A NEW SOLUTION OF CURRENT MEASUREMENT USING MULTISIM SOFTWARE

Luo Qian
Beijing Information Science & Technology University
Beijing 100192, China

Abstract

Multisim software is an analysis and simulation tool for analog and digital circuits. It is powerful and convenient to use and widely utilized in universities. However, in the circumstances of conventional circuit schematic diagram, Multisim software doesn't provide functions to measure currents of every branch circuit. And in many cases, such current measurement is a must. This paper first introduces Multisim software in the teaching area, then proposes a novel, practical method for current measurement. That is the solution of adding zero-volt source to measure branch currents. Application examples are presented. The results show that this solution is rapid and effective. This method can be widely used in practical applications.

Introduction of Multisim Software in Teaching

At present, during electronic circuit design, due to the high integration level, short competition cycle times and mistakes are easily made; hence, computer aided design (CAD) has been widely used. Multisim software is a powerful and professional CAD tool[1,2]. It provides a practical and efficient simulation environment for design and analysis of analog and digital circuits. It can truthfully analyze actual circuits, making simulations visual and more intuitive.

With the aid of a Multisim software platform, we can solve design problems; validate function and performance requirements; modify and optimize design results; accomplish the desired purposes of cost saving, manpower minimizing, development cycle times shortening; and improve reliability.

More importantly, the simulation circumstance can furnish us with a very good environment in the processes of teaching. The software makes up for the shortages of experimental equipment and obviously improves the quality of teaching in electronic technology. Multisim software is taught in the courses of 'Electronic Circuit CAD' and 'Electronic Design Automation (EDA)' for junior students. The design and optimization of electronic circuits by using EDA technology is an effective way to train and improve students' practice abilities and electronic circuit design skills. Multisim software provides a design environment to get what you see, user friendly interactive interfaces, dynamic display of components, various instruments and analysis functions, assistance to help students master advanced methods and skills of electronic circuits design, understanding of theoretical concepts. This can then improve their interests and ability in circuit learning, designing and product developing, and assist in effectively solving their problems during practice.

Multisim has been utilized widely in universities. It is an excellent design tool for electronic technology. There is a limitation, however: it cannot provide the current measurement for every branch in a circuit. This brings some inconvenience to users[3-5]. A new solution of measuring branch currents using Multisim software is proposed in this paper.

Present status of Multisim software for current measurement

Method of measuring currents using Multisim

In order to measure currents using Multisim, the function of 'DC operating point analysis' is applied. This function can only measure the currents of branches which including sources. For instance, in the circuit shown in Fig. 1, Multisim can only measure the current of I_v; currents of other branches cannot be measured. Fig. 2 shows the analysis window of DC operating point analysis.

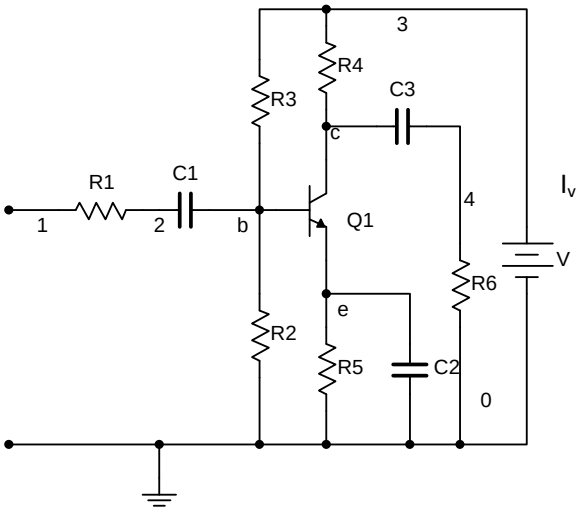

Fig. 1: Circuit of DC point analysis.

We see from Fig. 2, that Multisim software has only provided current measurement options for the source-contained branches.

Current measurement has been widely used in electronic circuit design and debugging. The results of current analysis are usually intermediate values for further analysis, such as for DC sweep analysis, parameter sweep analysis, temperature sweep analysis, sensitivity analysis, Monte Carlo analysis, worst case analysis, etc. So it is very important to solve the problem of current measurement.

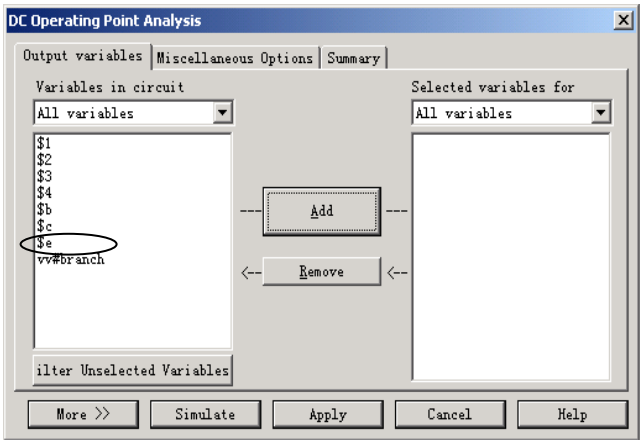

Fig. 2: DC operating point analysis parameter.

Current direction

As mentioned above, Multisim can only measure currents of branches containing sources. In Multisim software, the measured direction of current is defined as the arrowhead direction in Fig. 1.

For the NPN transistor analysis circuit in Fig. 3, though there is a source V_{ce} in the collector branch and it seems the collector current can be measured, the direction of current I_c is opposite to the direction of current I_v. This brings inconvenience to applications, especially, when applying DC sweep analysis to measure the output characteristic curves of a transistor. The analysis window is as Fig. 4.

When choosing "vvce#branch", the measured current is $-I_c$ and the analysis result is in Fig. 5. As the current is opposite, the curves are also opposite; this doesn't agree with our normal understanding.

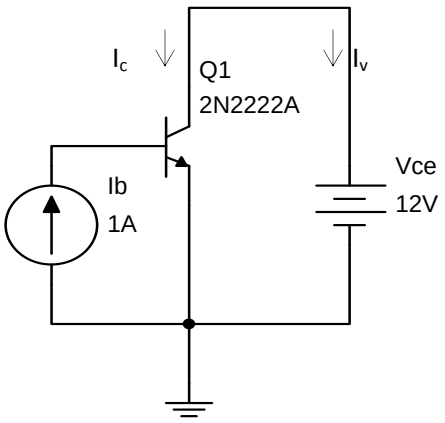

Fig. 3: Circuit for measuring transistor output characteristics curves.

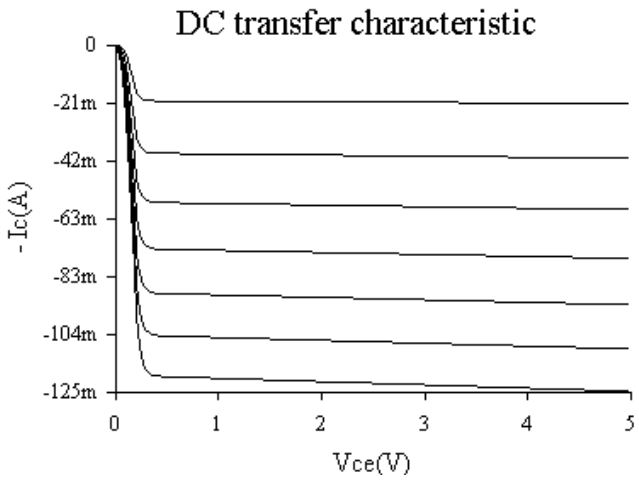

Fig. 5: Measurement results of transistor characteristic curves.

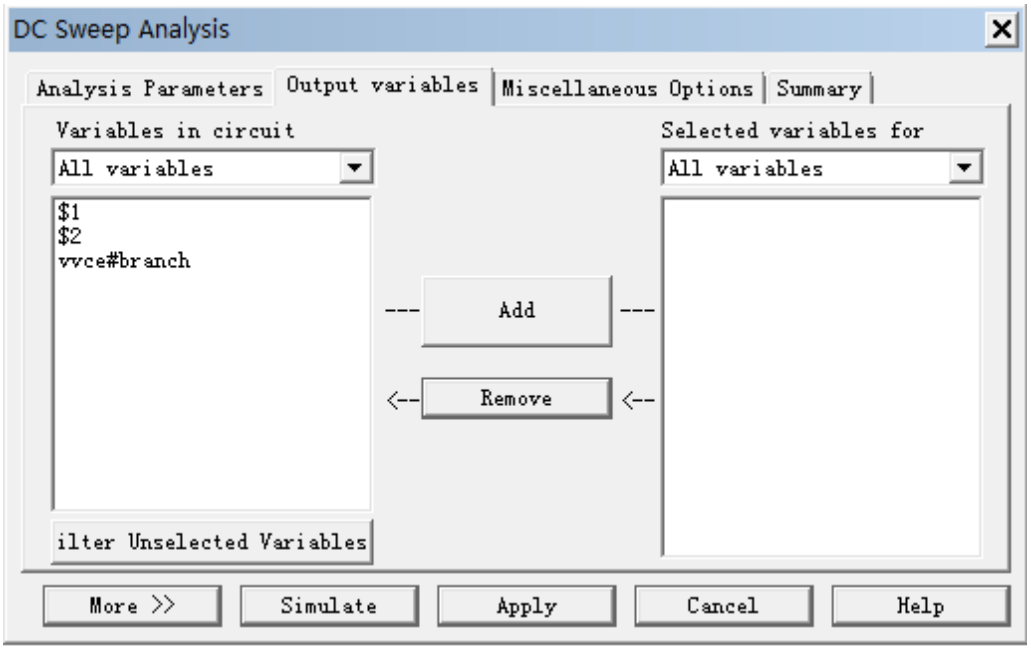

Fig. 4 Multisim parameter setting window for DC sweep analysis.

Though postprocessor function of Multisim can be used to achieve normal characteristic curves (as they are a cluster of curves) when using a postprocessor, functions need to be setup one by one for each curve. This method is complicated and fallible.

In the next part, a new practical and effective solution to measure branch currents is proposed to solve all the above problems.

Current measurement solution and simulation results.

Add another source on the branch.

As Multisim can only measure current of branches which contain sources, by adding an additional source on the branch, this branch's current can be measured. This additional source can be a DC voltage power source or AC voltage signal source.

In order to avoid the troublesome computation caused by the additional source and to ensure the circuit equivalent, the voltage of this source should be zero. (Sources provided by Multisim software are virtual and ideal, with zero inner resistance. If the source's voltage is zero, it will not have any influence on the electric circuit.)

We can see in Fig. 6 (after adding a zero volt source, $V_{0,}$ on the collector branch) in the measuring parameter design window (see Fig. 7), an option (vv0#branch) for this branch's current measurement appears. That is to say the collector current I_c can be measured.

Current direction solution

The direction of the zero volt source determines the resulting direction of current measurement. Determine the direction of the source when adding it; then the result direction of current measurement will be the expected direction.

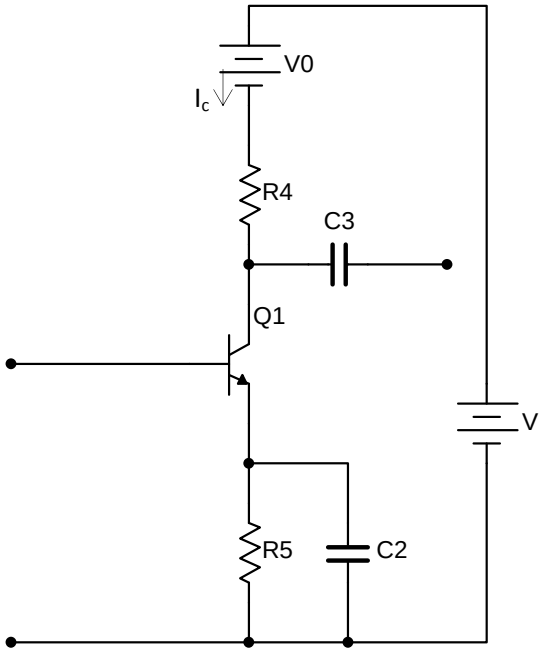

Fig. 6: Equivalent circuit of DC operating point analysis.

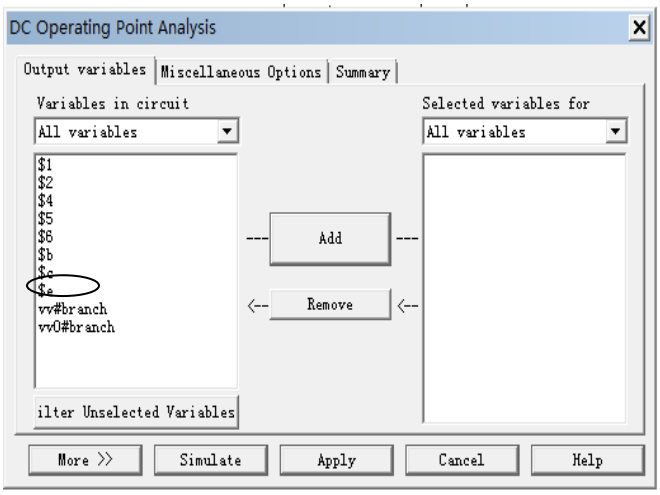

Fig. 7: parameter setting window for DC operating point analysis after circuit equivalent.

Current measurement examples and simulation results.

The measurement results using this method are given below. For the circuit in Fig. 6, the collector current measurement result is shown in Fig. 8.

After verification calculation, the result is exactly consistent with the actual current value. In other words, adding a zero-volt source does not affect the electric circuit's performance and the measuring results. This method can solve current measurement problems.

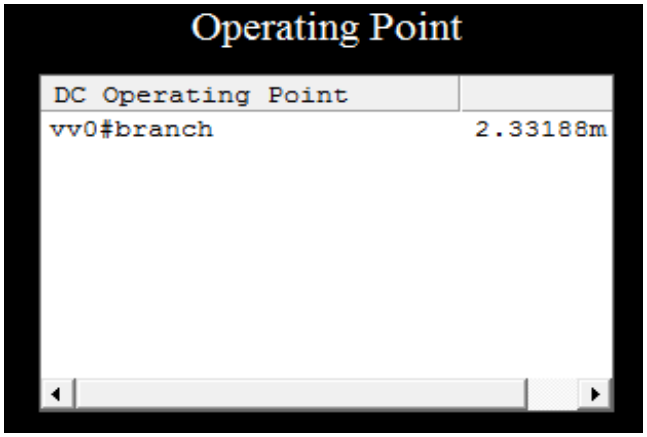

Fig. 8 after using equivalent circuit the collector current measurement results.

Using this method, we can also similarly solve the measurement problem of transistor characteristic curves with ease. The measuring equivalent circuit is in Fig. 9.

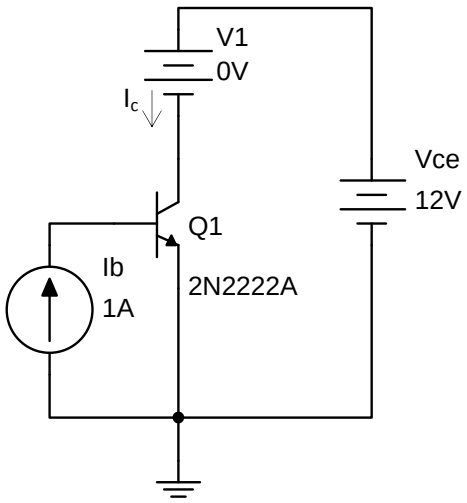

Fig. 9 Equivalent measurement circuit for transistor output characteristics curves.

By adding a zero volt source V_1 with its direction as shown in Fig. 9, the measured current direction will be consistent with the direction of I_c.

In the equivalent circuit, using DC sweep analysis, choosing "vv1#branch" in the output parameter setting window, we may obtain the transistor output characteristic curves directly. The measurement results are shown in Fig. 10.

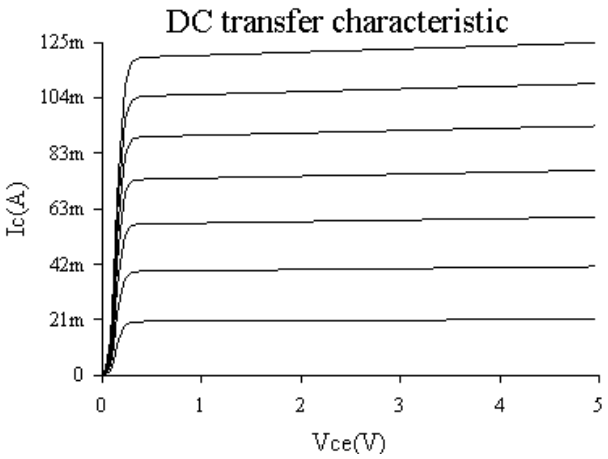

Fig. 10 Measurement results of transistor output characteristics curves after circuit equivalent.

This method is very convenient, the measurement result is completely consistent with the actual situation. Using this equivalent circuit method of adding zero volt source, we can also solve more problems when applying Multisim to other analysis functions, such as analyzing the impact of component parameter sensitivity on current measurements, components tolerance extent on current measurements, and so on.

In brief, using this method, we can make a fully equivalent circuit and use functions provided by Multisim to achieve the current measurement to all branches, meet the demands of varieties of occasions, and greatly simplify the operation processes. Therefore, this method can be widely applied in actual measurements. (Of course, in the actual circuit schematic design, the zero volt source should be deleted).

Conclusion

This article proposes a new effective and convenient method to measure branch currents using the Multisim software. This method uses the approach of adding another source of zero volt and has solved the limitation of Multisim software in branch current measurement. The method is simple and practical and can simplify operating processes of measurement. The measurement results are completely consistent with the real situation. This method can be widely used in actual circuit design, measurement, and simulation.

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Biographical Information

Luo Qian is teaching in the Department of Electronic Information Engineering of Beijing Information Science & Technology University. Her research interests include simulation and artificial intelligence for software information, as well as signal acquisition and processing.