

Fire Alarm Laboratory Class using LabVIEW Software taken by Students from Two-Year Colleges

Prof. Harry Franz, P.E.¹
University of Houston- Downtown
Member ASEE, IEEE, ISA, NSPE, TAP

Abstract

The purpose of this paper is to discuss the creation of a Safety and Fire Alarm Laboratory Course that uses LabVIEW and is taken by students that originate from two-year colleges.

The University of Houston – Downtown in Houston, Texas has recently instituted a Safety and Fire BSET program. One of the courses in the program is the “Fire Alarm” course. The challenge has been to create a laboratory that is within both budget and academic constraints, and which could be taken by a diverse mix of students from a variety of two-year colleges.

The “Fire Alarm” course laboratory requires the use of both software and hardware. The class students mostly work in a profession that is related to fire and safety. They are fire personnel, safety designers, and are of other related technical backgrounds. The students in the Fire Alarm course, however, have a greatly mixed level and background in math, computer science, and other academics.

The lab equipment and software must be readily useable to allow coverage of all material in the course in the time allocated. The LabVIEW software creates a laboratory that is within budget constraints and that is readily available and usable by students from two-year colleges that have differing academics. The software is used to both create standalone projects, and to design and interact with course hardware projects.

Innovative laboratory exercises to acquaint the safety and fire students with LabVIEW are used in the “Fire Alarm” course. The exercises both familiarize the students with the use of LabVIEW and the subject area of alarm systems.

The alarm systems software exercises incorporate the detection of fire signatures that include smoke, heat, and other changes in ambient conditions. The exercises also include the logic to activate alarms and fire suppression. Use of both digital logic and analog functions and systems are included in the exercises.

The exercises for the alarm systems laboratory start with very basic electrical and logic concepts that use fundamental LabVIEW features. The exercises quickly progress to more advanced concepts and advanced LabVIEW features. The students enjoy the software use and create colorful practical designs of panels and systems. The final course project design requires a working knowledge of both LabVIEW and alarm systems concepts.

Details of the innovative lab exercises that were created to help the Alarm System course students of mixed academic levels and backgrounds, to become proficient in the LabVIEW software, will be given and discussed. In addition, the outcome of the final courses projects the students designed and implemented are given in the addendum at the end of this paper.

¹ Associate Professor Control & Instrumentation Electronics Design and Safety & Fire Engineering Technology, UH-Downtown, Houston, Texas, 77002

sheet two

The University of Houston–Downtown (UHD) in Houston, Texas, Safety and Fire BSET program is about three years old. An important course that is part of the UHD Safety and Fire program is the “Fire Alarm” course. The course formal catalog name is “***Fire Suppression and Detection Systems***”. The formal catalog description includes operational capabilities and utilization requirements of fire detection and signaling systems, fire detection and suppression applied in practical problems, and experimental demonstrations and computer simulations. The purpose of the “Fire Alarm” course is to acquaint each student with the detection, logic, alarm, and suppression systems used for fire protection.

The course with materials at the junior level is taken by a diverse mix of students that originate from two-year schools with a variety of levels of math, electrical theory, logic, and software use. The students are also from within the University of Houston-Downtown itself and often are taking a double major.

It has been a challenge to create a laboratory for the alarm course that is within budget and that includes proper software and hardware. The projects have been built and developed by the students through the use of National Instruments LabVIEW software and respective hardware. The completed projects are used as training devices.

It also has been a major challenge to create course projects for the fire alarm laboratory because the level of academics of the students is quite varied, even though most of them work in a profession that relates to fire and safety. The majority of the students are fire personnel and safety designers, and the others have an assortment of technical backgrounds.

The basics of electrical, digital logic and analog design are first covered in the “fire alarm” course to either to form a solid basic understanding or to reinforce prior knowledge. Understanding of the basics is accomplished by using circuit simulation software exercises and LabVIEW exercises.

The exercises are readily completed by the students, even though the student body is greatly diverse, through numerous classroom detailed instruction and classroom examples. The exercise assignments are to an extent self-paced and vary from the very basic to advanced levels.

The alarm course circuit simulation software instruction starts with the students becoming acquainted the elements and symbols by using the software menus. An advantage of the menus is that each symbol when touched, gives the name of the symbol. The symbols are quickly learned and when used in conjunction with classroom circuit examples, students are readily able to complete the related circuit software exercises.

The use of basic circuit simulation software exercises includes resistors, and series, parallel, and combination circuits. Digital logic basic exercises include logic gates and combinations. Analog functions are introduced. Relays and ladder logic are given. The uses of retentive and non-retentive circuits are explained. Types of alarm circuit latches are covered.

The LabVIEW software instruction starts with an introduction to the front view or panel view. Elements for the panel are obtained from the control menu. It is noted to the students that this view is for the layout of devices. The menus are used to learn the name and use of each item. It is emphasized to the students that each device can be designated for use as an input or output. Uses of tools of the tool menu for the panel view are then given.

The back view or connection diagram is covered next. Use of the tool menu as it is used for the connection diagram is given. The wiring of the devices on the diagram is then demonstrated to the students.

A tie-in between front panel view and back connection diagram is made. Instructions and examples are given in the use of the menus for device designation as either an input control or output indicator, and for use of color choice, connection wiring, and other tools. The LabVIEW software quickly and clearly points out any errors and suggests how to correct them. Because the LabVIEW software is very user-friendly, most students are enthusiastic and have only minor difficulty.

Instruction is furthermore given in more advanced software exercises that include the combination of digital and analog. The LabVIEW software easily allows the combining of digital and analog data.

An example of the use of LabVIEW software given to the students that combines digital logic and analog functions is the switching of the flow of continuous analog data. The analog data trains are controlled by a switch device that is liken to the switching of a railroad trains that are switched either from the left track or from the right track. The switch position, which is either one way or the other, is controlled by digital logic. The switch position depends on either the digital logic “high” or “low” Boolean value. It is strongly noted to the students that the continuous data flow from the chosen path is indeed an analog data function.

Students are cautioned in the pitfalls of the improper use digital, analog, or the combination of both. Again, the use of the user-friendly LabVIEW software greatly helps to overcome the fact that the class student body has a diverse academic level background.

The LabVIEW color-coding of the different data types is an example of how the software helps to guide the students. The color green is for digital, orange is for analog, blue is for numerical values and so on. The LabVIEW software also alerts the user when improper connections of the devices are made. It also gives suggestions on possible corrections.

Another major challenge of the course is to cover all the required material in the time allotted even though much time at the beginning of the course must be spent on the basics of electrical, digital, analog theory and the basics of the circuit simulation software and LabVIEW. Software exercises have been created to bring each student to the proper level in the allotted time.

In addition to using the software to help students of diverse academics to obtain the required competency level of the course, the software also allows the on-time creation of both standalone projects and designs of course hardware projects.

Yet, another “alarm course” major challenge is that the alarm lab must be readily accessible in addition to being user-friendly, to allow students with varying academics to become proficient in the course software and hardware. The LabVIEW software has allowed creation of a laboratory that is within budget constraints and that is readily available and usable by students from two-year colleges that have differing academics.

Innovative laboratory hardware exercises designed through LabVIEW software allow students to become acquainted with the various types of alarm systems. The single-station systems, the multiple-station system, and the zone-alarm system are typical alarm system examples. The addendum of this paper shows these projects.

These alarm hardware systems incorporate the detection of fire signatures that include smoke, heat, and other changes in ambient conditions. Also included is the logic to activate alarms and fire suppression. Both digital logic and analog functions are used as part of the systems.

Course projects boards for the alarm class include: a relay logic board with primary and secondary power supplies, and latches; a household alarm system; a warehouse project; and a general system with various inputs and output that can be programmed in various configurations. Again, the addendum of this paper shows these projects.

To create colorful practical designs of panels and systems for the final course project requires a working knowledge of both LabVIEW and alarm system concepts.

The innovative lab exercises that have been created help the students from mixed academic levels and backgrounds become proficient in both the LabVIEW software and fire protection alarm systems. This in turn has facilitated the creation of the alarm course laboratory.

Please refer to the addendum following the bibliography of this paper to view a variety of project designs.

Bibliography:

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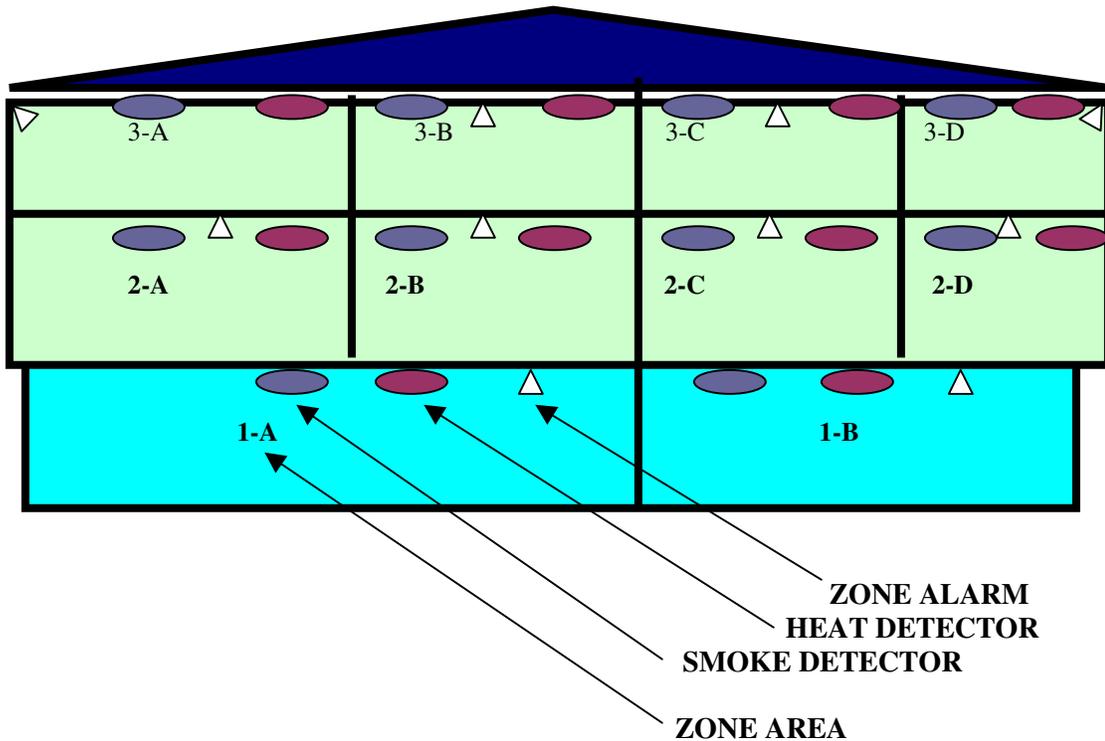
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PROJECT SAFETY & FIRE WAREHOUSE BUILDING FIRE & SECURITY ZONE ALARM SYSTEM

with MASTER ALARM ANNUNCIATOR PANEL



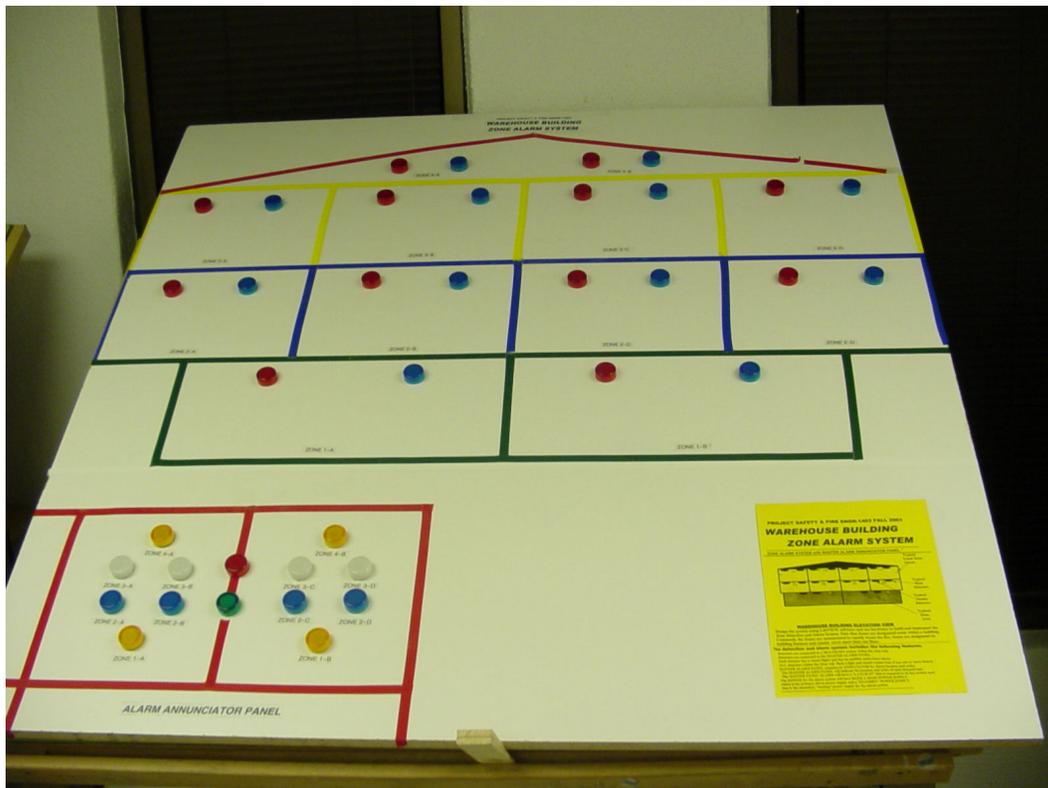
WAREHOUSE BUILDING ELEVATION VIEW

Design the system using LabVIEW software and use hardware to build and implement the Zone Detection and Alarm System. Note that Zones are designated areas within a building. Commonly the Zones are annunciated to rapidly locate the fire. Zones are designated by building features and cannot cover more than one floor. The detection and alarm system includes the following features. Detectors are connected in a MULTIUNIT system within the zone only. Detectors are connected to the MASTER ALARM PANEL

ADDENDUM – I- B

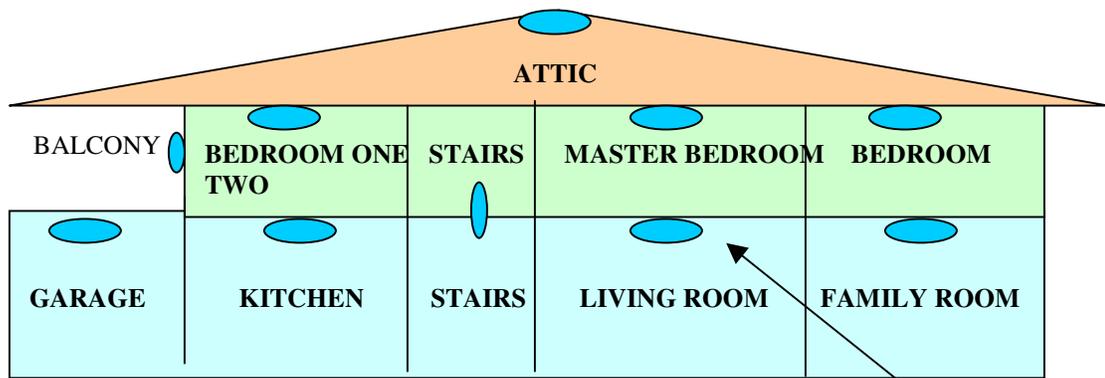
PROJECT SAFETY & FIRE WAREHOUSE BUILDING FIRE & SECURITY ZONE ALARM SYSTEM

with MASTER ALARM ANNUNCIATOR PANEL



ADDENDUM - I I- A
**PROJECT SAFETY & FIRE
HOUSE FIRE & SECURITY ALARM SYSTEM**

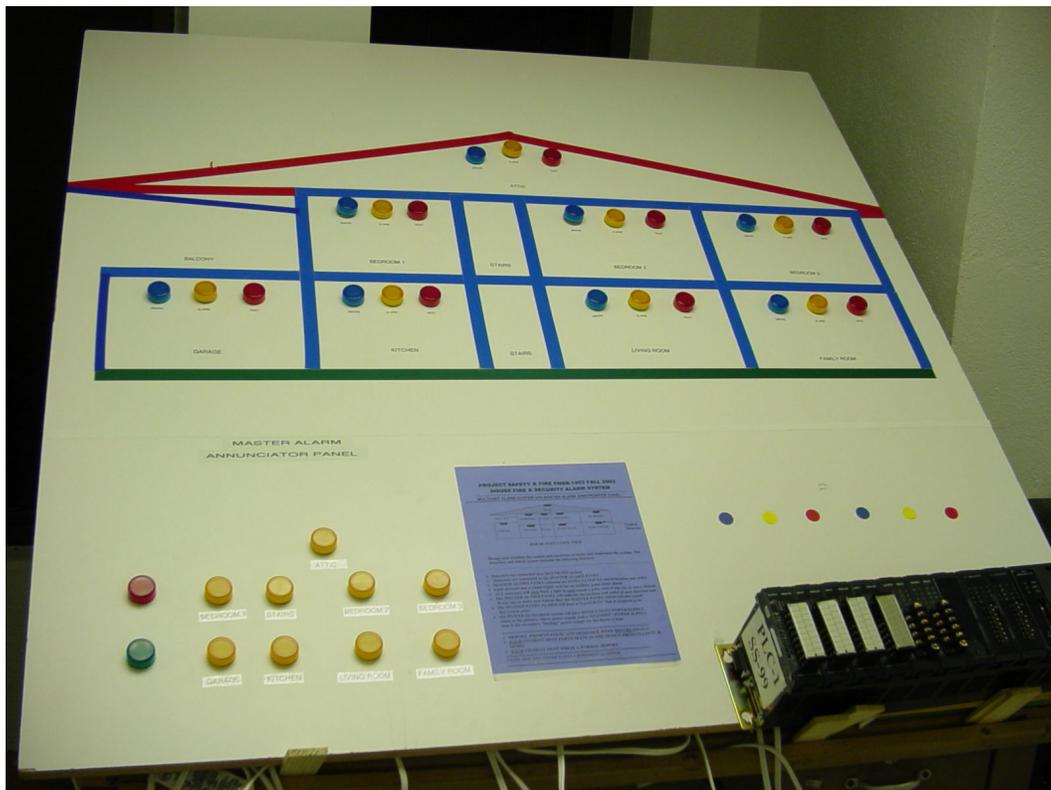
**MULTIPLE UNIT ALARM SYSTEM
with MASTER ALARM ANNUNCIATOR PANEL**



HOUSE ELEVATION VIEW TYPICAL DETECTOR

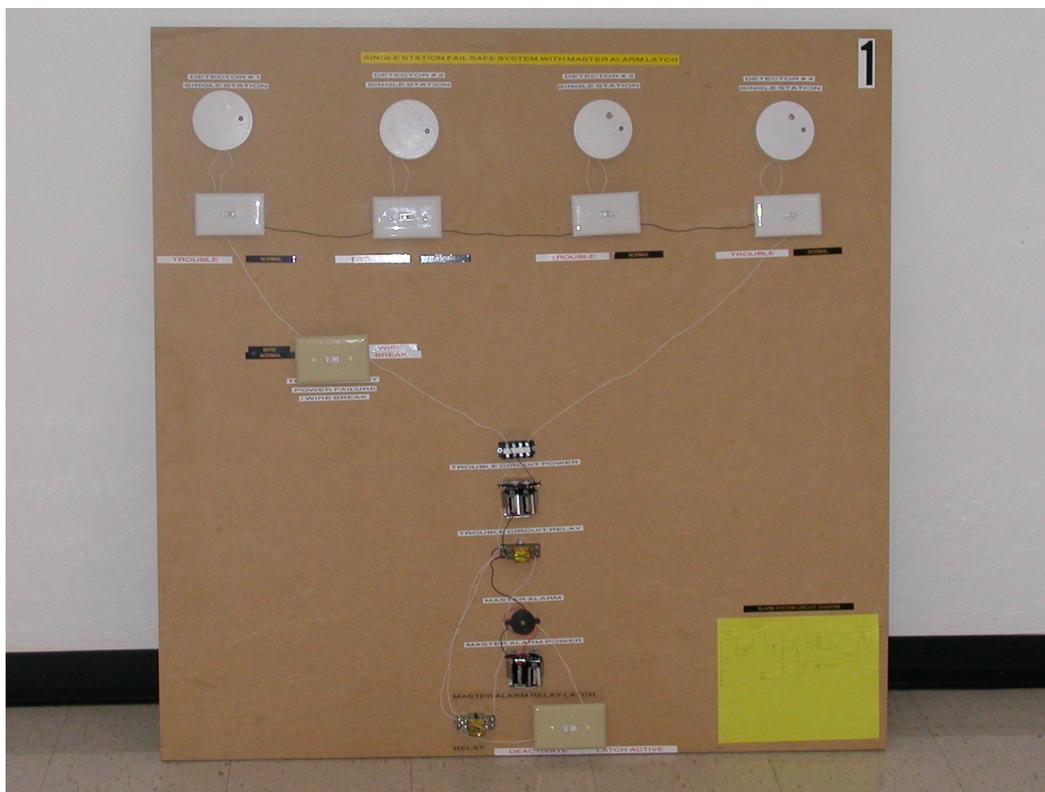
ADDENDUM - I I- B

PROJECT SAFETY & FIRE HOUSE FIRE & SECURITY ALARM SYSTEM



ADDENDUM -III- A
PROJECT SAFETY and FIRE
HARDWIRED SINGLE STATION FAIL SAFE ALARM SYSTEM
WITH MASTER ALARM LATCH

Each station independently alarms. A failsafe trouble circuit supervises all station and alarms if there is a broken wire or if any of the single station alarms. There is a master latch for the overall alarm system.



ADDENDUM -III- C
PROJECT SAFETY and FIRE
PROGRAMMABLE CONTROLLED ALARM SYSTEM
WITH VARIOUS HARDWARE

Various detectors are connected as inputs and various alarms & other devices are connected as outputs to the programmable control unit. The control logic is programmed into the control unit to create a variety of alarm systems. An annunciator panel also works in conjunction with the system.

