

An Automatic BJT Characteristic Extraction Device

Rakshith J., Deepika C. H., Lavanya M., Chethan K.

Abstract: Bipolar Junction transistor (BJT) is one of the widely used electronic component which act as a switch or amplifier where the input, output characteristics indicates the proper functionality of its operation. Firstly this paper gives a brief review of existing methodologies and also various devices available in the industries to obtain transistor characteristics. Furthermore a system to automatically extract the input, output characteristics is proposed.

Keyword: Bipolar Junction transistor input, output characteristics indicates

I. INTRODUCTION

Electronics is gaining lot of importance in today's world by developing automated systems. Many machineries and equipments uses electronic boards and became automated by reducing human interaction with machines. Electronics is divided into passive and active components. Some of the passive components like resistors and capacitors can be easily characterized due to its linear property. Whereas transistors or diodes will be difficult to characterize due to its nonlinearity property. Since transistors are used in various electronic circuits, like data storing in digital computers, controller in industries, television, mobile phones and radio transmitters. So transistors is one of the electronic component used in our day to day lives in many forms. There are many types of transistors which are available in the market, each having their own advantages and disadvantages. BJT is one of the type of transistor, which also have many disadvantages. One of drawbacks of transistor is to find characteristic of the transistor manually as it takes more time. To calculate the characteristics of the transistor manually it takes time by making connections, taking reading and plotting graph. In order to reduce the time some manufacturing companies developed some devices which calculate the characteristics values of the transistors. But these devices don't make much difference compared to manual calculation. Because in these devices circuit connections are already made but taking reading and plotting graph is same as manual calculation. So here is the BJT model which is different from existing devices available in the market. This device helps to generate a BJT characteristics plot by using microcontroller, DAC, ADC and

current source for all the modes of operation. When we get exact output from this device after all the process is done, it's easy to implement this model to calculate other transistors characteristics.

II. LITERATURE SURVEY

In this paper [1] the characteristic tracker is used to study the bipolar transistors output characteristics relations which is developed and implemented. The circuit design of characteristic tracker, operation description of digital and analog modules used in the circuit design, graphical representation of currents and voltage in the circuit design and information about the graphical representation is provided. It represents the effect of learning the output characteristics. The current in the output is independent of the collector voltage and it is found by specific values of current in base. When the power supply cascade is available the stated current in the collector can be offered to the base current to determine the original current in the base and to calculate the base resistor resistance. It is easy to determine DC or AC of transistors output resistance. The goal of this work is to develop a reliable noise proof characteristic tracker in relation to the schematic diagram and base element for analyzing group of output characteristics of bipolar transistor of this structures. The characteristic tracker is operated correctly and without any fail which is showed from the corresponding measurement of electronic modules.

In this paper [2], a semiautomatic equipment for tracking CE combination characteristic of collector and base for low level transistor are described X-Y recorder is used to plot transistor curves. This recorder is simple and low cost. plotting of curve is exact and it depends on the precise of X-Y recorder. The range of instrument to plot characteristic of collector is base current should be 40microseconds and voltage at the collector should be 15V, to plot base characteristics current should be 30microseconds. The instrument implement exact and fast transistor characteristic plotting which is important for designing special designs when determine exchange data of transistor is incomplete. Entrenched and complete performing points in the transistor is dependent on the performance of specific transistor circuits. The operation of this instrument defined for specific modes this work can be used to plot characteristics in other modes of transistors.

III. DEVICES AVAILABLE IN THE MACRKET

There are different devices available in the market which is used to measure the characteristics of transistors. measuring different characteristics in this devices is a tedious process.

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An Automatic BJT Characteristic Extraction Device

Where different values of current and voltages in different modes of configurations are observed and tabulated from the device.

Then graph is plotted according to the tabulated values to the required characteristics which is a lengthy process.

Different models available in the market are

1. This device is available from brand called CROWN which can measure output as well as input characteristics of NPN and PNP transistors in the configuration of common base only and it is used for industrial applications.



Figure 1: A device which measure input characteristics of NPN and PNP transistors

2. This device available is from AJANTA INDUSTRY that can measure output, input as well as transfer characteristics of an NPN and PNP transistor in the configuration of common emitter and common base and it is used in laboratory.



Figure 2: A device which measure input and transfer characteristics of both NPN and PNP transistors

3. This device is available for GUPTA BRAND 200212 and it is used to measure output as well as input characteristics of NPN and PNP transistors in the configuration of common emitter and common base.



Figure 3: A device which measure input and output characteristics of NPN and PNP transistors

4. This device is available from a brand called SEMI which can measure output as well as input characteristics of NPN and PNP transistors in common emitter and common base configuration of and it is used in laboratory.

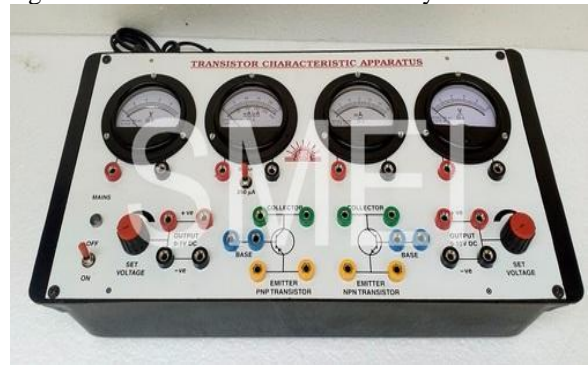


Figure 4: A device which measure input and output characteristics of NPN and PNP transistors common emitter and common base

5. This device is available from Batra Trading Company (BTC) to measure input as well as output characteristics of PNP and NPN transistors in the configuration of common base and NPN as well as PNP transistors output characteristics in the configuration of common base.

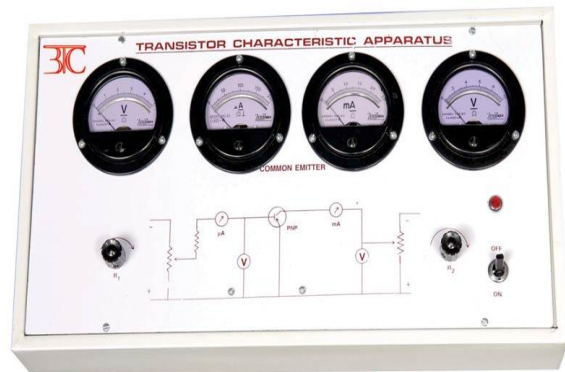


Figure 5: A device which measure output characteristics of NPN and PNP transistors

6. This device is available from H.I. Scientific Industry to study output as well as input characteristics of NPN and PNP transistors in common base and common emitter configuration.



Figure 6: A device which measure input and output characteristics of NPN and PNP transistors

IV. DRAWBACKS OF EXISTING SYSTEM ARE AS FOLLOWS

1. The device existing in market holds their advantage only in terms of specific applications, which can measure the characteristics for particular configurations of transistors.
2. The process of measuring different characteristics of BJT is very complex and time consuming process.
3. The available device produces result with less accuracy and precision.
4. Wrong connection of a components may damage the device and it is dangerous to the user this results in wrong output from the device leads to wrong characteristics measurement.
5. The error in the measurement of characteristics may occur due to various reasons such as error from the user or due to supply voltage variations.
6. Aging and Rusting of device may affect the performance.

V. PROPOSED SOLUTION FOR EXISTING DRAWBACKS

1. The drawbacks of the existing devices can be overcome by designing a device which can obtain BJT characteristics in all the three modes.
2. To overcome the complex and time consuming method of calculating the characteristics of BJT, one can design a circuit which can produce the characteristics of BJT automatically.
3. To overcome the size issues one can design a circuit which is more compact and consumes less power.
4. To overcome the accuracy issues one has to choose more accurate and precise results by decreasing error rates.
5. To overcome ageing and rusting issues, the components in the device need to be regularly replaced when they malfunction or damaged.
6. The circuit can be made compact by implementing them on a printed circuit board (PCB).

VI. PROPOSED SYSTEM

The system should consist of a hardware unit which can measure characteristics. This hardware unit must have a controller which executes the test routines and acquires the signals. Also it must be capable of measuring the following characteristics in CE, CB and CC modes of NPN BJTs input, output and transfer characteristics. Measurement must have a precision of +/- 0.01 with accuracy over 95% of true value. The block diagram of proposed system is as shown in below Figure 7.

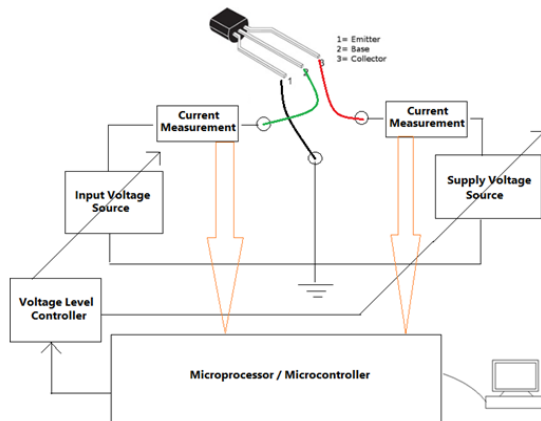


Figure 7: Block diagram of proposed system

To find input characteristics in CE mode. The digital data is feed from the microcontroller to both the DAC. Microcontroller allows only the digital inputs so it uses DAC. DAC converts the digital data into analog voltage. But the output current from the DAC is very low. Hence we need a current sourcing circuit whose input and output voltages are the same and produce some ampere of current. Converted analog signal gives it to the base of the transistor. Then emitter of the transistor is grounded. The collector of the transistor supply is given by another DAC which is controlled by the microcontroller. In order to measure the input characteristics it is necessary to know the values of V_{BE} and I_B . V_{BE} is measured using ADC then it take down the ADC values and feed it to microcontroller. Similarly it also does I_B . Then using this data in the excel sheet user have to tabulate the data and plot the graph. Then different values of V_{CE} curves is generated for the different values of V_{BE} and I_B . Similarly it also does for other characteristics of transistor in all the modes of operation.

VII. RESULT

In this paper the output and input characteristics of BJT is verified by using arduino. It has 14 digital I/O pins and 6 analog input pins. We give input from digital input pins which provide PWM output. This PWM analog signal gives voltage to the base, as already explained. Transistors start to conduct whenever the supply is ON. To plot input and output characteristics we need V_{BE} , I_B , V_{CE} and I_C . We get this from ADC pins in arduino, which are analog pins. In arduino there are 6 analog pins here we used 4 analog pins. For CE mode configuration different values of V_{BE} is varied with I_C to get input characteristics. Similarly different values of V_{CE} is varied with I_C to get output characteristics. Results which is already got from this method is shown in below Table 1, Figure 8 and Figure 9.

Table 1: Input and output characteristics

| Input Characteristics | | Output Characteristics | |
|-----------------------|----------|------------------------|----------|
| V_{BE} | I_B | V_{CE} | I_C |
| 0 | 0 | 0.043 | 0 |
| 0.6 | 0 | 0.0439 | 0 |
| 0.7 | 0.00022 | 0.4440 | 0.014663 |
| 0.8 | 0.002038 | 0.4440 | 0.014663 |
| 0.9 | 0.004819 | 0.381 | 0.034213 |
| 1.0 | 0.011461 | 1.598 | 0.039101 |

An Automatic BJT Characteristic Extraction Device

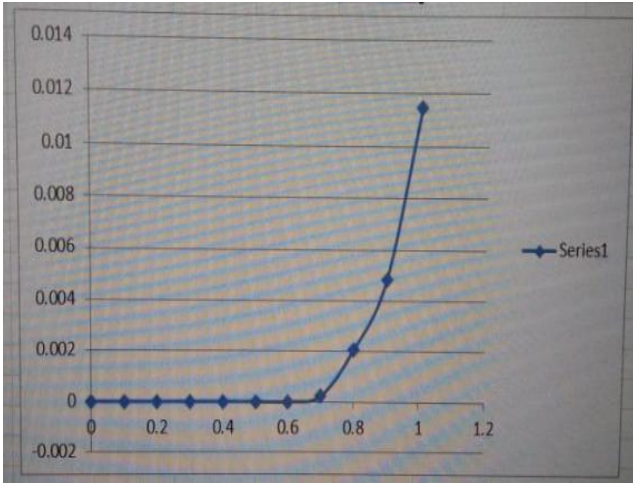


Figure 8: Input Characteristics

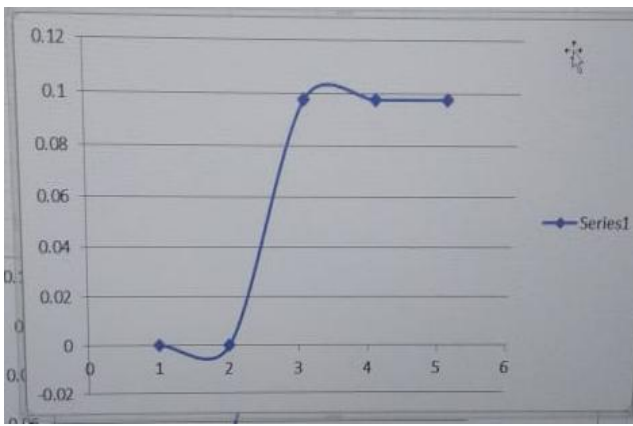


Figure 9: Output Characteristics



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VIII.CONCLUSION

Based on the survey and devices produced by various vendors, there exist some drawbacks like system produce only limited functionality and not fully automated. In order to outcome this drawbacks, we have proposed a system which can provide both input and output characteristics automatically.

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