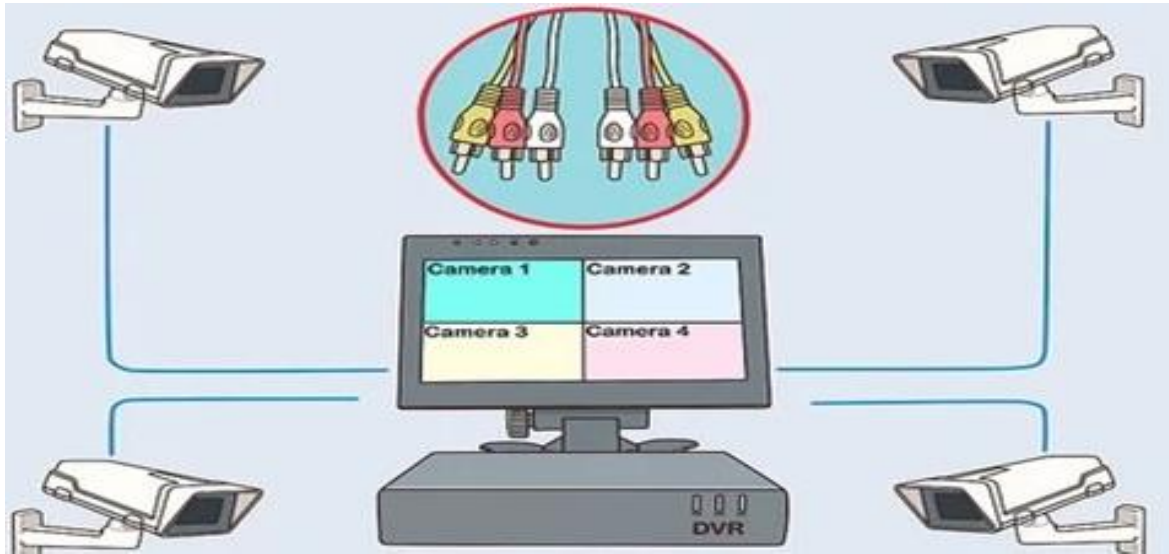


# BUILDING ELECTRICAL INSTALLATION LEVEL-III

Based on October 2023, Curriculum Version II



**Module Title: Extra Low Voltage Wiring Systems**

**Module code: EIS BEI3 M5 1023**

**Nominal duration: 64 Hours**

Prepared by: Ministry of Labor and Skill

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## **Acknowledgment**

**Ministry of Labor and Skills** wish to extend thanks and appreciation to the many representatives of TVET instructors and respective industry experts who donated their time and expertise to the development of this Teaching, Training and Learning Materials (TTLM).

## Acronym

AC .....	Alternating current
DC .....	Direct current
ELV .....	Extra low voltage
FELV .....	Protected extra-low voltage
SELV .....	Separated or safety extra-low voltage
UPS .....	Uninterruptible power supply
CCTV .....	Closed-circuit television
PA .....	Public address system
AV .....	Audio/video
AC .....	Access control
ID .....	Intrusion detection
HA .....	Home automation
NIR .....	Near-infrared
NTC .....	Negative temperature coefficient
PCB .....	Printed circuit board
PIR .....	Passive infrared
RFID .....	Radio-frequency identification

## Introduction to the Module

In building electrical installation field understanding of extra low voltage wiring systems, is very important for the overall ELV installation system. It helps to know basic extra low voltage concepts, methods of extra low voltage wiring system installation and configuration and also including connecting (terminating) procedures of extra low voltage installation system.

This module is designed to meet the industry requirement under the building electrical installation occupational standard, particularly for the unit of competency: Install and connect extra low voltage wiring systems.

### Module covers the units:

- Standard and principle of extra low voltage wiring system
- Install ELV wiring systems

### Learning Objective of the Module

- Understand the basic principles of electricity and ELV systems
- Identify the different types of ELV wiring systems and cables
- Select the appropriate wiring system and cables for a given application
- Safely and correctly install ELV wiring systems
- Connect ELV wiring systems to devices and accessories
- Understand OHS procedures and requirement
- Understand quality assurance and inspection

### Module Instruction

For effective use these modules trainees are expected to follow the following module instruction:

1. Read the information written in each unit
2. Accomplish the Self-checks at the end of each unit
3. Perform Operation Sheets which were provided at the end of units
4. Do the “LAP test” given at the end of each unit and
5. Read the identified reference book for Examples and exercise

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## Unit One: standard and principle of extra low voltage wiring system

This unit is developed to provide you the necessary information regarding the following content coverage and topics:

- General concept of ELV wiring system
- standard and code of practice
- Components and accessory for ELV
- tools, equipment and testing devices
- Fitting standard and lay out procedures
- OHS requirement and procedure

This unit will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Understand concept of ELV wiring system
- Follow standard and code of practice
- Identify components and accessories for ELV
- Identify & select tools, equipment and testing devices
- Follow Fitting standard and lay out procedure
- Observe OHS requirement and procedure

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## 1.1. General concepts of ELV wiring system

### Introduction

The ELV (Extra-Low Voltage) wiring system refers to a specialized electrical wiring system designed to carry low voltage electrical currents. It is commonly used for various applications where safety, energy efficiency, and control are important. The purpose of ELV wiring is to provide power and control signals to devices and systems that operate at voltages below the standard mains voltage (typically below 50 volts AC or 120 volts DC). ELV wiring is employed in a wide range of settings, including residential, commercial, and industrial environments.

#### A. Separated or safety extra-low voltage (SELV)

IEC defines a SELV system as "an electrical system in which the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, including earth faults in other circuits". It is generally accepted that the acronym: SELV stands for separated extra-low voltage (separated from earth) as defined in installation standards (e.g. BS 7671), though BS EN 60335 refers to it as safety extra-low voltage.

A SELV circuit must have: Electrical protective-separation (i.e., double insulation, reinforced insulation or protective screening) from all circuits other than SELV and PELV (i.e., all circuits that might carry higher voltages) Simple separation from other SELV systems.

### Types of extra low voltage

#### 1.1.1 Protected extra-low voltage (PELV)

IEC 61140 defines a PELV system as "an electrical system in which the voltage cannot exceed ELV under normal conditions, and under single-fault conditions, except earth faults in other circuits".

A PELV circuit only requires protective-separation from all circuits other than SELV and PELV (i.e., all circuits that might carry higher voltages), but it may have connections to other PELV systems and earth (ground). In contrast to a SELV circuit, a PELV circuit can have a protective earth (ground) connection. A PELV circuit, just as with SELV, requires a design that guarantees a low risk of accidental contact with a higher voltage. For a transformer, this can mean that the primary and secondary windings must be separated by reinforced insulation, or by a conductive shield with a protective earth connection, or that the secondary winding itself has an earthed terminal, so that any primary to secondary fault will cause

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automatic disconnection. (The principle of double fault to danger requires either basic and additional insulation to fail or basic insulation and the connection to the protective earth to fail simultaneously before danger arises.)

A typical example for a PELV circuit is a metal cased computer with a Class I power supply.

### 1.1.2. Functional extra-low voltage (FELV)

The term functional extra-low voltage (FELV) describes any other extra-low-voltage circuit that does not fulfill the requirements for an SELV or PELV circuit. Although the FELV part of a circuit uses an extra-low voltage, it is not adequately protected from accidental contact with higher voltages in other parts of the circuit. Therefore, the protection requirements for the higher voltage have to be applied to the entire circuit.

Examples for FELV circuits include those that generate an extra low voltage through a semiconductor device or a potentiometer or an autotransformer. A typical example is an electronically controlled toaster where the electronic timer circuit runs off an extra low voltage derived from a tap on the heating element. Another might be ELV signaling between mains powered smoke alarms, with the signaling voltage referred to supply neutral. In such cases the extra low voltage parts must be enclosed or insulated as to the standard of the mains voltage.

### 1.1.3. UK Reduced low voltage (RLV)

The IET / BSI (BS 7671) also define Reduced Low Voltage (RLV) which can be either single-phase or three-phase AC This system has been used for many years on construction sites, in both single- and three-phase configurations. The single-phase voltage is 110 V a.c. though having a "center tapped Earth" reducing the voltage to earth to 55 V AC. The three-phase system is 110 V phase-to-phase and 63 V to neutral / earth. This system voltage is slightly above the ELV limit, but is still very commonly used for cord-powered hand tools and temporary lighting in hazardous areas. As it is transformer-derived, the exposed voltage during an earth fault is depressed below the ELV level.

The Ethiopian standard for extra low voltage (ELV) is defined in the Ethiopian Electrotechnical Standards Institute (EESI) ES 82-2016 standard, "Low-voltage electrical installations". This standard defines ELV as "a voltage which does not exceed 50 V AC or 120 V DC".

The EESI ES 82-2016 standard also includes a number of specific requirements for ELV installations, including:

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- ELV installations must be designed and installed by a qualified electrician.
- ELV installations must be segregated from high voltage installations.
- ELV cables must be properly insulated and protected from damage.
- ELV equipment must be properly labeled and marked.
- ELV installations must be regularly tested and inspected.

**The following are some of the common applications of ELV systems in Ethiopia:**

- Residential lighting systems
- Commercial lighting systems
- Security systems
- Fire alarm systems
- Access control systems
- CCTV systems
- Audio and video systems
- Control system

**ELV systems offer a number of advantages over higher voltage systems, including:**

- Increased safety: ELV systems are less likely to cause serious injury or death in the event of an electrical shock.
- Reduced installation costs: ELV systems are typically easier and less expensive to install than higher voltage systems.
- Flexibility: ELV systems can be easily modified and expanded to meet changing needs.
- Reliability: ELV systems are generally very reliable and require minimal maintenance.

ELV systems are typically designed and installed by qualified electricians or security professionals. However, there are some basic ELV installation tasks that can be performed by DIYers, such as installing and testing smoke detectors and motion detectors.

ELV systems are a safe and reliable way to power a variety of low-voltage devices. With proper design and installation, ELV systems can provide years of trouble-free service.

**1.1.4. Extra low voltage (ELV) lighting systems**

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are a type of lighting system that operates at a voltage of 50 volts AC or less. ELV lighting systems are often used in commercial and residential applications because they offer a number of advantages over traditional lighting systems, including:

- Increased safety: ELV lighting systems are less likely to cause serious injury or death in the event of an electrical shock.
- Reduced energy consumption: ELV lighting systems are typically more energy-efficient than traditional lighting systems.
- Longer lifespan: ELV lighting systems typically have a longer lifespan than traditional lighting systems.
- Dimmability: ELV lighting systems are typically dimmable, which allows for greater control over the lighting environment.

**ELV lighting systems can be used to power a variety of lighting fixtures, including:**

- LED lights
- Fluorescent lights
- lights
- Halogen lights
- Incandescent

ELV lighting systems are typically designed and installed by qualified electricians. However, there are some basic ELV installation such as installing and connecting ELV lighting fixtures. .ELV lighting systems are a safe and efficient way to power a variety of lighting fixtures. With proper design and installation, ELV lighting systems can provide years of trouble-free service.

**Here are some examples of ELV lighting systems:**

- LED strip lights: LED strip lights are a popular choice for ELV lighting systems because they are energy-efficient, dimmable, and have a long lifespan. LED strip lights can be used to create a variety of lighting effects, such as accent lighting, cove lighting, and task lighting.
- ELV downlights: ELV downlights are another popular choice for ELV lighting systems. ELV downlights are typically used in general lighting applications, such as in kitchens, bathrooms, and living rooms. ELV downlights are available in a variety of styles and finishes to match any décor.
- ELV track lighting: ELV track lighting is a versatile lighting solution that can be used in a variety of applications, such as in retail stores, restaurants, and art galleries. ELV

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track lighting allows you to easily adjust the position and direction of the lights to create the desired lighting effect.

**ELV lighting systems can be powered by a variety of devices, including:**

1. **ELV transformers:** ELV transformers are the most common way to power ELV lighting systems. ELV transformers convert standard line voltage (120V or 240V AC) to extra low voltage (50V AC or less).
2. **ELV power supplies:** ELV power supplies are similar to ELV transformers, but they convert direct current (DC) voltage to extra low voltage (DC). ELV power supplies are often used to power LED lights.
3. **ELV dimmers:** ELV dimmers are used to control the brightness of ELV lighting systems. ELV dimmers are available in a variety of styles and configurations, including wall-mounted dimmers, remote control dimmers, and smart dimmers.

**ELV transformers** are available in a variety of sizes and configurations to meet the needs of different ELV lighting systems. When selecting an ELV transformer, it is important to consider the following factors:

- **Wattage:** The wattage of the ELV transformer must be equal to or greater than the total wattage of the ELV lighting fixtures that you are using.
- **Voltage:** The voltage of the ELV transformer must be compatible with the voltage of the ELV lighting fixtures that you are using.
- **Dimmability:** If you plan on using an ELV dimmer, be sure to select an ELV

**ELV power supplies**, also known as electronic low voltage power supplies, are used to convert direct current (DC) voltage to extra low voltage (DC). ELV power supplies are commonly used to power ELV lighting systems, such as LED lights, as well as other low-voltage devices, such as security cameras, doorbells, and thermostats.

ELV power supplies offer a number of advantages over traditional power supplies, including:

**ELV dimmers**, also known as electronic low voltage dimmers, are used to control the brightness of ELV lighting systems. ELV dimmers are available in a variety of styles and configurations, including wall-mounted dimmers, remote control dimmers, and smart dimmers.

ELV dimmers work by varying the amount of voltage that is supplied to the ELV lighting fixtures. When the ELV dimmer is turned down, the voltage is reduced, which causes the ELV lighting fixtures to dim. When the ELV dimmer is turned up, the voltage is increased, which causes the ELV lighting fixtures to brighten.

Example:

A common example of an ELV lighting system is an LED lighting system. LED lights are very energy-efficient and have a long lifespan. They are also dimmable, which allows you to create the perfect lighting environment for any occasion.

Wiring diagram:

The following is a basic wiring diagram for an ELV lighting system:

### **ELV lighting wiring diagram**

The ELV power supply or transformer is connected to the main power supply. The low-voltage cables are then connected to the ELV power supply or transformer and to the ELV lighting fixtures. The ELV lighting fixtures are also connected to the junction boxes.

ELV audio and video systems offer a number of advantages over traditional audio and video systems, including:

- **Increased safety**: ELV audio and video systems are less likely to cause serious injury or death in the event of an electrical shock.
- **Reduced energy consumption**: ELV audio and video systems are typically more energy-efficient than traditional audio and video systems.
- **Longer lifespan**: ELV audio and video systems typically have a longer lifespan than traditional audio and video systems.
- **Flexibility**: ELV audio and video systems are typically more flexible and easier to install than traditional audio and video systems.

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### Types of ELV audio and video systems:

There are two main types of ELV audio and video systems:

- **Wired ELV systems**: Wired ELV systems use cables to connect the audio and video components. Wired ELV systems offer the best performance and reliability, but they can be more expensive and difficult to install than wireless ELV systems.
- **Wireless ELV systems**: Wireless ELV systems use radio waves to transmit the audio and video signals. Wireless ELV systems are easier to install and less expensive than wired ELV systems, but they can be more susceptible to interference.

### Wiring diagram:

The following is a basic wiring diagram for an ELV audio and video system:

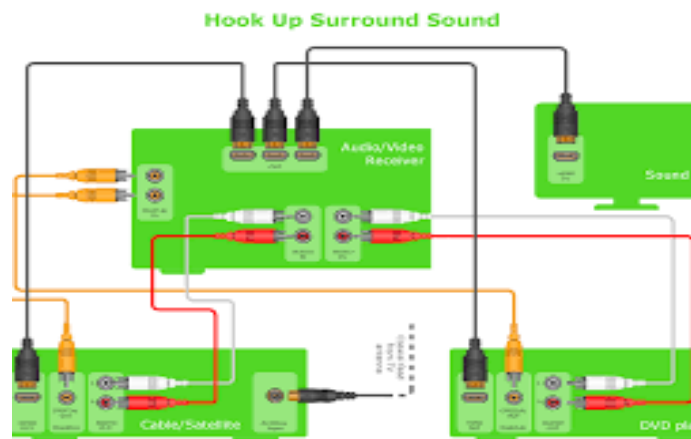


Fig 1.2. ELV audio and video wiring diagram

The ELV power supply or transformer is connected to the main power supply. The low-voltage cables are then connected to the ELV power supply or transformer and to the ELV audio and video components. The ELV audio and video components are also connected to the junction boxes.

### Example:

A common example of an ELV audio and video system is a home theater system. Home theater systems typically use ELV audio and video components, such as speakers, subwoofers, amplifiers, receivers, and projectors. ELV audio and video components are also commonly used in commercial applications, such as hotels, restaurants, and retail stores.

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### 1.1.5. Sensors

ELV systems often incorporate sensors for monitoring and control purposes. Examples include motion sensors, temperature sensors, light sensors, and pressure sensors. These sensors provide input t Sensors are devices that detect and measure physical or chemical properties in their environment. They are used in a wide variety of applications, including industrial automation, consumer electronics, and medical devices. There are many different types of sensors, but some of the most common include:

#### A. Temperature sensors

These sensors measure the temperature of their environment. They are used in a variety of applications, such as thermostats, refrigerators, and medical devices.

#### B. Pressure sensors

These sensors measure the pressure of their environment. They are used in a variety of applications, such as barometers, air compressors, and medical devices.

#### C. Flow sensors

These sensors measure the flow rate of a fluid or gas. They are used in a variety of applications, such as water meters, fuel injectors, and medical devices.

#### D. Motion sensors

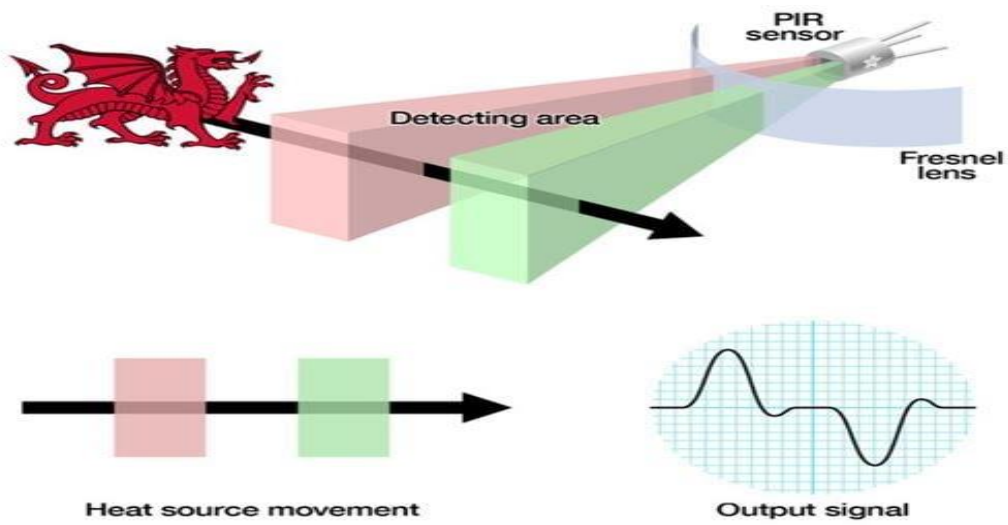
These sensors detect the movement of objects. They are used in a variety of applications, such as security systems, automatic doors, and video games.

#### A. Passive Infrared Sensors

The PIR is a motion sensor that you might have seen when you enter a restroom or an office space, usually having a white cover. They are small, low power, easy to use, and inexpensive. The way it senses movement is by sensing the change in temperature between the background and a warm body.

PIRs have a pyroelectric sensor that detects levels of infrared radiation – everything emits some low-level radiation, but a human body emits a good amount of heat. The PIR has two slots made of a special material that is sensitive to infrared. When the sensor senses a differential change between the two slots, this causes a pulse,.

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**Figure 1.1 : PIR sensing heat source movement and outputting pulses.**

The white plastic that you see on the PIR is called a Fresnel lens. The optic physics behind the Fresnel lens is a whole other interesting area to look into if you have time, but in this case, it gives the PIR sensor a much larger detection area making it more efficient. Figure 2 shows the inside of the Fresnel lens, where you can see the “sections” on it.



**Figure 1.2: Inside a Fresnel lens.**

### **B. Microwave Motion Sensors: How Microwave Sensors Work**

As the name implies, Microwave sensors uses continuous waves of microwave radiation to detect motion, similar to how a radar speed gun works. It sends out high radio frequency and measures the reflection off an object by sensing for a frequency shift. If it does detect a frequency shift, the motion detector is activated. Figure 3 shows how the Microwave sensors work.

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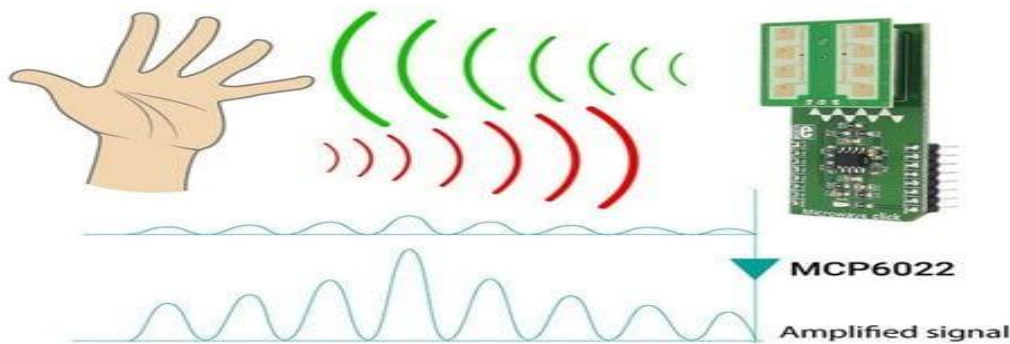


Figure 1.3: frequency shift on an object causes the signal to be amplified, motion.

Microwave sensors can cover a larger area than PIRs, but are more expensive and can be vulnerable to electrical interference. Its ability to penetrate material “see through walls” can cause frequent false alarms.

### C. Dual Tech Motion Sensors: How Dual Tech/Hybrid Sensors Work

There is technology that incorporates both PIR and Microwave sensors to have less false alarms. A quick rise in temperature in the room can cause the PIR to go off while wind can move an object and trigger the microwave sensor. With the Dual Tech/Hybrid, both sensors will need to sense changes which will trigger it on, causing false alarms to be extremely low.

### E. Image sensors

These sensors convert light images into electronic signals. They are used in a variety of applications, such as cameras, smartphones, and medical imaging devices.

Applications of sensor

- **Industrial automation:** Sensors are used to monitor and control industrial processes, such as manufacturing, food processing, and power generation.
- **Consumer electronics:** Sensors are used in a variety of consumer electronics products, such as smartphones, tablets, and wearable devices.
- **Medical devices:** Sensors are used in a variety of medical devices, such as pacemakers, insulin pumps, and blood pressure monitors.

Sensors are an essential part of many modern technologies. They allow us to monitor and control our environment in ways that were not possible before.

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## Use of sensor

- **Temperature sensors** in thermostats help to regulate the temperature of our homes and offices.
- **Pressure sensors** in tire pressure monitoring systems alert us when our tires are underinflated, which can improve fuel efficiency and safety.
- **Flow sensors** in water meters help to track our water usage and reduce waste.
- **Motion sensors** in security systems detect intruders and trigger alarms.
- **Image sensors** in cameras allow us to capture photos and videos of our memories. the system and trigger appropriate actions or responses.

### 1.1.6. Use & purpose of CCTV

CCTV Cameras are essential with the goal that signals can be effectively transmitted to a certain destination, for example, limited monitors. From the term itself, closed-circuit, CCTV footages are intended to remain inside the circuit and not to flow outside of the framework. Though, that is not the case right now since CCTV recordings are shown to the public.

It is by and large used for observing constantly or to screen one specific happening. CCTV has been turned out to be successful either for consistent checking or for observing certain activities. Security has been the primary reason for CCTV Installation despite the fact that it can accomplish more than guaranteeing security.

#### Types of CCTV cameras

There are several types of CCTV cameras available in the market, each with its unique features and installation requirements. Some popular types include:

**IP Cameras:** Internet Protocol (IP) cameras are digital cameras that transmit video data over a network, making them ideal for remote monitoring.

**Security Camera System:** These cameras are used primarily for security purposes and can be either wired or wireless.

**Analogue HD Cameras:** High-definition analog cameras offer high-resolution video, but they require a digital video recorder (DVR) to store footage.

**Wireless Cameras:** Wireless cameras use Wi-Fi to transmit video data, eliminating the need for cables during installation.

**Wired Cameras:** Wired cameras require a physical connection to a power supply and video cable, providing a more stable and reliable connection.

#### Use of CCTV cameras

Nowadays, the crime rate has increased to an extreme mode. Because of this the entire world is in freeze. The main answer for dispose of this issue is to set up a security framework around you and your home. There are many types of security systems that are available in the market according to your need. Each of these security cameras has extraordinary features and

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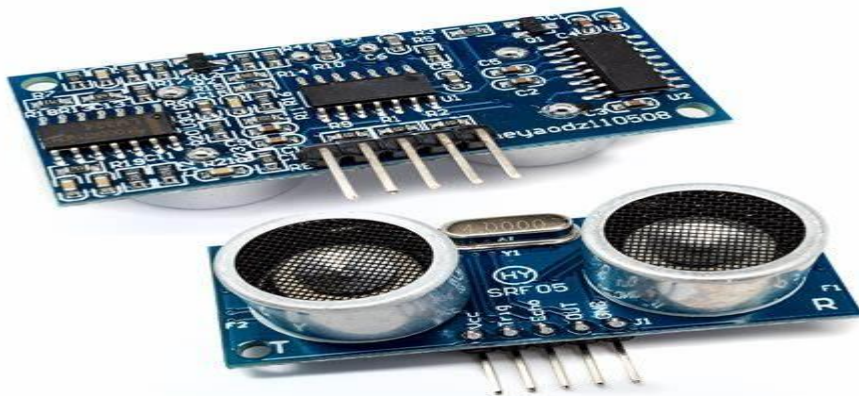
characteristics that suit your prerequisites. The need of security system relies upon the method of work like for commercial purpose or for your office or home.

#### The main purpose of CCTV cameras

- To do a constant check on the streets for traffic and unwanted vehicular accidents
- To monitor railway stations, bus stations, airports, hotels, shopping malls and all other public places that are crowded and need monitoring and protection.
- To keep a check on the ongoing activities in a company
- To catch thief's and to identify them later
- To do constant surveillance on places that needs protection

A security camera can give individuals an expanded feeling that all is well with the world and comfort them, especially in areas which is mostly crowded and under alert. Many of the CCTV cameras are modern, meaning you can view and monitor what is happening in your office or home even when you are away. This enables you to check in and survey your premises at the snap of a button, so your home security is dependably in reach

#### 1.1.7. Ultra sonic sensor



**Fig 1.4. Ultrasonic detectors**

An ultrasonic detector is a device that uses ultrasonic sound waves to detect the presence of objects. Ultrasonic sound waves are sound waves with frequencies above the human hearing range, which is typically 20 kHz. Ultrasonic detectors work by sending out ultrasonic sound waves and measuring the time it takes for the waves to return. If there is an object in the path of the sound waves, the waves will be reflected back to the detector faster.

#### Ultrasonic detectors are used in a variety of applications, including:

**Security systems:** Ultrasonic detectors can be used to detect intruders in buildings and other areas.

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Vehicle safety systems: Ultrasonic detectors are used in some vehicles to detect blind spots and other hazards.

**Industrial automation:** Ultrasonic detectors are used in some industrial processes to detect the presence of objects on conveyor belts and other machinery.

**Medical devices:** Ultrasonic detectors are used in some medical devices, such as ultrasound machines, to image internal organs and tissues.

#### 1.1.4. Solenoid and controller

The solenoids are simple electrical components and it has many uses in daily life. The term itself is derived from the Greek name “solen”, which illustrates a channel or a pipe. The second part of the name is taken from the Greek name “eidos”, which refers to an outline. Basically, it is a component in the form of a pipe. The solenoid is used in a variety of applications, and there are numerous types of solenoid designs available. Each of them has their own properties that make it useful in many precise applications. The various designs of these components do not change their necessary operating feature and the designing of the solenoids can be done in different ways. Generally, solenoid works on general electrical principle, but the mechanical energy of this device is distributed in a different way in different designs.

##### 1.1.8. What is a Solenoid and Its Working Principle

A solenoid is a very simple component, that includes a coil of wire that is covered around a core made out of a metal. When a current is applied to the solenoid, it has the effect of assembling a consistent magnetic field. Electricity changes to magnetism then it changes to electricity and, therefore, these two forces are united into one.

An attractive thing about the uniform field in a solenoid is that, if the solenoid has an immeasurable length, the magnetic field would be the similar everywhere along the element. In a solenoid, sometimes this translates to very small electrical components being able to do a marvelous amount of work. For instance, a powerful solenoid can simply slam shut a valve that would be demanding for even the burliest plumber to close by hand.

##### Different Types of Solenoids

There are various Types of Solenoids are available in the market. They differ in terms of their material, design and function. But all kinds of solenoids depend on the same electrical principles.

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- AC Laminated Solenoid
- DC C–Frame Solenoid
- DC D–Frame Solenoid
- Linear Solenoid
- Rotary Solenoid

### AC Laminated Solenoid

An AC laminated solenoid is famous for the amount of force that can be performed in their first stroke. They can also use a longer stroke than a DC solenoid. They are obtainable in several different configurations and ranges. These types of solenoids will produce a clean buzz when they are being used.



Fig 1.6.AC Laminated Solenoid

### DC C–Frame Solenoid

A DC C–Frame solenoid uses only a frame, formed like the letter C, which is covered around the coil. This kind of solenoid has an extensive range of different applications. Even though they are famous in a DC configuration, they can also be designed to be used with AC power.



Fig 1.7. DC C–Frame Solenoid

### DC D–Frame Solenoid

A DC D–Frame solenoid gears have a two-piece frame that is covered around the coils. These are used in several different applications like industrial applications. Like the C–Frame, these solenoids can also be designed in AC alternatives, for applications when the properties of an AC solenoid are more attractive than a DC solenoid.

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Fig 1.8. DC D–Frame Solenoid

### Linear Solenoid

This kind of solenoids is more familiar with the most people. These are capable of using a pulling or pushing force on a mechanical device and can be utilized for a variety of metering tasks. These solenoids are used in a different application. For instance, a solenoid on the starter device of a vehicle which includes a motor. Whenever electrical current flows through the solenoid, then it will move in a linear fashion to get two contacts together.



Fig 1.9.Linear Solenoid

When the two contacts are getting together, they let power to flow from the battery supply to the different components of the automobile and the automobile to start. The best application of the solenoid is electric lock. When the lock is attached to the bolt on a door, it can immediately protect a door sufficient to hold up to a great deal of violence.

### Rotary Solenoid

Rotatory solenoid is a good example of mechanical force which can be used in different methods to make easy of an automatic control process and quite easy to make life easier. In this solenoid, there is the similar coil and core design, though it is somewhat changed. In a rotary solenoid, a disc is used instead of the solenoid being a simple device with a core and

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coil. The body of the solenoid is lined up with the grooves and ball bearings are used to make easier motion.



Fig1.10. Rotary Solenoid

Triggering the solenoid makes the core to be drawn back into the coil. This force is converted into a rotation force in the disc. Most of the devices are also inbuilt with a spring. When the power supply is detached from the solenoid, the spring makes the core to be drawn out of the coil, releasing the disc and transferring it back to its unique position.

Similar to many electrical devices, this tool happens to have been developed as a security device. This product was first used during World War-II as a way to enhance the durability of the devices used in bombs. Nowadays, these kind of solenoids is general electrical components, which are very appropriate to utilize in trying industrial environments.

### **Applications of Solenoid**

A solenoid is an essential coil of wire that is used in electromagnets, inductors, antennas, valves, etc. The application of a solenoid differs in numerous types like medical, locking systems, industrial use, the bottom line and Automotive Solenoid Applications.

A solenoid is used to control a valve electrically, for example, the solenoid core is used to apply mechanical force to the valve.

These can also used in particular types of door locking systems, which use an electromagnet and offer a very secure closure.

The solenoid is used in many different appliances and products like computer printers, fuel injection gear used on cars and in various industrial settings.

The main advantage of the solenoid is, whenever an electricity is applied, the reaction of the solenoid is immediate.

That quick response is one of the most significant factors in resolving the applications of solenoids.

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Thus, this is all about different types of solenoids which includes AC Laminated Solenoid, DC C–Frame Solenoid, DC D–Frame Solenoid, Linear Solenoid, Rotary Solenoid and Tubular Solenoid. Furthermore, any queries to implement electrical projects, please give your feedback or suggestions in the comment section below. Here is a question for you

## 1.2. standard and code of practice

### Standards

There are a number of standards that apply to cables and wires. Some of the most common standards include:

- International Electrotechnical Commission (IEC) 60228: This standard covers the construction, testing, and marking of cables and wires.
- American National Standards Institute (ANSI)/Telecommunications Industry Association (TIA)-568: This standard covers the design and installation of commercial building cabling systems. It includes requirements for low-voltage twisted pair cables, which are commonly used for computer networks.
- Electronic Industries Alliance (EIA)/Telecommunications Industry Association (TIA)-570-B: This standard provides guidelines for the installation of optical fiber cable systems. It is often used for high-speed data networks.

In addition to these general standards, there may be specific standards that apply to certain types of cables and wires. For example, the National Fire Protection Association (NFPA) 70, National Electrical Code (NEC), provides requirements for the installation of electrical cables and wires.

When choosing cables and wires, it is important to select products that meet the applicable standards. This will help to ensure that the cables and wires are safe and reliable.

Here are some tips for choosing cables and wires:

- Consider the voltage and current requirements of the application.
- Choose cables and wires that are rated for the environmental conditions where they will be installed.
- Make sure to select cables and wires that are the appropriate size for the application.
- Follow the manufacturer's instructions when installing cables and wires.

electrical cable codes

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The electrical cables are allocated with codes by using numbers or letters for representing the voltage of cable, insulation material used, sheath, structural element, type of conductor.

The 10-digit commodity codes are mainly used for the import of goods from outside the EU & they are required for the declaration of TARIC imports.

### **use of Mims cable**

Mims cables provide an ageless, fireproof & lifetime electric cable solution. These cables are used for protecting necessary ‘life-critical’ circuits in tunnels, high-rise buildings, shopping centers, airports, towers, hospitals, hotels, etc.

### **electric cable advantages**

- Underground electrical cables can decrease the visual impact
- Fewer transmission losses
- Less affected from different weather conditions
- Increases reliability for power supply.
- Shielded twisted pair cable has high capacity, simple installation,
- UTP cable is less costly as compared to optic fiber & coaxial cable.
- Coaxial cables have higher bandwidth & less expensive as compared to FOC or fiber optic cables.
- Fiber optic cable has very high speed & bandwidth.

### **electric cable disadvantages**

- Underground electric cables are expensive as compared to others
- Finding damage and fault is difficult
- Maintaining underground cables is difficult.
- Shielded twisted pair (STP) cables have a large diameter and are more expensive as compared to coaxial or UTP cables.
- UTP cable has signal attenuation, so applicable for shorter distances.
- The number of node connections in coaxial cable is limited.
- Fiber optic cables are unsafe.

The electric cable applications include the following.

- Electrical cables are widely used to provide wiring in buildings, industries, etc
- These cables are used to transmit electrical energy from one location to another.

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- These are widely used in electronic devices.

Electrical cable size can be determined based on three essential factors voltage regulation, current carrying capacity & short circuit rating.

### types of cable and wire

There are various types of cables and wires used for different applications. Here are some commonly used types:

**Coaxial Cable:** Coaxial cables are used for transmitting high-frequency signals. They consist of a central conductor, an insulating layer, a metallic shield, and an outer insulating layer. Coaxial cables are commonly used for cable television (CATV), internet connections, and video surveillance systems.



Fig1.5. Coaxial Cable

**Ethernet Cable:** Ethernet cables, also known as twisted pair cables, are used for networking and data communication. They use twisted pairs of copper wires to transmit data and are commonly used for connecting computers, routers, and other network devices. Generally, the Ethernet cable is used in a wired network to connect different devices like PCs, routers & switches in a LAN. If this cable length is not long or not durable then the connection quality will be reduced. The port of Ethernet can be observed on the motherboard to plug the cable directly.



Images Ethernet Cable

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**HDMI Cable:** HDMI (High-Definition Multimedia Interface) cables are used for transmitting high-definition audio and video signals between devices such as TVs, monitors, and DVD players. They support both audio and video data in a single cable.



Fig1.6. HDMI Cable

**Optical Fiber Cable:** Optical fiber cables use thin strands of glass or plastic fibers to transmit data using light signals. They offer high bandwidth and are commonly used for long-distance communication, such as internet backbones and telecommunications networks.



Fig1.7. Optical Fiber Cable

**USB Cable:** USB (Universal Serial Bus) cables are used for connecting devices such as computers, printers, cameras, and smartphones. They are used for data transfer, charging, and connecting peripheral devices.

The USB (Universal Serial Bus) is very popular and standard cable used to connect different peripherals to a computer device. The devices which are connected by USB are music players, mice, keyboards, flash drives, and many more.

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Fig1.9. USB Cable:

**Power Cables** Power cables, also known as electrical cables, are used for transmitting electrical power. They come in various sizes and configurations, depending on the voltage and current requirements. Common types include non-metallic sheathed cable (NM), underground feeder cable (UF), and armoured cables.



Fig 1.1.0. Power Cables

**Speaker Wire:** Speaker wires are used for connecting speakers to audio amplifiers or receivers. They are usually made of copper and come in different gauges (thicknesses) depending on the power requirements of the speakers.



Fig1.11. speaker cable

**Control Cable:** Control cables are used for transmitting control signals in industrial automation and machinery. They are often multi-conductor cables and can be shielded to protect against electrical interference.

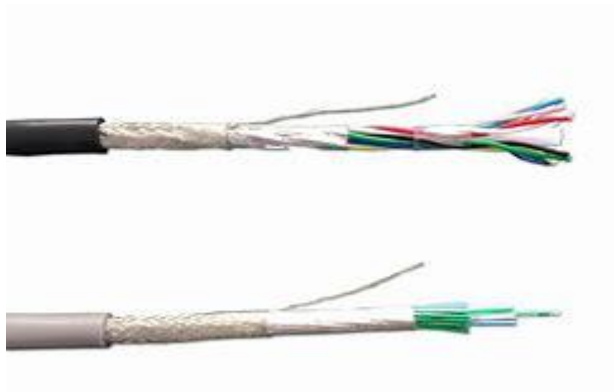


Fig 1.12. control cable

**Fire Alarm Cable:** Fire alarm cables are designed for fire detection and alarm systems. They are typically low-voltage cables and may have additional fire-resistant properties to ensure reliable operation during a fire.

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Fig 1.13 Fire Alarm Cable

**DVI Cable:** DVI (Digital Visual Interface) cable is a video display interface, used to attach the video card & LCD monitor. By using this cable, one can watch high-quality pictures without having any trouble.

These cables transmit video data to monitors at high resolutions like 2560 x 1600, so these are mostly applicable in CRT monitors with a VGA connection. The main intention to design this cable is to transmit analog and digital signals to the computer system.



Fig 1.14. DVI cable

**VGA Cable:** VGA (Video Graphics Adapter) cable is mainly used to transfer video signals by connecting the CPU & monitor of a computer. At present, these cables can be found in projectors & TVs.



Fig 1.16. VGA cable

**PS/2 Cable:** This PS/2 (Personal System/2) cable is available with a round connector with 6 pins. These cables are mainly used to connect the keyboard & mouse to the computer system. These cables are available in small size but we can extend by using some adapters based on the requirement. These cables are replaced by USB cables because USB cables can be plugged in very easily.



Fig 1.1.8. PS/2 CABLE

**Audio Cable:** Audio cables are used to connect headphones & earphones to the system. Generally, these are mainly used for connecting a PC sound card, small stereo audio device, or small CD player to any speaker.



Fig 1.19. audio cable

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**MIDI cable:** MIDI (Musical Instrument Digital Interface) cable carries music data, panning, vibrato, event messages, etc. These cables can be found in different earlier computer systems where sound cards include MIDI ports that joint different electronic musical instruments to computers. This cable also connects a synthesizer or MIDI keyboard to the computer. These are just a few examples of the many types of cables and wires available. The specific type of cable or wire used depends on the application, environment, and electrical requirements of the system.



Fig 1.20. MIDI cable

### 1.3. Components and accessory for ELV

#### Accessory for extra low voltage installation

**Conduit:** Conduit is a pipe that is used to protect and support ELV wires and cables. It is made of a variety of materials, including PVC, metal, and fiber.

**Cable ties:** Cable ties are used to bundle and secure ELV wires and cables. They come in a variety of sizes and materials, including plastic, metal, and nylon.

**Junction boxes:** Junction boxes are used to connect ELV wires and cables. They come in a variety of sizes and materials, including plastic, metal, and weatherproof.

**Termination blocks:** Termination blocks are used to terminate ELV wires and cables. They come in a variety of sizes and types, including screw-down, spring-loaded, and push-in.

**Labelling tape:** Labelling tape is used to identify ELV wires and cables. It is available in a variety of colors and materials, including vinyl, cloth, and heat shrinkable.

**Raceways:** Raceways are similar to conduit, but they are typically made of plastic and are designed to be mounted on walls or ceilings.

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**Cable trays:** Cable trays are open-bottom trays that are used to support and organize ELV wires and cables. They are typically made of metal or plastic.

**Cable clamps:** Cable clamps are used to secure ELV wires and cables to surfaces. They come in a variety of sizes and materials, including plastic, metal, and nylon.

**Wall plates:** Wall plates are used to cover ELV outlets and switches. They come in a variety of colors and materials, including plastic and metal.

**Communication devices:** ELV systems may include communication devices such as Ethernet switches, routers, modems, or wireless access points. These devices facilitate data transfer, network connectivity, and remote monitoring or control of the system.

**Control panels:** Control panels serve as the interface between the user and the ELV system. They provide buttons, switches, displays, and indicators for user interaction and system status monitoring.

**Security devices:** ELV systems commonly integrate security devices like CCTV cameras, access control systems, intruder alarms, and fire detection systems. These components help ensure the safety and security of a facility or premises.

**Audiovisual equipment:** In certain applications, ELV systems may include audiovisual components such as speakers, microphones, amplifiers, displays, projectors, and video conferencing equipment

**CCTV Connectors:** These are used for the need of terminating CCTV cables in installation for surveillance camera. High-end connectors are used to obtain weatherproof service without any trouble.



**CCTV Wire and Cable:** Used in different CCTV applications in order to have the CCTV cameras connected to the Digital Video Recorder. The use of CCTV Wire and Cable will depend on the type of application.



**CCTV Ground Loop Isolators:** This is a device, has a Ground Loop Interference reduced with the help of CCTV signals and also it can be easily installed in a new system or one of the existing systems.



**CCTV Camera Housings:** These are required for internal as well as external CCTV camera installations, though the use for exterior installation is more, in order to protect from elements. These are required for encasing the CCTV setup for both



**CCTV Mounting Brackets:** CCTV Mounting Brackets are used for a wide array of products like the CCTV camera housing, CCTV cameras and CCTV monitors.



**CCTV Power Supplies:** Along with the CCTV Power Supplies, Converters and Battery Packs are used for the purpose of CCTV Camera installation as well as mobile cameras, hardwiring and also for converting a camera of 12 VDC to 24 VAC of power supply.



**CCTV Surge Protector:** A key element for safety and protection of assets is the CCTV security system during CCTV operation. Unpredictable disruptions such as electrical surges and lightning strikes can cause serious disruptions to the otherwise proper functioning of a security system. The currents that occur due to surges can get carried over to the metallic conductor which may



include the electrical and plumbing wiring. The surge protection should be thus, installed properly in order to protect the CCTV system.

**CCTV Twisted Pair Baluns:** A balun (an acronym for Balanced/Unbalanced) changes one medium of transmission to another medium of transmission, using defined impedance (which, 75 ohms coaxial) for the first and another impedance for the transmission to another medium (of 120 ohms twisted pair, i.e., CAT5e).



**Switches and relays:** Switches and relays are used to control the flow of electrical current within the ELV system. They enable the activation or deactivation of various components or circuits based on specific conditions or user input. Before you begin the installation process, ensure you have all the necessary components for each type of security camera system. These components typically include:

- **Digital Video Recorder (DVR)** or Network Video Recorder (NVR): A DVR is needed for analog HD cameras, while an NVR is required for IP cameras.
- **Video Cable:** This cable connects the camera to the DVR or NVR.
- **Power Supply:** A power supply is needed to provide power to wired cameras.
- **Network Cable:** This cable is required for IP cameras to connect to the internet router.
- **Mounting Hardware:** You will need mounting hardware to secure the camera to the desired location.
- **Passive infrared** sensors (PIRs) detect people moving using infrared heat sensing,
- Dual Technology sensors use combined infrared and microwave sensing technologies to help reduce false alarms,
- **Magnetic door contacts** detect the opening and closing of doors and windows,
- **Glass break sensors** listen for the specific noise of breaking glass,
- **Shock sensors** detect attacks on doors and windows,
- **Smoke sensors** can be connected to the intruder alarm system to detect fire.

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- **Fire Alarm** Control Panel (FACP)
- **Smoke Detectors**
- **Heat Detectors**
- Manual Call Points (MCP)
- Notification Devices (horns, strobe lights, speakers)

## 1.4. tools, equipment and testing devices

### 1.4.2. CCTV camera tester

is a device that is used to test the functionality of CCTV cameras. It can be used to check the camera's image quality, resolution, focus, and other features. CCTV camera testers can be used by security professionals to troubleshoot problems with CCTV systems, or by homeowners to test their own CCTV cameras.

There are two main types of CCTV camera testers: analog and IP. Analog testers are used to test analog cameras, while IP testers are used to test IP cameras. Analog testers typically use a BNC connector to connect to the camera, while IP testers typically use an Ethernet cable to connect to the camera.

#### **CCTV camera testers typically have a number of features, including:**

- **Image quality testing:** This feature allows you to check the camera's image quality, resolution, and focus.
- **Video signal testing:** This feature allows you to check the camera's video signal strength and quality.
- **Audio testing:** This feature allows you to check the camera's audio signal strength and quality.
- **Power testing:** This feature allows you to check the camera's power supply.
- **Network testing:** This feature allows you to check the camera's network connection.
- When choosing a CCTV camera tester, it is important to consider the type of cameras that you need to test. You should also consider the features that are important to you.

#### **Here are some of the benefits of using a CCTV camera tester:**

- **Can help you to troubleshoot problems with CCTV systems:** If you are having problems with your CCTV system, a CCTV camera tester can help you to identify the source of the problem.

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- Can help you to test your own CCTV cameras: If you have your own CCTV cameras, you can use a CCTV camera tester to test their functionality.
- Can be used by security professionals: Security professionals use CCTV camera testers to troubleshoot problems with CCTV systems and to test new cameras.
- Here are some of the drawbacks of using a CCTV camera tester:
- Can be expensive: CCTV camera testers can be expensive, especially if you need a tester that can test a variety of cameras.
- Can be difficult to use: Some CCTV camera testers can be difficult to use, especially if they have a lot of features.

### **smoke detector tester**

is a device that is used to test the functionality of smoke detectors. It is important to test your smoke detectors regularly to make sure that they are working properly. Smoke detector testers can be used by homeowners, businesses, and security professionals.

There are two main types of smoke detector testers: aerosol testers and electronic testers. Aerosol testers spray a small amount of artificial smoke into the smoke detector. If the smoke detector is working properly, it will sound an alarm. Electronic testers emit a signal that mimics smoke. If the smoke detector is working properly, it will detect the signal and sound an alarm.




When choosing a smoke detector tester, it is important to consider the type of smoke detectors that you have. Aerosol testers can be used to test both ionization and photoelectric smoke detectors. Electronic testers can only be used to test ionization smoke detectors.

### **Here are some of the benefits of using a smoke detector tester:**




- Can help you to identify smoke detectors that are not working properly: Smoke detectors can fail over time, so it is important to test them regularly. A smoke detector tester can help you to identify smoke detectors that are not working properly so that you can replace them.
- Can help you to reduce the risk of fire: Smoke detectors are an important part of fire safety. By testing your smoke detectors regularly, you can help to reduce the risk of fire in your home or business.

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- Is easy to use: Smoke detector testers are easy to use. Simply follow the instructions on the tester.

<p>MultiMeter: An electronic device used for measuring voltage, resistance and current. It is used for checking voltage and continuity in the CCTV field.</p>	
<p>Hammer: Used for hitting, especially for cable clipping works.</p>	
<p>Pliers: Used for holding objects firmly and also cutting wires and cables.</p>	

<p>Wire cutter: Used for cutting as well as stripping wires.</p>	
<p>LAN Tester: This is a tool for connectivity measurement, which is used for CAT5 and CAT6 cable testing. This will check every connection of the cable to assure if it is perfect or not.</p>	
<p>LAN Crimping Tool: Used for crimping and cutting a RJ45 connector to a LAN cable.</p>	
<p>Screw Driver: To drive screws in any type of material.</p>	

<p>Aligner: A type of small screw driver which is needed for electronic devices and has a small screw place for calibrating.</p>	
<p>Drill Bit: This is used along with drilling machines in order to have holes drilled out of walls, to mount a camera, conduits along with different operations.</p>	
<p>Hexa Blade: Used for cutting conduits in order to fit these as per the site need.</p>	



<p>Drill Machine: Drill machines are two types – a hand drill while the other is a bench drill machine. These are used for camera mounting and also installing cable in conduits.</p>	
<p>12V 1A Power Supply: This needs to be kept along with the tools and then be used for checking the field issues for a CCTV.</p>	
<p>Measuring Tape: Ideal for any installation, it is used for measuring first. It can be used for measuring the length of cable.</p>	



Cleaning Brush: Often dust causes a lot of disorder in the CCTV system and hence it is required to carry a cleaning brush.



<p>CCTV Tool Monitor: It is a small monitor which has the required video inputs and used for checking the field anytime needed.</p>	
<p>Tool Bag: All the tools mentioned must be neatly arranged in a tool bag, otherwise the required tool may not be found at the time of need.</p>	

**Screws** A Screw is a sharp-pointed short metal pin of certain pitch length with helical threads running round of it. It is used to fasten two pieces together or join them for a desired working. It can fasten any type of piece made of either wood or metal. There are number of types of screws used to fasten various types of parts performing different functions. ( Types of Screw Heads )

It is usually made of metal with sharp point at one end and a head at another end. At the middle section which is known as shank has thread around it from the sharp point to the certain length that is partially or fully covered. To tightened the parts the majority of rotation of screw is towards clockwise direction and a screwdriver is required to perform this action.



- screwdriver
- electric drill
- ladder
- hammer
- fish tapes

Fish tape or fishing tape is designed to help with wire pulling through an electrical conduit run. The fish tape is used mostly in a wall cavity, duct, or ceiling that is already finished, and it helps to make sure that you can feed wire and cable through without having to make unnecessary holes in the wall.

Fish tape comes in different materials and sizes depending on the type of wire you are trying to pull. The fish tape is a helpful product that anybody can use, regardless of skill level. Think of it almost like a guide string for electrical wiring.



Fig fish tapes

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Fish tape is a tool that electricians will find to be very helpful. You may also see fish tape used for cable and data workers trying to run new lines to a house.

Without the use of fish tape, there will be times when more than one hole needs to be placed into a wall to feed a cable or wire through.

## 1.5. Fitting standard and laying out procedure

### 1.5.1. symbols standard

One common standard is the International Electrotechnical Commission (IEC) standard IEC 61769-1. This standard defines a number of symbols for low-voltage electrical systems, including symbols for telephone, data, security, audio, video, and fire alarm systems.

Another common standard is the British Standard BS 8519-1. This standard is similar to IEC 61769-1, but it also includes symbols for some additional systems, such as public address systems and paging systems.

In the United States, there is no single national standard for ELV symbols. However, the National Electrical Contractors Association (NECA) has published a guide to ELV symbols that is widely used by electricians and engineers.

In general, it is best to use the standard that is most commonly used in your region or country. This will help to ensure that your drawings are understood by other people who are working on the same project.

Here are some additional tips for using ELV symbols:

- Use the correct symbol for the system that you are representing.
- Draw the symbols in a consistent size and style.
- Label the symbols with clear and concise text.
- Use a legend to explain the meaning of any symbols that are not commonly used.

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Fig 1.5.1 Comen symbol for alarm and access controle

### 1.5.2. fitting standard and symbols

Where to install a CCTV camera is important because the position of the camera determines how well it can surveil an area. Most burglars enter through the front door, window, or back door, so it is important to place cameras in these areas.

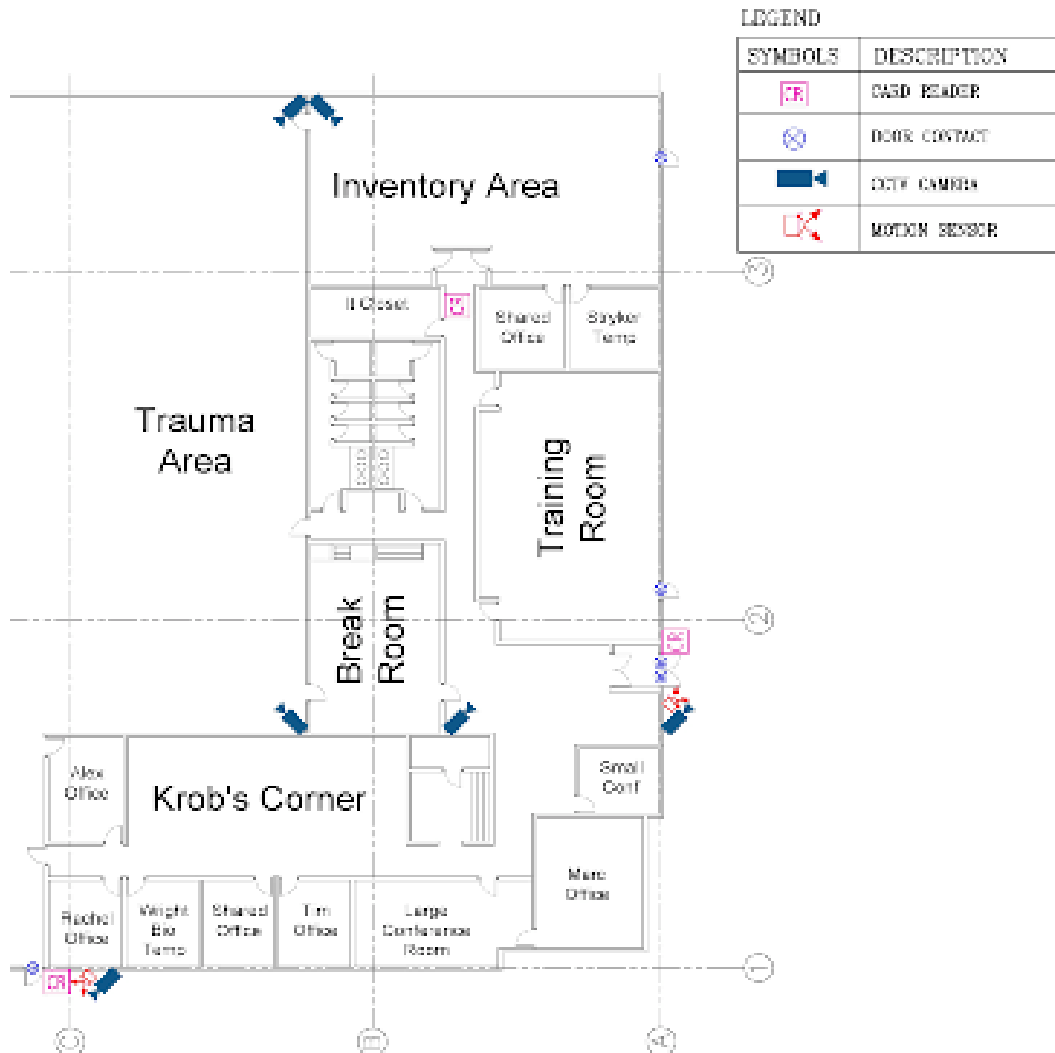
Additionally, it is important to place the camera high up (about 9 feet above the ground) so that it can cover as much area as possible and avoid vandalism.

If you're living in areas with frequent bad weather, make sure your camera's IP rating is high enough to withstand elements. For example, an outdoor surveillance camera with an IP66 rating can withstand the impacts of solid matter like dust and liquid-like rainwater, which could be rendered completely water-proof.

### CCTV

Proper mounting of your cameras is essential for ensuring the effectiveness of your CCTV installation and the longevity of your security camera systems.

Here are some important tips to follow when you install security cameras to guarantee a safe and secure setup:



**Height:** Mount cameras at a height that provides optimal coverage without compromising the quality of the video feed. Generally, outdoor cameras should be mounted 8-10 feet above the ground, while indoor cameras can be placed 7-9 feet high.

**Stability:** Choose a stable surface for your camera mounts, such as brick, concrete, or wood. Avoid mounting cameras on unstable surfaces like thin plastic or drywall, which may not provide adequate support.

**Visibility:** Position cameras so that they cover the desired area without being obstructed by objects or structures. Ensure that the camera's view is not blocked by trees, bushes, or other obstructions.



**Weather Resistance:** When installing outdoor cameras, use weatherproof housing and mountings to protect the camera from harsh weather conditions. This will prolong the life of your security camera systems.

**Cable Management:** Properly secure and manage cables to avoid tripping hazards, vandalism, or damage to the cables. Use cable clips, conduits, or cable covers to keep cables tidy and protected.

**Power Source:** Ensure that the camera is close enough to a power source and that the cables can reach without being stretched or strained. Use appropriate extension cables if necessary.

**Tamper Resistance:** Choose tamper-resistant mounting hardware to prevent unauthorized individuals from easily removing or adjusting your cameras. This is particularly important for outdoor cameras.

### **Correct location and alignment of Security alarm devices**

Whether you're securing a home, retail store or other commercial business, you need dependability from your systems. Intelligent intrusion detection is a delicate balance between responding to real security breaches and ignoring costly false alarm triggers.

The motion detector chosen ought to suit the requirements of virtually any application – from easy to difficult environments – and stand up to multiple challenges, including strong drafts, moving objects, and the presence of pets.

Homes and businesses which do not employ any form of security measures are 10 times more likely to be burgled than those with simple security measures

- Homes and businesses with no burglar alarm are three times more likely to be broken into than those with alarms.
- Around 20% of all house burglaries are carried out without forced entry. A burglar may see an open window or other easy point of entry and take their chance.
- Visible burglar alarms make intruders think twice. They not only act as a deterrent, but will also provide a warning that an intrusion is taking place.

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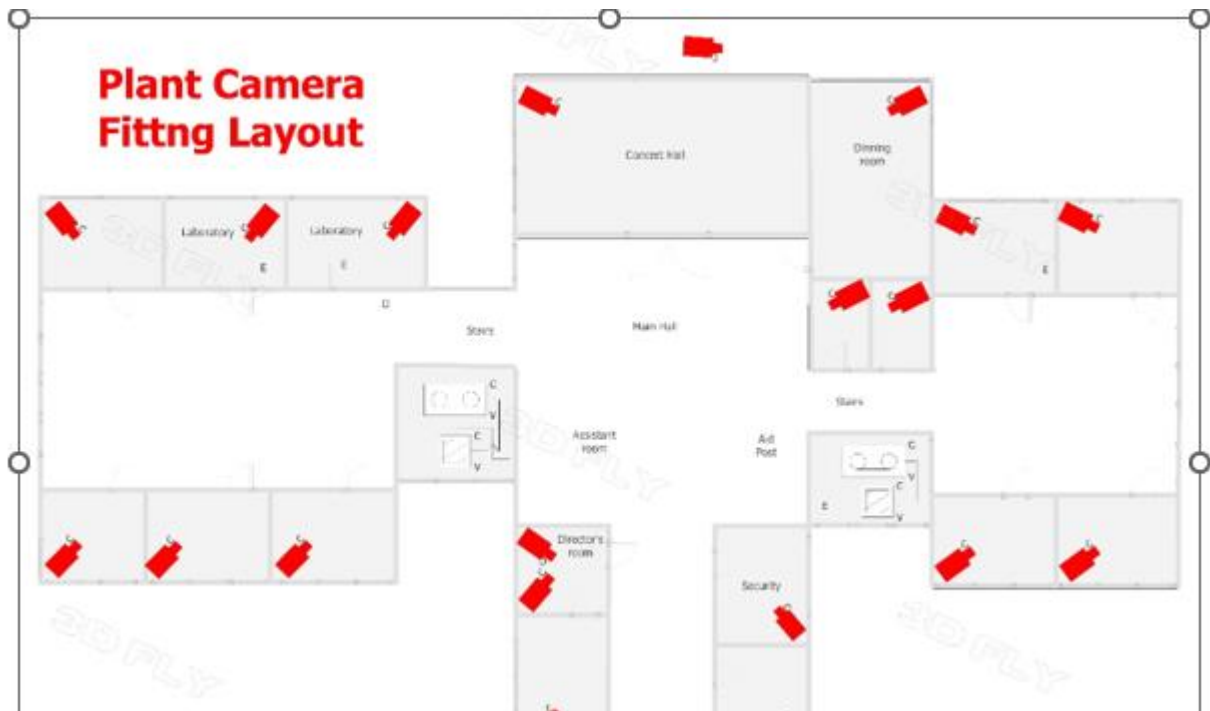


Fig 1.5.3. cctv fitting lay out

**There are various reasons for adopting a trap protection strategy.**

- The first is to limiting the false alarm potential of an alarm system. All detectors (even the top of the range ones) sometimes cause false alarm. This is becoming an increasing problem due to the hard line Police forces now take regarding attendance. False alarms result in a withdrawal of Police attendance and the more detectors a property have the higher the false alarm potential.
- Another important reason is cost – if using a good quality sensor it would be expensive to protect each room.

#### **Features of excellent motion detectors**

- They feature Microwave Noise Adaptive Processing to easily differentiate humans from false alarm sources, such as a ceiling fan or hanging sign.
- For increased reliability, dual sensors must process the PIR and microwave signals independently and must agree there is an alarm before the relay activates.
- There must be sealed optical chambers to prevent drafts and insects from affecting the detector, and our pet-friendly models rule out motion from family pets or guard dogs, so you only handle valid alarms.
- The detectors must integrate and process data from up to 6 different sensors to make intelligent alarm decisions.

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- It provides the best analysis of disturbances and adjusts to the background for ultimate false alarm immunity.

### **Intrusion Alarm Control Panel Features**

- The panel should be capable of handling wired detectors as well as with wireless detectors.

Ultimately, an alarm system gives property owners the peace of mind they desire to protect their homes, families, businesses and assets

#### **1.5.2 laying out procedure**

##### **Step 1: Conduct a site survey with your customer**

To ensure that you get the correct intruder alarm system for your customer, you need to carefully plan and design the system. This is achieved by conducting a short site survey in consultation with your customer.

##### **The location survey comprises two stages:**

- A risk assessment of the building content the total value of target items (electrical goods, jewelers and so on) will generally indicate the level of security required.
- A risk assessment of the building's fabric and structure how easy or difficult it might be to wire the entire the building, the level of physical security, location, break-in history and so on.
- The technical survey looks at those factors than might influence the choice and design of system and the final system design proposal. It will look at any aspect that might impact on the performance of the system such as electrical interference from local plant or machinery.
- The grade of intruder alarm system will depend upon the performance required as determined by the location survey.

The following questions will help you identify exactly what your customer wants to protect, and will enable you to map out the system plan and identify the most suitable components.

The site surveys

- Is the property isolated or in a built-up area?
- What parts of the property have to be protected? Does the entire property or just part require to be protected? What areas does the customer want to protect to identify the number of zones required?
- How many entry doors exist at the property and that require protection?
- In addition to intruder protection, does the customer require fire protection?
- How many zones will be required?
- What type of keypad does the customer require (integral, LED or LCD)?

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- Does the customer require additional keypads?
- Where will the control panel be located?
- Does the customer require the windows to be protected?
- How many rooms are to be protected with movement detectors?
- Does the customer have pets that will remain in the house when the system is set?
- What type of alert is required? (Sounding/visual/remote phone communication)?
- Where will the external siren be located?
- Is a dummy siren also required?
- Is key fob operation more suited to the household?

### Step 2: Map out the property and select products

Using the information you have obtained during the site survey, map out property layout and select the most appropriate products for the installation.

### Step 3: Decide where to position the Intruder alarm system components



Fig 1.6.1 mounting location layout

### Control Panels Positioning

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- For control panels with onboard keyboards such as Honeywell’s Optima Compact, these should be installed near the main access point in a convenient location for mains electricity supply and for user operation
- For control panels which are operated using remote keypads, such as Honeywell’s Accenta Mini, the panel can be concealed inside a cupboard or loft space in a convenient location for mains electricity supply and it makes the cabling to the sounder much easier.

### Best Practice

- It is best to install the control panel first.
- Check the panel voltage to ensure that the control panel has power. REMEMBER to disconnect power before proceeding with the installation of peripherals
- Remember to link out any zones that you are not using, you need to use a wire link across the unused zones
- The stand by battery can take several hours to charge up so it is a good idea to charge batteries before commencing the installation.

### Remote LCD or LED Keypads

#### Positioning

- Mount in a convenient location which allows easy operation for the system users, typically close to the main door, back door and master bedroom.
- Remember to check that the tamper spring on the keypads is closed
- It is recommended to use the tamper spring whenever the keypad is mounted against a wall so that it is triggered if an attempt is made to remove it.

### 3. PIR Motion Sensors

#### Positioning

- Install the sensor at a height of **3m-2.7m**
- Avoid direct or reflected sunlight remembering that the sun moves around during the year!
- Position the sensor away from windows and heating/cooling devices such as radiators and fans.
- The sensor must have a clear line of sight to the protection area.

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### avoid the common mistakes with installing PIRs.

Where the PIR has a look down or “sneak” zone, ensure that this is not obstructed

- Pay attention to avoid blind spots when positioning sensors
- Always adjust the sensitivity of each sensor once it is mounted, taking into consideration the lighting, the proximity to radiators, windows, mirrors and other external influences
- Tamper switches often cause problems. If you are using the tamper switch ensure that the tamper switch is closed. If you are not installing the tamper circuit (not advised) you need to ensure that the tamper circuit is linked out at the control pane.

If wall is not square you may need to alter the state of the plastic to make sure when mounting that you hear the tamper spring “click”, closing the circuit.

- Using the black jumper, you can easily set the red LED light to ON or OFF as indicated below. This is particularly useful in living rooms where the LED flashing on and off could be distracting.
- Allow up to one minute for the PIR to calibrate itself.

### Pet Tolerant Detectors

#### Positioning

- Follow the instructions for positioning PIR motion sensors.
- Select correct pet tolerant setting using the black jumper as indicated below.

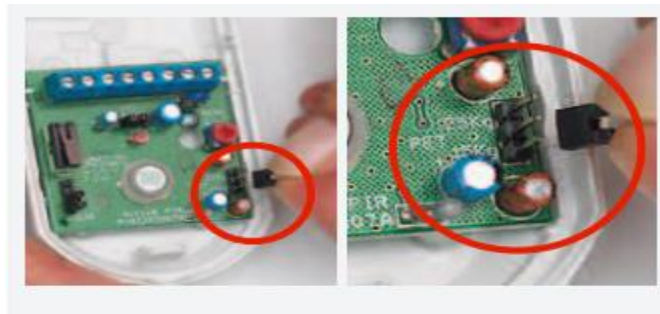


Fig 1.6.2 Pet Tolerant Detectors

### Smoke Sensors

#### Positioning

- Place in or just outside bedrooms or in the hallway close to any sleeping area. The top of the stairs is also a good place
- Do NOT place smoke sensors in kitchens or bathrooms.

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## Door Contacts.

### Positioning

- Mount the main part (part with connectors) on the fixed part of the door or window frame. Do not mount them further than 3” from the opening side of the door
- Mount the magnet on the mobile part of the door or window so that it is adjacent to the main part
- Ensure that the two parts are opposite each other and a small gap has been left Hints and Tips
- Ensure that wires are hidden so that they cannot be damaged
- Ensure that wires are hidden so that they cannot be Please note that some Honeywell door contacts have two rather than five terminals
- If there are only two screws, a tamper loop will need to be created by twisting the cables then insulating them with electrical tape
- Wrap the wire around the screw in a clockwise direction and tighten the screw for the best connection.

## External Sirens & Bells

### Positioning

- Install in a high location from which the strobe can be seen and the siren heard.
- Ensure that the tamper is closed.



Fig 1.6.3 siren and bells

## Internal Siren

### Positioning

- Place in the centre of the home out of reach.

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Fig 1.6.4 siren

## Speech Dialer Communications

### Positioning

- Locate where it can be easily operated by system users and in a convenient location for connection to the phone line.
- If possible, do not connect other telephone apparatus to the same line.

### Best Practice

- Connect the speech dialer directly into the control panel.
- Once wired in, test that the dialer dials through before programming the pre-recorded alert messages according to trigger cause (e.g. intruder, fire, and flood).

### How to avoid the common mistakes with installing a speech dialer

- Ensure that the speech dialer is the first item on the telephone line i.e. the first “slave socket” to be connected to the master socket (where more than one apparatus is unavoidable). This allows the speech dialer to “snatch the line” or disconnect any other call should it be triggered.

### Installation Advice and Best Practice

- When installing an intruder alarm it is imperative that you follow the necessary Health and Safety requirements according to The Electricians Guide to the 17th Edition of the IEE Wiring Regulations.
- Installation of the intruder alarm is straight forward provided that the installer is a qualified and experienced electrician.
- Use multiple core alarm cable and decide at the outset which colours you will use – Convention suggests red is live (+12V) and black is negative (0 Volts)
- Remember to “tin” the wire

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- Do not over tighten the screw on the connector block as this can shear the wire.
- When using the global tamper circuit, this is a continuous loop through all zones (contacts, PIRs PA devices etc.) so all tampers need to be wired.
- Do not work using live circuits
- Run the wires to all the locations of the peripherals.
- Mount the control panel in the desired location.
- Mount the keypad on the wall in the location agreed with the customer.
- Wire up the peripherals (detectors, bell boxes, communication devices...etc.)
- Activate the power.
- Carry out a walk test and check the system is working.

Once you have installed the Intruder alarm system and verified that all components of the system have power you need to commission the alarm.

## 1.6. OHS requirement and procedure

### 1.6.1. occupational health and safety

The Ethiopian Electrotechnical Standards Institute (EESI) ES 82-2016 standard, "Low-voltage electrical installations", includes a number of occupational health and safety (OHS) requirements for extra low voltage (ELV) installations.

The following is a summary of the key OHS requirements for ELV installations in Ethiopia:

- ELV installations must be designed and installed by a qualified electrician.
- ELV installations must be segregated from high voltage installations.
- ELV cables must be properly insulated and protected from damage.
- ELV equipment must be properly labeled and marked.
- ELV installations must be regularly tested and inspected.
- Electrical work must be carried out in a well-ventilated area.

In addition to the above requirements, the EESI ES 82-2016 standard also includes a number of specific OHS requirements for different types of ELV installations, such as ELV lighting systems, ELV security systems, and ELV fire alarm systems.

Failure to comply with the OHS requirements for ELV installations can put employees at risk of serious injury or death. It can also lead to prosecution and fines for the employer.

The EESI ES 82-2016 standard is a comprehensive document that covers all aspects of low voltage electrical installations, including ELV installations. The standard is essential reading for anyone involved in the design, installation, or maintenance of ELV systems in Ethiopia

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**The responsibilities of OH&S include:**

- Developing, maintaining, reviewing and auditing of the organization policies, procedures and systems related to machinery/equipment management;
- Providing monitoring of personal exposure and the environment where there is significant risk of physical exposure;
- Providing general information, instruction and advice on training requirements for machinery/equipment safety.

Company policy-: the health, safety and welfare at work of its employees; complying with Applicable health & safety legal requirements; and, the continual improvement of its health & Safety control arrangements and performance.

- Specifically, the Company is committed for providing and maintaining:
  - Control of the health & safety risks arising from work activities
  - a safe place of work with safe means of entry and exit
  - safe plant, equipment and systems of work
  - a safe and healthy working environment
  - arrangements for the safe use, handling, storage and transport of articles and substances
  - necessary information, instruction, training and supervision to protect safety and health at work
  - Objectives- overall occupational health & safety objective is to prevent accidents,

Injuries and occupational ill health at all locations under Company management control. Specifically, it is the Company's objective that the following 'minimum control arrangements' are in place at all Company locations:

Ethiopian Building Code (EBC) Standard ES 82-2016, "Low-voltage electrical installations", includes a number of training and safety procedures for extra low voltage (ELV) installations.

- Isolate the ELV system from the main power supply before working on it.
- Use appropriate personal protective equipment (PPE), such as insulated gloves and safety glasses.
- Be careful when working with ELV cables, as they may be damaged easily.
- Do not overload ELV equipment.
- Test ELV systems regularly to make sure they are working properly.
- Label and mark all ELV equipment clearly.

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In addition to the above procedures, the EBC Standard ES 82-2016 also includes a number of specific safety procedures for different types of ELV installations, such as ELV lighting systems, ELV security systems, and ELV fire alarm systems.

Failure to comply with the safety procedures for ELV installations can put employees at risk of serious injury or death. It can also lead to prosecution and fines for the employer.

Here are some additional safety tips for working on ELV installations:

- Always turn off the main power supply before working on an ELV system.
- Be careful when drilling holes in the ceiling or walls. Avoid drilling into electrical wires or plumbing pipes.
- If you are installing the ELV system outdoors, make sure the devices are weatherproof.
- Use cable ties or other fasteners to secure the cables and prevent them from being tripped over or damaged.
- Test the ELV system regularly to make sure it is working properly.

By following these safety tips, you can help to prevent accidents and injuries when working on ELV installations.

### 1.8.2. plane for an expected event

The Ethiopian Building Code (EBC) Standard ES 82-2016, "Low-voltage electrical installations", includes a number of requirements for planning for unexpected events in ELV systems.

The following is a summary of the key requirements for planning for unexpected events in ELV systems in Ethiopia:

**Identify potential hazards:** The first step is to identify all of the potential hazards that could affect the ELV system. This could include things like power outages, fires, floods, and earthquakes.

**Assess the risks:** Once the potential hazards have been identified, the next step is to assess the risks associated with each hazard. This includes considering the likelihood of the hazard occurring and the potential consequences if it does occur.

**Develop mitigation strategies:** Once the risks have been assessed, the next step is to develop mitigation strategies to reduce the likelihood and/or consequences of the hazards. This could include things like installing backup power supplies, surge protectors, and fire alarm systems.

**Develop contingency plans:** In addition to mitigation strategies, it is also important to develop contingency plans in case of an unexpected event. This could include things like

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having a plan for how to evacuate the building in case of a fire or how to communicate with employees in case of a power outage.

The following are some additional tips for planning for unexpected events in ELV systems:

- Regularly test and inspect the ELV system. This will help to identify any potential problems before they cause a major disruption.
- Have a qualified electrician on retainer who can be called in case of an emergency.
- Keep a record of all maintenance and repairs that have been performed on the ELV system. This will help you to identify any trends or recurring problems.

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## Self-Check 1

Name \_\_\_\_\_ ID no \_\_\_\_\_

**Part-I:** Choose the best answer from the given alternative

1. What type of cable is used for ELV wiring systems?
  - A . Coaxial cable
  - B. Twisted pair cable
  - C. Fiber optic cable
  - D. All of the above
2. Which of the following is a hand tool used for ELV wiring?
  - A. Wire strippers
  - B. Crimpers
  - C. Cable testers
  - D. All of the above
3. What is an accessory used for ELV wiring systems?
  - A. Conduit
  - B. Junction boxes
  - C. Cable ties
  - D. All of the above
5. What is an OHS requirement for working on ELV wiring systems?
  - A. You must be trained and competent in working on ELV wiring systems.
  - B. You must wear appropriate PPE, such as safety glasses and gloves.
  - C. You must isolate the power supply before working on ELV wiring systems.
  - D. All of the above
6. What is a CCTV system used for?
  - A. To monitor and record video footage
  - B. To control access to a building or area
  - C. To detect and deter intruders
  - D. All of the above
7. What is a solenoid?
  - A. A device that uses electricity to create a magnetic field that can be used to control a mechanical device
  - B. A device that controls the operation of a solenoid
  - C. A device that detects smoke and triggers an alarm
  - D. A device that produces a sound or light signal to warn people of danger
8. What is a controller?
  - A. A device that controls the operation of a solenoid
  - B. A device that detects smoke and triggers an alarm
  - C. A device that produces a sound or light signal to warn people of danger

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- D. All of the above
9. What is a smoke detector?
- A. A device that detects smoke and triggers an alarm
  - B. A device that produces a sound or light signal to warn people of danger
  - C. A device that uses electricity to create a magnetic field that can be used to control a mechanical device
  - D. All of the above
10. What is an alarm?
- A. A device that produces a sound or light signal to warn people of danger
  - B. A device that uses electricity to create a magnetic field that can be used to control a mechanical device
  - C. A device that detects smoke and triggers an alarm
  - D. All of the above

**Part-II: define the following teams**

1. ELV wiring system
2. Write 5 types of Hand tool
3. List the Accessory for CCTV installation
4. Fitting standard for smoke detector and alarm
5. What is the requirement for CCTV system
6. What is Solenoid and Controller
7. Define Smoke detector and its type

## Unit Two: ELV wiring systems installation

This unit to provide you the necessary information regarding the following content coverage and topics:

- wiring diagram and procedure
- Configuration and installation
- CCTV, alarm and smoke detector system
- Quality assurance and inspection
- Clear work site and allocate materials

This guide will also assist you to attain the learning outcomes stated in the cover page.

Specifically, upon completion of this learning guide, you will be able to:

- Understand wiring diagram and procedures
- Apply Configuration and installation
- Install CCTV, alarm system and smoke detector
- Perform different sensor installation
- understand quality assurance and inspection
- clear work site and allocate material



## 2.1 wiring diagram and procedure for installing extra low voltage system

### procedures and wiring diagram

1. **Plan the installation.** Identify the areas you want to monitor and determine the number and type of cameras you need. Choose camera locations that will provide the best coverage and visibility. Consider the lighting conditions at the site and the existing infrastructure.
2. **Mark the locations of the cameras.** Use a pencil to mark the spot on the wall or ceiling where you want to install each camera.
3. **Mount the cameras.** Follow the manufacturer's instructions to mount the cameras in the marked locations.
4. **Run the cables.** Run the cables from the cameras to the DVR or NVR. Be careful to avoid running the cables through walls or ceilings where they could be damaged.
5. **Connect the cables.** Connect the cables to the DVR or NVR and power supply according to the manufacturer's instructions.
6. **Configure the DVR or NVR.** Set the date and time, and create user accounts. Configure the recording settings, such as resolution, frame rate, and motion detection.
7. **Test the system.** Once the system is installed and configured, test it to make sure it is working properly. View the video footage on the monitor to ensure that the cameras are properly positioned and that the image quality is good.

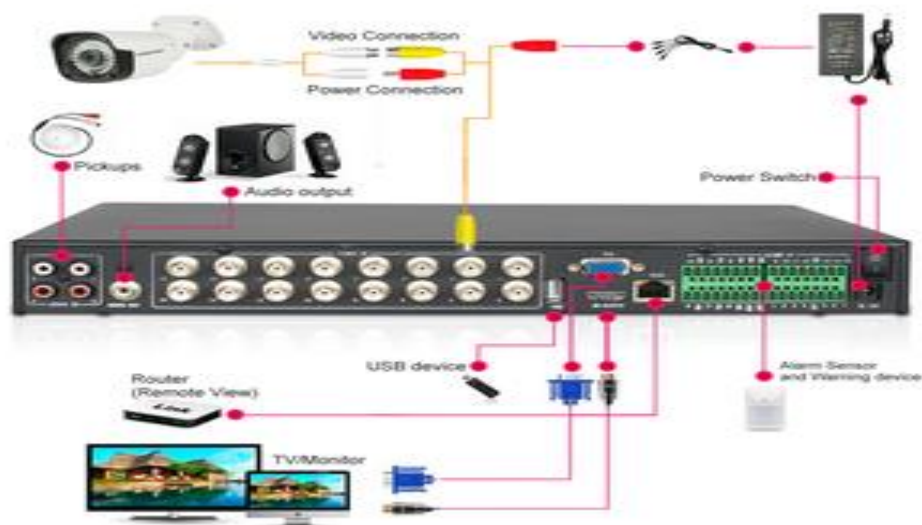


Fig 2.1. CCTV Configuration

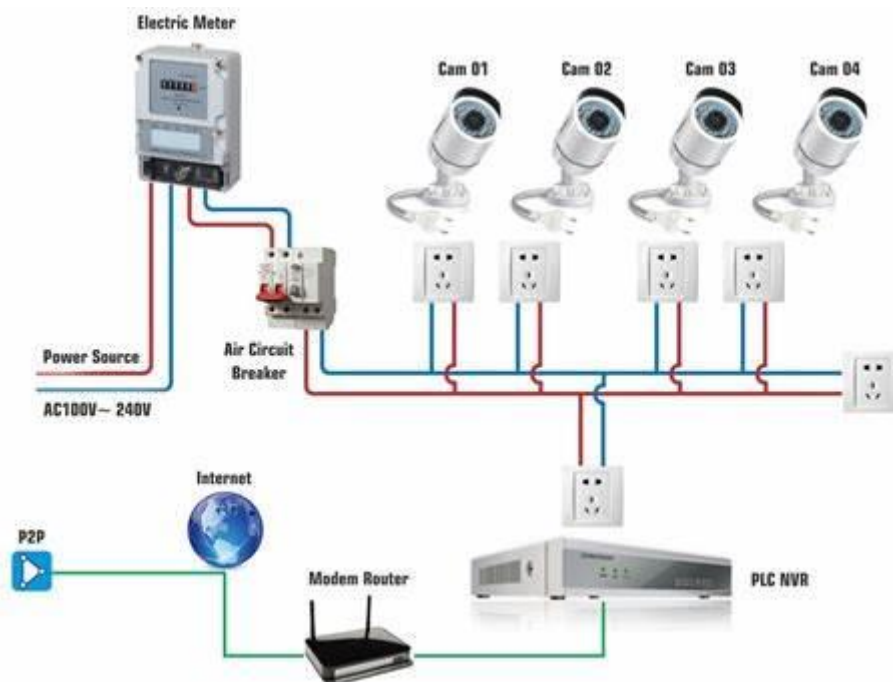
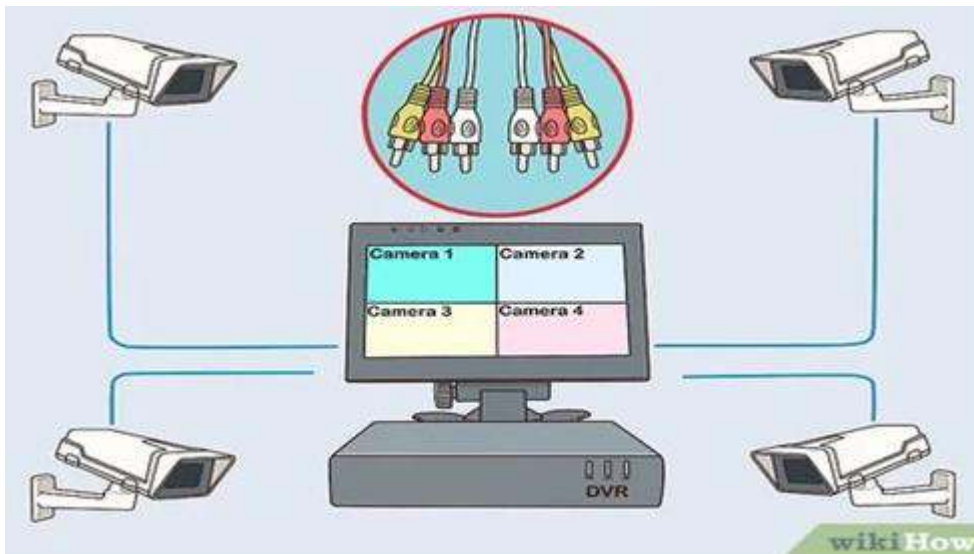
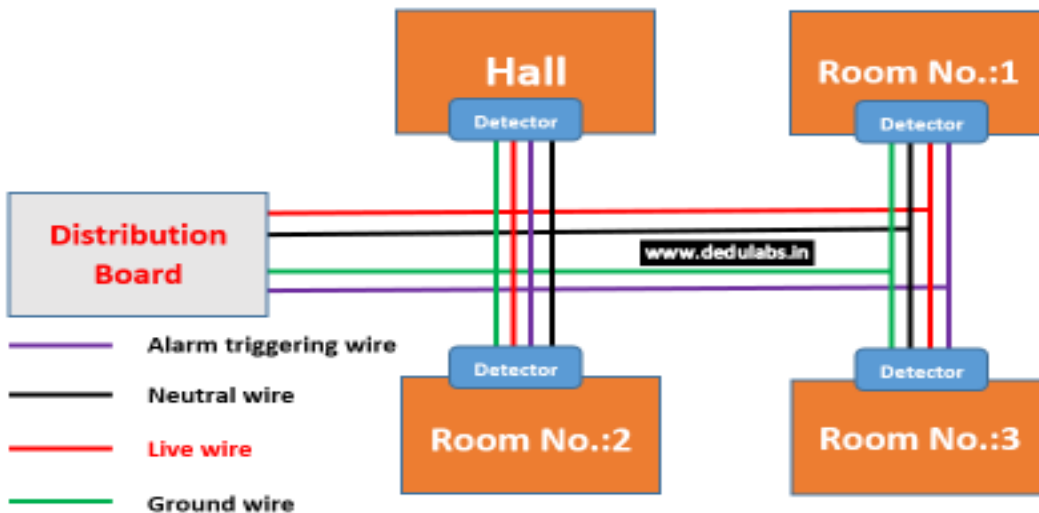


Fig 2.2 CCTV wiring diagram

- Use high-quality cables to ensure reliable video transmission.
- Place the DVR or NVR in a secure location to protect it from unauthorized access.
- Test the system regularly to make sure it is working properly.
- If you are not comfortable installing a CCTV system yourself, you can hire a qualified electrician or security company to do it for you.

### 2.1.2. Procedure for fire alarm installation

1. **Plan the installation.** Identify the areas you want to monitor and determine the number and type of devices you need. Choose device locations that will provide the best coverage and visibility. Consider the lighting conditions at the site and the existing infrastructure.
2. **Prepare the installation.** Mount the devices in the desired locations using the mounting hardware provided. Run the cables from the devices to the control panel. Connect the cables to the control panel and power supply.
3. **Configure the control panel.** Set the date and time, and create user accounts. Configure the recording settings, such as resolution, frame rate, and motion detection.
4. **Test the system.** Once the system is installed and configured, test it to make sure it is working properly. Trigger a manual call point or smoke detector to see if the alarm sounds. You should also test the system regularly to make sure it is still working properly.



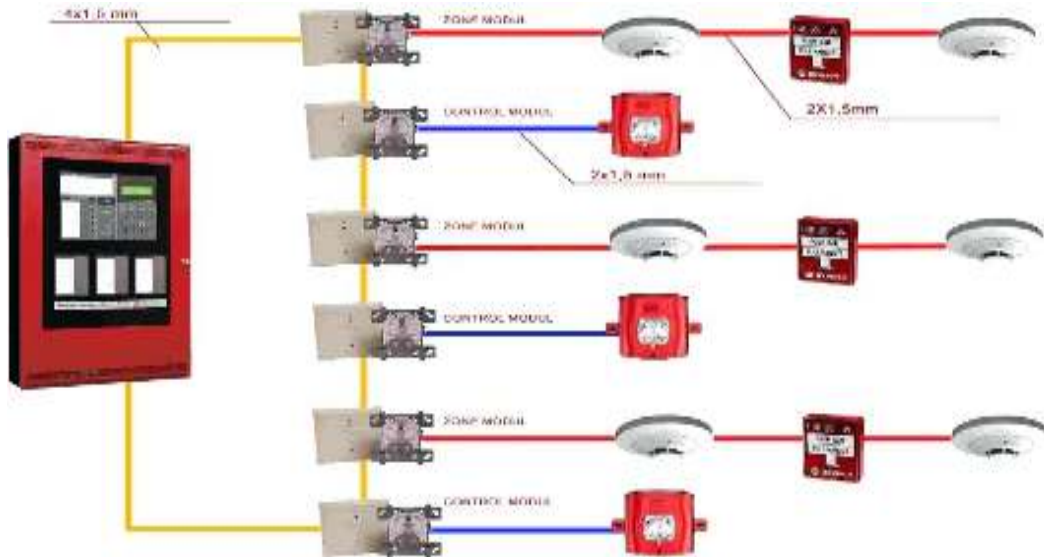


Fig2.3 fire alarm wiring diagram

- Use **high-quality cables** to ensure reliable communication between the devices and the control panel.
- Place the control panel in a secure location to protect it from unauthorized access.
- Test the system regularly to make sure it is working properly.
- If you are not comfortable installing a fire alarm system yourself, you can hire a qualified electrician or security company to do it for you.

### 2.1.3. Procedure for smoke detector installation

1. **Choose the location for the smoke detector.** Smoke detectors should be installed on every level of your home, including the basement and attic. Place them in the center of each room, at least 4 inches away from walls and corners. Avoid placing smoke detectors near vents, fans, or windows, as these can cause false alarms.
2. **Mark the location of the smoke detector.** Use a pencil to mark the spot on the ceiling where you want to install the smoke detector.
3. **Drill a hole for the mounting bracket (if needed).** Use a drill bit that is the same size as the mounting bracket screw. Drill a hole at the marked location.
4. **Attach the mounting bracket to the ceiling (if needed).** Use screws to attach the mounting bracket to the ceiling.
5. **Attach the smoke detector to the mounting bracket** (or directly to the ceiling if no mounting bracket is used). Use the screws provided with the smoke detector to attach it to the mounting bracket or ceiling.

6. **Install the battery (if needed).** Some smoke detectors are hardwired, while others require batteries. If your smoke detector requires batteries, install the battery according to the manufacturer's instructions.
7. **Test the smoke detector.** Once the smoke detector is installed, test it to make sure it is working properly. Press the test button on the smoke detector. The alarm should sound loudly.

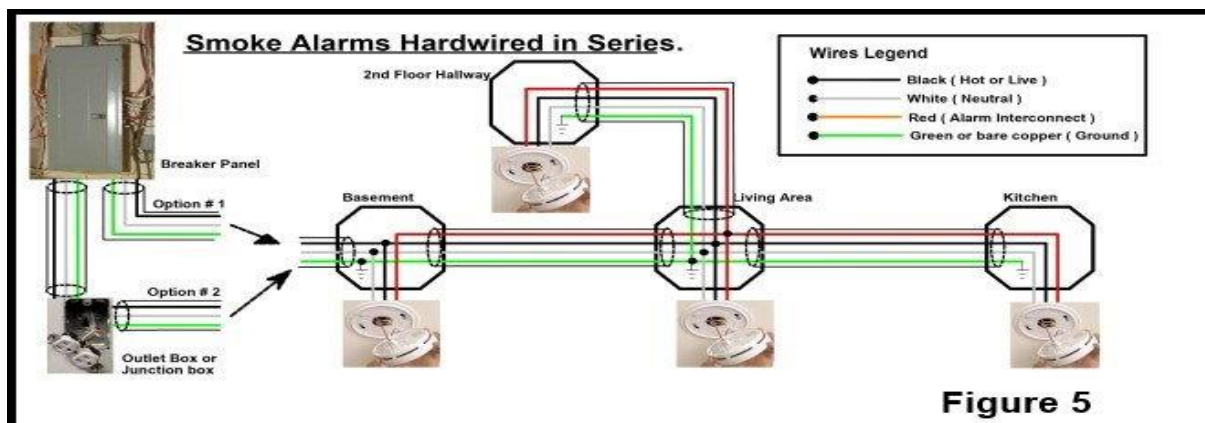
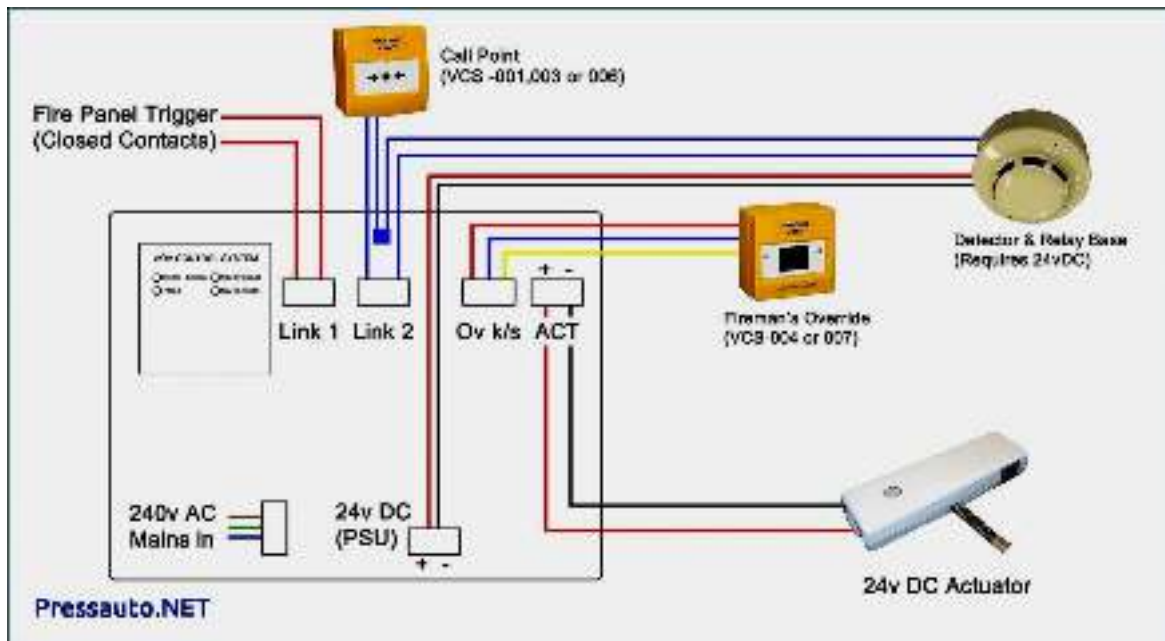


Fig 2.4 smoke detector wiring diagram

- Smoke detectors should be replaced every 10 years, or sooner if they are damaged or not working properly.
- Test your smoke detectors monthly to make sure they are working properly.
- If you have a hardwired smoke detector system, have it inspected and tested by a qualified electrician every year.

## 2.2 configuration and installation

CCTV surveillance system at home is not as complicated as you thought. Prepare the installation tools & materials and follow the steps below, you can install the cameras quite easily.

### Step 1. Check for Spots installation systems.

Pay attention to the following details when you decide on the areas where you'd like to place the camera:

- Mount your camera up high, to make sure it gets a clearer and wider view. Cover as many entries as possible by using the least number of cameras to save cost.
- Keep your security cameras out of reach of intruders and thieves, or naughty kids.
- Avoid pointing your camera directly to a light source, or it will result in a slight underexposure of videos and images captured by the CCTV camera.
- Put cameras near a power source. Even a wireless CCTV camera may need a power supply.
- Place the required mounting bracket for the camera under the eave. This helps protect outdoor security cameras from harsh or extreme weather.
- Do not install a security camera behind the windows. Or else, the IR reflection may lead to overexposed images and videos.
- Avoid installing security cameras in your neighbors' properties or other places where people shall enjoy a reasonable expectation of privacy.

### Step 2. Mount Cameras on the Wall

Some security cameras coming in an all-included package, such as Reolink PoE dome/bullet IP cameras, provide mounting brackets and screws. You can also use the mounting hole template to make your first-time video security installation much easier. Here's how you can use the mounting template inside the camera box.

First decide where you want to place the camera and then attach the mounting template to it, for example to the wall.

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Fig2.5. drill bit the same size

Then use a drill bit the same size as the screws that came with your camera to drill pilot holes in each of the marked locations on the template.



Fig2.6. hole drilling

If it is a wooden wall, you can drill the holes directly. If it is a drywall, use a power drill with a wood bit to create a starter hole, then switch to a metal bit to make the final hole.

Put the camera in your desired spot and make markers for drilling. Drill holes and screw your camera tightly on the wall, ceiling, and other spots you've determined for the camera mounting. And then point your camera in the right position and right angle.

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### Step 3. Arrange Wires and Cables

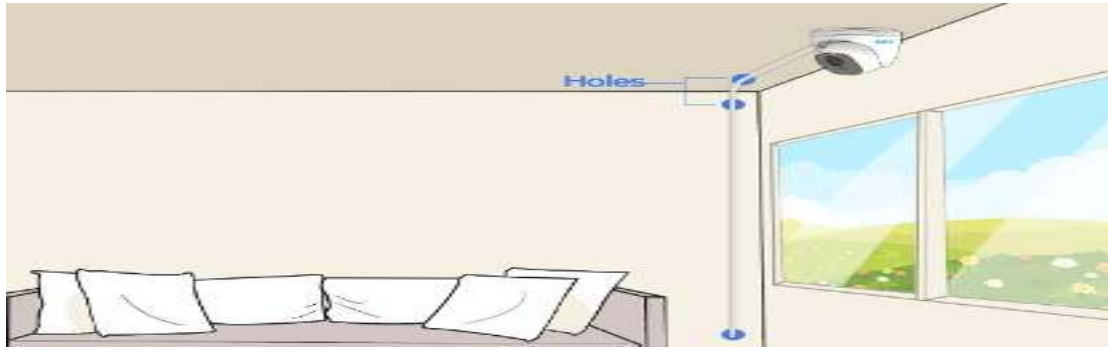


Fig2.7 wires and cables run

Before you get started, you should plan the security camera wire route, especially when you plan to install cameras in multiple spots, such as in hallways, the basement, the garage, through the attic, under the eave, or in the ceiling soffit. Drill holes where the wires will go through, and consider the nearest route if you are doing the installation in a two or three-story house. Push all of the ends of the camera cables on the holes you have drilled. In this process, you can use a fish tapes to make wires go through holes easily.

To keep the wires neat and prevent them from wearing out, you can use wire protection cover or conduit. You can also choose a room wherein you want all your cables to be placed. Check the article on how to run security camera wires for every detail on installing security camera wiring in the house and outside. It's definitely a good help for both experienced CCTV camera installers and green hands.

### Step 4. Connect Wires and Power On

After the wiring process, the next step is to connect your home CCTV security camera and check if it can get power supply. Here we will share wire diagrams about how to connect the camera, including wired and wireless cameras.

**PoE security camera connection diagram:**

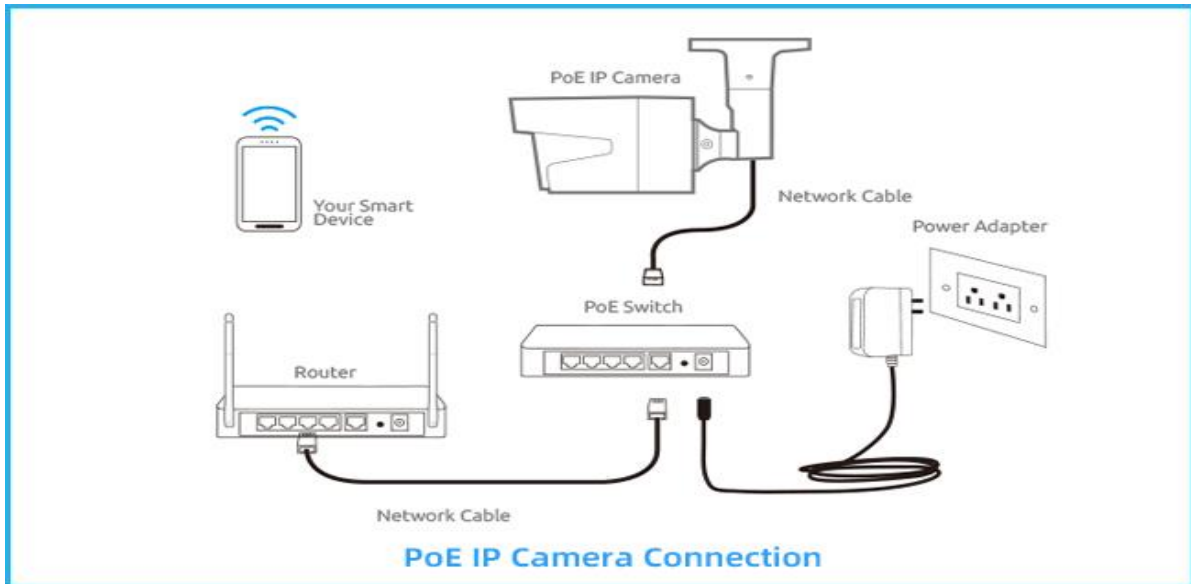


Fig 2.8. POE camera connection

The diagram shows a camera, a router, a Poe switch, and a power adapter. The camera is connected to the router with a signal cable. The router is connected to the Poe switch with a LAN cable. The Poe switch is connected to the power adapter with a power cord.

**Wireless IP camera connection diagram:**



Fig2.9. security camera connected to a router via a wife connection

The diagram displays a wireless security camera connected to a router via a wireless connection. The camera is able to connect to the router wirelessly and does not require any cables. The power adapter is used to provide power to the camera.

Do not forget that if you are using an NVR and a monitor, both devices need to be wired and powered up correctly. You may wish to plug them into the same specific socket to facilitate your wiring and cable management. In addition, you must take into account sudden power cuts. A sudden power failure can occur when an intruder tries to cut the power to your home. We recommend that you purchase a portable high-capacity battery backup for home use, such as a UPS, or use a generator and ensure that your home security system is connected to it. This way, your security camera can work continuously in such an emergency.

### **Set Up the CCTV Camera System**

Before you can say that your installation job is done, it is recommended for you to recheck the views of each camera. Check whether the cameras are working or recording. Also, check how far the camera can cover. Some self-install home CCTV camera manufacturers offer an mobile App and desktop software, for accessing your camera remotely from smartphones, computers and tablets. Get these surveillance features set up on the app/client, including live view, motion detection, video recording, and more to suit your needs.

Here are 3 simple steps for you to set up the IP camera for remote viewing within less than 2 minutes.

- Download the App or Client to your phones or computers.
- Launch the app and enter a unique ID number (UID) to add the camera device.
- Click the camera on the App or Client and you can view live streams over the Internet outside the home network.

security camera setup for motion detection in the Relink client software. If you are using a camera from another manufacturer, you will see a different setup screen.

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Fig2.10. camera setup setting

### System Configuration of DVR

Configuring DVR to meet the customer's requirements These includes system date, time, time format

(12 or 24-Hour), language, video resolution, video standards (PAL or NTSC).

Operation of Main Menu Main menu includes: video function, alarm function, system setup, management tool, system information.

Note:

All sub-menu setup will be effective by confirming SAVE, otherwise ineffective. When check box  is highlighted, it means certain function is selected. If unfilled means not selected.

### Operation Guide

By using mouse, *RIGHT click* and the pop-up window will appear. From the pop-up window, select *MAIN MENU*.

*Note:* for the first time that you do this, the DVR system will ask for *user name* and *password*.

Record

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*Note:* User should have “Record” authority, HDD should be installed and format properly, Setting video setup and playback function, including schedule, motion detection, and exterior alarm setting.

Inquire according to video type (ALL, NORMAL, ALARM, and MOTION DETECTION), channel, and time. The result will be displayed in a list

**Schedule** When the system boots up, it is in default *24-hour* regular mode. You can set record type and time in schedule interface. Setting at Main menu> Video function> video setting. Including schedule setting regarding *Regular*

(R) , motion detection video (M), Alarm (A) Manual (H)

*Note:* Please select the channel number first. You can select —all if you want to set for the whole channels.

Search recorded videos

**Backup,** Backup the recorded files to local storage device, support USB storage devices, support FAT32, NTFS;

**Detect:** Detect the USB portable device connected with DVR, and display the device name, Free space / Total space status.

**USB Backup:** list and backup the selected file, to the USB Devices, could be sorted by Record type, channel, time.

**Erase:** erase all the data in the USB device

**Alarm** Sub-menu: motion detection, camera masking, video loss, alarm input, alarm input, abnormality.

**Motion Detection** By analyzing video, when system detects sensitive moving signal, it will start motion detection alarm.

**3.2 Privacy Mask** When someone violently masks lens, the system can alert you to guarantee video continuity. You can select Alarm output, On-screen, PTZ Linkage.

**3.3 Video Lost** When video loss happens, you can select video lost to show information in local mainframe screen.

**Abnormity Event type:**

**No disk space:** DVR does not connect to the disk or hardware is error.

**Disk error:** The system cannot recognize the video storage because of disk error.

**No enough space:** No enough space for the disk (the percentage of free space will be showed).

**Network failure:** The network connection disrupted or network connection error.

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**IP conflict:** The IP address of disk recorder network is fixed, the conflict will occur once there is another same IP is set in the internet.

**Setting Submenu:** General, Encode, Network, Input, User Management, Pan/Tilt/Zoom, Serial Port.

**Note:** system setup will be done by user who has the authority

**General settings** These includes :

**System time:** use to set system time

**Date format:** there are three types:

YYYYY-MM- DD

MM-DD-YYYYY

DD-MM-YYYY.

**Date separator:**

**Time format:** 24-hour and 12-hour

**Language:** system supports languages: Chinese (simplified), English,

**HDD full:** Here is for you to select working mode when hard disk is full. There are two options: stop recording or rewrite.

**DVR No:** when you are using one remote control to control several DVRs, you can give a name to each DVR for your management.

**Video standard:** There are two formats: NTSC and PAL.

**Output method:** you can set self-adaptable, VGA input; TV input 3 types, support VGA and TVinput at the same time.

**Pack duration:** (Auto Logout) It is use to set proper User's operation duration. Value ranges from 0 to 60 Minutes. User need re-login the system after time out.

**IP address**

**Subnet mask**

**Gateway**

**DHCP:** highlight means select *Dynamic Host Configuration Protocol*

**TCP port:** Default 34567, configurable according to user's demand

**HTTP port:** Default 80, configurable according to user's demand

**UTP port:** Default 37778, configurable according to user's demand

**How to connect accessory and fitting for cctv**

**Max connection:** system support maximum of 10 users. 0 means there is no connection.

**Procedure** Assemble tools and connectors.



Split the power (black & white or black & red) pair away from the RG59 coaxial cable for about 6 inches at the camera location.

At the DVR location the split will need to be enough to connect the RG59 coaxial cable to the DVR and the power pair to the Power Distribution Unit.

Insert the metal sleeve over the RG59 coaxial cable.

Cut approximately 1 inch of the outer shell from the **cable exposing the copper shield.**

*NOTE:* The narrow/smaller end of the sleeve needs to be inserted over the RG59 cable **FIRST!**

Use the diagonal cutters to cut and trim back the shield until you have about 3/8 inch. Fold this back on the outer jacket.

Use the knife to carefully trim back the inner insulator around the copper center wire. You should leave about 1/16 to 1/8 inch insulator beyond the shield.

The inner copper wire should be about 1/2 inch long.

Pull the copper shield wire over the rear portion of the BNC **connector.**

Slide the metal sleeve up **OVER** the copper shield. Ensure that you are securely holding the BNC connector against the RG59 cable.

Often when you slide up the sleeve you will push the connector away from the inner core wire unless you are holding it securely.

Crimp the metal sleeve onto the BNC connector using the larger (inner die) of your crimp tool.

Now crimp the narrow end of the sleeve over the RG59 cable using the smaller (outer die) of your crimp tool.

The completed BNC assembly should look like the picture.

Prepare power line for CCTV camera.

Remove about two inches of the outer shield from the power portion of the Siamese cable.

Remove about 3/8 inch insulation from each of the wires.

Connections for the all-in-one (AIO) cameras will look similar





to the various connections shown at the right. These cameras are normally powered by 12 VDC.

These cameras will normally have a receptacle for power input and the center pin of the receptacle is Positive.

The cameras can be powered by a single brick with the proper plug or an adapter cable with the correct plug will be shipped with the camera to enable connection the power wires of the Siamese cable.



Connections for the all-in-one (AIO) cameras will look similar to the various connections shown at the right. These cameras are normally powered by 12 VDC.

These cameras will normally have a receptacle for power input and the center pin of the receptacle is Positive.

The cameras can be powered by a single brick with the proper plug or an adapter cable with the correct plug that is shipped with the camera to enable connection the power wires of the Siamese cable.

There are two options for power connections at the DVR end of the cable.

A Power Distribution Unit (PDU) or a single power source (commonly called a brick) for each camera. Both type of power sources come in 12 VDC and 24 VAC versions.

A 24VAC version of the PDU is shown. All connections are identical for both versions. Black wires are connected to the Negative or Common connection and the White (or Red) wire to the Positive connection.

Connect the assembled BNC connector with cable to the camera and DVR.

Connect the 12v power plug into 12vDC power receptacle on the camera and the other end into the Power Distribution Unit (PDU).

Connect the video monitor and mouse into the DVR.

Review connections before you turn ON the DVR system.

### 1.7. 2.3. Quality assurance and inspection

Quality assurance and inspection for extra low voltage (ELV) systems is similar to that for other electrical systems, but there are some specific considerations. ELV systems are

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typically less complex than higher voltage systems, but they are still important to test and inspect to ensure safety and reliability.

Here are some of the key steps involved in quality assurance and inspection for ELV systems:

Pre-installation:

- Review the ELV system design and specifications to ensure that they meet all applicable codes and standards.
- Inspect the ELV system equipment to ensure that it is in good condition and free from defects.
- Verify that the installation site is prepared and ready to receive the ELV system equipment.

Installation:

- Monitor the installation process to ensure that it is carried out in accordance with the design and specifications.
- Inspect the ELV system equipment and installation workmanship at regular intervals.
- Test the ELV system components and systems to ensure that they are functioning properly.

Post-installation:

- Conduct a final inspection of the ELV system to ensure that it is complete and ready for use.
- Test the ELV system in all operating modes to ensure that it is safe and reliable.
- Provide the ELV system owner with a commissioning certificate and maintenance manual.

In addition to the above steps, quality assurance and inspection for ELV systems may also include the following:

- Quality control plan: This plan should outline the specific procedures and requirements for quality assurance and inspection at each stage of the ELV system installation process.
- Quality control records: These records should document the results of all quality assurance and inspection activities.
- Non-conformance reporting and corrective action: A process should be in place to identify and report any non-conformances with the design and specifications, and to take corrective action.

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Quality assurance and inspection for ELV systems should be carried out by qualified and experienced personnel. This may include electrical engineers, inspectors, and technicians. Here are some specific examples of quality assurance and inspection activities that may be performed during ELV system installation:

- Inspecting the ELV system wiring to ensure that it is properly sized and installed.
- Verifying that the ELV system equipment is properly grounded.
- Testing the ELV system insulation resistance to ensure that it meets the required standards.
- Conducting a polarity check to ensure that the ELV system wiring is connected correctly.
- Witnessing the ELV system's first run and inspection by a qualified electrician.

By following rigorous quality assurance and inspection procedures, ELV system installation companies can help to ensure the safety and reliability of their products.

## **1.8. 2.4. clear work site and allocate material**

To clear a work site for ELV installation, you will need to:

1. Remove any obstacles or debris from the work area. This may include furniture, equipment, or other materials.
2. Clean the work area to remove any dirt or dust. This will help to prevent the spread of contaminants and improve the quality of the installation.
3. Protect any existing surfaces or finishes in the work area. This may involve covering them with drop cloths or plastic sheeting.
4. Disconnect any electrical or plumbing services that are in the work area. This will help to prevent accidents and ensure the safety of the installation team.

Once the work site is clear, you can begin to allocate materials for ELV installation. The specific materials that you will need will vary depending on the type of ELV system that you are installing. However, some common materials include:

- ELV cables
- Conduit
- Connectors
- Junction boxes

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- Mounting brackets
- Tools and hardware

It is important to allocate enough materials to complete the installation. You should also have some extra materials on hand in case of any unexpected problems.

**to allocating materials for ELV installation:**

- Create a list of all the materials that you will need. This will help you to ensure that you do not forget anything.
- Estimate the quantity of each material that you will need. This will help you to avoid overspending or running out of materials during the installation.
- Organize the materials in a logical way. This will make it easier to find the materials that you need when you need them.
- Label all of the materials with their name and quantity. This will help to prevent confusion and ensure that the correct materials are used.

## Self-Check-2.1

**Part-I: say True if the statement is correct and say false if the statement is incorrect:**

1. ELV wiring systems are used for low-voltage applications such as security systems and fire alarms.
2. CCTV cameras should be installed in areas with low lighting.
3. Smoke detectors should be placed at least 4 inches away from walls and corners.
4. Fire alarms should be tested monthly.
5. It is important to clear the work site before installing an ELV system.
6. Quality assurance and inspection are important steps in the ELV installation process.

**Part-II Choose the best answer from the given alternatives**

1. What is the best way to clear a work site for ELV installation?
  - A. Remove all obstacles and debris from the work area.
  - B. Clean the work area to remove any dirt or dust.
  - C. Protect any existing surfaces or finishes in the work area.
  - D. All of the above.

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2. What are some common ELV wiring system materials?
  - A. ELV cables
  - B. Conduit
  - C. Connectors
  - D. All of the above.
  
3. What is the best way to allocate materials for ELV installation?
  - A. Create a list of all the materials that you will need.
  - B. Estimate the quantity of each material that you will need.
  - C. Organize the materials in a logical way.
  - D. All of the above.
  
4. What is the purpose of quality assurance and inspection in ELV installation?
  - A. To ensure the safety and reliability of the installed system.
  - B. To identify and correct any non-conformances with the design and specifications.
  - C. To provide the system owner with a commissioning certificate and maintenance manual.
  - D. All of the above.

## Operation sheet 2.1: system configuration:

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Yr. & Sec: \_\_\_\_\_

Instructor: \_\_\_\_\_

### I. Title: System Configuration

Description: Configuring DVR to meet the customer's requirements.

### II. Objectives

1. Know the different setting of the DVR.
2. Configure the DVR system
3. Observe safety practices while working.

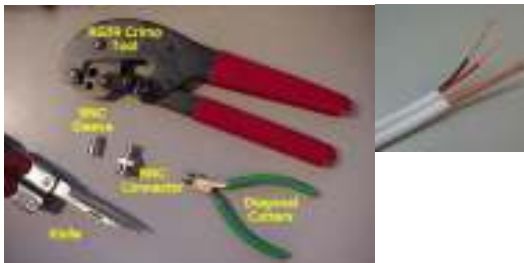
### III. Materials

DVR

CCTV cameras

BNC Connectors & Sleeves (2 per camera)

1 at camera location & 1 at DVR location



### IV. Procedure

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### 1. General settings

These includes system date, time, time format (12 or 24-Hour), language, video resolution, video standards (PAL or NTSC).

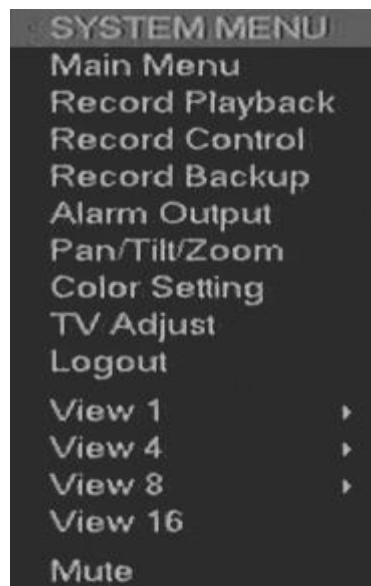


### 2. Operation of Main Menu

Main menu includes: video function, alarm function, system setup, management tool, system information.

Note:

- All sub-menu setup will be effective by confirming —SAVE, otherwise ineffective.
- When check box is highlighted, it means certain function is selected. If unfilled means not selected.



### Operation Guide

1. By using mouse, RIGHT click and the pop-up window will appear.
2. From the pop-up window, select MAIN MENU.

Note: for the first time that you do this, the DVR system will ask for user name and password.



### 3. Record



Note: User should have “Record” authority, HDD should be installed and format properly,

Setting video setup and playback function, including schedule, motion detection, and exterior alarm setting. Inquire according to video type (ALL, NORMAL, ALARM, and MOTION DETECTION), channel, and time. The result will be displayed in a list



### 3.1 Schedule

When the system boots up, it is in default 24-hour regular mode. You can set record type and time in schedule interface. Setting at Main menu> Video function> video setting.

Including schedule setting regarding Regular (R), motion detection video (M), Alarm (A) Manual (H)



Note: Please select the channel number first. You can select —all if you want to set for the whole channels.

### 3.2 Search recorded videos

## Operation sheet 2.2: CCTV installation:

**Operation Title:** install CCTV camera

**Purpose:** To know steps and installation technique

### Conditions or situations for the operations:

- ✓ Wearing proper personal protective equipment
- ✓ Make working area hazard free
- ✓ Read and interpret manual which guide you how to use tools and equipment.
- ✓ Always unplug the camera and DVR before performing any maintenance or repairs.
- ✓ Be careful when drilling holes in the wall or ceiling. Avoid drilling into electrical wires or plumbing pipes.
- ✓ If you are installing the camera outdoors, make sure it is weatherproof.
- ✓ Use cable ties or other fasteners to secure the cables and prevent them from being tripped over or damaged

### Equipment Tools and Materials:

- screws
- screwdriver
- electric drill
- ladder
- hammer
- fish tapes
- CCTV cameras
- DVR (digital video recorder)
- Power supply
- Cables
- Mounting brackets
- Tools (drill, screwdriver, etc.

## Steps in doing the task

1. Choose the camera location. The best camera locations are those that provide a clear view of the area you want to monitor. Avoid placing cameras in direct sunlight or where they will be blocked by trees or other objects.
2. Mark the location of the camera. Use a pencil to mark the spot on the wall or ceiling where you want to install the camera.
3. Drill a hole for the mounting bracket. Use a drill bit that is the same size as the mounting bracket screw. Drill a hole at the marked location.
4. Attach the mounting bracket to the wall or ceiling. Use screws to attach the mounting bracket to the wall or ceiling.
5. Attach the camera to the mounting bracket. Use the screws provided with the camera to attach it to the mounting bracket.
6. Connect the power cable to the camera. The power cable will typically connect to the bottom of the camera.
7. Connect the video cable to the camera. The video cable will typically connect to the side of the camera.
8. Route the power and video cables to the DVR. The DVR will typically be located in a central location, such as a security office or closet.
9. Connect the power and video cables to the DVR. The power and video cables will typically connect to the back of the DVR.
10. Power on the camera and DVR.
11. Configure the DVR. The DVR will typically have a menu system that you can use to configure the camera settings, such as resolution, frame rate, and motion detection.
12. Test the camera. Once the camera is configured, view the video footage on the monitor to make sure it is working properly.

**Quality Criteria:** Assured performing of all the activities according to the procedures

### Instructions:

1. Plan your installation. Identify the areas you want to monitor and determine the number and type of cameras you need. Choose camera locations that will provide the best coverage and visibility. Consider the lighting conditions at the site and the existing infrastructure.

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2. Prepare the installation. Mount the cameras in the desired locations using the mounting brackets. Run the cables from the cameras to the DVR. Connect the cables to the DVR and power supply.
3. Configure the DVR. Set the date and time, and create user accounts. Configure the recording settings, such as resolution, frame rate, and motion detection.



## Operation Title 2.3: terminate and install CCTV

**Purpose:** The physical cabling and connections to install the CCTV system

### Conditions or situations for the operations:

1. Identify equipment, tools, and different materials needed in System Installation
2. Apply different technique/s in installing DVR, CCTV cameras, and other peripherals.
3. Observe safety practices while working.

### Equipment Tools and Materials:

<p>DVR</p> <p>CCTV cameras</p> <p>screwdrivers (Flat &amp; Philip)</p> <p>RG-59 Crimp Tool</p> <p>BNC Connectors &amp; Sleeves (2 per camera)</p> <p>1 at camera location &amp; 1 at DVR location</p> 	<p>soldering iron w/ stand</p> <p>desoldering pump</p> <p>Knife</p> <p>Diagonal Cutters</p> <p>Multi tester</p> 
---	--

**Quality Criteria:** Assured performing of all the activities according to the procedures

### Precautions:

Wear personal protective equipment

Make working area hazard free

Read and interpret manual which guide you how to use tools and equipment

## Operation sheet 2.4: System Configuration DVR

**Operation Title:** Configuring DVR to meet the customer's requirements.

**Purpose:** To check of poor electrical connection between the terminals and the battery cables.

**Conditions or situations for the operations:**

- Know the different setting of the DVR.
- Configure the DVR system
- Observe safety practices while working working cloths fit with the body

**Equipment Tools and Materials:**

DVR

CCTV cameras

BNC Connectors & Sleeves (2 per camera)

1 at camera location & 1 at DVR location

## Operation sheet 2.5: smoke detector installation

**Operation Title:** install and connect smoke detector

**Purpose:** To understand the general steps and technique of smoke detector installation

**Conditions or situations for the operations:**

- ✓ Safe working area
- ✓ Properly operated tools and equipment
- ✓ Appropriate working cloths fit with the body

**Equipment Tools and Materials:**

- ✓ Smoke detector(s)
- ✓ Screws or mounting bracket
- ✓ Drill (if needed)
- ✓ Screwdriver
- ✓ Battery (if needed)

**Steps in doing the task**

1. Choose the location for the smoke detector. Smoke detectors should be installed on every level of your home, including the basement and attic. Place them in the center of each room, at least 4 inches away from walls and corners. Avoid placing smoke detectors near vents, fans, or windows, as these can cause false alarms.
2. Mark the location of the smoke detector. Use a pencil to mark the spot on the ceiling where you want to install the smoke detector.
3. Drill a hole for the mounting bracket (if needed). Use a drill bit that is the same size as the mounting bracket screw. Drill a hole at the marked location.
4. Attach the mounting bracket to the ceiling (if needed). Use screws to attach the mounting bracket to the ceiling.
5. Attach the smoke detector to the mounting bracket (or directly to the ceiling if no mounting bracket is used). Use the screws provided with the smoke detector to attach it to the mounting bracket or ceiling.

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6. Install the battery (if needed). Some smoke detectors are hardwired, while others require batteries. If your smoke detector requires batteries, install the battery according to the manufacturer's instructions.
7. Test the smoke detector. Once the smoke detector is installed, test it to make sure it is working properly. Press the test button on the smoke detector. The alarm should sound loudly.
  - Smoke detectors should be replaced every 10 years, or sooner if they are damaged or not working properly.
  - Test your smoke detectors monthly to make sure they are working properly.
  - If you have a hardwired smoke detector system, have it inspected and tested by a qualified electrician every year.

## Lap Tests

lab tests for extra low voltage (ELV):

Test 1: Measure the voltage and current of a power supply.

Test 2: Measure the resistance of a sensor.

Test 3: Measure the output of a sensor.

Test 4: Connect a sensor to a controller and test the functionality of the system.

Test 5: Connect a controller to an actuator and test the functionality of the system.

Test 6: Install a simple ELV system, such as a light control system or a motion sensor system.

Test 7: Troubleshoot a simple ELV system.

ELV lab tests:

Test 1: Install a simple CCTV system and test the functionality of the system.

Test 2: Install a simple access control system and test the functionality of the system.

Test 3: Connect a PIR sensor to a microcontroller and write a program to turn on a light when the sensor detects motion.

Test 4: Connect a temperature sensor to a microcontroller and write a program to display the temperature on an LCD display.

Test 5: Connect a keypad to a microcontroller and write a program to control a stepper moto using the keypad.

- Test 6: Connect a relay to a microcontroller and write a program to control a light using the relay.

These lab tests are designed to help you learn about the basics of ELV systems and how to install and troubleshoot them. The specific tests that you perform will vary depending on your course curriculum and the resources that are available to you.

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