



Development of Virtual Experiment on Rectifier Circuits

Bhaskar Y. Kathane

PCD ICSR, VMV College Campus, Wardhaman Nagar,
Nagpur (MS), India
bykathane@rediffmail.com

Pradeep B. Dahikar*

*Kamla Nehru Mahavidyalaya Sakkardara,
Nagpur (MS), India
pbdahikarns@rediffmail.com

Abstract:- In this research paper we are reporting how experiments on Rectifier are performed using the concept of virtual Intelligent SoftLab (VIS). Rectification is the conversion of alternating current (AC) to direct current (DC). This model explains you with the fundamentals of AC (alternating current) and DC (direct current) voltages using VIS model. The process of converting bi-directional AC Voltage into unidirectional DC is shown graphically. Software for conducting the experimentations in Rectifier has been developed which helps students to perform and practice the experiments. A Rectifier experiment provides a pictorial method of design and evaluating experiments. A Rectifier constructed using the Virtual SoftLab and observed actual outputs. This will help students in understanding working of rectifiers. This model performs half wave and full wave rectification successfully.

Keywords: -Virtual, SoftLab, Rectifier, VIS Model

I. ABOUT SOFTLAB

Electronics devices and the lack of resources make us unable to perform experiments, especially when they involve sophisticated instruments [1]. Web-based and video-based courses address the issue of teaching to some extent. Conducting joint experiments by two participating institutions and also sharing costly resources has always been a challenge. With the present day internet and computer technologies the above limitations can no longer hamper students and researchers in enhancing their skill and knowledge [2].

The SoftLab philosophy challenges us to link the physical laboratory experiment with its theoretical simulation model within a unified and interactive environment. The goal for each instance of a SoftLab laboratory is to create a software environment where experimental research, simulation and education coexist and interact with each other. As part of the SoftLab project, we are investigating the issues involved in the design and development of SoftLab Model for Electronics, Computer science and engineering. This paper describes how the SoftLab philosophy was used to design and implement.

The VIS forces us to address the challenge of solving experiments. Such systems require a wide range of expertise plus a flexible and diverse array of equipment. The SoftLab framework should provide the infrastructure and facilities that serve the needs for basic research.

The basic facilities include with VIS:

- High-performance graphics processors to support scientific visualization, and multimedia facilities.
- Software that allows application researchers to make full use of these facilities to evaluate their experiments without any risk.
- Virtual laboratories that provide scientists with a full range of functionality, both for experimental activities and for the mathematical modeling and simulation of the experimental processes.

The laboratory presents an ideal environment in which to accept and meet the challenges of computational science and engineering. Issues that must be addressed include mathematical software, electronic prototyping, geometric

modeling, parallel algorithms, databases, software engineering, and computer systems. This facility is used for research in electronics, computer science and engineering Department.

In order to support the various activities that take place in an physical laboratory, scientists must be able to use the virtual laboratory to

- perform physical experiments by interacting with and controlling remote instruments,
- simulate physical experiments through computer modeling of the experimental process,
- compare physical and simulated data by playing back recorded experiments, and
- Train scientists to understand the physical experiment, the computational model of the experiment, and the relationships between them.

A choice of these four *scenarios* is available to scientists after they have selected their virtual laboratory at the SoftLab gateway. The graphical interface which is then presented to the user is a software representation of the physical laboratory. Each important physical device is present, in particular, all instruments and equipment used during the experimental process must have a visual representation in the virtual laboratory.

In the *virtual experimentation scenario*, scientists will set up the virtual instruments and experimental process just as in the physical scenario. Afterwards, the physical setup is transformed to the input required for the computational model. Additionally, parameters that are strictly numerical will be specified via special interfaces, and an expert system will be on hand to query for process characteristics or computational parameters. During the processing of the computational code, the virtual instruments will receive intermediate results so that they can be animated to show the progression of the simulation process. Results can be visualized exactly as in the physical case. The simulated experiment may also be saved to the experiment database.

Here, too, the input configuration and output results will be used to define the experiment in the database. Since the physical and simulated experiments now reside together,

computations on their associated data can easily be done for comparison or analysis.

VIS can benefit thousands of students and professors to learn difficult experiments. The “Virtual laboratory” will bridge physical distance and availability of resources. Today it is possible to design good experiments among students for better learning [3].

VIS provides following benefits for Teachers

- Visual experiments for lectures.
- Home Experiments for students.
- Virtual laboratory exercises in lab session.
- Opportunities for independent exploration for highly motivated students.
- Animated visualization for students in classroom.

VIS provides following benefits for Students

- Experiment with electronics component safely and independently
- Supplement classroom exercises to improve understanding with electronics devices.
- Visual classroom laboratories at any place.

A. VIS USERS:

VIS Can used by

- Colleges to perform practical using SoftLab
- Teachers will teach the student with different practical based concept.
- Research student perform their experiments with different devices.
- Students can read and perform their task in classroom.

Virtual Labs would helpful to students at the graduate level, postgraduate level as well as to research scholars. This would help them in learning basic and advanced concepts through Virtual Intelligent SoftLab (VIS) experimentation. This system provides a complete Learning Management system around the virtual Labs where the students can learn, observe and research the various tools. Video-lectures, animated demonstrations and self evaluation program available in future. This system also shares costly equipment and resources with visual effects. The functionality provided by this problem solving environment will therefore be:

- Collect the experimental data in real time.
- Provide visualization of the experiments.
- Control the experiment.
- Input the experimental data to the computational model.
- Control the computational model and visualize the numerical simulation solution

SoftLab is such a flexible laboratory environment. Its goal is to simulate a laboratory space having a well-equipped storeroom of instruments and a variety of materials. Using SoftLab a student may be guided by an instructor to perform an experiment, or the student might also conceive of one on his own. The student may choose a substance to study, take out the instruments he needs, connect them together, make his measurements, and record and plot his results. The computer screen is the laboratory room. The experimental possibilities open to the student certainly are limited by the ability of the developers to maximize flexibility in a practicable way. Algorithms implemented so far have achieved the desired flexibility, and SoftLab has been well received [4].

The SoftLab philosophy challenges us to link the physical laboratory experiment with its theoretical simulation model within a unified and interactive

environment. The goal for each instance of a SoftLab laboratory is to create a software environment where experimental research, simulation and education coexist and interact with each other in a seamless manner

Once this problem has been solved for a particular scientific environment, the design of the virtual laboratory can begin. In order to support the various activities that take place in a physical laboratory, scientists must be able to use the virtual laboratory to

- perform physical experiments by interacting with and controlling remote instruments,
- simulate physical experiments through computer modeling of the experimental process,

II. RECTIFIERS

The process of converting bi-directional AC Voltage into unidirectional DC is known rectifications and the circuit used for this process is known as rectifier. AC Voltage consists of two half cycles. Upper half cycle is known as positive half cycle and lower cycle is known as negative half cycle.

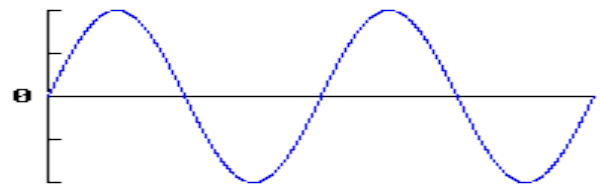


Figure-1: AC Waveform

A. Half Wave Rectifier:

Half wave rectifier is a simple and low cost rectifier circuit it is used where high quality DC is not required for example to operate Night lamp, Radio circuit, etc. A diode is connected in series with load RL and output is taken across RL. In first half cycle or positive half cycle of AC voltage, diode becomes forward bias it is acting as a closed switch, the current flows through the circuit its flow through RL. Thus same output voltage is developed across RL similar to half cycle of AC input. In next cycle or negative half cycle diode becomes reverse bias; diode is acting as an open switch thus current through circuit is not possible it is blocked by diode. i.e. $V_{out} = I \times R_L = 0 \times R_L = 0V$

Thus diode will conduct only at positive half cycle and it rectifies negative half cycle. Virtual half wave rectifier circuit and output observed using VIS model in fig-5.

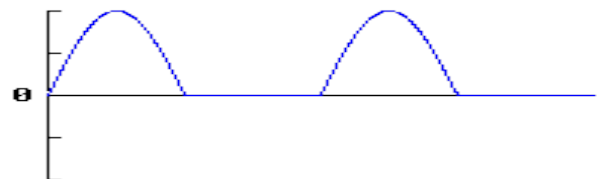


Figure-2: Half Wave Rectification.

B. Center Tap full wave Rectifier:

To utilize negative half cycle one or more diode is connected with special type of transformer called as center tap transformer. In centre tap transformer the middle terminal is tapped. In center tap rectifier diodes are conducting in alternate cycle so that current through RL flows in the same direction for both half cycles. Virtual full

wave center tap rectifier circuit and output observed using VIS model in fig-6.

C. Bridge full wave Rectifier:

This is more popular rectifier circuit because output is full wave DC and centre tap transformer is not required. For both half cycles of AC, current through RL is flowing in the same direction like center tap rectifier. But in bridge rectifier in each half cycle two diodes are in forward bias and other two diodes are in reverse bias. Virtual full wave bridge rectifier circuit and output observed using VIS model in fig-8.

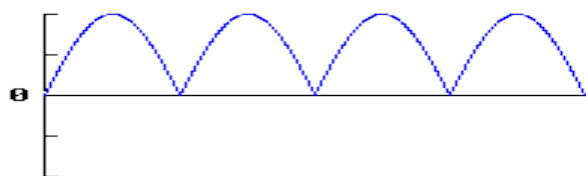


Figure-3: Full Wave Rectification.

D. Dual Polarity Center tap Rectifier:

The full-wave center-tapped rectifier polarity at the load may be reversed by changing the direction of the diodes. Furthermore, the reversed diodes can be paralleled with an existing positive-output rectifier. The result is dual-polarity full-wave center-tapped rectifier in Figure below. Note that the connectivity of the diodes themselves is the same configuration as a bridge [5].

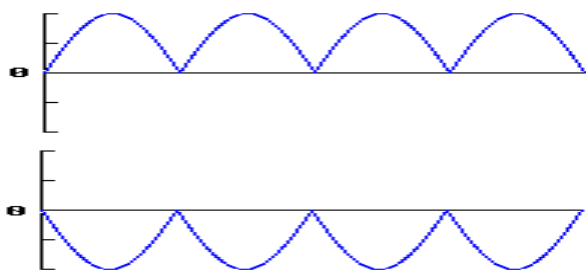


Figure-4: Full Wave Dual polarity center tap Rectification.

III. TOOLS & TECHNOLOGY

Visual Basic is a third generation event-driven programming language and integrated development environment from Microsoft for its COM programming model. VB is also considered as relatively easy to learn and use programming language, because of its graphical features. Visual Basic was derived from BASIC and enables use of graphics user interface, access to database and creation of ActiveX controls and objects. A programmer can put together the component provided with Visual Basic itself to develop an application. The language not only allows programmers to create simple GUI applications, but can also develop complex applications.

Programming in VB is a combination of visually arranging Component or control on a form, specifying attributes and actions of those components. Visual Basic can create executables (EXE files), ActiveX control or DLL files, but is primarily used to develop Windows applications. The beauty of this model is that it does not require the Database to manage data.

IV. VIS MODEL

We have constructed the programs in 'VB' such that all the blocks in the model can be fully visualized on the screen. This model can demonstrate the activities of Rectification visually. Inputs accepted through software and virtual output will observe on screen. In an experiment we can provide different input values and observe output. This model provides circuit connection facility to user to make connection properly otherwise the result is not generated [6].

A. Design Specifications:

You need to design Rectifier that accepts input as alternative current (AC) and outputs the direct current (DC). For developing the concepts of Rectification based on simulation technique is shown in figure in fig-5, fig-6, fig-7, fig-8 shown below [6].

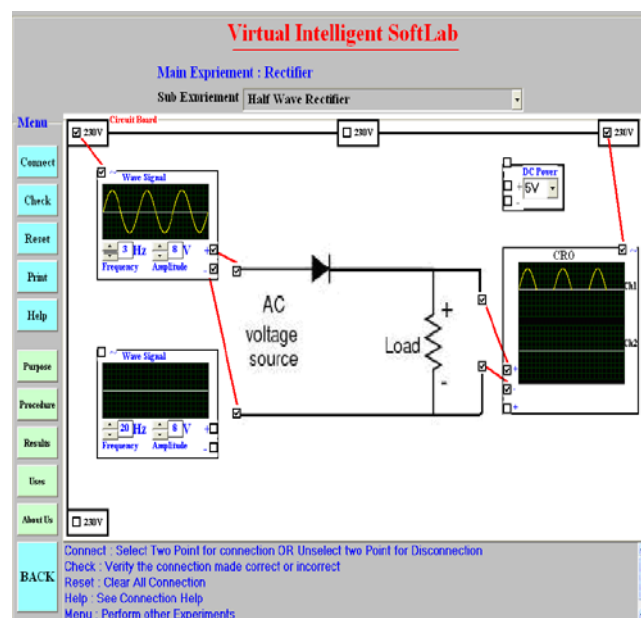


Figure-5: Half Rectifier VIS Model

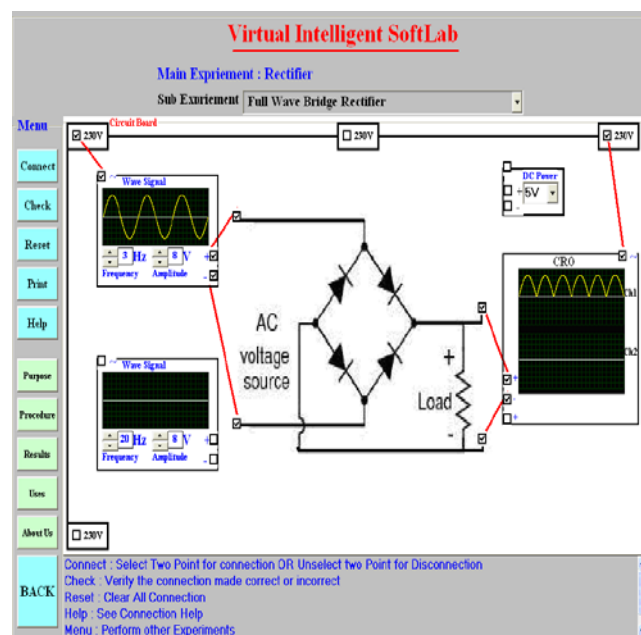


Figure-6: Full wave Bridge Rectifier VIS Model

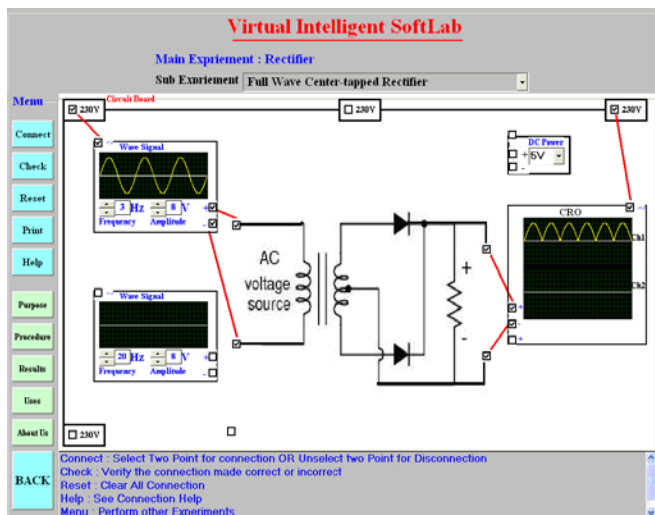


Figure-7: Full wave Center tapped Rectifier VIS Model

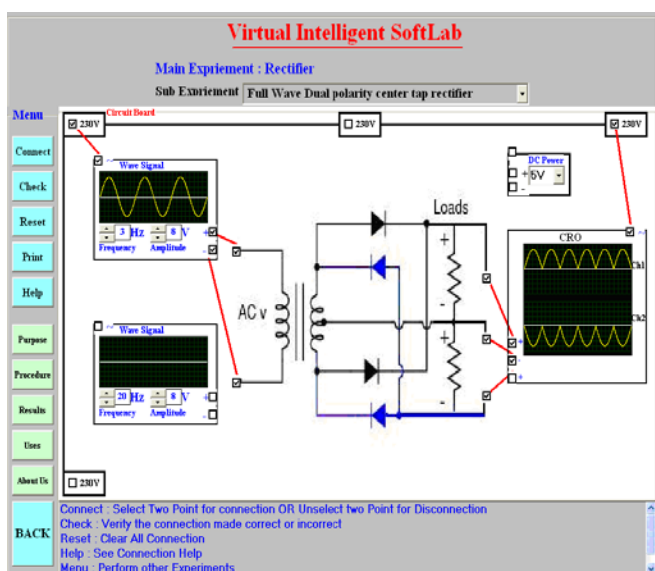


Figure-8: Full wave Dual polarity VIS Model

B. Implementations:

Once the VIS is ready then we implement the circuits using then following steps. The Circuit Connection Steps are

- Connect AC power supply to wave generator virtual device and CRO.
- Connect AC wave signal to Input circuit switches.
- Connect Output pin to CRO switches

Experiment Implementation Steps are

- Made connection to selection two switches using mouse
- Click on Check Button to verify the connection
- Click on Reset Button if the connection is totally WRONG
- Click on Help Button if you need Connection HELP
- Click on Menu Button if you want to perform other Experiments

C. Results:

Virtual outputs are totally animated with the combination of software and observed actual outputs virtually. Inputs and

Outputs are fully animated with virtual CRO and observed actual results.

V. CONCLUSIONS

SoftLab will help Electronics, Computer Science and Engineering department students to perform and practice experiments to improve their understanding of the subject. VIS is designed in such a way that it's made more effective and realistic by providing virtual inputs and product virtual outputs. For the 'touch and feel' part, the students can possibly visit an actual laboratory.

VI. ACKNOWLEDGEMENT

I thank Dr. D. A. Deshpande, Director, PCDICSR VMV College campus for his valuable inputs and constant guidance. I also thank Dr. U. A. Lanjewar, Professor, PCD ICSR VMV College campus for his extensive support and encouragement for this work.

VII. REFERENCES

- [1]. Virtual Labs: <http://www.vlab.co.in/>
- [2]. Virtual Labs at IIT Guwahati http://www.iitg.ernet.in/cet/home_listexperiments.html
- [3]. A Virtual Laboratory: <http://www.virtlab.com/main.aspx>
- [4]. http://www.cs.purdue.edu/research/cse/softlab/softlab-vlabs/softlab-framework/softlab_report/report.html
- [5]. http://www.allaboutcircuits.com/vol_3/chpt_3/4.html
- [6]. B.Y. Kathane, P.B. Dahikar (Jan 2012), "Design and Implementation of Adder and Subtractor using Virtual Intelligent SoftLab", "International Journal of Computer Science and Telecommunications", ISSN 2047-3338, Vol.3 No.1, pp 66-69

Short Bio Data for the Authors



Mr. Bhaskar Y. Kathane completed M.Sc. (Computer Science) and pursuing Ph.D. from R.T.M. Nagpur University, Nagpur. He is Assistant Professor in the Department of Master in Computer Application (MCA), VMV College, Nagpur (MS), India. Presently he is working as a research scholar in University Campus, RTM Nagpur University, Nagpur. His research interests include Virtual Intelligent SoftLab (VIS); A Software Solution for Laboratories. He is associate member of IETE (India).



Dr. P.B. Dahikar is a Reader in the Department of Electronics, Kamla Nehru Mahavidyalaya, Nagpur (India). He has more than 20 years of experience in teaching and research. His current area of research includes Electronics Instrumentation and Simulation. He has published more than twenty papers in referred national