

The ABC's of Fire Alarm Systems - Section I

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A fire alarm system is used primarily to evacuate the premises in the event of occurrence of a fire condition and then secondarily to report the fire to the proper authorities.

A fire alarm system differs somewhat from a security system. The security system only recognizes two states or conditions: normal or alarm, and cannot differentiate between a line break and the opening of an alarm switch. The fire alarm system recognizes four different states or conditions: normal, alarm, trouble and supervisory.

Simplistically speaking, a basic system consists of a fire alarm control panel (FACP) to which are connected initiating (input) devices, notification (output) appliances, a source of operating power, and a source of standby power in the event the operating power should fail.

The function of a fire alarm control panel is basically three-fold:

- 1) Accept an alarm or supervisory input from an initiating device.
- 2) Provide an alarm output to the notification appliance(s).
- 3) Monitor the integrity of the panel itself and also the wiring to the above devices.

MINIMUM BASIC SYSTEM

Fire alarm systems have changed dramatically over the past few years, primarily due to the advent of the low priced microprocessor. Basically there are two different approaches used for the fire alarm control panel, conventional and addressable.

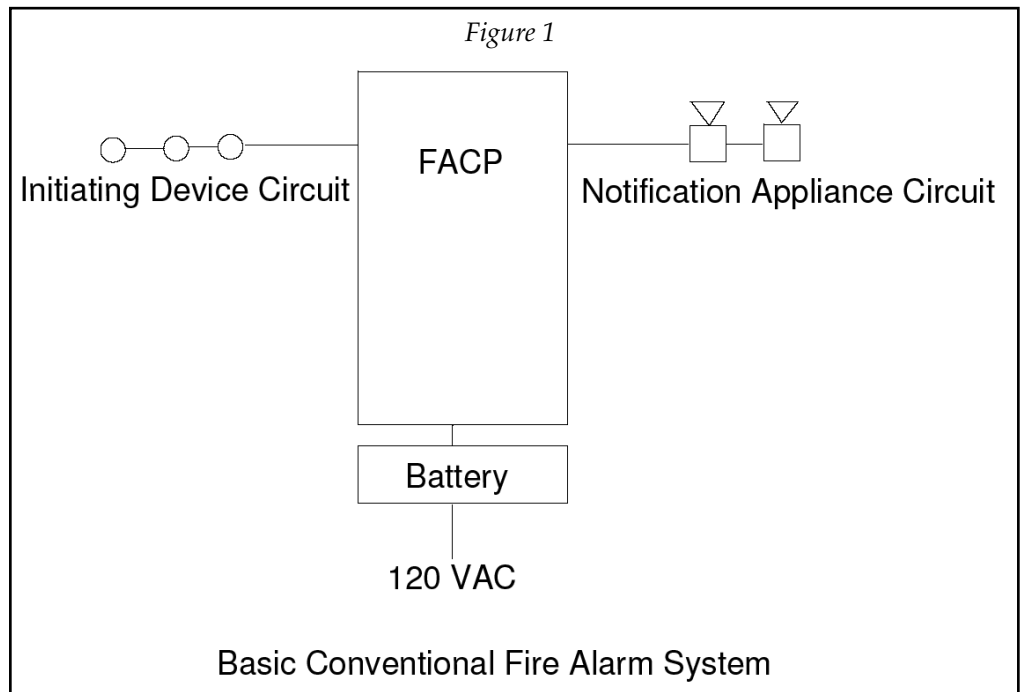
We are concerning ourselves in this installment with the conventional (hard-wired) system as opposed to an addressable system, which will be covered in a following installment.

The minimum basic components of a conventional system are:

- 1) A locked fire alarm control panel listed for the purpose by a Nationally Recognized Testing Laboratory, (NRTL) as recognized by OSHA. The standard governing fire alarm control panels is ANSI/UL Standard 864, currently entering it's ninth edition. OSHA currently recognizes Underwriters Laboratories, Factory Mutual Approvals and ETL-Semko as certified to test equipment per this standard.

- 2) A primary operating power supply (120 VAC).
- 3) A secondary or standby power supply. This is most often a rechargeable storage battery, although generators are permitted subject to certain conditions.
- 4) At least one initiating device circuit to which is wired at least one manual station, automatic heat or smoke detectors, waterflow switch activated by a sprinkler system, etc. These devices are located in one area, or zone, so an alarm condition in this zone can direct fire fighting personnel to the source of the alarm. Typically, a zone usually consists of a floor of a small building, or wing of a larger building, etc. with area limitations defined in the National Fire Alarm Code (NFPA 72).
- 5) At least one (output) notification appliance circuit to which is wired at least one horn, bell, and strobe, if required.

The basic minimum system is shown in Figure 1.



The secondary power supply (usually a battery) automatically furnishes operating power to the system in the event of failure of the main 120 VAC supply or if the main supply voltage falls below 85% of normal ("Brown-out" condition). The battery must be of the rechargeable type, since dry cells are not permitted.

The ABC's of Fire Alarm Systems - Section I . . . *Continued from page 42*

A gel-cell battery is a rechargeable battery.) The battery must operate the system for a specified period of time in a standby or quiescent condition, and have sufficient reserve at the end of the standby period to operate the panel in an alarm condition for a period of five (5) minutes. Batteries are required by the National Fire Alarm Code in all fire alarm systems not having multiple standby generators. The control panel must also be capable of recharging the battery within a specified period after a discharge.

BASIC SYSTEM OPERATION

Initiating devices employed in a supervised, conventional system usually have normally open, 'dry' contacts which close on alarm. ('Dry' contacts are contacts that have no voltage applied to them.) Exceptions to this are 2-wire smoke detectors, which receive their operating power from the (supervisory) current flowing through the circuit, and alter the characteristics of the circuit when they go into alarm. These will be covered in a separate article.

The act of operating a manual station or actuation of an automatic detector closes the contacts of the device and applies power to the alarm circuitry, causing the panel to go into alarm, light one or more red LEDs on the panel, and energize the notification appliance(s). This appears to resemble the classic operation of a doorbell system, but the BIG difference here is that the fire alarm control has the ability to monitor its own integrity, commonly referred to as *supervision*.

SUPERVISION

A supervised system (sometimes referred to as a "closed circuit" system) will create a trouble signal in the event of a break in the field wiring, disconnection or removal of an initiating device or notification appliance, failure of main operating power, disconnection of the standby battery, or off-normal position of a panel switch. A trouble condition will light one or more yellow LEDs on the panel and cause an audible signal, (usually a piezoelectric device) to sound. The audible signal can be silenced by operating the 'Trouble Silence' switch on the panel. Since the panel is locked, the trouble sounder can only be silenced by authorized personnel who have access to the key.

In a conventional system, supervision is made possible by use of an 'End of Line' (EOL) device, usually a resistor, although other components may be used, depending on the designer.

TROUBLE CIRCUITRY

Many years ago, manufacturers used relays to achieve supervision. Two relay coils, alarm and supervisory, were connected in series with the initiating device circuit. The supervisory relay was rated at a lower voltage and was continually energized by the reduced current flowing through the circuit via the EOL device. The alarm relay was rated at the operating voltage and would only energize when the current was increased by an initiating device that short-circuited the EOL device. If the circuit is opened by a break in the wiring, or unauthorized removal of a detector or station, or if the winding of either relay opened, the trouble relay contacts would fall out, applying voltage to the trouble LED and sounder. These

relays were eventually replaced by solid state components, mostly microprocessors, that monitor the circuit supervisory current.

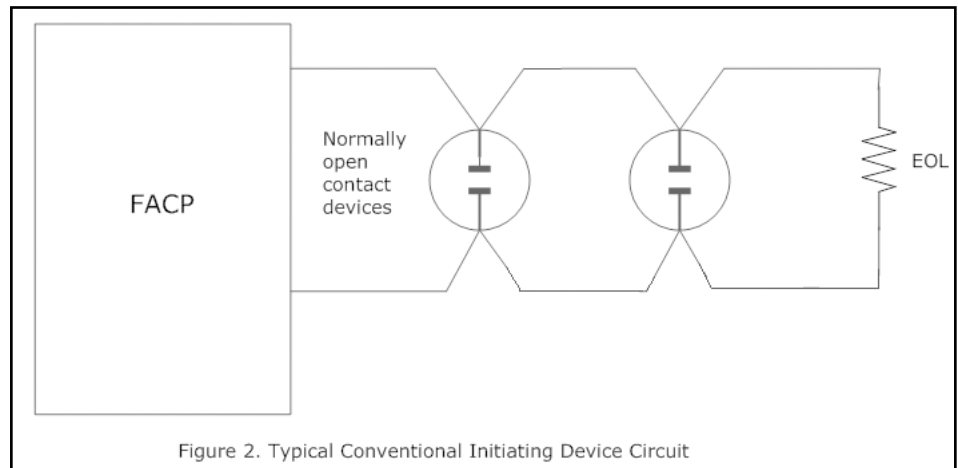


Figure 2. Typical Conventional Initiating Device Circuit

In Figure 2, we see an initiating circuit of a Fire Alarm Control Panel (FACP). Current flows out of the FACP and through the circuit, in and out of one contact of the initiating devices, through the end of line resistor (EOL), through the second contact of each initiating device and back to the FACP. (We will discuss the "in and out" wiring to the contacts later.)

Continued on page 44

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In the event of a break in the outside wiring, unauthorized removal of a detector or station, failure of the main power supply, or removal of the EOL device, the microprocessor will sense the change in circuit current and create a trouble condition, energizing the yellow System Trouble LED, a yellow Zone Trouble LED dedicated to that circuit, and an audible sounder inside the panel, signifying a trouble condition. The sounder may be silenced by operating a 'Trouble Silence' switch, but the yellow LED(s) will remain lit. Once the trouble condition is rectified and the circuit in question is restored to normal, the audible signal will sound again, or 'ring back'. The trouble silencing switch is then restored to the normal position, silencing the sounder and extinguishing the Trouble LED(s).

ALARM PROCESSING

In the event of an alarm, the contacts in the initiating device close, shunting out the EOL, raising the circuit voltage to full operating voltage, and energizing the alarm circuitry. The alarm circuitry will then apply operating power to the notification appliance circuit, sounding horns, flashing strobes, and performing other functions.

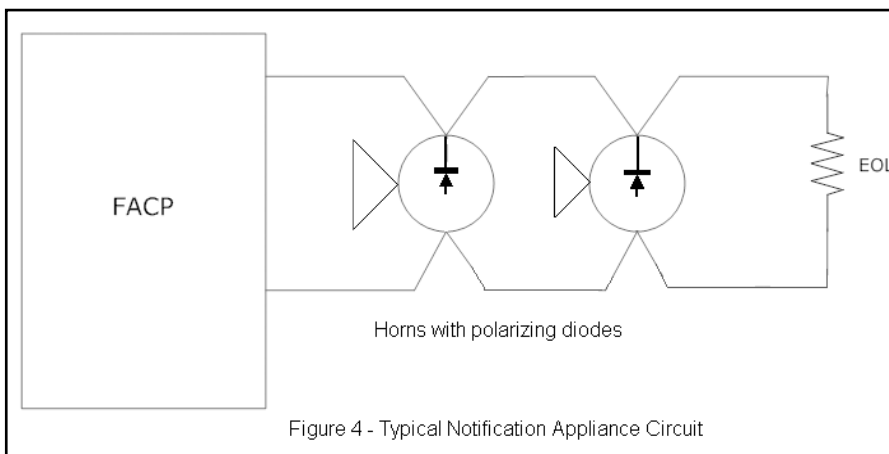
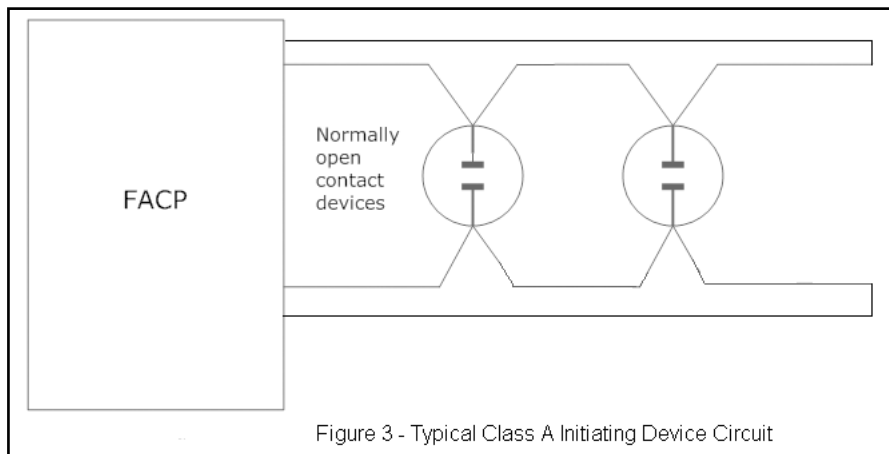
This type of circuit is referred to as a Class B, Style B circuit. The National Fire Code, NFPA Standard 72, makes references to both 'Classes' and 'Styles' for circuits. The Class A or B designation has been traditionally used for discussion purposes, while the Style designations refer to a wider variety of circuits having subtle differences which are beyond the scope of this article. (The 2010 Edition of the National Fire Alarm Code will apparently do away with style classifications and adopt new definitions of Classes.)

CLASS B, STYLE B INITIATING CIRCUIT

Thus, a Class B (or Style B) circuit is a two-wire circuit with external EOL. Any device electrically located beyond a break in the field wiring will be disabled. Any devices located electrically before the break will still be able to turn in an alarm. A Class B system is economical, since it only uses two wires, but has several drawbacks, such as survivability, or inability to operate if a device beyond the break goes into alarm. Also, the EOL is often installed in the last initiating device, the location of which is often unknown if a less than competent installer doesn't document the location at the FACP. Therefore, we see the need to develop a better circuit. The Class A, Style D circuit is an answer.

CLASS A, STYLE D INITIATING CIRCUIT

A Class A (or Style D) initiating circuit uses four wires, and has the EOL device located on the FACP terminal board or at least, inside the cabinet. Figure 3 shows a typical Class A circuit. The circuit operates in the same fashion as a Class B circuit, but the wiring returns to the FACP after the last initiating device. In the event of a wiring break, etc., the



trouble circuitry operates and connects line A to line D, and line B to line C, thus effectively shunting out a single break anywhere in the circuit. Alarm operation otherwise is exactly the same as in the Class B circuit. A Class A circuit therefore, has the ability to turn in an alarm in spite of a single break in the circuit. This gives the circuit a greater degree of survivability than the Class B circuit, eliminates the problem of 'lost' EOL devices, and makes trouble shooting easier. The main disadvantage is that it requires twice the amount of wires and the codes require that the return pair be run in separate raceways or conduit from the outgoing pair to ensure survivability. One typical trouble situation is often caused by a different trade unknowingly cutting through a conduit. There are numerous horror stories regarding this.

CLASS B, STYLE Y NOTIFICATION APPLIANCE CIRCUIT

Notification appliances, such as bells, horns, strobes or combination horn/strobes are likewise installed in Class B or Class A configurations. However, the supervision of these appliances is made possible by use of blocking diodes wired internally in each device. As you probably already know, a diode only conducts DC voltage in one direction. If the polarity of the supply voltage is reversed, the diode will become an open circuit, and no conduction occurs. See Figure 4.

Every notification appliance is equipped with a blocking diode. Thus the appliance is supervised up to the point of connection to the circuit. The internal coils, etc. are NOT

Continued on page 45

The ABC's of Fire Alarm Systems - Section I . . . *Continued from page 44*

supervised. Supervisory voltage is applied to the notification appliance circuit, which conducts the current to each appliance where it is blocked by the diode, travels through the EOL device, and back to each appliance and hence to the FACP. In the event of a break or removal of an appliance, the circuit will open and a trouble condition will occur, just as in an initiating circuit. During alarm, the polarity of the voltage is reversed by panel circuitry, and the blocking diodes conduct the current to the interior components of the appliance.

SUPERVISORY CIRCUIT

Supervisory circuits are basically used to detect 'off normal' conditions in the sprinkler system, if one exists in the building. A supervisory circuit is basically an initiating type of circuit, Class A or B, to which are connected supervisory or 'tamper' sprinkler system switches. These switches transfer if a gate valve has been operated to shut off a sprinkler system, if sprinkler pressure is dropping due to a leak, if the water level in a rooftop tank is too low, too high, or if a "freeze up" is imminent, etc., or in general, indicate a problem or tampering with the sprinkler system. In this case, the supervi-

sory switch process the signal in the same manner as an alarm, but the panel circuitry is programmed not to energize the notification appliances or transmit an alarm signal off premises. Instead, the circuit lights its associated LED and the trouble sounder may sound, as the sharing of the audible trouble signal by both trouble and supervisory circuits is permitted. Sometimes a single notification appliance may be energized, such as a flashing yellow light, etc.

Thus, we see the operation of a simple, basic system. A larger system would have additional initiating circuits, notification appliance circuits, circuits that make off premise notification (fire department) by various means, and control circuits to capture elevators, shut down air circulating equipment, and perform various required auxiliary functions.

Our next installment will cover the devices that place a conventional fire alarm system into alarm.



2009 Golf Outing

August 22—8 a.m.

It seems like we just finished cleaning the desert sand off our clubs, and here we are already thinking about next years Outing. The Florida Section is already hard at work planning what we hope will be a great golf outing at one of the premier golf courses in Central Florida.

The National Course at Champions Gate was designed by Greg Norman and offers a great mix of American style bunkers to challenging tee shots for every skill level. As you drive towards a couple of the greens there's enough sand and water to make you think your over on Daytona Beach.

The Outing is going to be held on Saturday the 22nd at 8:00 AM. The price is \$55.00 per person. This will include your round, cart and a catered lunch after in the Club House. Registrations can be downloaded from the IMSA web site or contact the Golf Committee for more information and pricing on club rentals.

We hope all of you can join us for one of the more unique events of the conference.

Sincerely, The Officers of the Florida Section

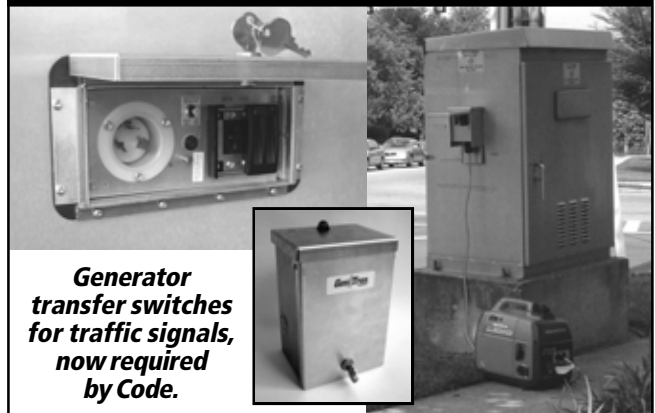
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