

Use of LabVIEW Software to Create a Virtual Electrical Power Systems Lab

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Abstract

This paper discusses the creation of a Virtual Electrical Power Systems Laboratory for the University of Houston–Downtown in Houston, Texas. *Electrical Power Systems*, the electrical engineering technology EET-3334 course, contains the basic principles and applications of electrical power systems.

Both circuit simulation software and LabVIEW are used to create exercises and design projects. Included in the course are practical lighting designs and motor controls. Also included is computer simulation of electrical single phase and three phase power systems, and various related applications.

The class students have a diverse technical experience level and a varied background in academics. The circuit software and LabVIEW software have both been chosen to provide easily useable software for all of the class students.

Three-phase electrical power generation by DELTA and WYE generators with combinations of WYE and DELTA loads is simulated on software. Both balanced and unbalanced loads are simulated. Using software, a visual demonstration has been created that shows the resulting consequences of what occurs when balanced loads become unbalanced. The visual demonstration also shows what can be done to correct imbalances in the circuits.

LabVIEW software has been used to create a cost effective user-friendly electrical power systems virtual laboratory. The LabVIEW class exercises are designed to concurrently familiarize the students with the use of LabVIEW and with electrical power systems.

Innovative laboratory projects to design automatic motors control systems, automation power factor correction, automatic load wire sizing, and related applications all have been completed by the students using LabVIEW.

The electrical power systems laboratory at first uses the basics of LabVIEW and then as the course progresses the more advanced LabVIEW features. Students create practical designs of motor control panels and systems. Final course student project designs use LabVIEW.

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Introduction

The goal is to create a virtual electrical power systems lab where students can learn both electrical power systems and the use of LabVIEW as a tool. Students taking the electrical power systems course are not necessarily required to have a prerequisite knowledge of LabVIEW. The primary goal of the electrical power systems course is definitely to have the students learn the concepts of electrical power systems. An additional goal is to have students learn the latest tools of software for lab work.

A virtual laboratory allows a variety of electrical power systems lab work to be performed with a minimum cost. In addition, the cost effective lab software allows the students to also learn a tool that can be used in a variety of other courses. LabVIEW is a tool that can be used for both design and lab work.

The students in the virtual electrical power systems lab learn both to program functional block diagrams and apply them to operate the respective panels that are created for the particular electrical power systems. The object of the lab exercises and projects is to allow the students to gain experience in the creation of electrical power systems and controls, and to gain experience in the operation the operation of the systems.

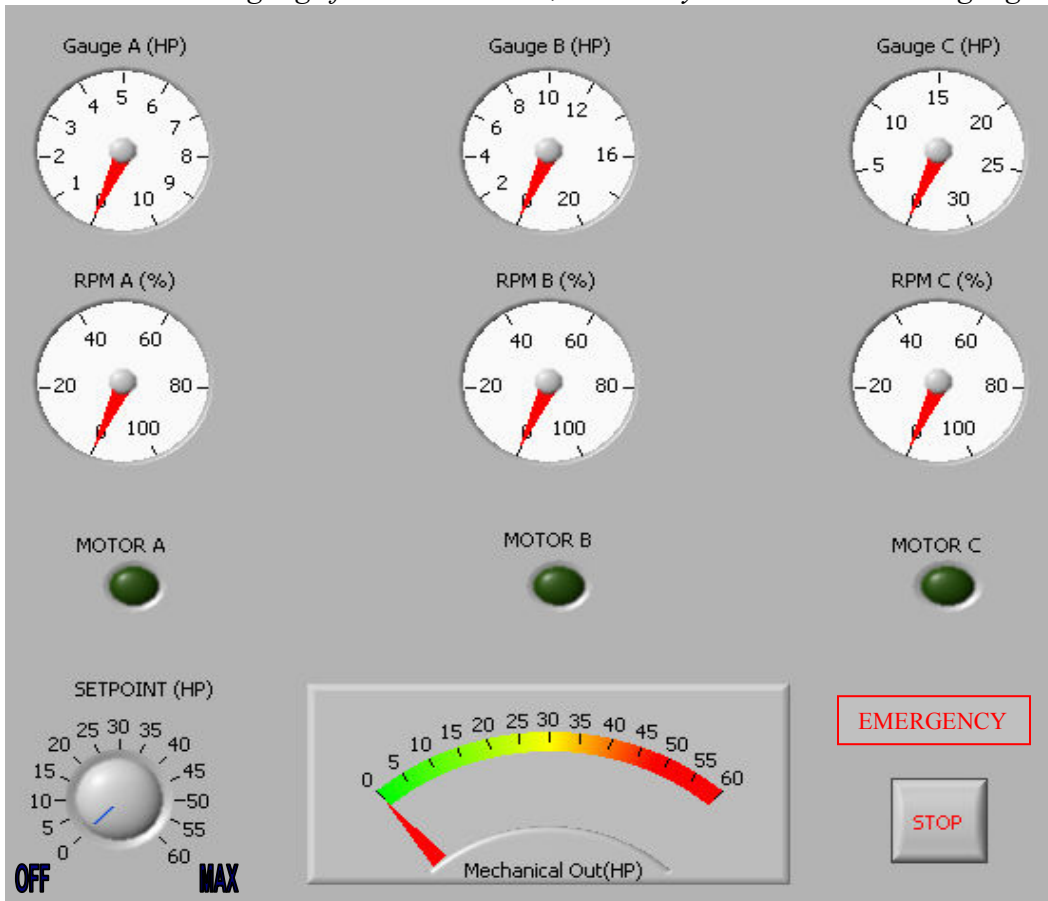
Background

The Electrical Power Systems course of the University of Houston –Downtown Engineering Technology department contains the basics principles and applications of electrical power systems. To create a virtual laboratory circuit simulation software, Visual Basic and LabVIEW are used for exercises and design projects. Included in the course are practical single phase and three phase power systems with WYE and DELTA loads, lighting designs, cabling sizing, transformer sizing, and motor control.

Even though circuit simulation software and Visual Basic have been used, the LabVIEW software has been chosen as the predominate software for the virtual lab exercises and projects because of its ability to provide easily useable software for a variety of class students. LabVIEW has the ability to create virtual projects with panels and logic analog and digital control.

Refer to figure 1 a sample LabVIEW student project panel view of a motor control project.

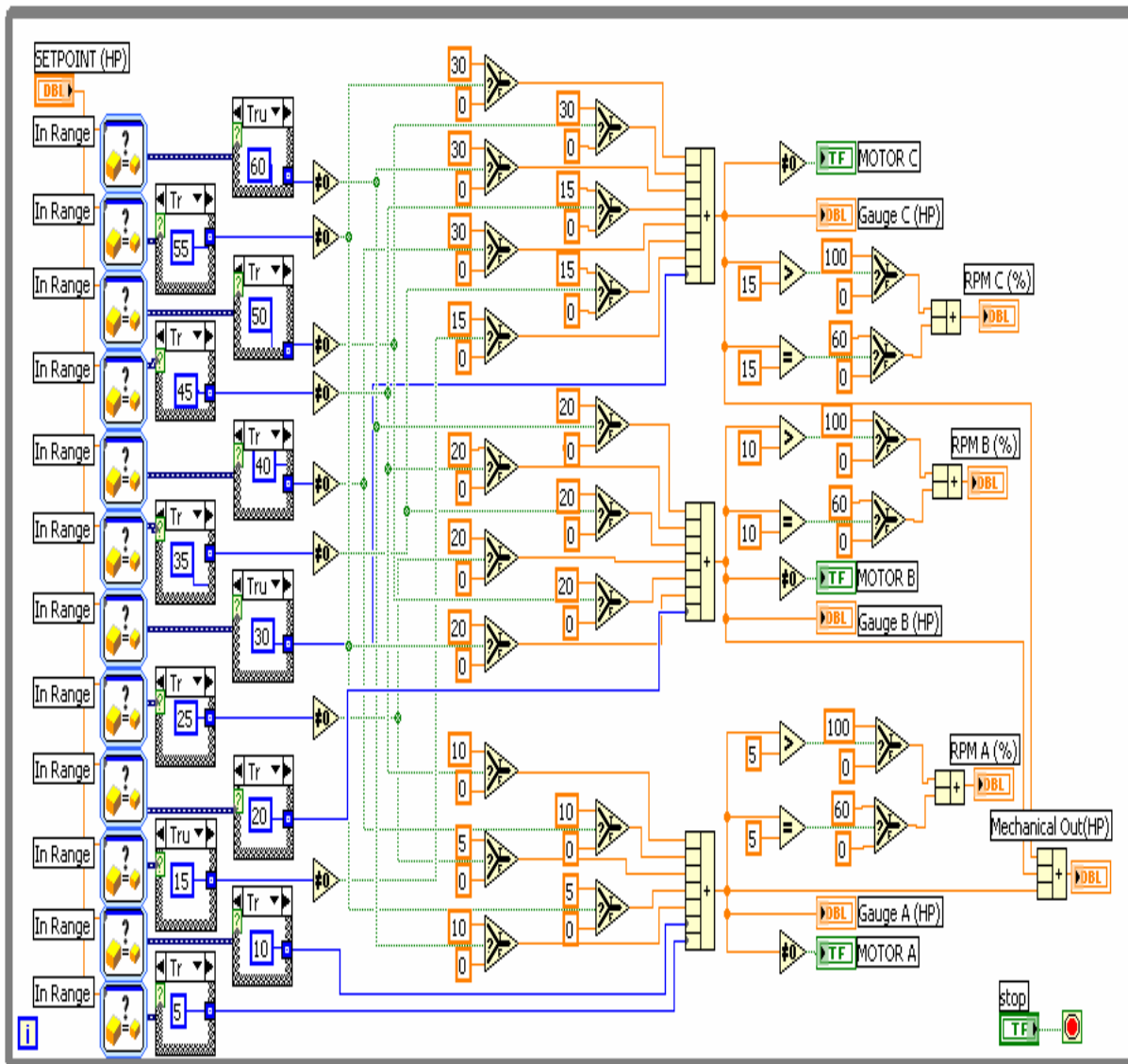
Figure 1 LabVIEW panel view from a student project for a motor control system
 System with motors A, B, C, which combine to give the total, set HP.
 Each motor has a gauge for HP and RPM, and the system has a total HP gauge



Methodology

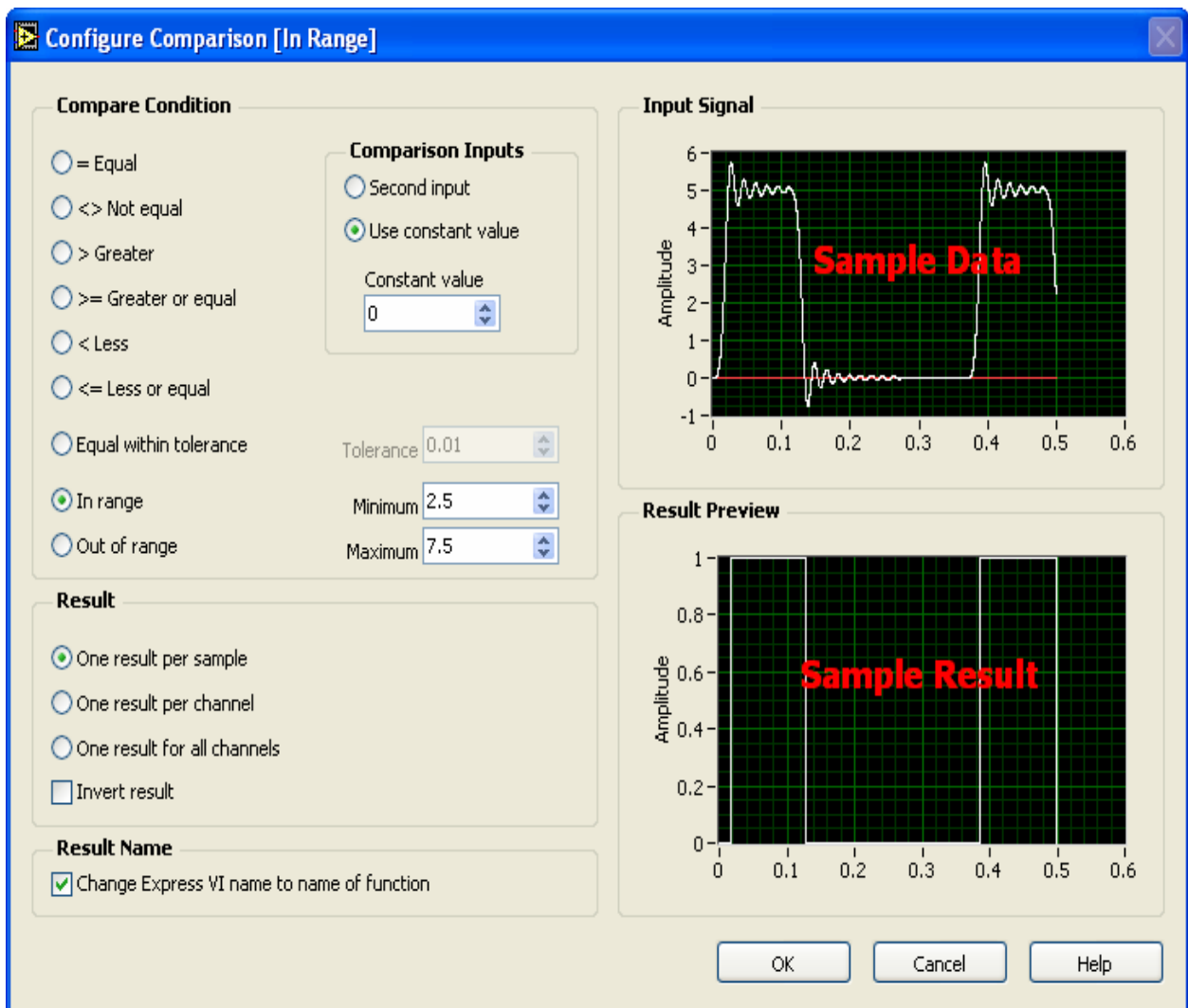
The LabVIEW software has also been chosen as the predominate software for the electrical power systems course because of its ability to be easily programmed for a variety of class projects. It has the ability to create a virtual project control panel that is used with a broad spectrum of functional block logic. This includes both analog and digital control blocks. Some blocks even use both digital and analog data. Note the functional block logic in the LabVIEW diagram figure 2 of the student project. A feature of the LabVIEW software functions is that makes the data flow student user friendly by color-coding.

Figure 2 LabVIEW diagram for the motor control system. student project
 In this diagram, analog data is gold, Boolean is green, and constant data is blue.
 Triangle shapes at center/right are data selectors, triangle shape at far right are ">".
 Boxes at left permit data to pass if certain under range conditions



Furthermore, yet another reason the LabVIEW software has been chosen as the predominate software for the electrical power systems course because of its ability to provide easily graphical data access for a variety of class students. Note the graphical data figure 3 below.

Figure 3 LabVIEW plot of graphical data figure from a student project for a motor control
Input sample data is graphically displayed for comparison with resultant data.



Examples of Student Work

A student exercise for a motor control system in Figure 4 shows the panel view of the system and figure 5 shows the diagram for this system. System motors that run either in high, low or idle speed. If one motor alone runs, it runs in high. If both motors run, each runs in low speed. Note that the high, low, and idle speed for each motor can be set.

Figure 4 LabVIEW panel view from a student exercise for a motor control system
This student project automatically controls a multi-motor combination to pre-selected points. The motor system has motors that either run in high, low or idle speed. If one motor alone runs, it runs in high. If both motors run, each runs in low speed.

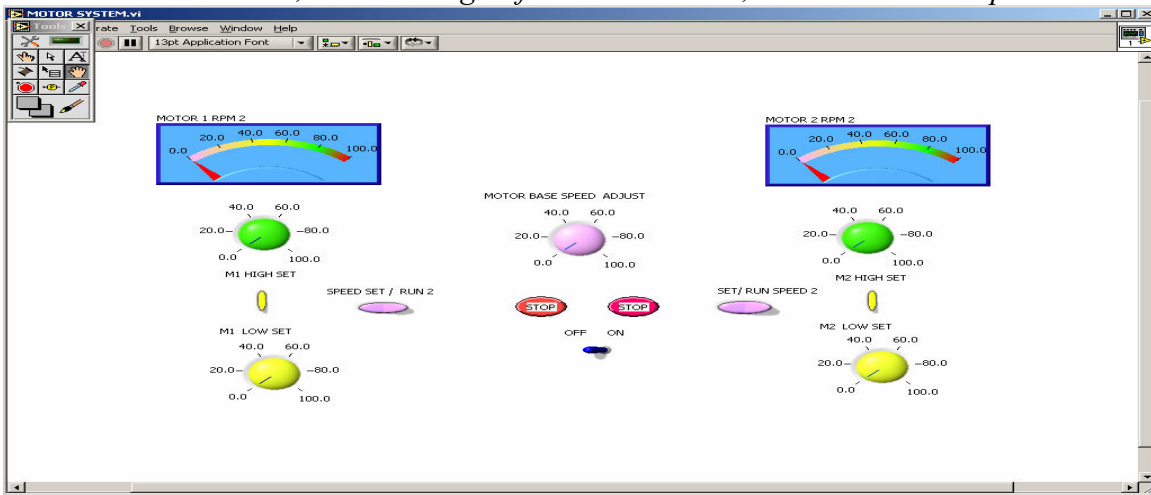
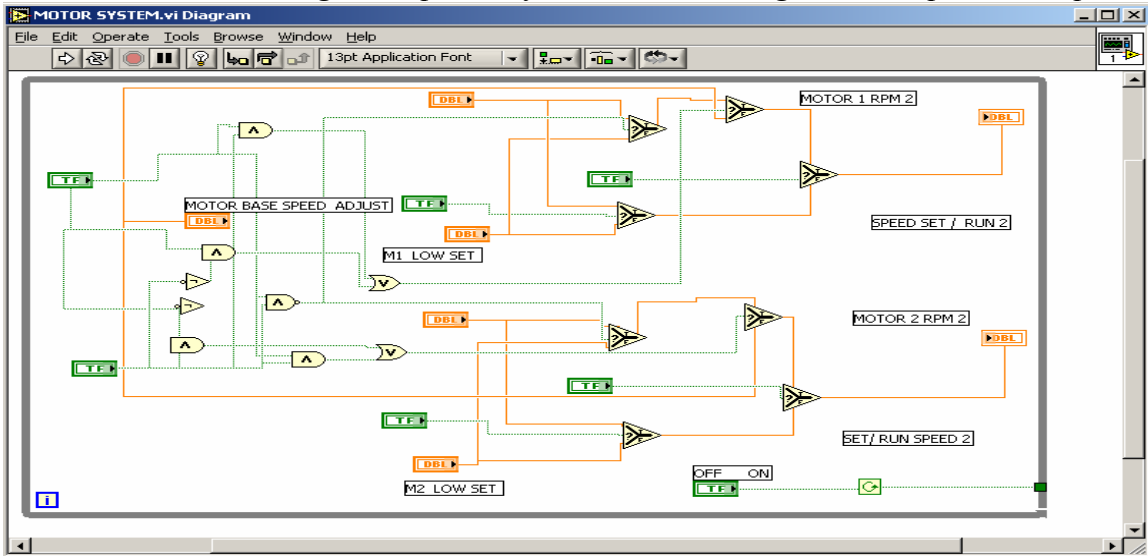


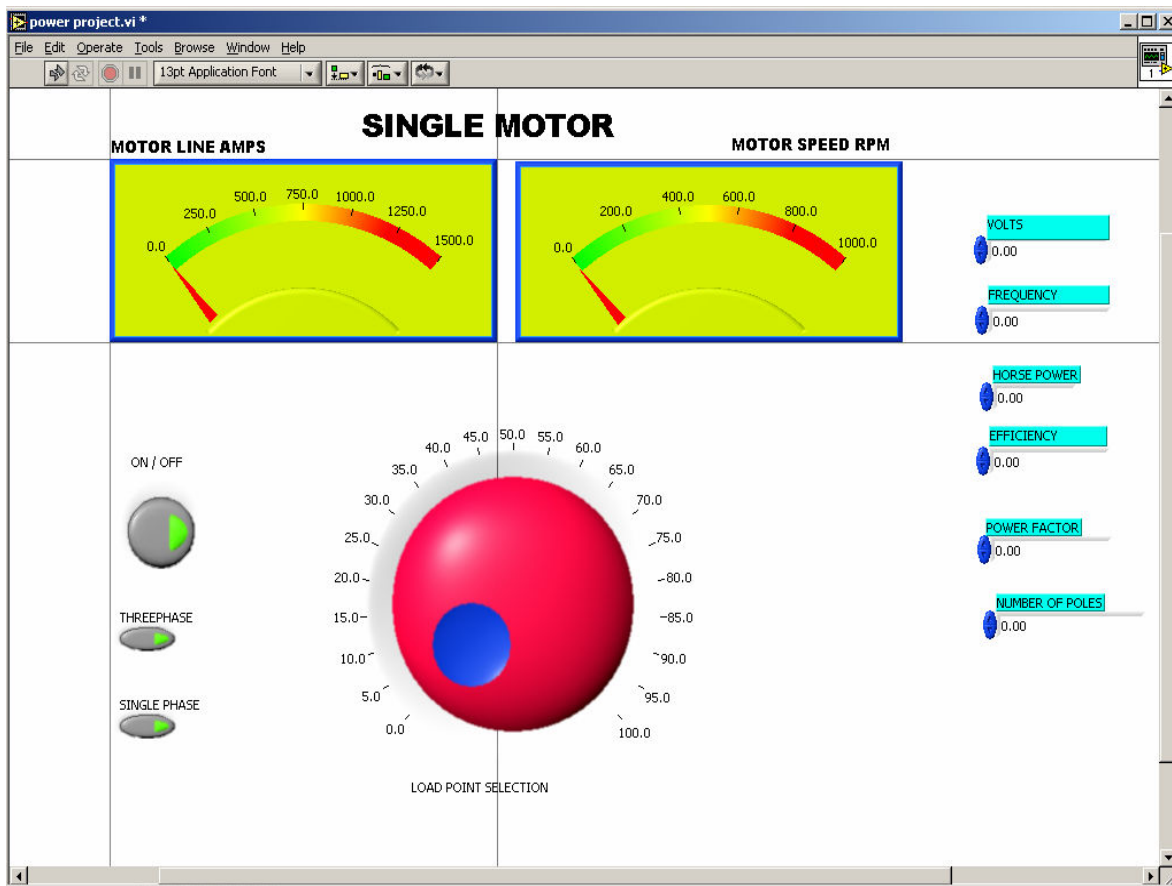
Figure 5 LabVIEW diagram view for panel view just above
Digital logic gates have green lines, the gold analog lines for data flow, and the devices for data select each have a green input line for data select and gold data input and output lines.



Examples of Student Work (continued)

LabVIEW has also been used by the students for an exercise for a single motor. A control panel for a single motor that will find motor load current and RPM speed for various nameplate data single-phase and three-phase motors. The input on the panel determines motor nameplate data, and functional blocks find the load current and RPM that are given as outputs on the panel meters. This panel and diagram are more practical and interesting application than just calculations that are to be shown alone on paper. It also allows a multitude of combinations of nameplate data for a variety of motors. It allows the student to learn the topic by creating functional logic and then to observe the results in a manner that simulates a practical application.

Figure 6 LabVIEW panel view from a student exercise for a single motor load
Panel for a single-phase/ three-phase motor. Motor load current and RPM speed for various nameplate data determined by motor nameplate input data. Functional blocks find the load current and RPM that are displayed by the panel as outputs.

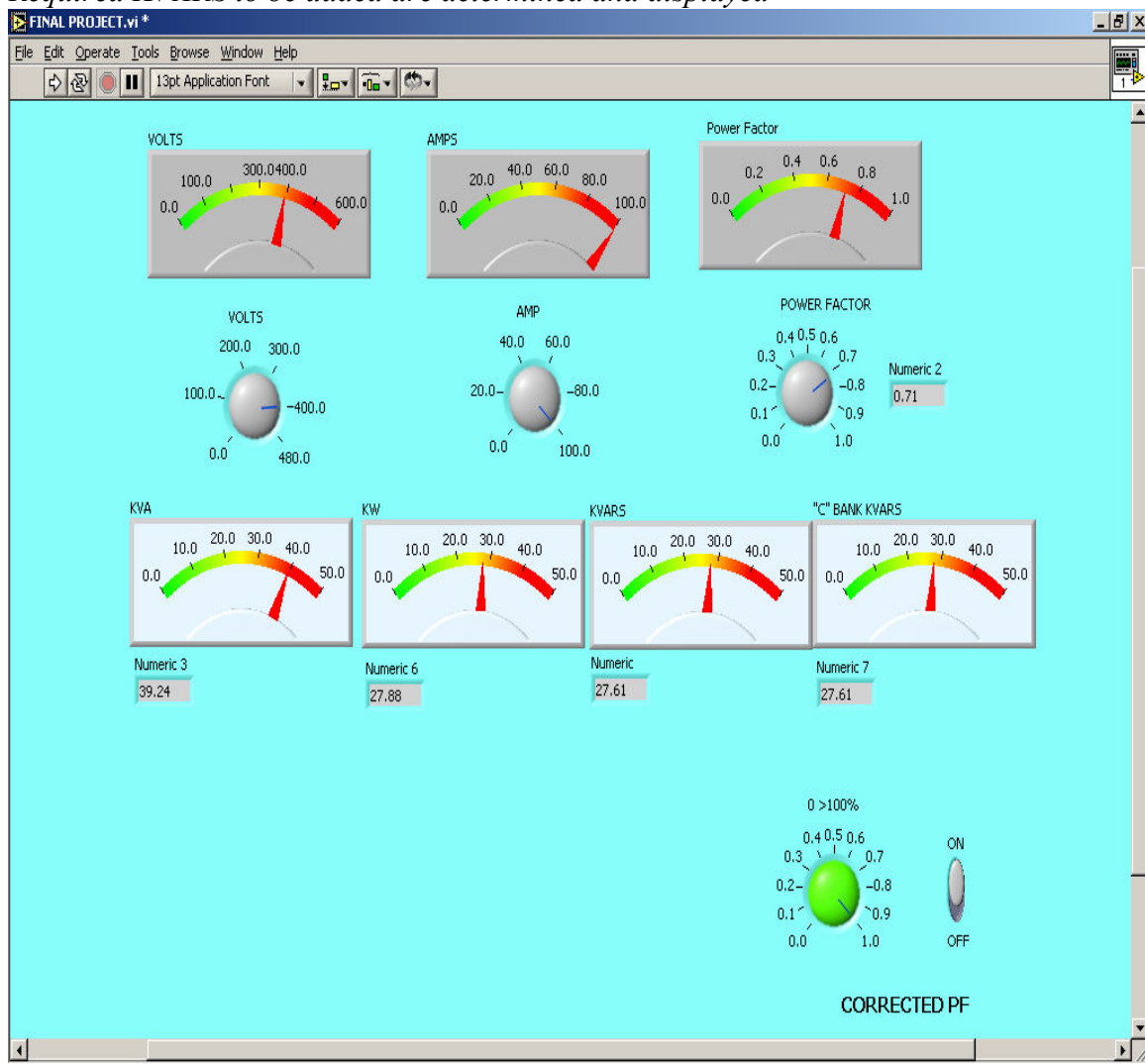


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In addition, innovative virtual laboratory projects have also been made for electrical power Systems by using LabVIEW for automatic power factor correction. Again, the students learn both the basic concepts of power factor correction and the use software.

In the power factor correction student project the panel view is used for the original system load voltage, current, and power factor. These inputs are used by function blocks to determine original load KVA, KW, and KVARs. The desired new power factor is dialed in. Required KVARs to be added are determined and displayed.

Figure 7 LabVIEW panel view from a student project for a Power Factor Correction
In the power factor correction student project the panel view is used for the original system load voltage, current, and power factor. These inputs are used by function blocks to determine original load KVA, KW, and KVARs. The desired new power factor is dialed in. Required KVARs to be added are determined and displayed



Other Student Project Work

Another student project that has been created is automatic load wire sizing, which determines the wire size required for loads, and a lighting design project for various needs.

Other student projects are three-phase electrical power generation by DELTA and WYE generators with combinations of WYE and DELTA loads. Both balanced and unbalanced loads are simulated. Using software, a visual demonstration has been created that shows the resulting consequences of what occurs when balanced loads become unbalanced. The visual demonstration also shows what can be done to correct imbalances in the circuits.

Summary and Conclusion

LabVIEW software has been used to create a cost effective user-friendly electrical power systems virtual laboratory. The LabVIEW class exercises are designed to concurrently familiarize the students with the use of LabVIEW and with electrical power systems.

A sample of the innovative laboratory projects to design automatic motors control systems, automation power factor correction, automatic load wire sizing, and related applications that have been completed by the students using LabVIEW will be demonstrated. The LabVIEW exercises that were created will be given and discussed. Outcomes of the electrical power systems projects will be demonstrated.

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Biography

HARRY FRANZ is an Associate Professor of Control & Instrumentation Electronics Design and Safety & Fire Engineering Technology at the University of Houston-Downtown. He received a B.S.E.E with honors and an M.S.E.E. from the University. of Pittsburgh. He also has credits towards a PhD. E.E., a P.E. registration by N.C.E.E.S. exam and sixteen years experience in industry. He is a member of ASEE, IEEE, ISA, NSPE, & TAP.