(IJCSIS) International Journal of Computer Science and Information Security,
Vol. XXX, No. XXX, 2010

A LOW COST PC-BASED CURVE TRACER FOR STUDYING V-I CHARACTERISTICS OF 2-TERMINAL SEMICONDUCTOR-DIODE

Mst. Shayeala Pervin
IT Division
Sonali Bank Head Office
Dhaka, Bangladesh
shayeala@yahoo.com

Shamim Ahmad
Dept. of Computer Scienec and Engineering
Rajshahi University
Rajshahi, Bangladesh
shamim_cst)@yahoo.com

***Abstract*— The studying the Voltage-Current (V-I) characteristics of electronics derives is a very common experiments for the students of electronics engineering. This paper shows very cheap and convenient way to serve the above purpose. A very cheap older personal computer (PC) that has become almost unusable, canbe reused to study the V-I characteristic of semiconductor devices, which may be helpful for the students in the third world countries. An Industrial standard Architecture (ISA) card slot has been designed for the acquisition of necessary data and the necessary software has been developed to drive that card and to display the obtained data graphically on the monitor. In this work, the designed card has been used experimentally to study the V-I characteristic of a forward biased P-N junction rectifier and satisfactory result has been obtained**

Keywords-component; Microprocessor, ISA slot, Interfacing, ADC, DAC, Diode, I/O Ports.

I. INTRODUCTION

This is very common task for the students of electronics engineering to study the voltage-current (V-I) characteristic of different semiconductor devices [1]. Generally, students use some variable-power supply and ampere-volt meter to get necessary data to study the V-I characteristic of semiconductor devices and then plot the obtained data on paper. This process takes huge time and has some chance of having reading-error. Moreover, it may need further analysis of the obtained data. In this regard, several curve tracer has been designed [1] and a lot commercial curve tracer are available in the market, for example, Tektronix 370A Curve Tracer, price $26,995, Tektronix 370B Curve Tracer, price $34,950, Tektronix 576, 577D1 and 577D2 Curve Tracers, Measures DC Parameters for 2 & 3 Terminal Semiconductors, Tektronix 576-U Curve Tracer, price $3,395.00, Tektronix 577D1 Storage Curve Tracer, Test Two- and Three- Terminal Discrete Semiconductors etc. However, the prices of these devices are very high.

From this viewpoint, in this paper, a cheap approach has be presented obtain the V-I characteristic curve of 2–terminal semiconductor diodes by employing just a low-cost old-dated 386 series computer.

An Industrial Standard Architecture (ISA) compatible card has been developed where the 2-terminal semiconductors diode is to be mounted to have its V-I characteristic. A DAC (digital to analog converter), on that card, is used to provide necessary DC voltage across the diode and an ADC (analog to digital converter), on the same card, is used to get the varying voltage across the diode as well as a series register. Finally software has been developed to drive the card, to control the DAC and ADC, and to calculate the current passing through the diode needed to display its characteristic curve on computer monitor. An experimental data and curve that have obtained by using this card, it will be presented in this paper. In contrast with the high price of the available curve tracer, the total cost of this hardware is about 12 USD and at least an old-dated 386-series computer which are almost unusable right now.

II. V-I CHARACTERISTSIC OF 2-TERMINAL SEMICONDUCTOR DIODE

A diode is a two terminal device consisting of a P-N junction formed either in Ge or Si crystal. When the diode is forward-biased [1] and the applied voltage is increased from zero, hardly any current flows through the device in the beginning. It is so because the internal barrier voltage VB whose value is 0.7V for Si and 0.3V for Ge is opposing the external voltage. As soon as V_B is neutralized, current through the diode increases rapidly with increasing applied battery voltage. When the diode is reversed-biased [2], majority carriers are blocked and only a small current (due to minority carriers) flows through the diode.

III. DESIGN CONSIDERATION

The overall system design involves both hardware design and software design. The hardware design [3~6] provides the logic circuit for developing the system. The software controls the operation of the system and produces the desired output.

A. Hardware Design

Fig-1 shows the block diagram of hardware design. The hardware design requires the following major components [7], Rectifier Diode 1N10004, Operational Amplifier (LM741), the 555 Timer. The frequency of the clock generated by 555 is calculated by the relation $f = 1.44/(R_A + 2R_B)C$, where R_A, R_B are resistances and C is capacitance.

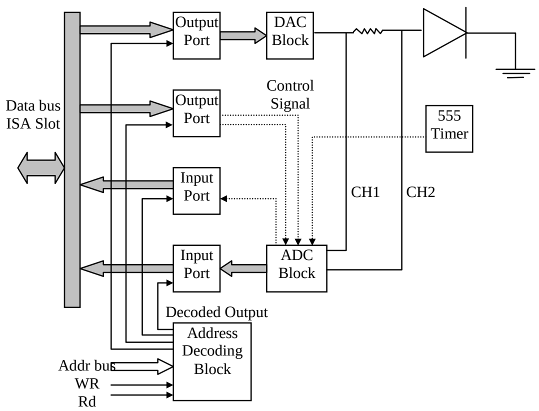
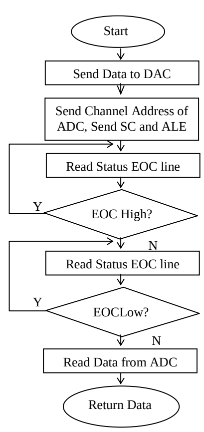


Figure 1. Blcok diagram of the hardware design.

In this design, R_A=1K, R_B=10k, and C=0.01μF, address decoder 74688, Bi-directional buffer 74LS245 Decoder 74LS138, Latch 74LS377 and ADC 0809 were used. The Data and address buses are come from ISA bus interface of the PC. Address decoding block generates decoded output to select the input/output port. DAC block converts the digital input come from the MPU to equivalent analog output. This analog output is used as the supply voltage to the diode characteristic circuit. Conversely, ADC block converts the analog input to digital output. The two channels (ch1, ch2) of the ADC have been used for reading the analog voltages across the resistor as in Fi[illegible] DC su[illegible]

Figure 2. Flow chart of the software.



B. Software Design

Small-dedicated software has been developed for controlling the ADC activities and plotting the forward characteristic curve of P-N junction diode. The software uses input port for reading digital data from ADC and output port for controlling the activities of the ADC. The program has been developed using C language [7] and contains two modules. One module is for plotting the characteristic curve and to send data to DAC. The other module contains a user defined function *data (unsigned char, unsigned char)* for controlling the ADC.

The other module contains a user defined function *data (unsigned char, unsigned char)* for controlling the ADC. The function sends the address of the channel, start conversion (SC) and ALE signal to the output port addressed 300H. The end of conversion (EOC) is monitored by constantly reading EOC pin of the IC through first bit of the input port addressed 300H. Once the EOC signal is received, the complete 8-bit digital data is read from the ADC. The function then returns the equivalent integer value of the read unsigned data. A flowchart for the part of the program is shown in Fig-2.

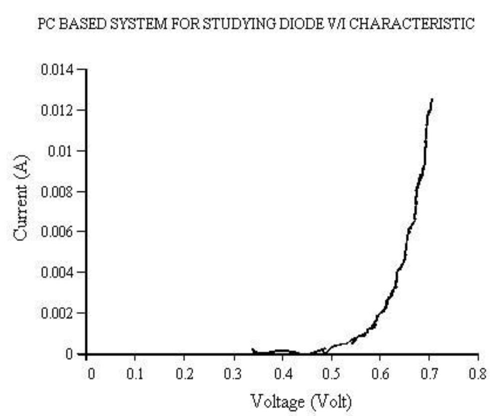
In this work, software controls digital data come from the MPU to the output port 377 that is to be used for the input of the diode. One channel (CH1) of the ADC is used to read the supply voltage V_A and another channel (CH2) is used to read the output voltage V_B of the circuit shown in Fig-1. Then the diode voltage is calculated by V_A-V_B and diode current is calculated by $I = (V_A - V_B)/ R$.

Port addresses are decoded as follows: Output port for DAC 301H; Output port for control signal of ADC 300H; Input port for control signal of ADC 300H; Input port to read data from ADC 301H. Bit 7 of output port 300H is used as a channel selector; when it is zero, channel 1 is selected and channel 2 is selected when it is 1. Bit 6 of output port 300H is used to give ALE and SC signal of ADC. Bit 0 of input port 300H is used to read the EOC signal of ADC.

IV. RESULTS AND DISCUSSION

Figure 3. Experimentaly found V-I Characteristic curve of P-N diode

A P-N junction diode was taken as a testing element for the experimental use of the proposed system, corresponding V-I



characteristic curve drawn by the system is shown in Fig-3.

The performance of developed system is at satisfactory level. As the ADC did not give the stable output, therefore, so to obtain more accurate value, the input readings were taken 50 times and then find the average. The forward characteristic curve had little error because of unavailability of resistance with precise value. With some modifications, the system will be equally applicable for displaying reverse V-I characteristic curve.

REFERENCES

[1] J. Millman, C. C. Halkias, Electronic Devices and Circuits, TATA McGraw-Hill Edition, 1994.

[2] U. Kumar, “Design of an indegenised negative resitance characteristic curve tracer”, Active and Passive Elc. Comp,, vol. 23, pp 13-23, 2000.

[3] D. V. Hall, Microprocessors and Interfacing: Programming and Hardware, TATA McGraw-Hill Edition, 1991.

[4] W. A. Triebel, A. S. The 8088 and 8086 Microprocessors: Programming, Interfacing, Software, Hardware, And Applications, Prentice-Hall of India-2002.

[5] M. Rafiquzzaman, Microprocessors: Theory And Applications- Intel And Motorola, Revised Edition, Prentice-Hall of India-2002, pp .

[6] R. J. Tocci, Digital Systems: Priciples And Applications, Sixth Edition, Prentice-Hall of India-1996.

[7] Microprocessor Data Hand Book, BPB Publications, 1992.

[8] H. Schildt, Turbo C/C++: The Complete Reference, Second Edition, .