Industrial Maintenance

Addressable Fire Alarm System

Fire Alarm Learning System

Course Sample

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Safety and Common Symbols

The following safety and common symbols may be used in this course and on the equipment:

Symbol	Description
DANGER	**DANGER** indicates a hazard with a high level of risk which, if not avoided, will result in death or serious injury.
WARNING	**WARNING** indicates a hazard with a medium level of risk which, if not avoided, could result in death or serious injury.
CAUTION	**CAUTION** indicates a hazard with a low level of risk which, if not avoided, could result in minor or moderate injury.
CAUTION	**CAUTION** used without the *Caution, risk of danger* sign ⚠, indicates a hazard with a potentially hazardous situation which, if not avoided, may result in property damage.
	Caution, risk of danger. Consult the relevant user documentation.
	Caution, risk of electric shock
	Caution, lifting hazard
	Caution, hot surface
	Caution, risk of fire
	Caution, risk of explosion
	Caution, belt drive entanglement hazard
	Caution, chain drive entanglement hazard
	Caution, gear entanglement hazard
	Caution, hand crushing hazard

Safety and Common Symbols

Symbol	Description
	Notice, non-ionizing radiation
	Consult the relevant user documentation.
	Direct current
	Alternating current
	Both direct and alternating current
	Three-phase alternating current
	Earth (ground) terminal
	Protective conductor terminal
	Frame or chassis terminal
	Equipotentiality
	On (supply)
	Off (supply)
	Equipment protected throughout by double insulation or reinforced insulation
	In position of a bi-stable push control
	Out position of a bi-stable push control

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Preface

Fire alarm systems utilizing modern technology and employing good engineering practice in the application of codes and standards greatly increase the chances of limiting fire propagation and saving lives.

The Addressable Fire Alarm System reproduces an environment where you will develop your skills in the installation and wiring of a fire alarm system. You will also familiarize yourself with the configuration of an addressable fire alarm control panel.

The courseware and the equipment supplied with this learning system must only be used for **educational** purposes.

Completion of this course will not make you a competent fire alarm technician without at least one or two years of working experience with another experienced technician. Necessary skills and hands-on training must be obtained in the workplace through daily on-the-job training. This course does not accredit you to make any change or setting in a fire alarm system.

We hope that your learning experience with this learning system will be the first step of a successful career.

We invite readers to send us their tips, feedback, and suggestions for improving the course.

Please send these to services.didactic@festo.com.

The authors and Festo Didactic look forward to your comments.

About This Course

The Job Sheets in this manual provide a systematic and realistic means of learning how to install and program an addressable fire alarm system.

Safety considerations

Safety symbols that may be used in this course and on the equipment are listed in the Safety and Common Symbols table at the beginning of this document.

Safety procedures related to the tasks that you will be asked to perform are indicated in each exercise.

Make sure that you are wearing appropriate protective equipment when performing the tasks. You should never perform a task if you have any reason to think that a manipulation could be dangerous for you or your teammates.

Reference material

Refer to the *Technical Reference Manual* supplied with your fire alarm control panel as reference.

Systems of units

Units are expressed using the International System of Units (SI) followed by units expressed in the U.S. customary system of units (between parentheses).

Appendices

- Appendix A: *Component Graphical Representation and Wiring Diagrams*, shows how to install and connect the devices.
- Appendix B: *Wiring Information*, provides information about wiring fire alarm systems and contains a procedure to determine the number of wires required for electrical circuits.
- Appendix C: *FACP Configuration Procedure*, describes how to configure the fire alarm control panel.
- Appendix D: *Sound Level Settings of the Horns*, describes how to adjust the sound level settings of the horns in the learning system (Instructor Guide only).

To the Instructor

You will find in this Instructor Guide all the elements included in the Student Manual together with the answers to all questions, results of measurements, graphs, explanations, suggestions, and, in some cases, instructions to help you guide the students through their learning process. All the information that applies to you is placed between markers and appears in red.

Accuracy of measurements

The numerical results of the hands-on exercises may differ from one student to another. For this reason, the results and answers given in this course should be considered as a guide. Students who correctly perform the exercises should expect to demonstrate the principles involved and make observations and measurements similar to those given as answers.

Tools required to perform the Job Sheets (not supplied with the learning system)

- Screwdriver, narrow blade, 1/8"
- Screwdriver, square blade, tip number 2
- Screwdriver, Phillips blade, tip number 2
- Cable jacket stripper, 1/4" to 3/4" O.D. cable
- Wire stripper, 10-25 AWG
- Cutter
- Multimeter
- Dry erase board marker

Sound level adjustment

Make sure the sound level of the horns is adjusted for the correct level. Test all the types of horns supplied with the learning system (horn G1RF-HD and audible detector base KI-ABST), and adjust the sound level as indicated in Appendix D (Instructor Guide only).

Glass rods

Remove the glass rods from the fire alarm stations. They are not required for learning purposes.

To the Instructor

FX-CU software

- The FX-CU software is required to configure the FACP. Make sure the application is installed on a host computer located near the FACP.
- Make sure the FACP is connected to the host computer using the Ethernet cable and Ethernet-to-USB adaptor supplied with the learning system.
- Appendix C shows how to configure the FACP using the FX-CU software. This procedure may take a relatively long time to perform when a student needs to read the descriptions of all the parameters that can be set. It is therefore recommended to highlight the parameters to modify or set (accepting the values of the other parameters) to reduce the configuration time.

Sample

Extracted from

Job Sheets - Instructor

Detection Circuit – Class B

System overview

The Addressable Fire Alarm learning system is designed to allow you to become familiar with an addressable fire alarm system. You will learn how to install and connect devices, you will be introduced to the equipment and circuits commonly used in the domain, and you will familiarize yourself with the configuration of a fire alarm control panel (FACP).

As Figure 1 shows, the learning system mainly consists of a fire alarm control panel (FACP), an auxiliary panel (AP), electrical boxes, and conduits. The components supplied with the system include smoke and heat detectors, fire alarm stations, a horn, and many other components that mount in the electrical boxes. Connections are made using shielded cables running in EMT conduits.

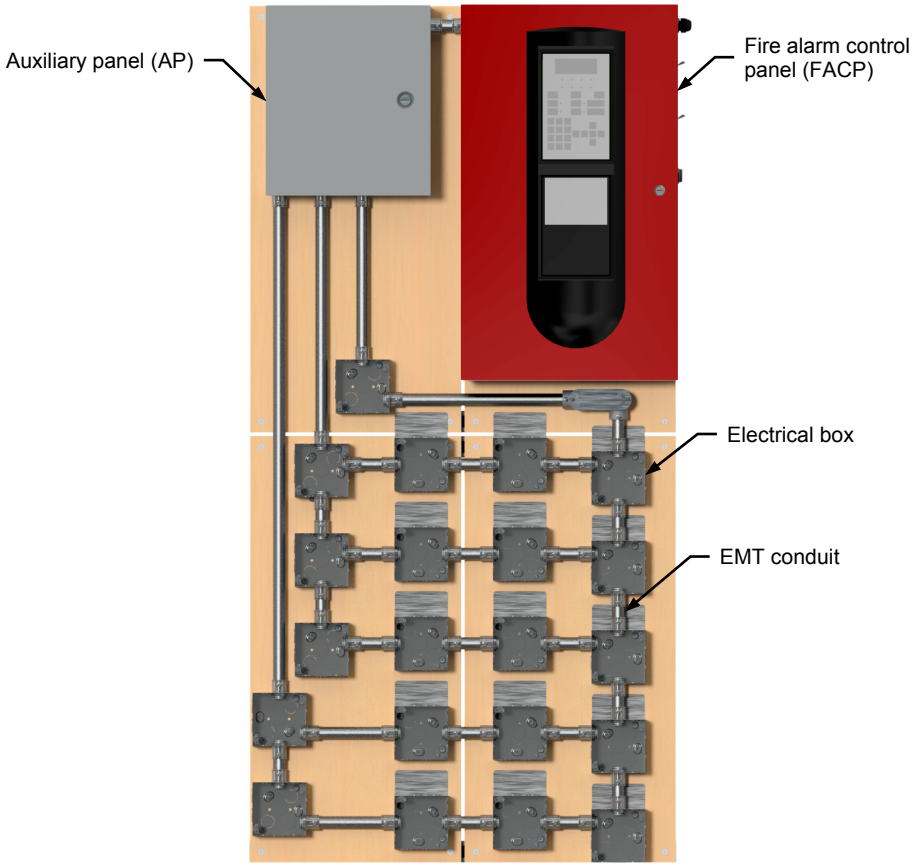

Figure 1. Addressable Fire Alarm learning system.

Fire alarm control panel

The fire alarm control panel (FACP) supplied with the learning system is a cabinet with a Class A or Class B intelligent device loop that supports up to 250 device addresses. Loop controller modules may be added in combination to expand total system capacity in 250-point increments up to 1000 device addresses. It also includes four NACs that may be wired for either Class A or Class B operation.

System display and LEDs

The display and LEDs of the fire alarm control panel (FACP) are shown in Figure 2 and described in Table 1.

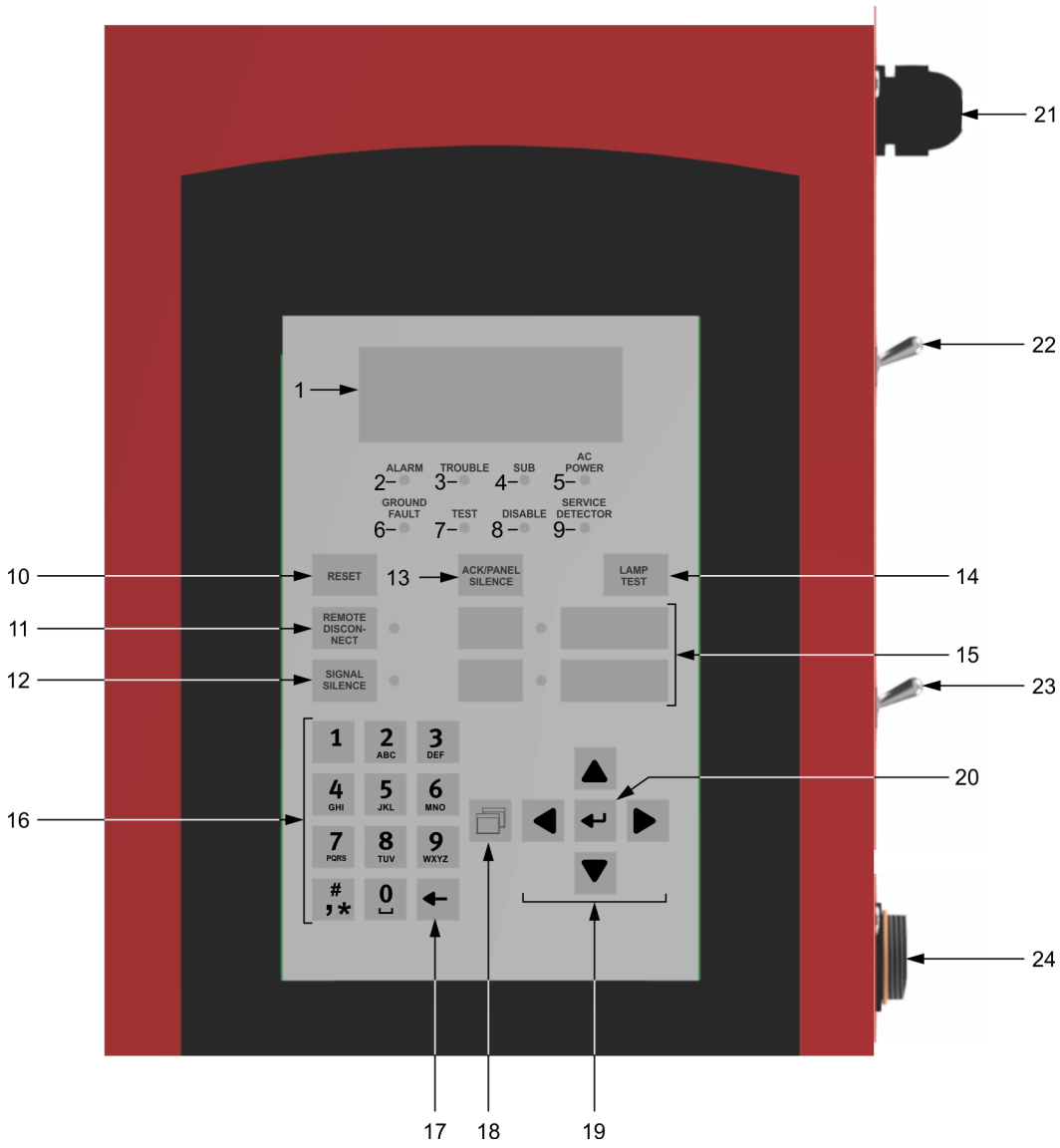

Figure 2. Display and LEDs of the FACP.

Table 1. Description of the display and LEDs of the FACP.

No.	Name	Description
1	Display	Provides the user interface with the control panel for system programming, testing, report viewing, and off-normal event notification.
2	Alarm	Red LED. It flashes when there is an active alarm event on any loop. It remains on once acknowledged.
3	Trouble	Yellow LED. It flashes when there's a fault with a monitored circuit or system component, or when a circuit is disabled. It remains on once acknowledged.
4	Sup (Supervisory)	Yellow LED. It indicates when there is an active supervisory event on any loop. It remains on once acknowledged.
5	AC Power	Green LED. It is on when the panel has ac power.
6	Ground fault	Yellow LED. It remains on during an active ground fault.
7	Test	Yellow LED. It remains on when performing an audible walk test. It flashes during a silent test.
8	Disable	Yellow LED. It remains on when there is a disabled circuit or alarm relay.
9	Service detector	Yellow LED. It indicates the detector needs servicing.

Control buttons

The control buttons of the fire alarm control panel (FACP) are shown in Figure 2 and described in Table 2.

Table 2. Description of the control buttons of the FACP.

No.	Name	Description
10	Reset	Initiates a system reset.
11	Remote disconnect	Enables or disables the CMS devices (dialer and network card), or the common alarm relay in modem dialer only, and purges all pending event transmission to the CMS.
12	Signal silence	Silences notification appliances activated by an alarm condition. Pressing the button a second time turns the NACs back on.
13	Ack (Acknowledge) / Panel silence	Silences the panel and annunciator sounders during an active trouble, supervisory, or alarm event and acknowledges new event activations.
14	Lamp test	Initiates a panel lamp test. This button allows users to verify proper operation of the LEDs on the panel and the remote annunciators.
15	Programmable buttons 1 and 2	Allow the programming of different functions (ex: activate, disable, unlatch, restore).
15 (opt.)	Alarm ON (programmable button 1 in Canadian markets)	Places the control panel in the alarm condition. The Alarm ON event is restored on system reset. This button is used for manual evacuation in Canadian markets.
16	Alphanumeric keyboard	Used to enter passwords, create text labels, and enter device and group numbers. Each button can enter multiple numbers or symbols by holding down the button.
17	Cancel	Mainly used to return to the previous screen or erase the previous character.
18	Menu	Opens and exits menu mode. Menu mode allows users to see the report, test, control, program, and diagnostic options.
19	Directional arrows	Used to move the cursor and navigate in menus.
20	Enter	Displays detailed information about an event, opens a submenu, or enters the selected data into the system.

Power components and Ethernet connector

The power components and Ethernet connector of the fire alarm control panel (FACP) are shown in Figure 2 and described in Table 3.

Table 3. Description of the power components and Ethernet connector of the FACP.

No.	Name	Description
21	AC power connector	The ac power connector allows connection to an ac power outlet to supply power to the FACP.
22	AC power switch	This switch connects the FACP to an ac power outlet. This switch must only be set to the I (on) position once all devices are installed and wired, and the system is ready for commissioning.
23	Battery switch	This switch connects the FACP to standby batteries within the panel. The Battery switch must not be set to the I (on) position before the AC Power switch is set to the I (on) position. Doing otherwise could damage the FACP.
24	Ethernet connector	This connector allows connection to a host computer through an Ethernet cable. Connecting the FACP to a host computer running the FX-CU software permits an easier configuration of the FACP. See Appendix C for more information on how to configure the FACP using the FX-CU software.

Display expander LEDs

The display expander LEDs provide LED annunciation for up to 16 zones, with two LEDs for each zone. Note that zones 1 to 12 have only unicolor LEDs, while zones 13 to 16 include a bicolor LED. The display expander LEDs are shown in Figure 3 and described in Table 4.

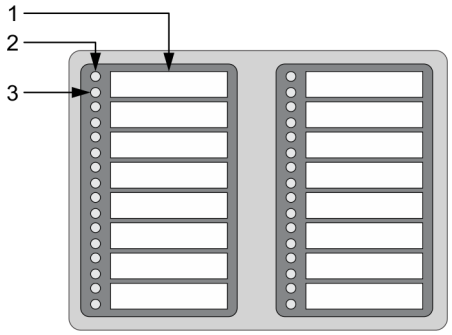

Figure 3. Display expander LEDs.

Table 4. Description of the display expander LEDs of the FACP.

No.	Name	Description
1	Zone display	Label window.
2	Alarm/Active LED	**Zones 1 to 12**: Red LED flashes to indicate an alarm state.
		Zones 13 to 16: Red LED flashes to indicate an alarm state or yellow LED flashes to indicate a non-alarm state.
3	Trouble LED	Yellow LED flashes to indicate trouble.

Auxiliary Panel

To protect the integrity of the fire alarm control panel (FACP), no connections should be made in the panel. All connections are made in the auxiliary panel. Most of the terminals available inside the FACP are accessible in the auxiliary panel. The function of the terminals is described in Table 5.

Table 5. Function of the terminals in the auxiliary panel (AP).

Terminal name		Function
SUP	Supervisory relay	Provides a normally open dry contact that closes when a supervisory event is generated.
SUP		
NO	Alarm relay	Provides normally open NO and normally closed NC dry contacts. This relay switches positions when an alarm event is generated.
C		
NC		
+	Aux. power (24 V)	Provides 24 V dc power output for powering audible and visible notification appliances, and controls for ancillary equipment.
Com		
A (-)	SLC1 	Terminal connections for wiring an intelligent addressable loop to the controller SLC card. The B terminals are used for Class-B wiring configuration. The A and B terminals are used for Class-A wiring configuration.
A (+)		
B (-)		
B (+)		
-	NAC1	Terminals - and + of notification appliance circuit 1. NAC1 can be used for Class-B wiring configuration. NAC1 can also be connected to NAC3 for Class-A wiring configuration.
+		
-	NAC2	Terminals - and + of notification appliance circuit 2. NAC2 can be used for Class-B wiring configuration. NAC2 can also be connected to NAC4 for Class-A wiring configuration.
+		
-	NAC3	Terminals - and + of notification appliance circuit 3. NAC3 can be used for Class-B wiring configuration. NAC3 can also be connected to NAC1 for Class-A wiring configuration.
+		
-	NAC4	Terminals - and + of notification appliance circuit 4. NAC4 can be used for Class-B wiring configuration. NAC4 can also be connected to NAC2 for Class-A wiring configuration.
+		
Note: Damage to the FACP may occur if the loop terminals come into contact with the other terminals in the auxiliary panel.		

Initiating devices and notification appliances

A fire alarm system mainly consists of a control panel, initiating devices that send information to the control panel, and notification appliances that receive information from the control panel.

Initiating devices may be fire alarm stations, detection devices such as smoke and heat detectors, and supervisory switches. Notification appliances may be audible and/or visual signaling devices, such as horns, strobes, and lights.

The control panel supervises the initiating device circuits (IDC) and notification appliance circuits (NAC) to prevent failure in the system.

Addressable fire alarm systems use sophisticated electronics that employ a system of electronic questions and answers to verify circuit viability. The control panel knows the names of all the devices that are connected to it. After asking a question to each device on its list, the control panel must receive an answer from that device only. Failure to receive the proper answer causes the panel to generate a trouble signal.

When using components that are not addressable such as a horn in a notification appliance circuit (NAC), a resistor is placed at the end of the line to monitor the current flowing in the circuit. Depending on the measured current value, the FACP determines if the circuit is in a normal, open, or short circuit condition.

Resetting the fire alarm control panel

Pressing the Reset button restores the FACP to the normal state if no device or circuit is active. This has no effect on disabled and latched devices.

When the Reset button is pressed, a reset indication appears on the display. Once the reset process is completed, this indication disappears. If the condition causing an alarm has not been cleared, the panel remains in an alarm state. Disabled devices and zones remain disabled after reset.

Level 1 and Level 2 passwords

The FACP has two password levels, Level 1 and Level 2.

- Level 1: allows users to access the programmable buttons on the front panel, change the system clock, activate and restore devices and NACs, as well as disable and enable devices, NACs, events, and zones. The default password for this level is 1111.
- Level 2: allows users to access the control panel's programming functions. The default password for this level is 2222. To prevent unauthorized access to the programming functions, it is recommended to attribute another password for Level 2.

Detection Circuit – Class B

OBJECTIVE

- Wire a detection circuit
- Install and connect a fire alarm station and detectors
- Configure a fire alarm control panel
- Test and reset a fire alarm station, heat detector, and smoke detector

PROCEDURE

Circuit description

The circuit in this Job Sheet consists of three initiating devices: a fire alarm station FAS1, a heat detector HD1, and a smoke detector SD1.

Circuit setup

1. Table 6 shows the list of equipment required to perform this Job Sheet. Figure 4 shows the arrangement of the components on the learning system.

Table 6. List of equipment.

Device	Description	Model
EOLR1, EOLR2, EOLR3, EOLR4	End-of-line resistor	15 kΩ
FAS1	Fire alarm station (addressable)	FX-270
HD1 (connected to SB2)	Heat detector	KIR-HD
SD1 (connected to SB1)	Smoke detector	KIR-PD
SB1, SB2	Standard detector base	KI-SB
The electrical box covers and the cables are not included in the lists of equipment.		

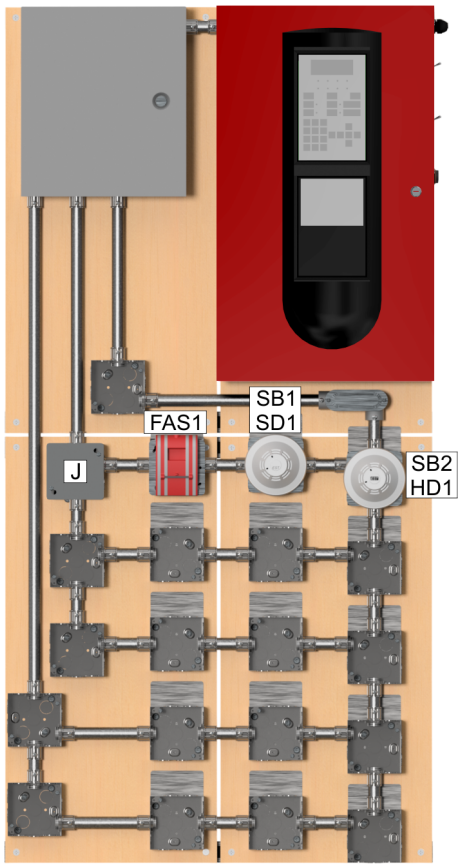

Figure 4. Arrangement of the components on the learning system.

2. Make sure both the AC Power and Battery switches are set to the O (off) position before proceeding to the next step.

3. Set up the circuit as follows:

Refer to Appendix A to know how to install and connect the devices. Make sure to respect the polarities.

Refer to Appendix B to obtain information about fire alarm cables. Appendix B also includes a procedure to determine the number of wires required to connect electrical circuits. Refer to this procedure if necessary.

- Install single-device covers on the electrical boxes where fire alarm station FAS1 and standard detector bases SB1 and SB2 are to be installed.
- Install the cables required to connect the circuit shown in Figure 5. Leave enough length for the connections.

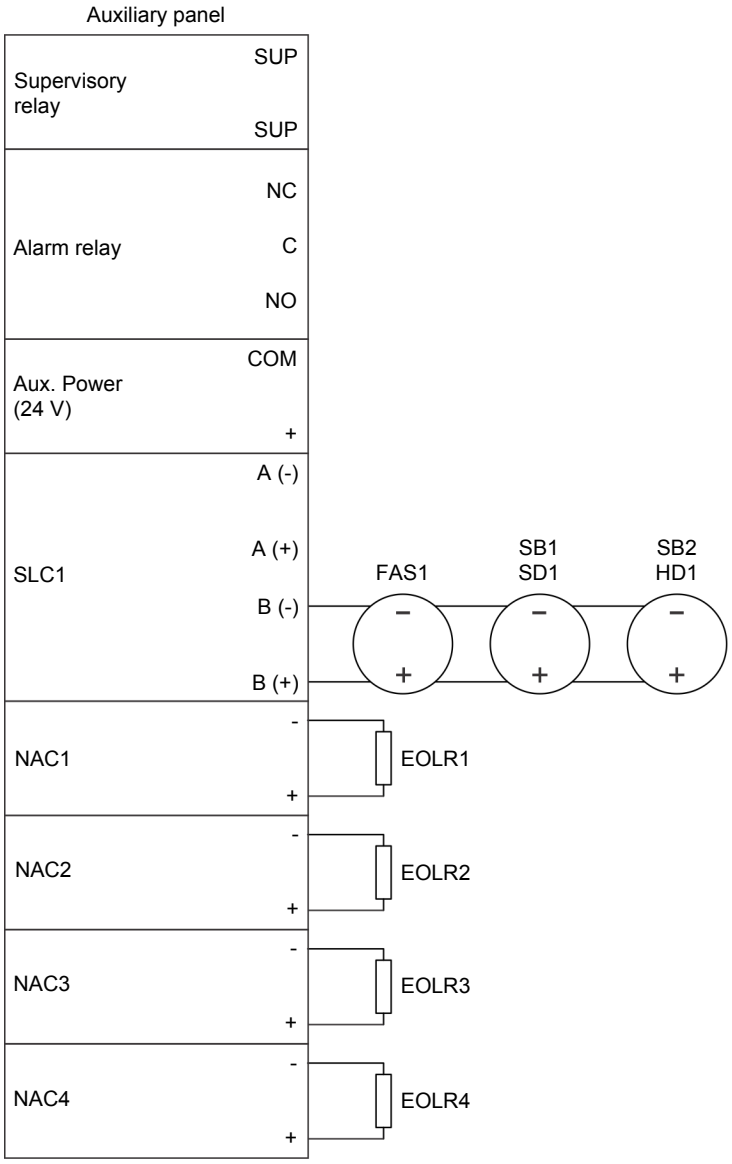

Figure 5. Schematic diagram.

- Observe addressable fire alarm station FAS1. Notice that it combines a single-action pull station with an addressable mini module mounted on the back of the unit. On this mini module, use a slotted screwdriver to adjust the rotating dials. These dials set the address of the fire alarm station. The left dial sets the tens, while the right dial sets the ones. Note down the address of the devices you install so that you can recognize them during programming.
- Install standard detector bases SB1 and SB2 on single-device covers.

- Connect the components as shown in Figure 5. Consult the manufacturer's documentation to know how to wire each device.

The detection circuit shown in Figure 5 is wired in Class B configuration. The wiring classes will be explained in Information Job Sheet 6.

Depending on local electrical codes, it may be necessary to ground the electrical boxes. Ask your instructor if this requirement applies to your area.

Always connect the drain of the cable shield to the ground terminal in the auxiliary panel. This connection in not shown in the schematic diagrams.

- Observe detectors HD1 and SD1. On the back of the detectors, use a slotted screwdriver to adjust the rotating dials. These dials set the address of the detectors. The left dial sets the tens, while the right dial sets the ones. Note down the address of the devices you install so that you can recognize them during programming.
- Install detectors HD1 and SD1.
- Install a flat cover on junction box J, as shown in Figure 4.
- Install end-of-line resistors EOLR1, EOLR2, EOLR3, and EOLR4 in the auxiliary panel, as shown in Figure 5.
- Test the wiring circuitry as described in section 4 of Appendix B.

4. Set the AC Power switch of the FACP to the I (on) position.

Set the Battery switch of the FACP to the I (on) position.

CAUTION

Always power the FACP in the order given above. Doing otherwise could damage the FACP.

Always keep the FACP connected to an ac power outlet. This maintains the charge of the standby batteries.

The FACP automatically performs a Loop Initialization, causing the buzzer to beep. Press the Ack/Panel Silence/Acknowledge button to silence the buzzer.

Depending on the current panel configuration, at the end of the Loop Initialization, the display may indicate trouble messages (e.g., Loop 1 Device 001). These messages will disappear during the configuration process.

Restoring the fire alarm control panel to default parameters

5. Before performing any job sheet, it is recommended to restore the FACP to its default parameters. To do so, perform the following steps:

- On the FACP, select Main Menu → Program → Restore Defaults.
- Enter the password to log on as a level 2 operator (the default password is 2222).

- You are then prompted to define which system to restore to defaults. It is recommended to select Panel only. Selecting the CMS only option restores the network parameters to defaults.

CMS stands for Central Monitoring Station.

6. Once the Restore Defaults command is initiated, you need to restart the FACP before the corrections are applied. To do so, perform the following steps:
   - On the FACP, select Main Menu → Program → Panel Restart. Select Yes when asked if you are sure.
   - Wait for the FACP to complete its initialization procedure.

Configuration of the fire alarm control panel

Throughout this section, refer to Appendix C to know how to configure the FACP.

7. Perform the following sections of Appendix C to make the basic configurations of the FACP. Note that the loop class corresponding to the current setup is B.
   - Executing the Auto Program command on the FACP
   - Launching and setting up the FX-CU software
   - Configuring the FACP using the FX-CU software

When creating and configuring a new project, make sure to enter values that help identify the project in relation to this course (for example, enter the job sheet name in the description).

8. Configure the NACs for Class B operation by performing the Configuring the NACs section of Appendix C. To do so, set NAC1 to NAC4 to Class B. This should already be set by default.

9. Upload the current FACP configuration in the software to the FACP. To do so, perform the Writing on the FACP section of Appendix C. This overwrites the previous configuration on the FACP.

System testing

10. Once the FACP is in normal mode (no alarm, supervisory, trouble, or monitor events), observe its display. Does it indicate the text you entered in the Banner menu of the FX-CU software?

    ❑ Yes ❑ No

Yes

Fire alarm station

11. Test the operation of fire alarm station FAS1 by pulling the handle.

Does the red Alarm LED on the FACP flash after a few seconds?

❑ Yes ❑ No

Yes

12. Observe the display of the FACP. Does it indicate the device name of the fire alarm station?

❑ Yes ❑ No

Yes

13. Reset the fire alarm station as follows:

- Open the fire alarm station by using a flat blade screwdriver to turn the cover release screw counterclockwise while pulling the cover away from its backplate.
- Set the toggle switch to the normal position, and close the cover.

14. Reset the FACP. Wait a few seconds for the reset to take effect.

Smoke detector

15. Using a smoke can, test the operation of smoke detector SD1 by injecting smoke in the openings of the detector.

Does the red Alarm LED on the FACP flash after a few seconds?

❑ Yes ❑ No

Yes

16. Observe the display of the FACP. Does it indicate the device name of the smoke detector?

❑ Yes ❑ No

Yes

17. Reset the smoke detector by blowing room-temperature air in the openings of the detector.

18. Reset the FACP. Wait a few seconds for the reset to take effect.

Heat detector

19. Using a hair dryer, test the operation of heat detector HD1 by blowing hot air in the openings of the detector.

Do not touch the detector with the hair dryer to prevent the plastic of the detector from melting.

Does the red Alarm LED on the FACP flash after a few seconds?

❑ Yes ❑ No

Yes

20. Observe the display of the FACP. Does it indicate the device name of the heat detector?

❑ Yes ❑ No

Yes

21. Reset the heat detector by blowing room-temperature air in the openings of the detector.

22. Reset the FACP. Wait a few seconds for the reset to take effect.

23. Ask your instructor to check your work.

24. Perform the following manipulations to finish your work:

- Set the Battery switch of the FACP to the O (off) position.
- Set the AC Power switch of the FACP to the O (off) position.
- Remove the components and the wires from the electrical boxes.
- Return the components to the storage location.

Name: _____ Date: _____

Instructor's approval: _____