Application of a Remote Lab: Single Phase PFC Circuit

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Abstract—**Some universities may not have enough resources to provide each student with a separate device in the laboratory. When the number of students in the experiment exceeds the number of devices, then the experiment is carried out by some of the students only while the rest remains indifferent to the experiment. Therefore, not all the students can benefit from the experiment. Nowadays remote laboratory and its applications are being very popular by young scientists and undergraduate students who are willing to learn and research in different topics of their interests. Web and computer are two fundamental tools for this kind of education. In this paper, matlab simulation of single phase PFC is being presented as a remote laboratory application for the students.**

Index Terms— **Remote Laboratory, matlab simulation, internet**

I. INTRODUCTION

Access to information has been facilitated due to the developments in communication technologies. Consequently, recent developments in distance education have brought about the issue of holding sessions with students in different locations. It is possible to improve quality of education and decrease cost of education by increasing the number of student benefiting from seminars given by professors. Some universities have already made such implementations. As already known, some universities want their students to study in the lab to complement the theoretical learning process. Especially, lab work has great significance in the faculties of engineering. Theoretical courses have to be enhanced in the lab. To be able to grasp the topic, it is important for the student to 'apply' theory in the lab and observe the cause-effect relationship.

The ideal labs are those where each student has an experiment device and there is no time constraint. However, universities may not have the resources to provide each student with a separate device in the lab. When the number of students in the experiment exceeds the number of devices, then the experiment is carried out by some of the students only while the rest remains indifferent to the experiment. Therefore, not all the students can benefit from the experiment. It may not be possible to increase the number of devices due to cost concerns especially in state universities. In this case, the solution is to decrease the above mentioned difficulties by using remote laboratory.

It is possible to use some programs to set up remote labs. Thus, before they join the actual experiment, they can learn the measurements they have to make in the experiment, how to change the physical magnitudes, how to follow these changes through the devices in the lab and to draw graphs. Consequently, in the lab, they will have the opportunity to enhance their experience in the remote lab by getting to know experiment material and measurement devices [4].

II. APPLICATION OF A REMOTE LABORATORY

A. Single Phase PFC circuit in general

Solid-state ac–dc conversion of electric power is widely used in adjustable-speed drives (ASDs), switch-mode power supplies (SMPSs), uninterrupted power supplies (UPSs), and utility interface with nonconventional energy sources such as solar PV, etc., battery energy storage systems (BESSs), in process technology such as electroplating, welding units, etc., battery charging for electric vehicles, and power supplies for telecommunication systems, measurement and test equipments. Conventionally, ac–dc converters, which are also called rectifiers, are developed using diodes and thyristors to provide controlled and uncontrolled dc power with unidirectional and bidirectional power flow. They have the demerits of poor power quality in terms of injected current harmonics, caused voltage distortion and poor power factor at input ac mains and slow varying rippled dc output at load end, low efficiency and large size of ac and dc filters [1]. Consequently, power factor correction (PFC) is the biggest concern for ac-dc converters in the industrial applications.

The PFC circuits are very popular subject for electrical engineers and it is easy to simulate it in matlab simulation programme. For this reason one of the PFC circuit is shown below with its simulation results.

B. PFC AC-DC converter as a remote Laboratory example

Things to do in the experiment:

1. Run the MATLAB programme in your PC and open the relevant document which you downloaded before. You can find it at the university where you are going to take the remote lab anywhere in the world via internet. We can add user account number and password to control the students and also download the relevant document.

2. Open the file and run the programme then you can see the input, output voltage and also input current and switch position. For example figure 1.

3. Because of these are transient results run this cycle 50 times for the permanent or real results. Then see the results and observe the difference for example figure 2.
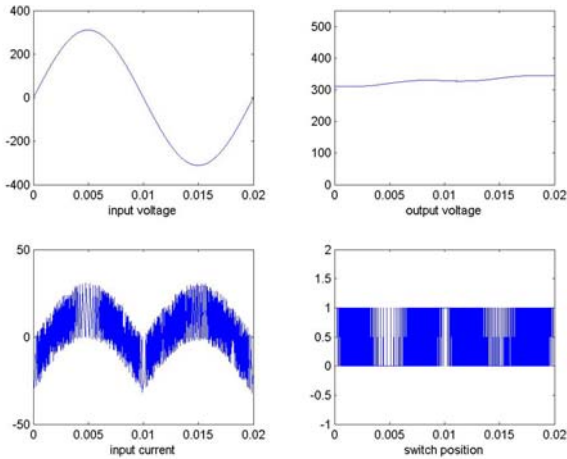

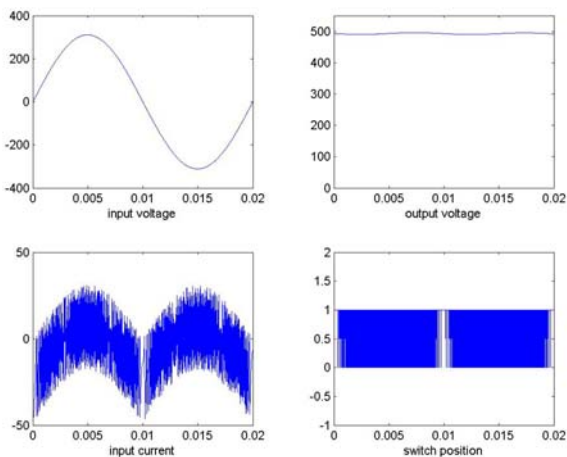Figure 1 Input, output voltage and also input current and switch positions transient

Figure 2 Input, output voltage and also input current and switch positions

4. Calculate the input ITEF values for both figure 1 and 2 with matlab programme.

5. Calculate the switching frequency of the boost semiconductor.

6. Calculate the input and output power for the both figure 1 and 2.

7. Students can change some of the variables such as R (output load), L (input boost inductance), C (output condansator), D (sample rate) ratings in the matlab m-file. So every single variable affects the results in a different way. Consequently students can observe which variable affects what and how.

They can do the same experiments in the remote lab as in the actual lab. The devices like oscilloscope, ammeter and voltmeter, which are used in the actual lab, can also be used in the m-file for the remote lab. For a real remote lab, students can access the remote lab internet address by their account number and password. Then they use assistant programmes with their matlab m-file to change the real lab prototype device's variables. For this purpose, data acquisition cards can be used. As a result, students can access the real lab and use the device from anywhere in the world via internet. Other experiments of the power electronics can be prepared in the same way. The remote lab can be incorporated into the labs of other sciences.

III.   CONCLUSION

In the remote lab, the experiment devices can be flexibly used wherever you want and how many you want, because there is no need like oscilloscopes, voltmeter, and ammeter for each student near their PC. On the other hand in real lab, changing even one of the experiment equipment may lead to additional costs and also it is very difficult to observe for all the students. For remote lab, because all the students are in all the world around, they take an account number and password to access the remote lab. So every student can take the benefits of remote lab. It is obvious that remote lab experiments can decrease the cost of laboratory experiments while spreading the knowledge and application of the experiment all over world via internet. As a conclusion, single phase PFC circuit is explained in this paper as a remote lab application. Laboratory works are extremely important for electrical engineers while they are applying the theory to the experiment. Remote lab experiments may lead to increase the benefits of the real lab for young scientist and also for the undergraduate students.

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