203: Electrical installations technology  
**Handout 10: Alarm and emergency systems**

**Learning outcome**

The learner will:

1. know wiring systems of electrical installations.

**Assessment criteria**

The learner can:

3.1 describe principles of operation of different **circuit types.**

**Range**

**Circuit types**: Lighting, power and heating, alarm and emergency systems, data communications, control circuits, ring final, radial.

**Alarm and emergency systems**

The alarm and emergency systems that electricians are most likely to encounter are the following:

* fire alarm systems
* intruder alarm systems
* emergency lighting.

Before looking at alarms systems, there is a need to understand basic circuit configurations, including the following:

* open circuit
* closed circuit.

**Open circuit**

As the name would suggest, in the open circuit arrangement the circuit is incomplete or ‘open’ and detection devices close to initiate an alarm condition.

The advantage of this system is that, as detectors are connected in parallel with the circuit, it is easy to connect or disconnect sensors as required.

The drawback with this system is that if a circuit conductor or connection is broken, the alarm will not operate when required. However, by incorporating monitoring of the circuits, an alarm condition can be indicated when a conductor or connection is broken.

Monitoring is achieved by connecting an **end of line** (EOL) resistor across the circuit at the last detector (or call‑point) and a monitoring voltage applied to the circuit; the resulting current will be relatively small. When a detector closes, the EOL resistor will be short‑circuited and the current will increase greatly, which will be detected by the control panel that will initiate an alarm condition. This arrangement is shown simply below:

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| 01 Open circuit.png |

**Closed circuit**

As the name would suggest, in the closed circuit arrangement the circuit is complete or ‘closed’ and detection devices open to break the circuit to initiate an alarm condition.

The disadvantage of this system is that, as the detectors are connected in series, the circuit must be interrupted to insert additional sensors and this would prove difficult in practice.

The advantage of this system is that if a circuit conductor or connection is broken, the alarm will operate; this could be considered **fail safe** and therefore monitoring is not required.

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| 02 Closed circuit.png |

**Fire alarm systems**

Fire alarm systems are designed to protect one or both of the following:

* life
* property.

When protecting life, the alarm will be initiated by a combination of manual call points and automatic detectors, and will generally be audible and possibly automatic to a remote alarm receiving centre who will then summon the emergency services.

When protecting property, the alarm will generally be initiated by automatic detectors with emergency services being summoned by a remote alarm receiving centre; this is because these properties are generally unoccupied most of the time.

The range of automatic detectors includes:

* smoke detectors
* heat detectors
* flame detectors.

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| 03 Manual Call Point.png | 04 Smoke detector.png |

It is a requirement that firefighters do not have to search further than 30 metres into premises to determine the location of the fire. For this reason, a number of circuits are installed in zones.

Generally, there is more than one sounder circuit but not normally as many as there are detector circuits.

Fire alarm circuits are generally wired in the open circuit configuration so end of line monitoring is required. This monitoring is also applied to the sounder circuit but it is necessary for diodes to be installed so that the monitoring voltage does operate the sounder; the voltage is reversed in alarm condition to operate the sounder (see below):

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| 05 Closed circuit sounder.png |

When installing smoke detectors in domestic premises – apart from retrofit battery alarms – it is a requirement that the detectors are mains powered with battery backup and, if more than one is installed, they should be linked so that when one goes into alarm condition, they all go into alarm condition.

**Intruder alarm systems**

Intruder alarms are designed to detect an intrusion or attempted intrusion into premises. A range of detectors are available for this purpose, including:

* break glass detectors
* door and window contacts
* passive infrared movement detectors
* ultrasonic movement detectors
* microwave movement detector
* beam break detectors.

Most intruder alarm systems are wired closed circuit as a failsafe measure so that if the cable is cut the alarm is initiated anyway. Additional protection is provided by installing a tamper circuit that is run with the detector circuit. Enclosures of detectors (and sounder box and the panel itself) will be fitted with one or more micro-switches that will open the tamper circuit to give a tamper warning if the alarm is not set or a full alarm if it is set. Additionally, cutting the tamper circuit conductors will have the same effect.

Modern intruder alarm panels are multi‑zone or addressable so detectors can be wired to their own circuits, thus making identification of the source of the alarm much easier. A typical detector zone arrangement is shown below:

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| 06 Intruder alarm circuit.png |

Since the detector and tamper circuits have different polarities, if a would-be intruder tried to short out the detector contact, the probability is that they would short out the wrong pair of conductors and this would also trigger an alarm condition.**Emergency lighting**

Emergency lighting must not be confused with standby lighting, whose purpose is to provide sufficient illumination for normal activities to continue. Emergency lighting provides sufficient illumination to allow occupants to safely evacuate premises in the event of an emergency. Similarly, emergency lighting will not provide long-term lighting but should last over a sufficient duration for the evacuation to take place; emergency lighting luminaires are rated at between one to three hours duration.

There are two classifications of emergency lighting:

* maintained
* non-maintained.

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| **Maintained emergency lighting**  These are emergency lighting luminaires that are illuminated at all materials times, ie all the time the premises are expected to be occupied. An example of this type is an illuminated exit sign in public entertainment premises, eg cinemas.  The luminaire is powered from the mains supply under normal conditions and this also keeps internal batteries charged. If the supply fails, the batteries keep the luminaire lit. | 08 Maintained emergency lighting.png |

A circuit for this is shown above. Although a relay is shown, this is to make it easier to understand how it works; most luminaires achieve the switch-over by using electronics.

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| **Non-maintained emergency lighting**  These are emergency lighting luminaires that are only illuminated during a power failure. At other times the luminaire is off.  A circuit for this is shown on the right. | 09 Non-maintained emergency lighting.png |

All emergency luminaires must be tested regularly to determine that they stay illuminated for the rated period of time, eg one or three hours. This is usually carried out by inserting a special ‘fish-tail’ key into a special witch to simulate a power interruption.

The period of time that the luminaire remains illuminated under battery power is then recorded on the luminaire testing sheet.