubair, Kerima M. Ziadan Salma A. Mahmood
Computer Department Physics Department Computer Department
College of Sciences-University of Basrah

ABSTRACT

The present paper describe the design of an interface for measuring electric conductivity of different materials. It is designed and built an interface circuit consists of three analogue / Digital converters and its accessories to engage it with Microcomputer through the card of parallel port of printer. The main aim of building this circuit is to measure the electrical properties such as voltage, current, and then electric conductivity.

The operating programs for this circuit runs under MSDOS environment for the sake of controlling its operation and calculating the required results later.

KEYWORDS

Interface, electrical conductivity, digital converters

LIST OF ABBREVIATIONS

Symbol	Definition
PC'S	Personal computers
PI	Pentium 1
ECG	Electrocardiogram
ITO	Indium - Tin - Oxide

INTRODUCTION

Industrial revolution caused in giant development in the electronic field, electronic system including computer industry witnessed a continuous developments after inventing the large scale integrated circuits[1].

The appearance of the microprocessors at the onset of seventies of the last century such as 80386 led to make a giant improvements in manufacturing PC's, as it was anticipated parallel processing techniques increasing the capacity of memory and processing speed rate of these memories to be qualified with the continuous increase in successive processor speed (40486, PI, PII, PIII, PIV); furthermore, these developments a compromised with a great increase of hard disk's capacity which led to increase the storage capacity of modern software which is working with the configuration of Windows operating system[2].

Thus computer become a tool of a wide range of uses in all fields of real world (scientifically, industrially, and administrationally) as it is used the computer in the scientific

laboratories to perform different tests and analyses[3,4]. In addition to use it in an industrial control system through connecting the computer with the external environment through output / input ports provided by interfacing cards.

Interface between Computer and Systems

Owing the complications occurred in the field of new artificial which Man is mostly disable to control it manually, also the difficult of making experimentally measurements for lots of them, which needs a long and continuous hard work. Therefore, automation these artificial systems is very useful specially in case of routine operations such as display, measuring, or test for several components as well as its advantage for complicated operations of multi inputs and outputs or remote controlling or dangerous operations.

For the above mentioned reasons we use computer as a typical means to solve such problems easily and quickly.

Manufacturing different interface cards which are compatible with Personal Computers (PC's) effect on spreading of using computer in this important field, these cards contain digital input / output ports to deal and processed input / output digital data from and into the device in which the computer should be connected.

Similarly, these cards may contain Analogue / Digital (A / D) converters by which the computer could process the analogue signals transferring it into digital value. These cards may also

contains Digital/ Analogue (D / A) converters by which it could transferred output digital value of the computer into its match analogue value relevant to the system to be processed by the computer.

To complete the requirement of interface connecting between the computer and different systems, it is needed to append sensors to read different measurements of the system in addition to actuators excited computer instructions. Fig (1) shows the interface connection between the computer and another different system.

- **Data Acquisition Part**

  In data acquisition part, information is acquired from real world; which may be physical quantity; must be prepared to process in order to convert it into data processed via computer [5], data acquisition part can be subdivided into [6] :

  a- Sensor: Generally they're devices which convert energy from one form to another, it produce a signal which is continuous representation of the measurements and converts it in to an analogue electrical signal.

  b- Signal conditioner: It is a part conditions the signal and makes it suitable for conversion into a digital signal by (A/ D) converters, because the signal that came from the sensor might not be suitable for direct into

continuous processing[7]. Filtering or amplifying operations may be included in this part.

c- A / D converter: In many cases digital representation to the analogue signal is preferred so that this signal will be ready for processing by computer.

- **Data Processor Part**

This part deals with processing the digital data in computer

using software programs.

- **Data Distribution Part:**

This part usually provide many outputs towards the target object which develops the system or to control it. This part consist of :

a- (D / A) converter: After the data are processed, we have to converted the digital signal again into an analogue signal.

b- Signal condition: In this part the signal conditioned in order to suit the actuator.

c- Actuator: Finally, the analogue signal is delivered to an actuator or output transducer. The information is often converted into a non-electrical form, able to activate a switch, a valve, an indicator, a type of display, etc….

REVIEW ON THE PREVIOUS DESIGN

There were many attempts in this aspect for example a study focused on measurement of size distribution by forward light scattering for particles suspended in a solution, specially designed interface circuits is built and data equation using IBM personal computer. Calibration of the system and testing have been achieved using five sizes groups of methyacralate and sephadax particular which was prepared by metallic sieve filtration[4]. Another study dealt with a computer based data acquisition and computing and connecting it with TGA device via IBM printer port for personal port, then measured the temperature and the lose of the sample weight using many equations that controls the subject[3]. The third attempt was the study of construct a set of electronic circuit operating, which interfaced with a personal computer as an (ECG) device known by physicians and those working in health centers[8]. The last attempt was depended on designing of PC hardware / software implementations investigated to introduced the signal processes for the measurement in the power system. The interface circuit is applied to 3- phase system as an equipment for measuring power factor, supply frequency, lead / lag indication and face sequence indicator[9].

Our research deals with Designing Interfacing Circuit of Measuring Electric Conductivity for Different Materials.

Interface Design

The design of each interface of computer includes two parts:-

1. Hardware of the card which is connected with computer through parallel printer port.
2. Software: It is the part organizes and operates the hardware.

Interface Hardware

Hardware design of each simple interface satisfies the forward requirements of that design, it should be returned the required objective to be achieved in respect of the performance of that interface under different conditions. To realize this object, we should measure three variables in the experiment:

1. Voltage applied on pattern.
2. Current passed the pattern.
3. Ambient temperature of the pattern.

As it is known, the values of the above mentioned three variables are analogue values, then it is needed A/D converters to transform these values in digital data that can be read by the computer.

Analogue to Digital (A/D) Converters:

It is Selected A/D converter of AD574 type[10] for the following reasons:

1. As to the simplicity of that converter and that there is no need for external pulse (clock) as it is generated inside the converter itself.

2. Speed of converting.
3. Number of output bits of this converter are twelve digitals which leads to the high accuracy in measuring as the number of levels could be felt along with analogue imputer of the converter equals to 2^{12} (= 4096 levels).

   A/D converter above mentioned can be received one analogue signal only as it has on input only, almost analogue multiplexers are connected to extend analogue inputs through connecting it by analogue multiplexer and then connected the outputs of that multiplexer with one input of analogue converter as shown in fig.(2)

Thus it can be used one converter to read three variables or more. To ensure the accuracy of measurement especially that regarding to measure the stability of the pattern, it is used three converters to ensure reading these variables at the same moment, as it is excited three converters at the same time by connecting signals of Start of Conversation (SOC) of these converters together as shown in fig. (3)

As in fig. (3) it is noted that the number of digital bits resulted from converting three analogue values in 36 Binaries, as we mentioned before, engaging the card with computer is through parallel line printer card which contains three ports (PC) interfacing as follow:

1. Output Data Port.
2. Input Data Port.

3. Output Card Port.

It is known that input port in case of the printer is the only input port contains five bits only as it need four of which to read 36 Binaries. Thus, it should be read these binaries in groups (clusters (by using Digital multiplexers as it is selected IC 74LS285[11], which contains four digital multiplexers of 1 to 2 types. Thus, this circuit has eight inputs, four outputs and two control signals (A/B, G) as shown in fig. (4).

To read 36 digital bits which are the outputs of three converters, it is used six circuits of 74LS285; two circuits for each converter, fig (5) shows the method of connecting six circuits.

It is noticed that it is connected four outputs of both six circuits together which connect after them to bits of input port of status port for the printer card.

By looking at fig (5) and table 1, we see that it can be read digital bits (36 bit) of three connectors divided by nine successive groups by controlling seven signals which are selected signals and six enable signals for six circuits of multiplexers using 3 to 8 decoders.

Decoder Circuit

To complete designing the interface, it is selected decoder of (74LS138) type [11,12] contains three inputs and eight outputs. It is connected inputs to the ports of data outputs for printer card to generate the required address. It is used seven outputs of the

decoder to control reading digital data by using the multiplexer circuit mentioned above.

Depending on fig. (6) and table (2) we can summarize the addresses that use to operate the interface.

The algorithm of operating the interface : it is simple algorithm that collect the data of the three signals : Voltage, current, and Temperature. As shown in the appendix1.

RESULTS AND DISCUSSION

After connecting the previous circuit we get the final design of the interface circuit as shown in fig. (6). And in order to check the efficiency of the previous design we made a simple experiment to check the work of the A/D units. Also before that as we said we must do a signal conditioning because the A/D might accept only a voltage signal as input.

So we connect a resistance and measured the voltage generated at the ends of the resistance which is equal to the B end of the sample as shown in fig. (8)

To calibrate the values of analogue / digital of voltage and current figs. (9,10,11) show the calibration operation.

After the success of this experiment, we examine the designed circuit on (ITO) sample to check its stability and conductivity measurements and compare them with those measured manually as shown in fig (11,12) and table (4).

CONCLUSIONS

This paper verify the efficiency of the interface , it is compare it against the results that were taken by manual measurements with those were taken by the aid of computer. The results revealed the efficiency of the interface circuit and high accuracy as well as the speed in performing the measurements.

REFERENCES

1) J.Millman, "Microelectronics: Digital and Analog circuits and systems", McGraw- Hall, 1984.
2) W.A. Triebel, "The 80386, 80486, and PENTIOM PROCESSORS: hardware, software, and terfacing", Prentice- Hall, Inc., 1998.
3) K.R Radhi, "A computer Based Data Acquisition and computing, TGA via IBM printer port", M.Sc Thesis, Collage of Science, Basrah University, 1998.
4) H.L. Saadon "Measurements of size distribution of suspended particles by laser beam scattering and its applications", M.Sc. thesis, Collage of Science, Basrah University, 1996.
5) W. Bolton, " Measurement and instrumentation systems", 1986.

6) A.FP. Van Putten, “Electronic measurement systems”, I*o*P publishing UK, 1996 .

7) “How to choose a data acquisition system”, Internet outline, http://seminars Adaptsscience.co.uk, Feb. 26,2001.

8) ثـورة عبـد الحسـين شـريف، "اسـتخدام الحاسـبة المايكرويـة فـي تخطيط كهربائيـة القلـب، اطروحـة [8]السيطرة علـى جهـاز ماجستير، كلية العلوم ،قسم الحاسبات، جامعة البصرة، 2001.

9) S.S. Hardan, “ Study of PC Interfacing for measurement in power system”, Diploma thesis, College of Electrical Engineering, Basrah University, 2001.

10) Analog devices , “Complete 12 – Bit A/D Converter”, www.analog.com/uploadeted files, Data sheet/267824459ad594.A.pdf Printed in one Technology way, USA, 2000.

11) "SIGNETICS CORPORATION", copyright 1974.

12) Industrial commercial Entrainment, "ECG semiconductors Master Replacement guide", copyright by Phillips ECG, Oct.1995.

Table (1)
Truth Table of multiplexer

INPUT				Output
Enable	Select	A	B	
H	X	X	X	Z
L	L	L	X	H
L	L	H	X	L
L	H	X	L	H
L	H	X	H	L

H= High level L= Low level X= Irrelevant
Z= high Impedance(off)

Table (2)
The truth table of (74LS138)

INPUTS					OUTPUTS							
ENABLE		SELECT										
G1	G2	C	B	A	Y0	Y1	Y2	Y3	Y4	Y5	Y6	Y7
X	H	X	X	X	H	H	H	H	H	H	H	H
L	X	X	X	X	H	H	H	H	H	H	H	H
H	L	L	L	L	L	H	H	H	H	H	H	H
H	L	L	L	H	H	L	H	H	H	H	H	H
H	L	L	H	L	H	H	L	H	H	H	H	H
H	L	L	H	H	H	H	H	L	H	H	H	H
H	L	H	L	L	H	H	H	H	L	H	H	H
H	L	H	L	H	H	H	H	H	H	L	H	H
H	L	H	H	L	H	H	H	H	H	H	L	H
H	L	H	H	H	H	H	H	H	H	H	H	L

G2 = G2A + G2B
H= high level , L = Low Level
X = irrelevant

Table (3)
Address used to operate the interface

D3	D2	D1	D0	Operation
0	0	0	0	Read D8-D11 from A/D1
1	0	0	0	Read D4-D7 from A/D1
0	0	0	1	Read D0-D3 from A/D1

Continued-Table (3)
Address used to operate the interface

D3	D2	D1	D0	Operation
0	0	1	0	Read D8-D11 from A/D2
1	0	1	0	Read D4-D7 from A/D2
0	0	1	1	Read D0-D3 from A/D2
0	1	0	0	Read D8-D11 from A/D3
1	1	0	0	Read D4-D7 from A/D3
0	1	0	1	Read D0-D3 from A/D3
0	1	1	0	(STC)Start of conversation for analogue converters.

Table (4)
The Calibration between the Manual and Computerized Values of the Electrical Conductivity for (ITO) Sample

(k)	V(v)Comp.	I (mA)Comp.	σ (S/cm)Comp.	V (v) Man.	I (mA)man.	σ (S/cm)man.
313.5	1.274657	61.534	1.931	1.25	62.1	1.987
318	1.277053	61.407	1.923	1.26	62	1.968
320	1.309111	60.984	1.863	1.28	61.6	1.925
323	1.316487	60.857	1.849	1.29	61.5	1.906
325	1.294327	61.196	1.891	1.28	61.6	1.925
327	1.301641	60.984	1.874	1.285	61.5	1.914
331	1.333667	60.519	1.815	1.305	61.2	1.875
333	1.323801	60.646	1.832	1.31	61.1	1.865
335	1.355827	60.181	1.775	1.325	60.8	1.835
337	1.355796	60.138	1.774	1.33	60.8	1.828
339	1.387822	59.673	1.72	1.36	60.3	1.773
343	1.456636	58.447	1.605	1.43	59	1.65
345	1.532888	57.178	1.492	1.505	57.7	1.533
348	1.645897	55.106	1.339	1.61	55.5	1.378
350	1.64347	55.191	1.343	1.59	55.6	1.398
353	1.677861	54.556	1.301	1.65	55.1	1.335
355	1.697562	54.26	1.279	1.66	54.9	1.303
358	1.739392	53.584	1.232	1.71	54	1.263
360	1.7468	53.499	1.225	1.72	54	1.255
363	1.884428	51.046	1.084	1.86	51.4	1.105
365	2.002354	48.89	0.977	1.99	49.1	0.986
368	2.115581	47.114	0.891	2.09	47.5	0.913
370	2.27291	44.365	0.781	2.23	45	0.807

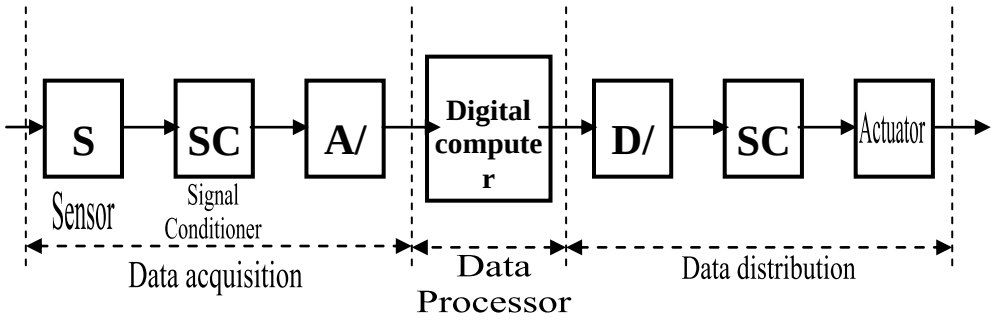

Fig (1)
Interface between Computer and Different Systems

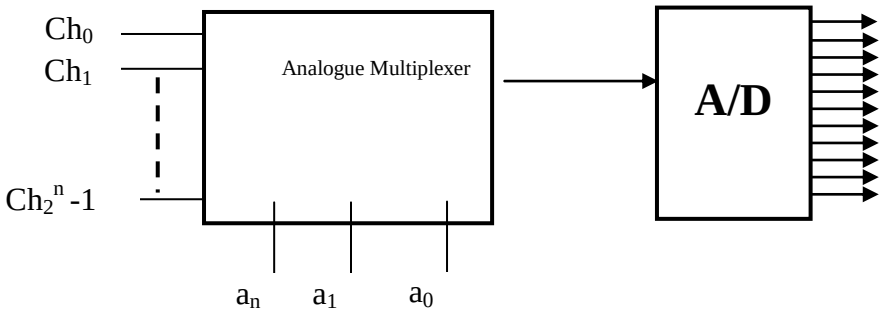

Fig. (2)
The Connection between A/D converters and analogue multiplexer

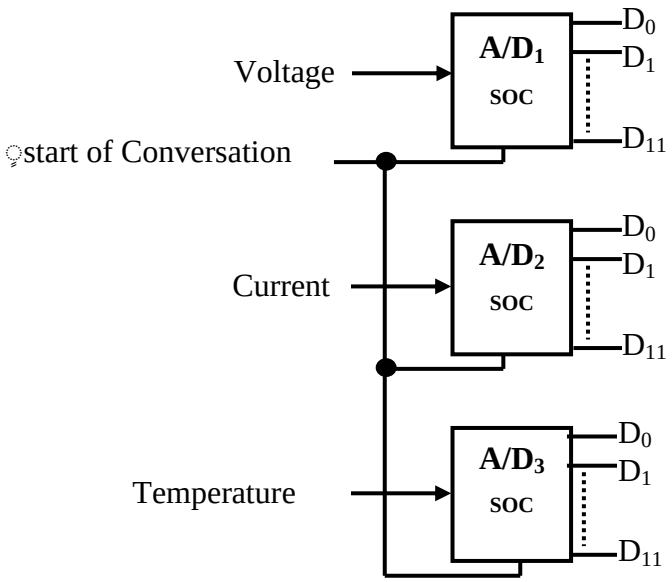

Fig. (3)
The Connection of Three Converters Working Together
Digital Multiplexer

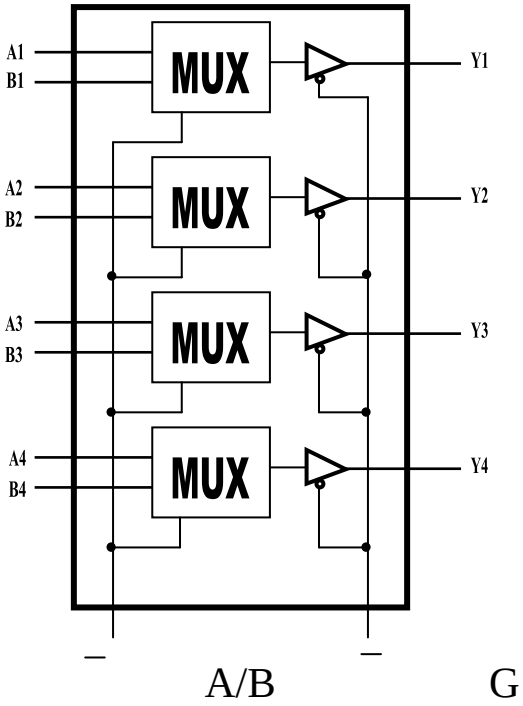

Fig. (4)
Block diagram for (74LS285) integrated circuit

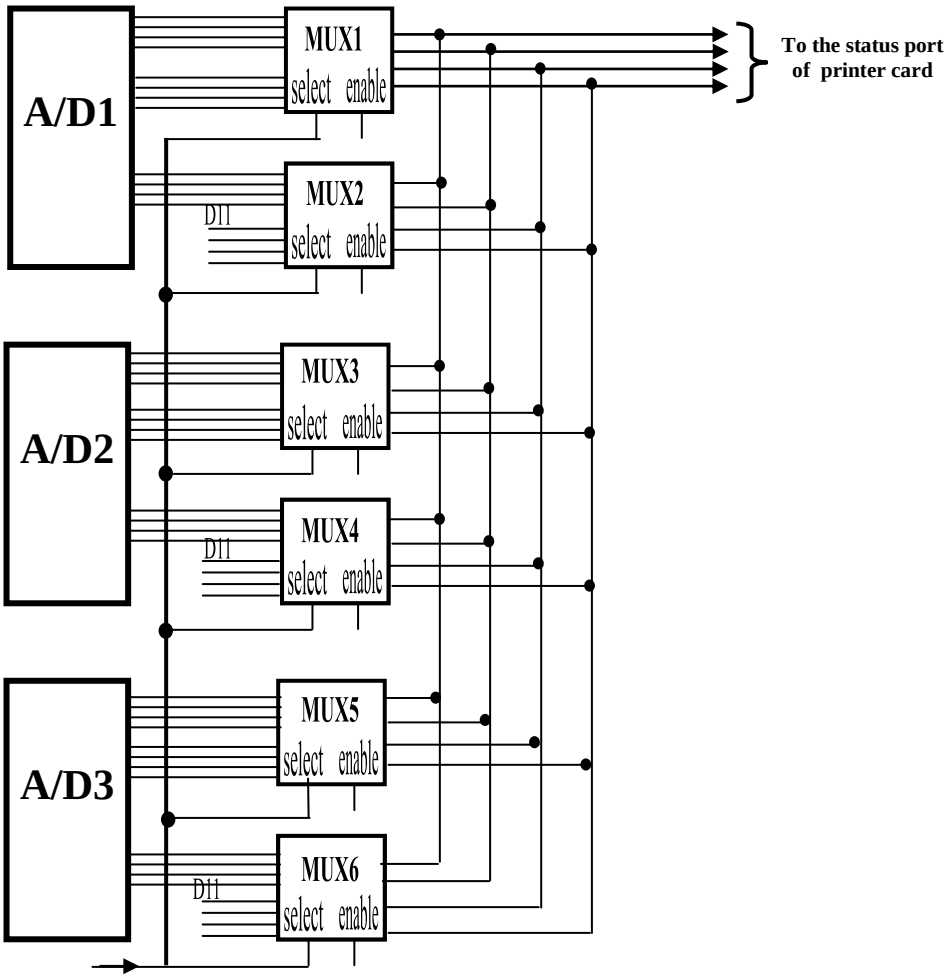

Fig. (5)
The Method of Connecting Six Multiplexers

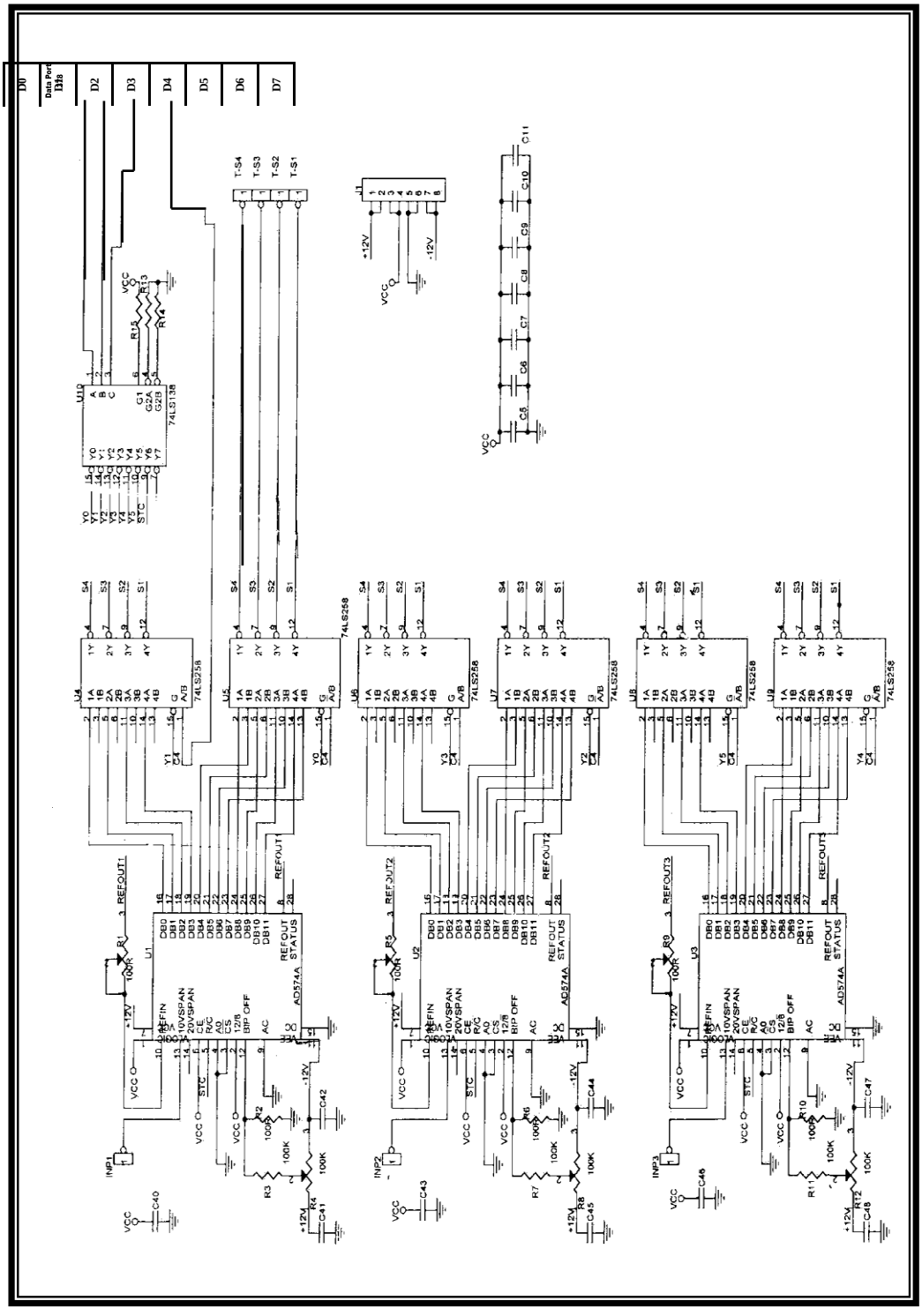

Fig. (6)The complete design of the Interface Software

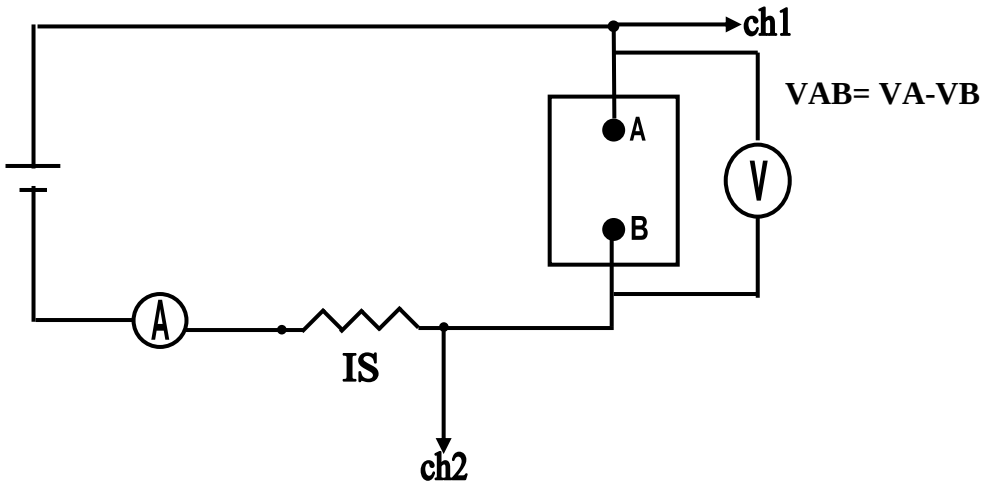

Fig (8)

Current signal condition circuit.

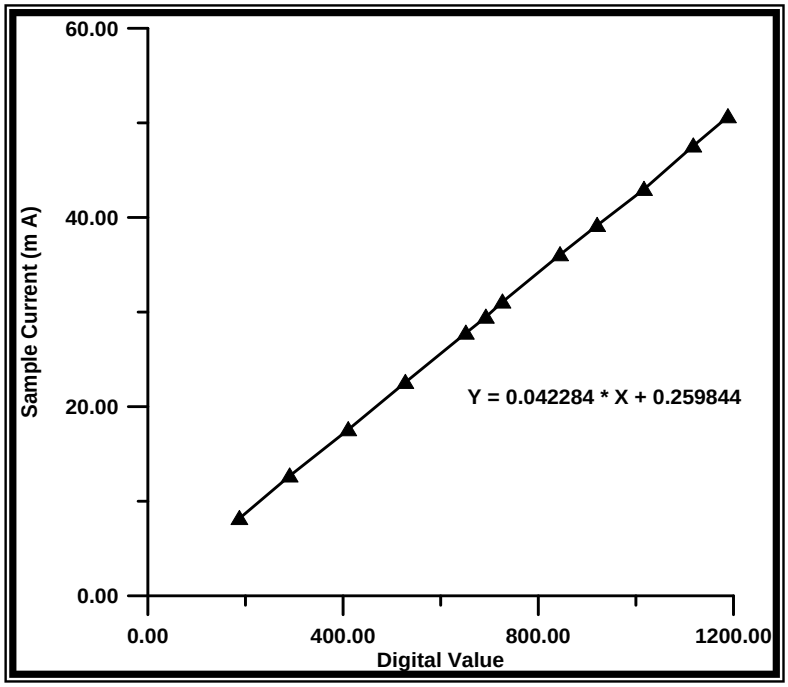

Fig. (9)
Current calibration of the sample with the digital value of the A/D converter

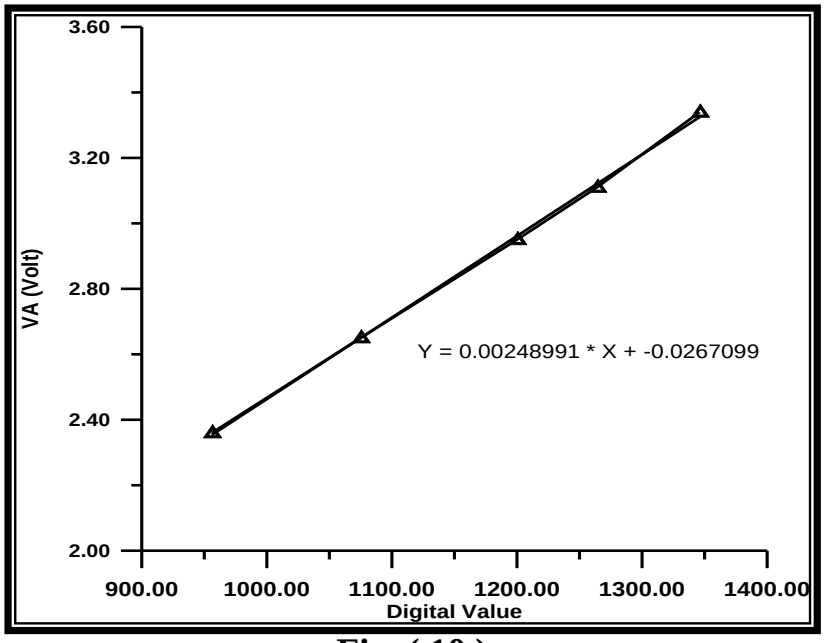

Fig. (10)
Voltage calibration of the end A with the digital value of the A / D converter

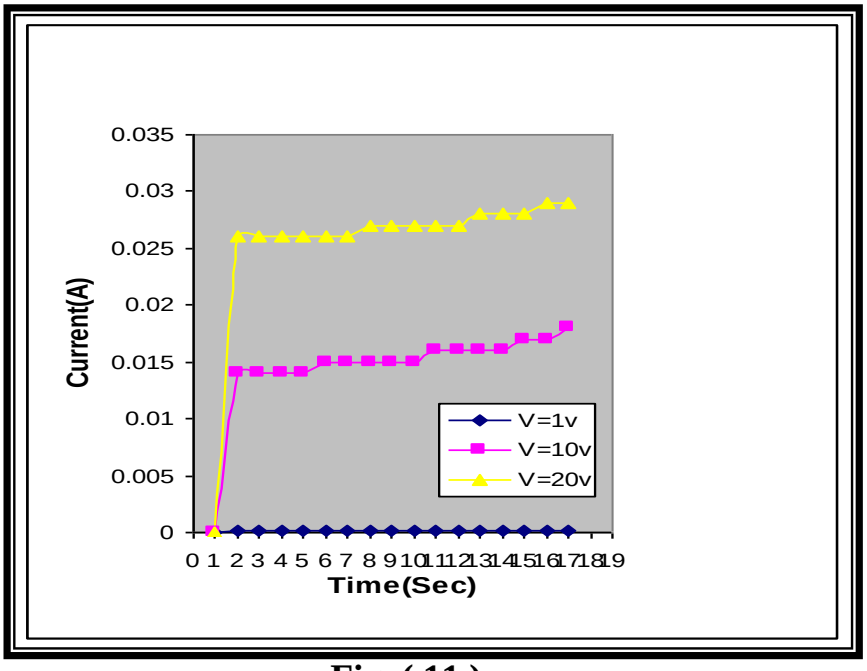

Fig. (11)
Manual measurement of Stability for (ITO Glass) sample

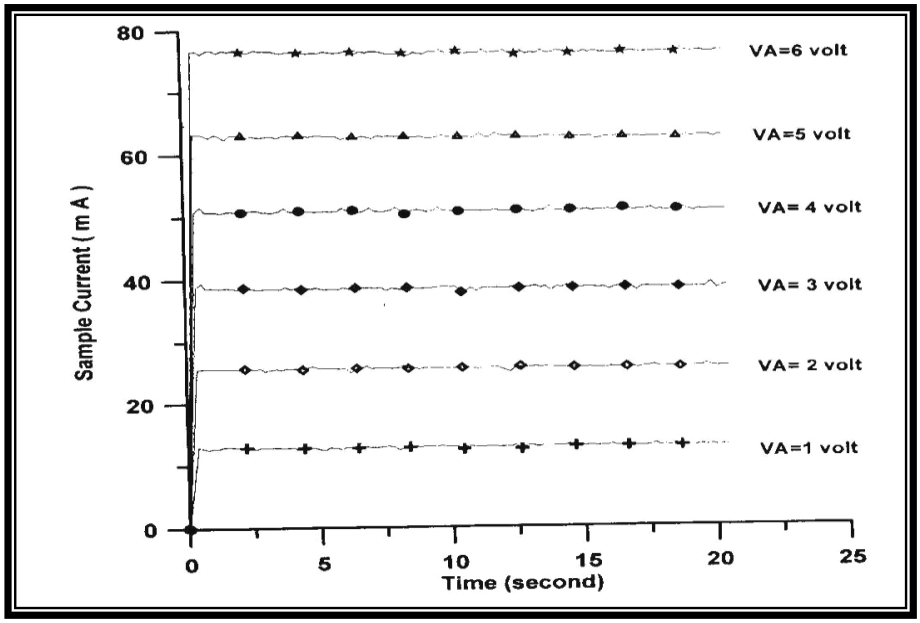

Fig. (12)
Auto measurement of Stability for (ITO Glass) sample

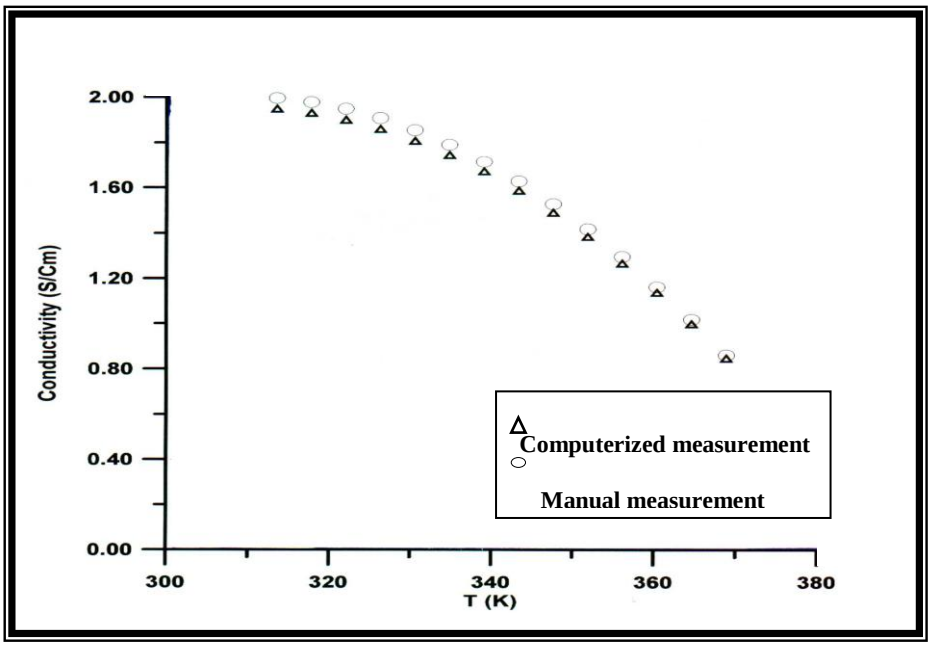

Fig. (13)
The calibration between the manual and computerized values of the electrical conductivity for (ITO) sample

تصميم دائرة بينية لقياس الخصائص الكهربائية للمواد المختلفة

علياء سعد الجبير، أ. د كريمة مجيد زيدان، د. سلمى عبد الباقي محمود
قسم علوم الحاسبات قسم الفيزياء قسم علوم الحاسبات
كلية العلوم –جامعة البصرة

الخلاصة

لقد تم تصميم وبناء دائرة بينية تتكون من ثلاث محولات تماثلية / رقمية والدوائر الملحقة بها لغرض تعشيقها مع الحاسب المايكروي من خلال بطاقة الطابعة المتوازية . الهدف الاساس من بناء هذه الدائرة هو قياس المواصفات (الكهربائية) للعينات المختلفة مثل التوصيلية الكهربائية والاستقرارية.

كما تم كتابة البرامج التشغيلية لتلك الدائرة لغرض السيطرة على عملها وحساب النتائج المطلوبة لاحقاً.

ولغرض اثبات كفاءة البينية تم مقارنة النتائج المأخوذة بوساطة القياسات اليدوية مع تلك المقاسة باستخدام الحاسب وقد اظهرت نتائج المقارنة فعالية الدائرة ودقتها العالية فضلاً عن سرعة انجاز القياسات.

الكلمات الدالة

دائرة بينية، التوصيلية الكهربائية، محولات تماثلية /رقمية.