iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 6 **Issue:** III **Month of publication:** March 2018

DOI: http://doi.org/10.22214/ijraset.2018.3213

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

Design and Development of an USB Interfaced NPN Transistor Curve Tracer

Taher Muhammad Mahdee[1], Atiquer Rahman Sarkar[2], Md. Mamunur Rashid[3]
[1, 2, 3]Dept. of Computer Science & Engineering, Bangladesh Army University of Science & Technology

Abstract: The available transistor curve tracers on the market usually directly shows the curves in an embedded display. They do not have any interface to connect with the computer. We are developing an USB interfaced portable and affordable Transistor Curve Tracer that displays the dynamic characteristic curves of NPN transistors. We are creating it around a PIC18f4550 microcontroller which has built in USB capabilities. It also has 10bit- Analog to Digital Converter (ADC). On the host side, we have developed a Graphical User Interface application to operate the device.
Keywords: Transistor Curve Tracer, USB interfacing, NPN transistor, IO Interface, Data Acquisition

I. INTRODUCTION

It is frequently needed to physically measure transistor parameters such as current gain, breakdown voltages, and impedance [1]. A transistor curve tracer is designed to provide the circuit conditions required to make these measurements. Our transistor curve tracer plots the static collector curve of an NPN transistor. It displays a family of curves of collector current, IC, versus collector-to-emitter voltage, VCE, for various values of base current, IB.

The existing NPN transistor curve-tracers are costly and often, do not have any interface with the computer [2]. We chose USB over parallel ports because parallel ports are hard to find in laptops and computers nowadays [3]. And almost all computers come with built-in USB ports. Since ease of use was primary in the creation of the USB, many features have been designed in to make USB devices among the easiest to install. USB devices are true “plug-and-play” [4]. The host PC automatically identifies a peripheral when it is plugged in, and searches for the software necessary to operate it. Anybody who can operate a PC can install a USB peripheral and have it running in seconds.

II. PRINCIPLE OF OPERATION

The curve tracer can generate and display a family of curves of collector current, IC, versus collector-to-emitter voltage, VCE, for various values of base current, IB [5]. Three basic functional circuits are used to generate this display:

A. A sweep voltage generator for control of the collector voltage,
B. A base current source which can be controlled to provide a number of equal increments of base currents with each sweep of the voltage generator,
C. A timing source to change the base current at the start of each voltage sweep.

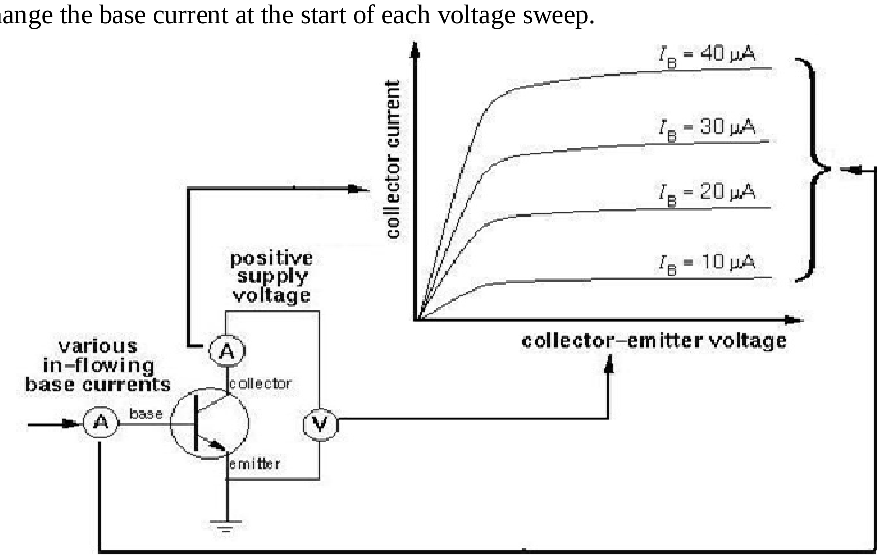


Fig 1 IC-VCE Curve of an NPN transistor

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 6.887
Volume 6 Issue III, March 2018- Available at www.ijraset.com

III. DESIGN AND IMPLEMENTATION

The procedure is to set a value of IB and hold it fixed while we vary VCC. By measuring IC and VCE, we get the data for graphing IC versus VCE. Since we know the VCC, VBB, RC and RB; and we get the value of VCE from the device, we can calculate the IB and IC as follows [6]:

$$I_B = \frac{V_{BB} - 0.7}{R_B} \quad and \quad I_C = \frac{V_{CC} - V_{CE}}{R_C} \tag{1}$$

Then we plot the IC, versus VCE, for various values of base current, IB.

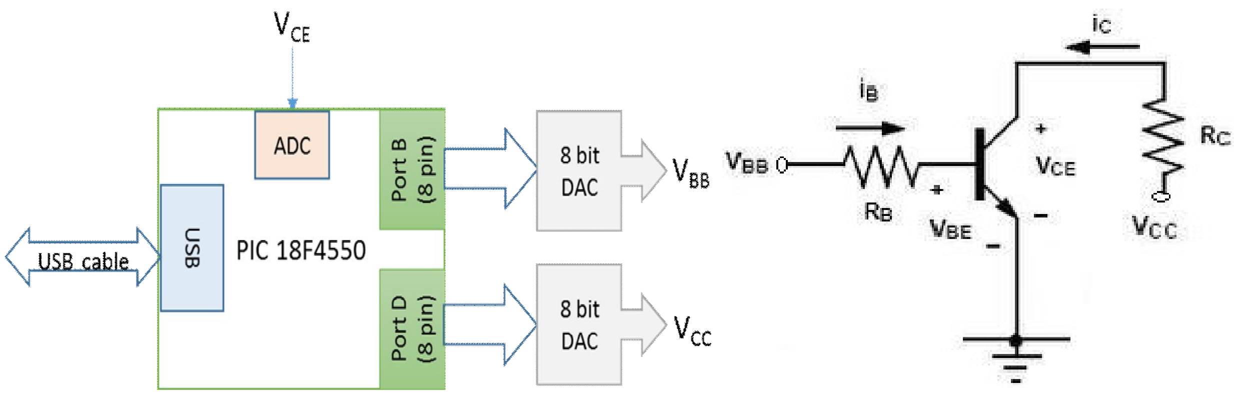


Fig 2 Schematic diagram

We used Windows' built-in HID (human interface device) drivers to communicate with the device. PIC18F4550 microcontroller was used to establish USB connectivity [7], to set the DACs, and to perform voltage readings. There's no need for a custom driver; the device uses the drivers included in Windows. Any device that can function within the limits of the HID specification (control and interrupt transfers only) may be able to be designed as a HID. C# was used on the host side software (any programming language that supports API function calling will do).

A. *The steps can be summarized as follows:*

1) Step 1: Enumerate the device with the host PC.
2) Step 2: Send from PC to device - the digital equivalent of VCC and of VBB values
3) Step 3: The device receives the data and set port B and port D accordingly
4) Step 4: Wait for the DAC conversion of the port B (VCC) and of port D (VBB) value
5) Step 5: Do the Analog to Digital conversion of VCE and send the value back to host PC
6) Step 6: The host PC writes the data in a file.
7) Step 7: Repeat step-2 to step-6 as many times as needed with different values to produce the curve.

IV. OPERATION

When the device is plugged in for the first time, the following “Found New Hardware” notification appears.

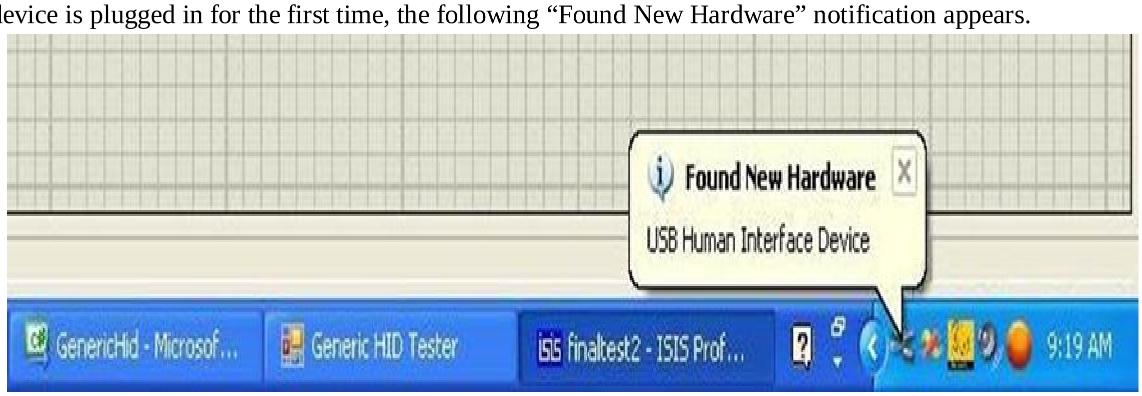


Fig 3 Connecting the Curve Tracer for the first time

We then open the host-side software and click on EXECUTE button. The microcontroller sends back 255 readings of VCE to the computer and saves them in a text file. We then open the text file and plot the IC-VCE curve using MS-Excel (could be done using any plotting tools, e.g. MATLAB).

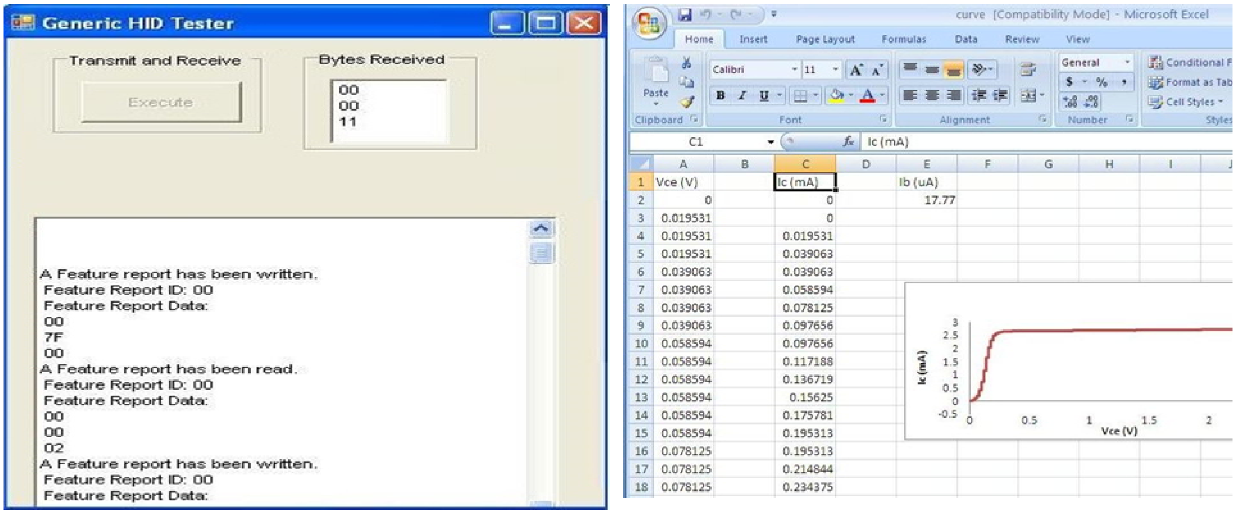


Fig 4: Host-side software and a plot of a reading

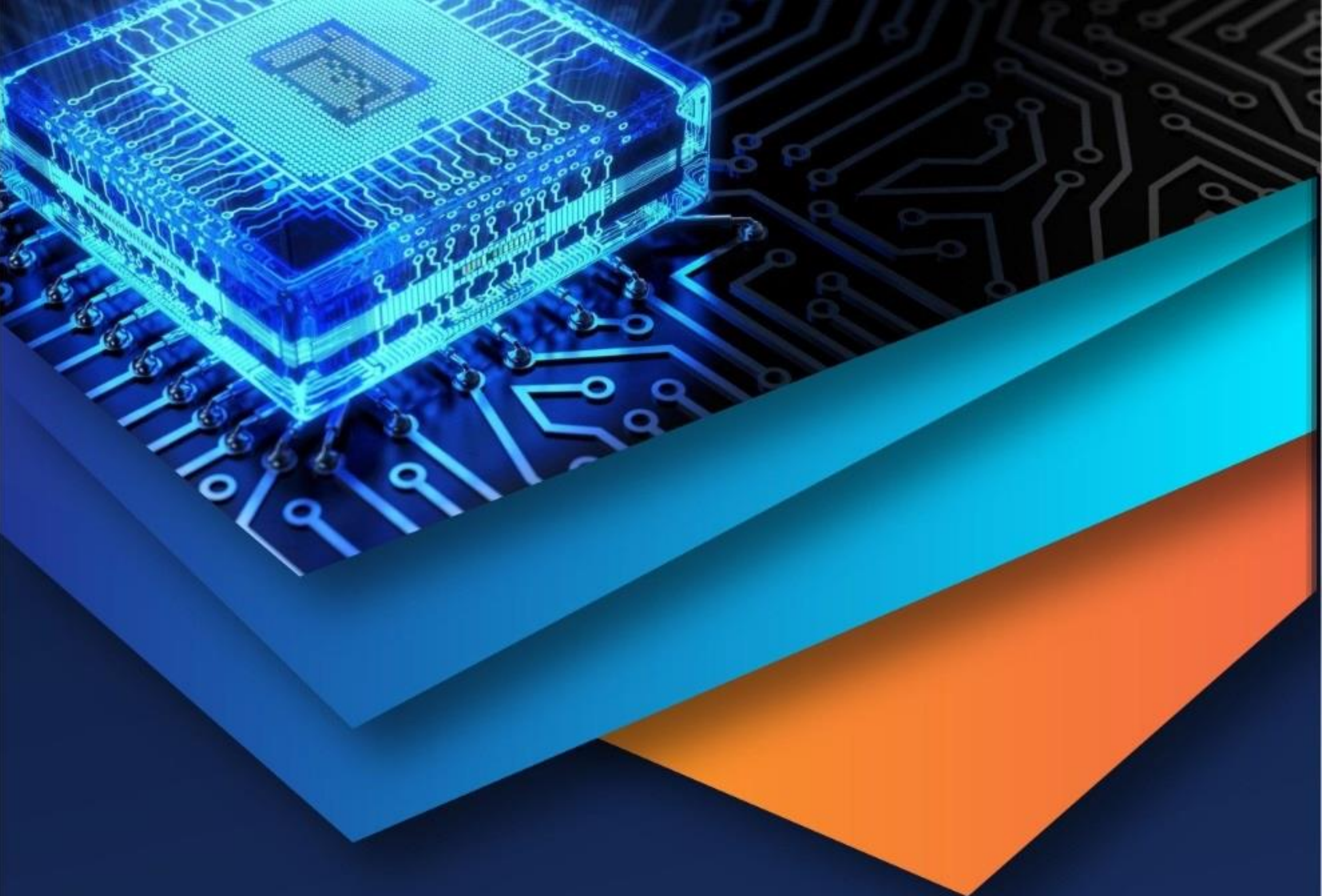
On the host side, we have used two different programs: one for generating the required data and another for plotting the curve. This was done to give the user an opportunity to explore the data in ways that suits him/her best.

V. CONCLUSIONS

In this work, we have successfully designed and implemented the NPN-transistor curve tracer. With a slight design modification in future, it can fully characterize two terminal (diodes/DIACs) and three terminal devices. It can be modified to display all of the interesting parameters such as the diode's forward voltage, reverse leakage current, reverse breakdown voltage, and so on.

REFERENCES

[1] Linder, M. 2001. DC parameter extraction and modeling of bipolar transistors (Doctoral dissertation). Retrieved from www.diva-portal.org/smash/get/diva2:8940/fulltext01.pdf
[2] Goldwasser, S. M. 2006. Basic Testing of Semiconductor Devices and other information including Introduction to Curve Tracers. Retrieved from http://www.repairfaq.org/REPAIR/ F_semitest.html
[3] Sharma, T. K., Parihar, P. S. 2014. Network Based Data Acquisition and Logging System using PIC Microcontroller. In International Journal of Engineering (IJE), Vol. 8, Issue-2, pp. 22-29
[4] Tehami, S., Khan, M. A. and Mazhar, O. 2015. Hardware and software designing of USB based plug n play data acquisition device with C# and LabView compatibility. In IEEE 21st International Symposium for Design and Technology in Electronic Packaging. DOI: 10.1109/SIITME.2015.7342313.
[5] Samajpati, D. and Mal, S. 2011. Microcontroller Based Transistor Curve Tracer. DOI: 10.13140/RG.2.1.3900.1446.
[6] NPN Transistor Tutorial - The Bipolar NPN Transistor. 31 Dec. 2017, Retrieved from www.electronics-tutorials.ws/transistor/tran_2.html. Accessed 1 Feb. 2018.
[7] Microchip Technology Inc. 28/40/44-Pin, High-Performance, Enhanced Flash, USB Microcontrollers with nanoWatt Technology. PIC18F2455/2550/4455/4550 Data Sheet



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY