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Low Cost PC Based BJT Curve Tracer cum Binning Machine

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Abstract: Determination of the characteristics of semiconductor component and its segregation is very important before circuit assembly. Though a number of equipments are commercially available to determine the characteristics of the semiconductor devices, but they are costly, bulky and take considerable workspace. A need was felt to develop low-cost equipment which can be operated anywhere. This paper presents the design and experimental results of a low cost PC based BJT Curve Tracer cum Binning Machine. The machine consists of hardware part which is implemented using 89c51 microcontrollers and software part which is developed in Microsoft Visual Basic 6.0. This system plots the input characteristic curves, h-parameters, C-E resistance and early voltage of the given transistor. Binning machine is used to find the working mode of BJT and to find whether the BJT is working or not. All the data can also be stored in a user defined output file in the computer for further analysis. This paper also describes the principle of operation and block diagram of the machine. This machine can be used by hobbyists, professionals and students alike.

Keywords: BJT, Curve tracer, Tests, Binning, Transistor, PC, Microcontroller

I. Introduction

In product development it is extremely important to know the characteristics of BJT accurately. It is possible to obtain a V-I plot by hand with an ammeter, voltmeter and an adjustable power source. But it is more convenient to display the complete curve in an automated measurement by using an instrument called curve tracer. Curve tracers are available in the market from various manufacturers. Since these instruments include power supplies, switches and X-Y display, they are expensive and take significant benchspace. It is possible to make a curve tracer utilizing plotting and other provisions of the personal computer. Transistor binning is a process of identifying different types of transistors into categories so that they could be easily used for required purposes. This paper presents theory, description, functioning and result of the low-cost PC-Based BJT Curve Tracer cum Binning Machine. The summary of the work along with conclusions is also presented. Section-2 describes the theory of the curve tracer. Section-3 gives the block diagram along with the description of each block and its functioning. Section-4 gives the process description. The results and conclusions are given in section-5. Summary of the work is given in section-6.

II. Theory

The transistor is a three terminal device. It has three regions, namely Emitter, Base and Collector. The bipolar junction transistor is a current controlled device. BJT's are used in three different configurations: (1) Common Base (2) Common Collector (3) Common Emitter. The summary of these configurations is given in table-1.

Table-1: Transistor configuration summary ^[10]

BJT Configuration	Common Base	Common Collector	Common Emitter
Voltage Gain	High	Nearly unity	High
Current Gain	Unity	High	High
Power Gain	$\approx$ Voltage gain	Medium	Very high
Input output phase relationship	0°	0°	180°
Input Resistance	Low	Quite high	Relatively low
Output Resistance	Relatively high	Quite low	Relatively high

IV. Process description

There are two microcontroller in the system in which one is 'Master' and other is 'Slave'. The microcontrollers are initialized as soon as the system is switched on. It then checks whether character is provided (by pressing the 'START BUTTON' on the PC screen) as the input or not. If not, then it waits till the character is given as an input. If a character is present, then it is fetched. It then checks which variable is given as an input. Figure-2 shows the flow chart of the process.

When the Microcontroller 1 receives the input as 'D' from the computer, it calls ADC (Analog to Digital Converter) activates the ADC. If the ADC is busy then it checks until the ADC is free and if it is free then it continues as such. It then clears the R/H of ADC and then checks for the polarity. If the value is over range, then it returns '+99999' if it lies within the range it performs conversion and returns the digital value to the microcontroller. When the microcontroller receives the input as 'A' then it calls DAC1 (Digital to analog converter). It converts it into hexadecimal from ASCII value, and then the value is moved to port 1 of microcontroller 2. The value of V_{CE} is obtained and it is common for both input and output characteristics of the transistor. When the microcontroller receives the input as 'B' then it calls DAC2 (Digital to analog converter). It converts it into hexadecimal from inputted ASCII value, and then the value is moved to port2 of microcontroller 2. The values of I_B and V_{BE} are obtained.

V. Result and conclusion

C. Curve Tracer

When the program of the curve tracer machine, developed in Visual Basic 6.0, is run on a PC, a window appears on the PC screen. The window provides two options, namely 'Curve Tracing' and 'Binning'.

After properly inserting the BJT in the 'Device under Test' Port as we click on the button "Curve Tracing" the following screen shown in figure-3 appears. The curves obtained and shown in figure-3 are the characteristic curves of the BJT under test. It contains all the information regarding the parameter of the transistor. Now this information can be used for the transistor binning.

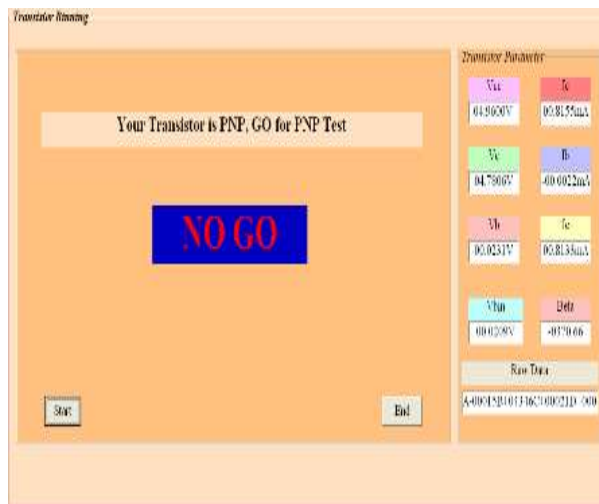


Figure-3: Input characteristics of transistor



Figure-4: Testing of transistor

D. Binning of transistors

After properly inserting the BJT in we click on the button "Binning". A window as shown in figure-4 appears on the PC. If the transistor parameters do not match from the given set of parameters, the screen shown in figure-4 results. However, if the transistor parameters are matched with the given set of parameters instead of 'NO GO' shown in figure-4 'GO' appears indicating the transistor is OK.

In the forward active mode, the base is higher than the emitter and the collector is higher than the base (In this mode, $I_c = \beta_f I_b$). In the reverse active mode, the base is lower than the emitter and the collector is lower than the base. Table-2 and Table-3 shows the modes of operation of the npn and pnp BJT respectively.

In this part we have checked three different transistors i.e. BC547, CK100, SL100 which were inserted in the port given in the circuit. All the transistors were checked whether working or not. After that, their parameters were automatically calculated for forward active mode and reverse active mode by click on the start button. All parameters were automatically calculated and saved in a specific file.

Table-2: Mode of operation of a npn transistor

B-E Junction	B-C Junction	Mode of Operation
Forward	Reverse	Forward- active
Forward	Forward	Saturation
Reverse	Reverse	Cutoff
Reverse	Forward	Reverse-active

Table-3: Mode of operation of a pnp transistor

B-E Junction	B-C Junction	Mode of Operation
Reverse	Forward	Reverse- active
Reverse	Reverse	Cutoff
Forward	Forward	Saturation
Forward	Reverse	Forward-active



Figure-5: Transistor Forward active mode and Reverse active mode testing

VI. Summary

The input characteristic curves of the BJT can be drawn and binning of Bipolar Junction Transistors (BJTs) can be done by this simple machine. It is very light weight and involves a negligible cost for any institute laboratory or industry to afford. This curve tracer circuit was designed for low power BJT curve tracing and binning. It can be extended for high power transistors and diodes characteristic curve tracing and binning.

VII. References

- [1]. Wee Beng Lim, Kim Tai, Amir Seyhoozadeh, Jin Tao, Jamie Cooney, A Macintosh based transistor curve tracer and analyzer, AIP, Rev. Sci. Instrum. Vol 60, No. 2, February 1989.
- [2]. E. Moreno-Garcia, Curve Tracer with a Personal Computer and Lab VIEW, 14th International conference on Electronics, Communication and Computers (CONIELECOMP'04), IEEE Computer Society.
- [3]. DANIEL METZGER, Transistor and FET curve tracer, Electronics World, August 1971.
- [4]. Melvin Chan, Transistor Curve Tracer, Electronics World Magazine, January 1968, pp55- 60,66
- [5]. Peter D. Hiscocks, James Gaston Low-Cost Curve Tracer Uses PC-Based Scope, Syscomp Electronic Design Limited, June 2007.
- [6]. Activity-4: A BJT Curve Tracer, Catalogue, Analog Devices.
- [7]. Curve Tracer, Catalogue, Radiant Technologies, Inc.
- [8]. Jacob Millman and Christos C. Halkias, Electronic Devices and Circuits, Tata McGraw-Hill.
- [9]. Muhammad Ali Mazidi, Janice Gillispie Mazidi, The 8051 Microcontroller and Embedded Systems.
- [10]. Sedra and Smith, Microelectronic Circuits, 5th Edition, Oxford University Press.
- [11]. Steven Holzner, Visual Basic 6 Programming Black Book, Dreamtech Press.
- [12]. Syscomp DSO-101 PC-Based Oscilloscope, www.syscompdesign.com, The classic Tektronix 575 CurveTracer.

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