DRAFT STUDY MATERIAL

Job Role
CCTV Installation Technician

QP Code: ELE/04105



NSQF Level: 4 | Sector: Electronics

Class: 11

PSS Central Institute of Vocational Education, Bhopal

(A constituent unit of National Council of Educational Research and Training, Ministry of Education, Government of India)

Shyamla Hills, Bhopal-462 013, Madhya Pradesh, India, Website : www.psscive.ac.in

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Textbook for Class 11

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FOREWORD

The National Education Policy (NEP) 2020 envisions a dynamic and inclusive education system that is deeply rooted in India's rich cultural heritage while also preparing learners to navigate the demands and opportunities of the 21st century. This transformative policy promotes an education that is holistic, integrated, and skill-oriented.

The National Curriculum Framework for School Education (NCF-SE) 2023 supports this vision by offering a comprehensive roadmap for learning across stages. In the foundational years, it emphasizes the holistic development of learners through the five dimensions of human existence, known as the pañchakoshas: the physical (annamaya), vital (prāṇamaya), mental (manomaya), intellectual (vijñānamaya), and spiritual (ānandamaya) aspects. These dimensions remain vital throughout the educational journey and are especially relevant in vocational education, where personal growth must complement professional preparedness.

High-quality vocational textbooks are essential to bridging the gap between theoretical knowledge and practical skills. The CCTV Installation Technician textbook for Grade 11 is designed with this objective. It introduces students to essential concepts in electronic surveillance systems, installation techniques, wiring and networking fundamentals, system configuration, troubleshooting, safety protocols, and professional ethics, competencies that are foundational to the technician role overall.

This textbook has been developed in alignment with the National Skill Qualification Framework (NSQF) and National Occupational Standards (NOSs), ensuring that learners acquire job-ready skills along with the values of discipline, integrity, responsibility, and teamwork. The content promotes experiential learning through real-life scenarios, hands-on tasks, and self-reflective activities that nurture both technical expertise and human values.

The National Council of Educational Research and Training (NCERT), through its constituent unit, the Pandit Sunderlal Sharma Central Institute of Vocational Education (PSSCIVE), Bhopal, has played a leading role in developing this resource. A dedicated team of subject experts, educators, and practitioners has worked collaboratively to ensure that the textbook serves as a meaningful, accessible, and inspiring resource for students.

Beyond the textbook, it is essential to encourage students to extend their learning through school-based activities, fitness sessions, library resources, and participation in vocational and community initiatives. Teachers, parents, and school leaders play a crucial role in guiding and mentoring students as they explore opportunities and prepare for the world of work.

I express my appreciation to all those who contributed to the development of this vocational textbook and welcome constructive feedback from users to improve future editions.

Dinesh Prasad Saklani
Director
National Council of Educational Research and Training

About The Textbook

The practice of CCTV installation and surveillance management is essential in ensuring safety, security, and effective monitoring across residential, commercial, and public spaces. This textbook has been developed to provide learners with foundational knowledge, practical skills, and ethical awareness necessary for building technical competence, problem-solving ability, and responsible professional conduct in the field of electronic surveillance systems.

Unit I introduces students to the domain of CCTV systems and the basics of electronics, covering the purpose, evolution, and applications of surveillance technology. It familiarises learners with fundamental electrical concepts such as voltage, current, resistance, AC/DC supply, and essential safety practices. Students gain an understanding of different types of CCTV systems and their role in enhancing security across sectors.

Unit II focuses on CCTV system components and tools, emphasising key hardware elements such as cameras, lenses, DVRs, NVRs, storage devices, and monitoring systems. It provides practical exposure to installation tools, testing equipment, and personal protective gear required for safe and efficient operations. Learners develop the ability to identify, handle, and configure various components used in real-world installations.

Unit III covers cables, connectors, and power supply systems that form the backbone of CCTV infrastructure. Students learn about coaxial and Ethernet cables, BNC and RJ45 connectors, termination standards, cable testing procedures, and power management practices. This unit strengthens learners' technical precision and ensures they can establish stable and secure system connectivity.

Unit IV focuses on site survey, camera installation, and basic troubleshooting. Learners are guided through site assessment techniques, camera placement strategies, mounting methods, cable routing, documentation, and preventive maintenance practices. It also introduces systematic troubleshooting methods to diagnose and resolve common installation faults, while reinforcing safety standards and professional communication with clients.

The textbook encourages experiential learning through laboratory work, hands-on installation practice, field visits, simulation exercises, and project-based activities. It integrates technical knowledge, practical proficiency, safety compliance, and ethical responsibility to provide a comprehensive understanding of the role of a CCTV Installation Technician in modern security systems.

This resource will help educators and trainers guide students towards meaningful engagement with the field of self-defence, enabling them to build a strong foundation for personal safety awareness and related skill-development pathways.

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CONTENTS

Unit 1: Introduction to CCTV Systems & Basics of Electronics

Session -1 Overview of CCTV System

Have you ever noticed cameras in your school corridors, shopping malls, or banks? These are CCTV cameras, and they have become a common sight in our daily lives. CCTV stands for Closed Circuit Television. Unlike regular television that broadcasts programs to everyone, CCTV works differently. It records and displays video images only to specific people who need to watch them, like security guards or building managers. Think of CCTV as a special television system that works in a closed loop. The cameras capture what is happening in front of them, and this video is sent through cables or wireless signals to monitors or recording devices. Only authorized people can see these images. This is why we call it →closed circuit→ - because the signal travels in a closed path, not broadcast openly like regular TV channels.

The basic idea behind CCTV is simple: to watch and record activities in specific areas. When you see a camera mounted on a wall or ceiling, it is continuously observing that space. Some cameras just show live images on a screen, while others also record everything for later viewing. This recorded footage can be very helpful when something important happens and needs to be reviewed later. CCTV cameras come in many shapes and sizes. Some are small and hidden, while others are large and clearly visible. The visible ones often serve as a warning to people that they are being watched. Some cameras can move and zoom to get better views of different areas. Modern cameras are quite smart - they can work in darkness using infrared light, and some can even detect movement automatically.

In today's world, CCTV has become essential for security and safety. Schools use it to ensure students are safe. Shops use it to prevent theft. Traffic police use special CCTV cameras to monitor roads and catch traffic rule violations. Even homes now have CCTV systems to protect families and property. The people who work with CCTV systems are called CCTV technicians. They install the cameras, connect all the cables, set up the recording equipment, and make sure everything works properly. Learning about CCTV systems opens up many career opportunities. As more places need security systems, there is growing demand for skilled technicians who can install and maintain these systems. CCTV technology continues to improve rapidly, with modern systems connecting to the internet, sending alerts to mobile phones, and using artificial intelligence to recognize faces or detect unusual activities.

1.2 Evolution of Surveillance Systems

Early Methods of Surveillance

Long before cameras were invented, people found ways to watch and protect their communities. In ancient times, guards stood on high towers and walls to spot enemies approaching their cities. These watchtowers were the first form of organized surveillance. Guards would use drums, horns, or fire signals to warn others about danger. To see distant objects more clearly, people developed simple telescopes and later binoculars. Binoculars became an important tool for surveillance because they allowed guards and military personnel to observe activities from far away without being detected. Ship captains used binoculars to spot other vessels on the horizon, and border guards used them to monitor movement across boundaries. In villages, people took turns keeping watch at night, often equipped with binoculars to get better views in low light conditions. Even today, you might have seen watchmen in residential areas who patrol and keep an eye on suspicious activities, sometimes using binoculars for distant observation. These human-based surveillance methods worked, but they had limitations. Guards could get tired, fall asleep, or miss important events. They could only watch one area at a time and couldn't record what they saw for later review.

Invention of Photography and Early Recording

The invention of photography in the 1800s changed everything. For the first time, people could capture and keep permanent images of events. Early cameras were large and needed long exposure times, but they proved that visual information could be recorded. During this period, binoculars were also improved with better lenses and became standard equipment for police and security forces. In the early 1900s, motion picture cameras were developed. These could record moving images on film reels. However, these early cameras were expensive and complicated to use. Only trained photographers could operate them properly. The film had to be developed in special darkrooms using chemicals. Despite these challenges, some businesses and government buildings started using film cameras for basic security recording, though this was not very common due to the high costs and technical difficulties involved.

Security personnel still relied heavily on binoculars for real-time surveillance while cameras served as backup recording devices.

Introduction of Electronic Surveillance

The real breakthrough came in the 1940s and 1950s with electronic technology. The first true CCTV system was installed in Germany in 1942 to monitor rocket launches. After World War II, this technology spread to other countries. In the 1960s, banks in the United States began installing CCTV cameras to prevent robberies and record criminal activities. These early electronic systems used large cameras connected to television monitors through cables. The images were displayed live on screens, and some systems could record on magnetic tapes. This was much better than film cameras because the results could be seen immediately without developing. However, the cameras were still bulky, the image quality was poor, and the recording tapes were expensive. During this time, binoculars remained important for security personnel who needed to observe areas beyond camera coverage or when cameras malfunctioned. Only large businesses and government buildings could afford these systems, so smaller establishments still depended on human surveillance with binoculars.

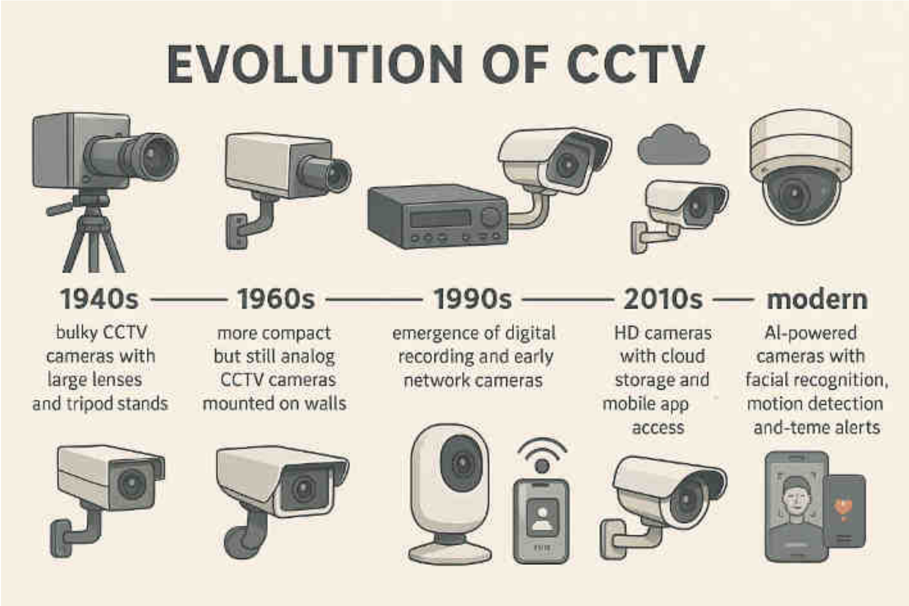
Modern Digital Revolution

The 1990s brought the digital revolution that transformed surveillance completely. Digital cameras replaced analog ones, providing much clearer images. Personal computers became powerful enough to handle video recording and playback. Instead of using expensive tapes, video could be stored on computer hard drives. The internet allowed cameras to be monitored from anywhere in the world. By the 2000s, surveillance systems became smaller, cheaper, and much more reliable. Today's

CCTV systems are incredibly advanced compared to early versions. Modern cameras are tiny but produce high-definition images even in complete darkness. They can automatically detect movement, recognize faces, and send instant alerts to mobile phones. Cloud storage means video footage can be saved online and accessed from anywhere. Artificial intelligence helps cameras understand what they are seeing and can distinguish between normal activities and potential security threats. Wireless technology has eliminated the need for complex cable installations. Smart cameras can now work independently and make decisions about what to record and when to send alerts. This digital revolution has made surveillance systems affordable for homes, small businesses, and schools, not just large organizations. While binoculars are still used by security professionals for specific situations, modern camera technology has largely replaced the need for manual observation in most surveillance applications.

1.3Evolution of CCTV

The development of CCTV technology has been a fascinating journey that spans over eight decades. From simple black and white cameras to today's intelligent systems, CCTV has transformed completely. Understanding this evolution helps us appreciate how far the technology has come and where it might go in the future.



Evolution of CCTV technology from early systems to modern digital cameras

The Beginning Years (1940s-1960s)

The first CCTV system was created in Germany in 1942 by an engineer named Walter Bruch. This system was used to watch rocket launches from a safe distance. The cameras were huge, bulky devices that needed special operators to work them. The images were displayed on small television screens that showed only black and white pictures. The quality was very poor, and you could barely make out details of what was being recorded. These early systems used thick coaxial cables to connect cameras to monitors, which made installation very expensive and complicated. Only military organizations and very large companies could afford such systems because they cost thousands of dollars.

After World War II ended, some American companies started experimenting with CCTV for commercial use. In the 1950s, a few banks began installing these systems to monitor their vaults and teller areas. However, the cameras were still very basic. They could not zoom in or move around, and the operators had to manually adjust them if they wanted to see different angles. The monitors were small and flickered constantly, making it difficult to watch for long periods. Recording was not possible yet, so everything had to be watched live by security guards.

Analog Era Development (1970s-1980s)

The 1970s brought significant improvements to CCTV technology. Cameras became smaller and more reliable, though they were still quite large compared to today's standards. The introduction of videocassette recorders (VCRs) was a major breakthrough. For the first time, security footage could be recorded and played back later. This meant that incidents could be reviewed even if no one was watching the monitors when they occurred. However, VCR tapes were expensive and could only record for a few hours before needing to be changed.

During this period, color cameras were also developed, but they were much more expensive than black and white ones. Most businesses continued using black and white systems because they were more affordable and reliable. The cameras started having basic features like manual zoom lenses and the ability to rotate left and right. Some systems could switch between multiple cameras automatically, showing different views on the same monitor every few seconds.

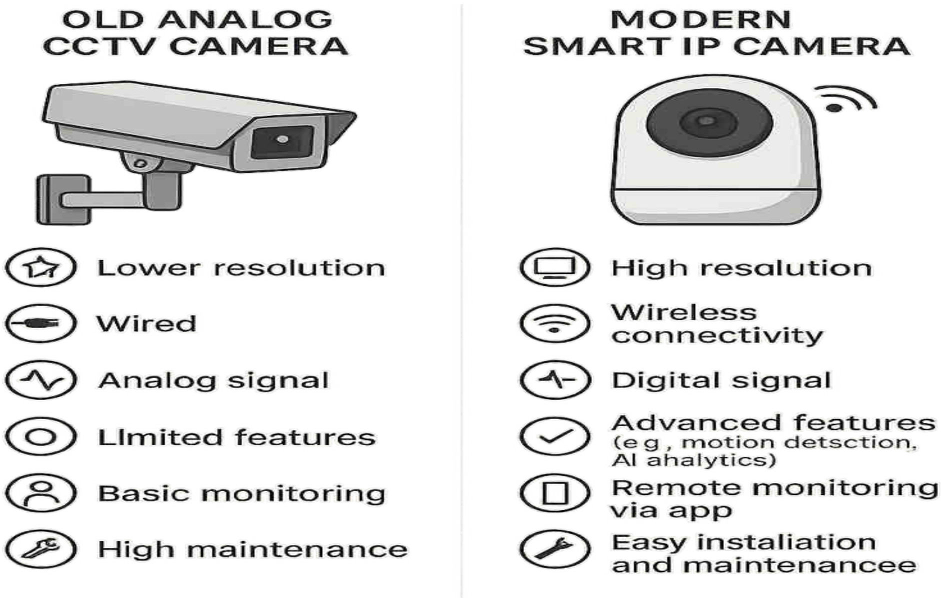
Digital Revolution (1990s-2000s)

The 1990s marked the beginning of the digital age for CCTV. Computer technology advanced rapidly, and digital video recorders (DVRs) replaced VCR tapes. DVRs could store hundreds of hours of footage on computer hard drives, and the recorded videos could be searched quickly to find specific events. The image quality improved dramatically with digital cameras that produced much clearer pictures than their analog predecessors.

Internet connectivity became available for CCTV systems in the late 1990s. This meant that cameras could be monitored remotely from any location with an internet connection. Business owners could watch their stores from home, and security companies could monitor multiple client locations from a central control room. CD and DVD recording became popular for backing up important footage, replacing the old tape systems completely.

Modern Smart Era (2010s-Present)

Today's CCTV systems are incredibly advanced compared to the early versions. High-definition (HD) cameras produce crystal-clear images that can capture fine details like faces and license plates from considerable distances. Many cameras now record in 4K resolution, which is four times sharper than regular HD. Night vision technology using infrared light allows cameras to see clearly in complete darkness.



Comparison between traditional analog CCTV and modern smart cameras

Modern cameras are equipped with artificial intelligence that can automatically detect movement, recognize faces, and even identify specific objects like vehicles or packages. Smart cameras can send instant alerts to mobile phones when they detect unusual activity. Wireless technology has eliminated the need for complex cable installations in many situations. Cloud storage allows footage to be saved online and accessed from anywhere in the world.

Some of the latest CCTV systems can analyze behavior patterns and predict potential security threats before they happen. Voice commands and mobile apps make these systems easy to control and monitor. Solar-powered cameras can operate in remote locations without electrical connections. The integration with smart home systems allows CCTV to work together with other security devices like alarms and automatic lighting.

This remarkable evolution continues today as manufacturers develop even more advanced features like 360-degree cameras, facial recognition systems, and integration with artificial intelligence platforms. The CCTV systems of tomorrow will likely be even more intelligent and user-friendly than what we have today.

1.4 Purpose of CCTV-

CCTV systems serve many important purposes that help keep people, property, and information safe. By installing cameras in strategic locations, we can watch over places continuously, record events for future review, and deter unwanted activities. The main aim of CCTV is to provide a reliable eye where constant human monitoring is not possible. For example, a camera at a home's entrance can alert residents to visitors or intruders at any hour. In offices, cameras help supervisors ensure that all employees follow rules and maintain productivity. In public areas, CCTV makes people feel safer by showing that someone is always watching. This constant oversight helps prevent crimes such as theft, vandalism, and trespassing.

Recording events is another key purpose of CCTV. When a camera captures video, it stores that footage on digital media. If an accident happens in a parking lot or a dispute breaks out in a shop, recorded clips can be played back to find out exactly what occurred. In case of theft or damage, police can use these recordings as evidence to identify suspects and solve cases. Even in schools, video evidence can clarify what happened during incidents like vandalism or bullying. Such recordings make it easier to resolve conflicts fairly and accurately. Without CCTV, investigators must rely on eyewitness accounts, which can be unreliable. Recorded footage offers clear visual proof.

CCTV also helps in maintaining operational efficiency and quality control. In factories and warehouses, cameras monitor production lines to ensure machines and workers follow safety protocols. Supervisors can spot potential hazards, like blocked emergency exits or employees not wearing protective gear. In retail stores, managers use CCTV to watch customer flow and staff behavior. They can see which aisles are busiest and adjust staff deployment accordingly. Some stores also use cameras to study how customers interact with products, helping them improve store layouts and displays. In traffic management, CCTV cameras at busy intersections track vehicle movements and detect congestion. Traffic authorities can respond faster to jams, clear accidents, and adjust signal timings based on real-time data from video feeds.

Another important purpose is remote monitoring and control. Modern CCTV systems connect to the internet, allowing authorized users to view live footage from anywhere using a smartphone or computer. A security guard at a control room can monitor dozens of cameras spread across multiple locations. Homeowners can check their security cameras while on vacation, ensuring their property remains safe. Business owners can keep an eye on their shops or offices even after closing hours. If a camera detects unusual motion, it can send an instant alert via email or app notification. This remote capability gives users peace of mind, knowing they can respond quickly to emergencies or suspicious activities.

CCTV also plays a role in safeguarding sensitive information and ensuring compliance. In financial institutions, cameras protect vaults, ATMs, and teller areas to prevent fraud and unauthorized access. Healthcare facilities use CCTV to monitor drug storage rooms and critical-care units, ensuring that only authorized personnel enter. In laboratories handling dangerous chemicals or pathogens, video surveillance ensures all protocols are followed correctly. Many industries must comply with legal regulations requiring certain areas to be under constant watch. CCTV systems help organizations meet these standards and avoid penalties.

Finally, CCTV acts as a deterrent. The mere presence of visible cameras often discourages people from committing crimes. When potential offenders notice cameras, they think twice before attempting theft, vandalism, or other illegal actions. This psychological effect reduces crime rates and creates a safer environment. In communities where CCTV is widely used, residents report feeling more secure in public spaces and residential areas. By combining deterrence, monitoring, recording, and remote access, CCTV systems fulfill multiple purposes that benefit society and businesses alike.

1.5 Applications of CCTV in different sector

CCTV systems have found their way into almost every part of our modern life. From the moment you step out of your house to the time you return, you likely encounter dozens of CCTV cameras. These systems serve different purposes in different places, making our world safer and more secure. Understanding where and why CCTV is used helps us appreciate its importance in today's society.

CCTV applications across various sectors - education, retail, banking, and traffic management

Educational Institutions

Schools and colleges use CCTV cameras extensively to ensure student safety and maintain discipline. In your own school, you have probably noticed cameras in corridors, playgrounds, entrance gates, and parking areas. These cameras help teachers and administrators monitor what happens when they are not around. During exam periods, CCTV recordings can prove helpful if there are questions about cheating or misconduct. Many schools also use cameras on their buses to ensure students behave properly during transportation. Parents feel more confident sending their children to schools that have proper CCTV coverage. The cameras also help investigate incidents like bullying or accidents, providing clear evidence of what actually happened.

Commercial and Retail Spaces

Shopping malls, supermarkets, and individual shops rely heavily on CCTV for theft prevention. Store owners can monitor their merchandise and catch shoplifters in action. The cameras also help them observe customer behavior and improve store layouts. In restaurants, CCTV ensures food safety standards are maintained in kitchens and helps resolve disputes with customers. Banks and ATMs have some of the most advanced CCTV systems because they handle large amounts of money. These cameras record every transaction and help investigate fraud or robbery cases. Many shops now use CCTV footage to analyze customer traffic patterns and decide which products to display prominently.

Transportation and Traffic Management

Traffic police use CCTV cameras to monitor road conditions and catch traffic rule violations. Speed cameras automatically photograph vehicles that exceed speed limits. At traffic signals, cameras record vehicles that jump red lights. Parking areas in malls and offices use CCTV to guide customers to empty spaces and prevent vehicle theft. Airports and railway stations have extensive CCTV networks for security screening and crowd management. Public buses and trains now have internal cameras to ensure passenger safety and resolve disputes. Even highway toll booths use cameras to identify vehicles and process payments automatically.

Industrial and Manufacturing Sectors

Factories use CCTV systems to monitor production processes and ensure worker safety. Cameras help supervisors check if employees are following safety procedures and wearing protective equipment properly. In chemical plants and oil refineries, special cameras can detect gas leaks and fire hazards before they become dangerous. Construction sites use CCTV to prevent theft of expensive equipment and materials. Mining operations rely on cameras to monitor dangerous underground conditions and coordinate rescue operations if accidents occur.

Residential Security

Home security systems have become very popular as CCTV technology has become more affordable. Families install cameras at their main gates, gardens, and inside their houses. Modern home systems can send alerts to your mobile phone when someone approaches your door. Smart doorbells with built-in cameras let you see and talk to visitors even when you are not at home. Many apartment complexes and housing societies have CCTV systems in common areas like elevators, parking lots, and playgrounds.

Home security CCTV systems for residential protection

Healthcare and Hospitals

Hospitals use CCTV in operation theaters, intensive care units, and medicine storage areas. This helps maintain hygiene standards and prevents theft of expensive medical equipment. Cameras in patient rooms can help nurses monitor critical patients remotely. Mental health facilities use surveillance to ensure patient safety and prevent self-harm incidents.

Government and Public Places

Government offices, courts, and police stations use CCTV for security and transparency. Public parks, stadiums, and event venues rely on surveillance systems for crowd control and emergency management. Tourist attractions use cameras to guide visitors and prevent damage to historical monuments.

The applications of CCTV continue to expand as technology improves and costs decrease. Understanding these various uses will help you better appreciate the career opportunities available in the CCTV installation and maintenance field.

What You Learned

1. CCTV stands for Closed Circuit Television, a security system that shows video only to specific people.
2. Surveillance systems evolved from ancient watchtowers with binoculars to modern digital cameras with AI.
3. The first CCTV system was installed in Germany in 1942 to watch rocket launches.
4. CCTV prevents crime, collects evidence, monitors operations, and deters potential offenders.
5. CCTV is used in schools, shops, banks, factories, homes, hospitals, and government buildings.
6. CCTV evolved from bulky analog cameras to smart digital systems with wireless connectivity.
7. Today's CCTV has AI, facial recognition, night vision, cloud storage, and mobile alerts.

Points to Remember

1. CCTV works in a →closed circuit→ - video goes only to specific monitors, not public broadcast.
2. Early surveillance used human guards with binoculars, but they got tired and couldn't record events.
3. VCR recording in the 1970s allowed footage to be stored and reviewed later.
4. DVRs replaced VCR tapes in the 1990s with longer recording times and quick search features.
5. Modern cameras work in darkness using infrared light and send alerts to mobile phones.
6. CCTV deters crime, provides evidence, monitors safety, and enables remote surveillance.
7. Different sectors use CCTV differently - schools for safety, banks for security, factories for compliance.

↵ Wireless technology and cloud storage make modern CCTV easier to install and access remotely.

Practical Exercises

1. CCTV Application and Field Mapping Exercise

Objective: To identify and understand how CCTV systems are used in different sectors and environments.

Duration: 45 minutes

Materials Required:

- Chart paper or worksheets
- Colored pens/pencils
- Sample images of different locations (optional)

Instructions:

Step 1: Field Identification (10 minutes)

- Make a list of ↵different places where you have seen CCTV cameras
- Examples: school, shopping mall, bank, hospital, traffic signal, etc.
- Write down what type of activities happen in each place

Step 2: Application Matching (15 minutes)

- Match each location with its primary CCTV purpose:
    - Crime prevention
    - Traffic monitoring
    - Safety supervision
    - Evidence collection
    - Access control
    - Quality monitoring
- Explain why that particular application is important for that location

Step 3: Mapping Exercise (15 minutes)

- Draw a simple map of your school or neighborhood
- Mark all the places where CCTV cameras are installed or should be installed

- Use different symbols for different types of surveillance needs
- Color code based on the level of security required (high, medium, low)

Step 4: Discussion (5 minutes)

- Present your mapping to the class
- Discuss which locations need CCTV the most and why
- Share any interesting observations about CCTV placement

Assessment: Students will be evaluated on accuracy of matching, creativity in mapping, and participation in discussion.

2. Creating CCTV System Evolution Timeline

Objective: To understand the historical development and technological advancement of CCTV systems.

Duration: 60 minutes

Materials Required:

- Large chart paper or poster board
- Markers, colored pencils
- Ruler
- Reference materials or internet access

Instructions:

Step 1: Research Phase (20 minutes)

- Collect information about major CCTV developments
- Note down at least ↵important milestones from 1940s to present
- Include: first CCTV system (1942), VCR introduction, digital cameras, internet connectivity, HD cameras, AI features

Step 2: Timeline Creation (25 minutes)

- Draw a horizontal timeline on chart paper
- Mark decades from 1940 to 2020
- Place each milestone at the correct time period
- Add brief descriptions of each development
- Use pictures or simple drawings to illustrate key changes

Step 3: Technology Impact Analysis (10 minutes)

- Below each milestone, write how that technology made CCTV better
- Examples: →VCR allowed recording for later viewing", →Digital cameras gave clearer images→
- Use arrows to show progression from simple to advanced systems

Step 4: Future Prediction (5 minutes)

- Add your prediction for CCTV technology in 2030
- Think about what new features might be developed
- Consider how CCTV might become even smarter or easier to use

Assessment: Timeline accuracy, understanding of technological progression, creativity in presentation, and logical future predictions.

3. Role Play: CCTV Control Room Operator

Objective: To practice the responsibilities and skills required for operating CCTV surveillance systems.

Duration: 50 minutes

Materials Required:

- Role play scenario cards
- Incident report forms
- Timer or stopwatch
- Chairs arranged as control room setup

Instructions:

Step 1: Setup (10 minutes)

- Arrange classroom to simulate a CCTV control room
- One student sits as the CCTV operator facing multiple →monitor screens→ (can use desks/boards)
- Other students receive role cards (visitors, employees, security guards, suspicious persons)
- Operator gets an incident report sheet and communication device (phone/walkie-talkie)

Step 2: Scenario Execution (25 minutes)

Scenario 1: Normal Operations (8 minutes)

- Various people enter and exit the →monitored area→
- Operator observes and logs routine activities
- Practice identifying normal vs unusual behavior

Scenario 2: Security Alert (8 minutes)

- One person exhibits suspicious behavior (looking around nervously, trying doors, etc.)
- Operator must spot the suspicious activity
- Follow protocol: observe, document, alert security

Scenario 3: Emergency Situation (9 minutes)

- Someone pretends to fall or needs help
- Operator must quickly identify the emergency
- Coordinate with security/medical team
- Keep detailed records of the incident

Step 3: Documentation Practice (10 minutes)

- Operator fills out incident report for each scenario
- Include: time, location, people involved, action taken
- Other students review if all important details were captured
- Discuss what information is most important for reports

Step 4: Role Rotation and Debrief (5 minutes)

- Switch roles so different students can be operators
- Discuss challenges faced during monitoring
- Share what skills are most important for CCTV operators
- Identify areas where more training would be helpful

Key Skills Practiced:

- Attention to detail
- Quick decision making
- Clear communication
- Accurate documentation
- Understanding of security protocols

Assessment: Quality of observation, appropriate responses to situations, accuracy of incident reports, and teamwork during role play.

Practice Questions

Fill in the Blanks

1. CCTV stands for ___________ ___________ Television.
2. The first CCTV system was installed in ___________ in the year ___________.
3. Early surveillance systems used ___________ and telescopes to watch distant objects more clearly.
4. The introduction of ___________ recorders in the 1970s allowed security footage to be stored and reviewed later.
5. Modern CCTV cameras can work in complete darkness using ___________ light technology.
6. ___________ video recorders replaced VCR tapes in the 1990s with longer recording times.
7. Today's advanced CCTV systems feature ___________ intelligence and ___________ recognition capabilities

Fill in the Blanks - Answers

1. **Closed Circuit Television**
2. **Germany in the year 1942**
3. **binoculars and telescopes**
4. **VCR recorders in the 1970s**
5. **infrared light technology**
6. **Digital video recorders replaced VCR tapes**
7. **artificial intelligence and facial recognition**

Multiple Choice Questions

1. What does the term →Closed Circuit→ in CCTV mean?

a) The camera is broken

b) Video signals travel only to specific monitors

c) The system works without electricity

d) Cameras are placed in circular arrangements

2. Which country installed the first CCTV system?

a) United States

b) United Kingdom

c) Germany

d) Japan

3. What was the main limitation of early CCTV systems in the 1940s-1960s?

a) They were too small

b) They were very expensive and had poor image quality

c) They worked only at night

d) They could not be installed indoors

4. Which technology replaced VCR tapes for CCTV recording?

a) DVD players

b) Digital Video Recorders (DVRs)

c) Cassette tapes

d) CD players

5. What is the main purpose of visible CCTV cameras in public places?

a) To record everything

b) To act as a deterrent to prevent crimes

c) To monitor traffic only

d) To replace security guards completely

6. Which feature is NOT typically found in modern smart CCTV systems?

a) Night vision capability

b) Mobile phone alerts

c) Radio broadcasting

d) Facial recognition

Multiple Choice - Answers

1. b) Video signals travel only to specific monitors
2. c) Germany
3. b) They were very expensive and had poor image quality
4. b) Digital Video Recorders (DVRs)
5. b) To act as a deterrent to prevent crimes
6. c) Radio broadcasting

subjective Questions

1. List any three sectors where CCTV systems are commonly used and

explain why they are important in each sector.

2. Explain how CCTV technology evolved from analog to digital systems.

3. What are the main purposes served by CCTV systems in modern society?

4. Describe the role and responsibilities of a CCTV operator.

5. How do modern CCTV systems provide remote monitoring capabilities?

Session -2 Basics of Electronics

Electricity is the driving force behind every CCTV system. To understand how CCTV cameras, recorders, and power supplies work, we must first learn about three basic terms: voltage, current, and resistance. These are the foundations of all electrical and electronic systems.

Voltage

Voltage can be thought of as the →push→ that makes electric charges move. Just like water needs pressure to flow through a pipe, electricity needs voltage to flow through wires. It is measured in volts (V). A CCTV camera often works on 12 volts DC, which means that its power supply gives a constant push of 12 volts to run the camera.

Current

Current is the actual flow of electric charges through a wire or circuit. If voltage is like water pressure, then current is the flow of water itself. The higher the current, the more electrons are moving. Current is measured in amperes (A). CCTV cameras typically consume a small amount of current. For example, a standard CCTV camera may use around 0.5 to 1 ampere. If too much current flows through a wire, it can heat up or even damage components.

Resistance

Resistance is like the friction in a pipe that slows down water flow. Every wire or component resists the flow of electricity to some extent. Resistance is measured in ohms (Ω). Materials such as metals have low resistance, which is why they are used for wires. On the other hand, materials like rubber or plastic have very high resistance and are used as insulators to block electricity and protect us.

Ohm’s Law

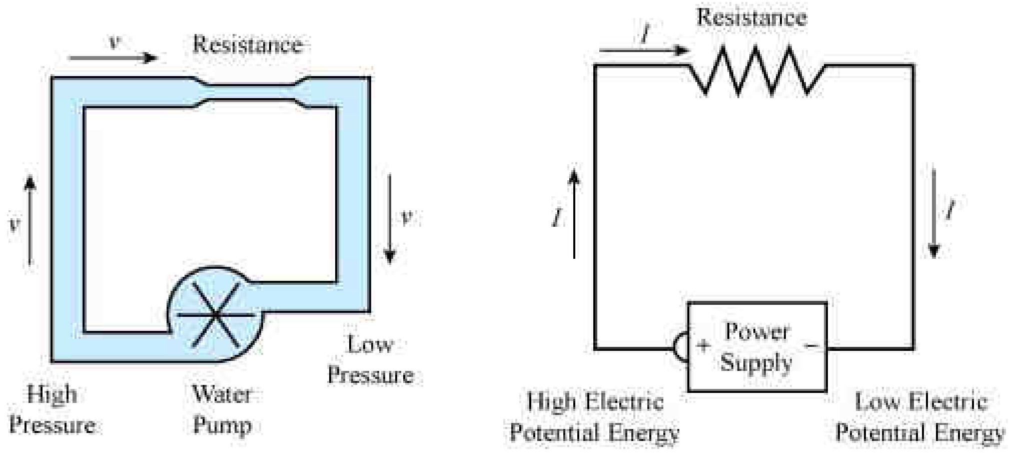
The relationship between voltage, current, and resistance was discovered by the German scientist Georg Simon Ohm. His law is called Ohm’s Law and is one of the most important rules in electrical work. Ohm’s Law states:

$$V = I \times R$$

This means Voltage (V) is equal to Current (I) multiplied by Resistance (R). In other words, if we know any two values, we can calculate the third. For example, if a CCTV camera operates at 12 volts and it needs 0.5 amperes of current, the resistance in the circuit can be calculated as:

$$R = V \div I = 12 \div 0.5 = 24 \text{ ohms.}$$

Similarly, if we know the resistance and voltage, we can calculate how much current will flow. This law helps technicians design circuits, select the right power supply, and check for problems. For example, when installing CCTV systems, a technician must check the voltage of the adapter, know the current rating of the camera, and ensure that the wires used have appropriate resistance so that there is no drop in performance.



Types of Current – AC vs DC

Electricity is the flow of electric charges through a conductor such as a wire. This flow can take place in two different ways, depending on how the charges move. These are called Direct Current (DC) and Alternating Current (AC). Both forms of current are important in our daily life and also in CCTV systems.

Direct Current (DC):

In direct current, charges always flow in a single, steady direction. Imagine water flowing in a pipe from one end to the other without changing its path. In the same way, in DC, electricity moves from the positive side of a source (like a battery) to the negative side. The flow is smooth and constant.

Most small electronic devices such as CCTV cameras, LED lights, remote controls, and mobile phones work on DC. Batteries and power adapters supply this type of current.

Because DC is steady, it is safe for delicate electronic circuits where sudden changes in electricity can cause damage.

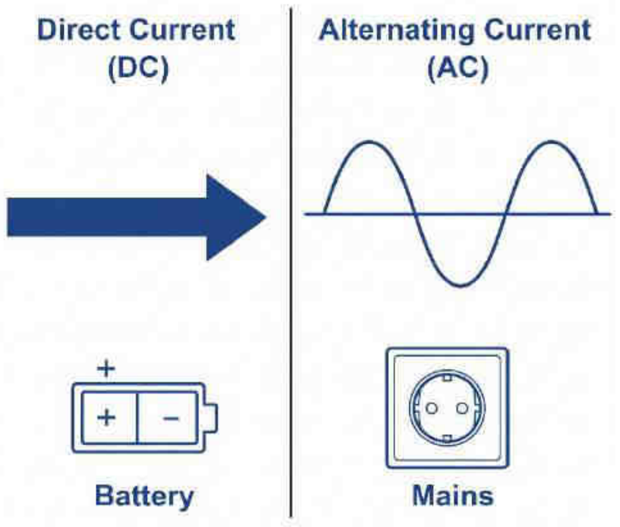
Alternating Current (AC):

Alternating current does not flow steadily in one direction. Instead, it keeps changing its direction again and again, many times in a second. This change happens in a repetitive wave-like cycle.

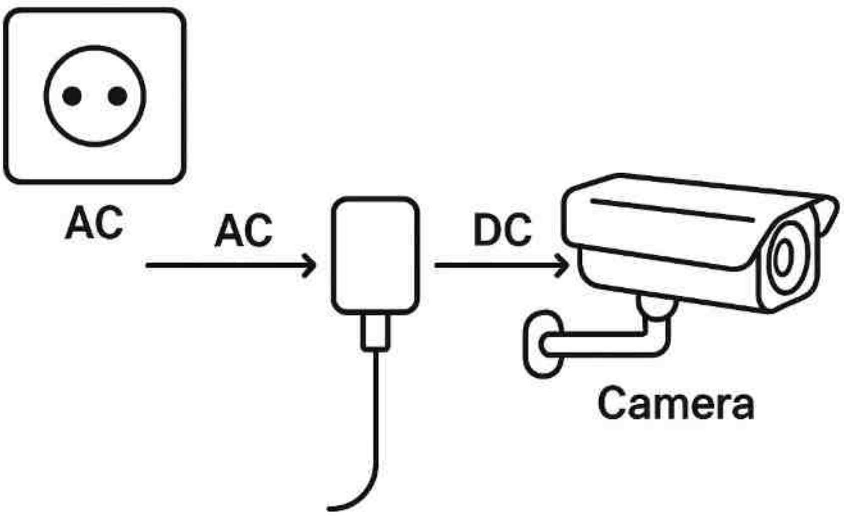
The electric supply we get in our homes, shops, and offices is AC. This is the form of electricity sent through large power stations and transmission lines. The reason is that AC can be moved over long distances more easily and with less loss of power. This makes it more suitable for distributing electricity from power plants to every building.

In India, the current from the mains supply changes its direction **50 times in one second**. This is known as **50 Hertz (Hz)** frequency. Because of this rapid alternation, the appliances we plug into sockets—fans, refrigerators, televisions, and even DVRs in CCTV setups—are all designed to work on AC.

AC and DC in CCTV Systems:



Both AC and DC are used in security technology. A CCTV system usually relies on DC for powering cameras, recorders, and sensors because these devices require stable and low-voltage supply. However, the electricity coming from the wall socket is AC. Here, a **power adapter or power supply unit** is used to convert AC into DC so that sensitive electronic equipment can function safely.



CCTV system showing AC to DC conversion through power adapter

Electrical Safety Practices

Working with electricity requires care because it can be dangerous. Knowing and following electrical safety practices is essential for your safety and the safety of others.

Common Risks

The most common risk is an electric shock, which happens when current flows through your body. The severity of the shock depends on the amount of current, its path, and how long you're in contact with it. Even a small current can be fatal. This is why you must never touch bare wires or work on electrical devices with wet hands, as water is an excellent conductor.

Another major risk is a short circuit. This occurs when a live wire makes contact with a neutral or ground wire, creating a very low-resistance path. The result is a sudden surge of current that can cause wires to overheat, melt, or even start a fire, and can also damage equipment. To prevent this, always use the right type of wire and ensure all connections are properly insulated.

To prevent these dangers, always follow these rules:

- **Switch off the power:** Before you begin any work, disconnect the device from the power source completely. Don't just rely on a switch; this simple step is the most crucial for preventing a serious accident.

- **Use insulated tools:** Always use tools with plastic or rubber handles that are designed for electrical work. These materials don't conduct electricity, so they act as a barrier between you and the live current.
- **Check for damage:** Before you use any equipment, inspect the power cord and wires for damage like frayed insulation or a loose plug. If you find any damage, don't use it.
- **Work in a dry area:** Avoid working with electricity in wet or damp environments. Water conducts electricity and can make a safe situation very dangerous.
- **Be aware of your surroundings:** When you're working, pay attention to what's around you. Make sure there aren't other metal objects or tools near the circuit you're working on, and if you're using a ladder, ensure it's made of a non-conductive material.
- **Use correct protective equipment:** For some jobs, you might need to wear special safety gloves or shoes with insulated soles for an extra layer of protection.

Power Rating and Fuse Usage

When you use any electrical device, have you ever noticed the small label or sticker on it? This label tells us important information about how much power the device needs to work properly. This is called the power rating.

What is Power Rating?

Power rating tells us how much electrical energy a device uses in one second. We measure power in watts (W). Think of it like this - if current is the flow of water and voltage is the pressure, then power is how much work the water can do.

The formula for power is simple:

Power (P) = Voltage (V) × Current (I)

For example, if a CCTV camera needs 12 volts and draws 2 amperes of current, its power consumption would be:

P = 12V × 2A = 24 watts

power rating label on a CCTV camera showing voltage and current specifications

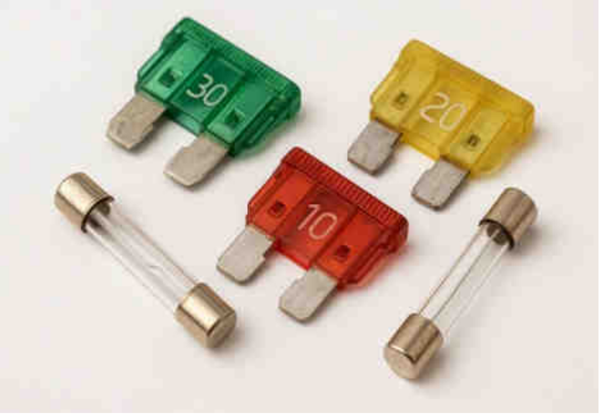
Every electronic device has a power rating written on it. A table fan might use 75 watts, while a small LED bulb uses only ↳ watts. CCTV cameras typically use between 10 to 50 watts depending on their size and features.

Why is Power Rating Important?

Knowing the power rating helps us in many ways. First, it tells us how much electricity bill we will have to pay. Second, it helps us choose the right power supply for our devices. If we connect a device to a power supply that gives less power than needed, the device won't work properly. If we give it too much power, it might get damaged. When installing CCTV systems, you must add up the power ratings of all cameras, monitors, and recording devices. This total will tell you what size power supply you need for the complete system.

Understanding Fuses

Now let's talk about fuses. A fuse is like a safety guard for electrical circuits. It protects our expensive electronic equipment from getting damaged due to too much current.



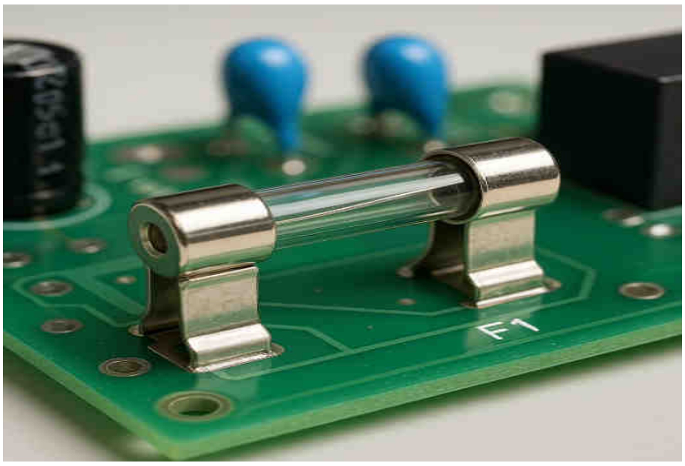
photograph of different types of electrical fuses used in circuits

A fuse is a thin wire or metal strip that melts when too much current flows through it. When it melts, it breaks the circuit and stops the current flow. This prevents damage to other parts of the circuit.

Types of Fuses

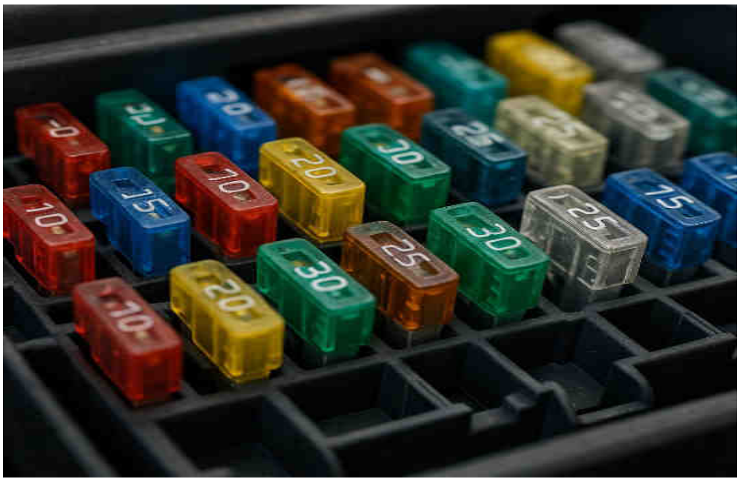
There are several types of fuses we commonly use:

Glass Fuses: These are small cylindrical fuses with metal caps on both ends. You can see the thin wire inside through the glass. They are commonly used in electronic circuits.



Glass fuse properly installed in an electronic circuit board with fuse holder

Blade Fuses: These look like small plastic blocks with two metal prongs. Cars use these types of fuses a lot.



Blade fuses installed in an automotive fuse box showing real-world usage

Ceramic Fuses: These are stronger than glass fuses and can handle higher currents. They are often used in industrial equipment.

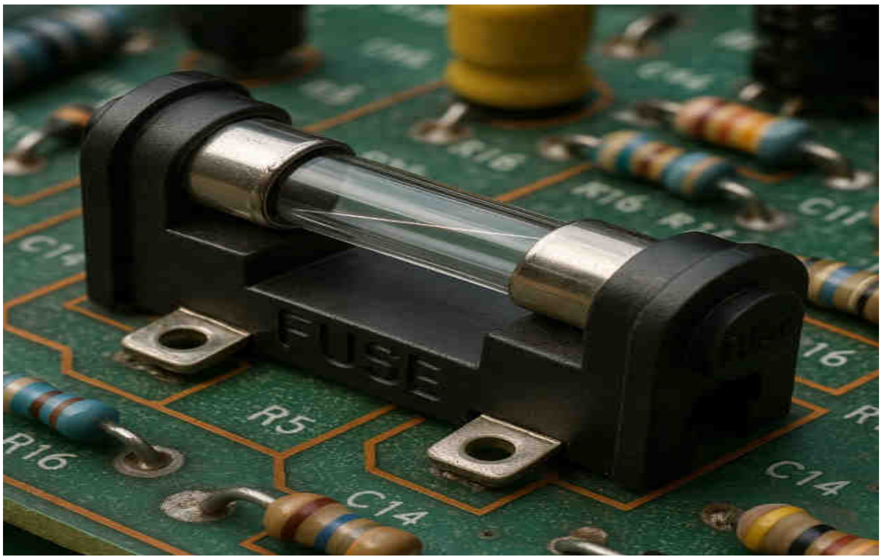
Ceramic fuse installed in industrial electrical equipment for high current protection

How to Choose the Right Fuse

Choosing the correct fuse is very important. The fuse rating should be slightly higher than the normal current that flows through the circuit, but lower than the current that would damage the equipment. For example, if a CCTV camera normally draws 2 amperes, you might use a 2.5 ampere fuse. This way, the fuse won't blow during normal operation, but it will protect the camera if something goes wrong and too much current tries to flow.

Fuse Placement in Circuits

Fuses should always be connected in series with the device they are protecting. This means the current must pass through the fuse before reaching the device. Usually, we place fuses close to the power source, right after the positive terminal. In CCTV installations, we often use fuses in the main power supply box and sometimes individual fuses for each camera. This gives us better protection and makes troubleshooting easier.



photograph showing a fuse properly installed in a circuit board

Identifying a Blown Fuse

When a fuse gets damaged due to excess current, we say it has →blown→ or →burnt out". You can easily identify a blown fuse by looking at it carefully.

Comparison between a blown fuse and a good fuse showing the melted wire

In a glass fuse, you will see that the thin wire inside has melted and broken. Sometimes the glass might also look blackened from the heat. When this happens, you need to replace the fuse with a new one of the same rating.

Remember, when a fuse blows, never replace it with a wire or a fuse of higher rating. This removes the protection and can cause fires or damage to equipment. Always use the correct rated fuse as specified by the manufacturer.

Understanding Power Adapters and SMPS

Have you ever wondered how your mobile phone charger works? Or how CCTV cameras get the right amount of power from the wall socket? The answer lies in power adapters and SMPS devices.

What is a Power Adapter?

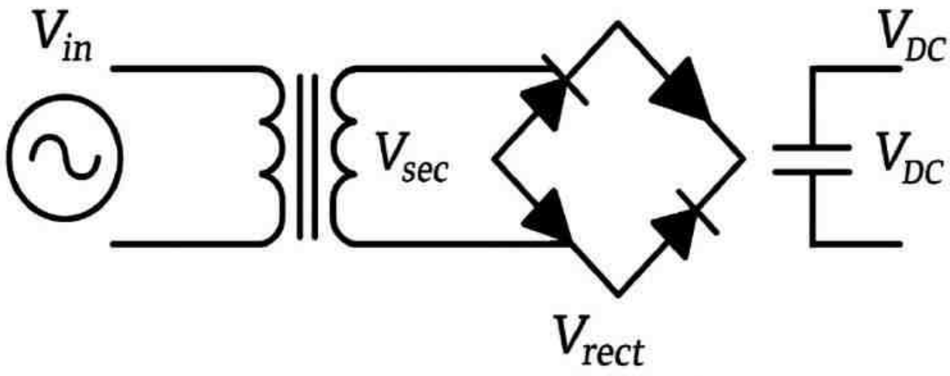
A power adapter is a small device that changes the electricity from your wall socket into the type of electricity that electronic devices need. Most wall sockets in India provide 230 volts AC (alternating current), but many electronic devices like CCTV cameras, mobile phones, and laptops need much lower DC (direct current) voltage to work safely.

Power adapter showing AC input plug and DC output cable with voltage specifications

Think of a power adapter like a translator. Just as a translator converts one language to another, a power adapter converts one type of electrical power to another type. The wall socket speaks "230V AC→ but your CCTV camera only understands "12V DC".

How Does a Power Adapter Work?

Inside every power adapter, there are several important parts working together. The main component is called a transformer. This transformer reduces the high voltage from the wall socket to a lower, safer voltage.



Complete power adapter circuit showing transformer, rectifier, and filter components

The process happens in simple steps. First, the 230V AC enters the adapter then the transformer reduces this voltage to a lower level, maybe 12V or 24V. But it's still AC power. Next, special electronic components called diodes convert this AC power into DC power. Finally, capacitors help make the DC power smooth and steady.

What is SMPS?

SMPS stands for Switch Mode Power Supply. This is a more advanced type of power adapter that works differently from traditional adapters. Instead of using heavy transformers, SMPS uses electronic switches that turn on and off very quickly - thousands of times per second.

SMPS unit showing internal circuit board with electronic components

SMPS devices are much smaller and lighter than old-style adapters, even though they can provide the same amount of power. They are also more efficient, which means they waste less electricity and don't get as hot during operation.

Advantages of SMPS

SMPS has many benefits over traditional power adapters. They are much lighter in weight, so they are easier to carry and install. They also produce less heat, which makes them safer and more reliable. Most importantly, they can work with different input voltages - this means the same SMPS can work in different countries with different electrical systems. For CCTV technicians, SMPS is very useful because one power supply can handle multiple cameras. Instead of using separate adapters for each camera, you can use one SMPS unit to power several cameras at once.

Power Adapters in CCTV Systems

In CCTV installations, power adapters play a very important role. Most security cameras need 12V DC power to operate, but some larger cameras might need 24V DC. The power consumption varies depending on the camera type - simple cameras might use 10 watts while advanced cameras with night vision can use up to 50 watts.

CCTV power supply adapter with multiple DC output connections for cameras

When installing multiple cameras, technicians often use centralized power supplies. These are larger SMPS units that can provide power to many cameras through individual cables. This setup makes installation cleaner and troubleshooting easier.

Choosing the Right Power Adapter

When selecting a power adapter, you need to match three important things: voltage, current capacity, and connector type. Getting any of these wrong can damage your equipment or cause the adapter to fail. Always read the device label carefully. If your CCTV camera says "12V DC, 2A", then use an adapter that gives exactly 12V DC and can provide at least 2A current. You can use an adapter with higher current rating (like 3A or 4A), but never change the voltage.

Different types of DC power connector plugs showing various sizes and configurations

Safety Tips

Power adapters can become hot during use, so always ensure proper ventilation around them. Never cover adapters with cloth or place them in enclosed spaces. If an adapter becomes too hot to touch, disconnect it immediately and check for problems. Also, always buy adapters from reliable manufacturers. Cheap, low-quality adapters can be dangerous and might damage your expensive CCTV equipment. Look for safety certifications and warranty when purchasing power supplies for professional installations.

What You Learned

1. You learned how voltage pushes electric current through wires, just like water pressure pushes water through pipes.
2. You discovered that current is the actual flow of electrons and is measured in amperes.

3. You understood that resistance opposes current flow and is measured in ohms.
4. You learned Ohm's Law (V = I × R) to calculate voltage, current, or resistance when you know the other two values.
5. You found out that DC flows in one direction while AC changes direction many times per second.
6. You learned how power adapters convert AC from wall sockets to DC for CCTV cameras and other electronic devices.

Points to Remember

1. Always check the power rating on device labels before connecting any power supply.
2. CCTV cameras need DC power, usually 12V, to work properly.
3. Never replace a blown fuse with a wire or higher-rated fuse as it removes safety protection.
4. AC current from wall sockets in India changes direction 50 times per second (50 Hz frequency).
5. Use the correct voltage adapter - wrong voltage can damage expensive CCTV equipment.
6. Always switch off main power before working on any electrical installation.
7. Fuses protect circuits by melting when too much current flows through them.

↵ SMPS power supplies are lighter and more efficient than traditional transformer-based adapters.

Practical Exercise: Electronics Fundamentals for CCTV Systems

Objective

To understand and verify basic electrical principles through hands-on experiments and develop safe working practices essential for CCTV technicians.

Materials Required

- Digital multimeter
- Breadboard
- Resistors (100Ω, 220Ω, 470Ω, 1kΩ)
- DC power supply or └V battery
- AC power adapter (12V)
- Connecting wires
- LED indicators
- Safety equipment (gloves, goggles)
- Notebook for observations

Activity 1: Verification of Ohm's Law

Aim

To verify the relationship V = I × R through practical measurements.

Procedure

Step 1: Circuit Setup

Connect a 220Ω resistor between the positive and negative terminals of a ↳V battery using a breadboard. Leave space for multimeter connections.

Step 2: Voltage Measurement

Set multimeter to DC voltage mode. Connect red probe to positive side and black probe to negative side of the resistor. Record the reading.

Step 3: Current Measurement

Switch multimeter to current mode. Break the circuit and insert multimeter in series so current flows through it. Record the reading.

Step 4: Resistance Verification

Turn off power. Set multimeter to resistance mode. Measure the resistor and compare with its color code value.

Step 5: Calculate and Compare

Using Ohm's law (V = I × R), calculate the expected current: I = V ÷ R. Compare your calculated values with measured values and record any differences with possible reasons.

Observations Table

Resistor Value	Measured	Measured	Calculated	Difference

	Voltage	Current	Current	
220Ω				
470Ω				
1kΩ				

Questions

1. Does your measured current match the calculated value?
2. What could cause small differences in readings?
3. How does changing resistance affect current flow?

Activity 2: AC and DC Current Identification

Aim

To identify different types of current sources and understand their applications in CCTV systems.

DC Source Testing

Connect a └V battery to an LED through a 220Ω resistor. Observe steady glow, then reverse battery connections. Note that LED only works in one direction (polarity matters). Measure voltage with multimeter.

AC Source Testing

Take a 12V AC adapter (transformer type, not SMPS). Set multimeter to AC voltage mode and measure output voltage. Connect LED - it may flicker or glow dimly due to alternating current.

Observations

DC Characteristics:

- Voltage: ____V
- LED behavior: _________________
- Polarity: Important/Not important

AC Characteristics:

- Voltage: ____V
- LED behavior: _________________
- Frequency: ____Hz

Create a table listing CCTV components and their power requirements:

Component	Power Type	Voltage	Current	Application
CCTV Camer				
DVR				
Monitor				

Activity 3: Electrical Hazard Identification and Safety Measures Aim

To identify potential electrical hazards in CCTV installations and learn safety practices.

Hazard Identificat

Walk around your lab/workshop and identify: exposed wires, overloaded sockets, wet ar near electrical equipment, damaged wire insulation, and missing earth connections. M locations and count devices per socket.

Step 3: Safety

Examine and test the following safety equipment:

1. **Insulated screwdrivers** - check insulation
2. **Multimeter** - verify CAT rating
3. **Safety gloves** - look for damage
4. **First aid kit** - check contents
5. **Fire extinguisher** - verify type (CO_2 for electrical fires)

Safety Aspect	Check (✓/✗)	Action Required
Power disconnected		
Tools inspected		
Work area cleared		
Safety equipment worn		
Emergency contacts available		
First aid kit accessible		

Assignment Questions

1. List five potential hazards you might encounter during CCTV installation and how prevent them.

2. Explain why CCTV cameras use DC power instead of AC power.
3. Calculate the power consumption of a CCTV system with:
    - 4 cameras (12V, 2A each)
    - 1 DVR (12V, 3A)
    - 1 monitor (230V, 1A)
4. Design a simple safety checklist for CCTV installation work.

Fill in the Blanks

1. Voltage is measured in _______ and can be thought of as the →push→ that
2. Current is the actual flow of electric charges and is measured in _______.
3. According to Ohm's Law, Voltage equals Current multiplied by _______.
4. In India, AC current from mains supply changes direction _______ times per
5. CCTV cameras typically work on _______ volts DC power.
6. A _______ protects electrical circuits by melting when too much current flows

Multiple Choice Questions

1. What is the unit of measurement

   a)

   b)

   c)

   d) Watts

2. Which type of current flows

   a) AC (Alt

   b) DC

   c) Both AC

   d) None of the above

3. If a CCTV camera operates at 12V and draws 2A current, what is the resista

a) 6 ohms

b) 24 ohms

c) 10 ohms

d) 14 ohms

4. What does SMPS stand for?

a) Simple Mode Power Supply

b) Switch Mode Power Supply

c) Standard Mains Power Supply

d) Secure Mode Power System

5. Which material has very high resistance

a)

b)

c)

d) Rubber

6. What happens when you connect a 12V DC

a) Camera

b) Camera may

c) Camera

d) Camera uses less power

7. The frequency of AC supply in India is:

a) 25 Hz

b) 50 Hz

c) 100 Hz

d) 60 Hz

↵ Which component converts AC to DC in a power adapter?

a) Transformer only

b) Capacitor only

c) Rectifier circuit

d) Resistor only

Short Answer Questions

1. Why do CCTV cameras use DC power instead of AC power?
2. List three safety measures you should follow while working with electrical equipment.
3. Explain what happens when a fuse →blows→ in an electrical circuit.
4. What are the three things you must match when selecting a power adap equipment?
5. Calculate the power consumption of a CCTV system with 2 cameras (12V, 1/ DVR (12V, 2A)

Unit 2: CCTV System Components & Tools

Session 1. Key Hardware Components

Figure 1 Complete CCTV System Components

1. Cameras

When you think about a CCTV system, the camera is the first thing that comes to mind. It's the eye of the security system. A CCTV camera is basically a device that captures video and converts what it sees into signals that can be recorded or displayed on a monitor. Without a good quality camera, your entire security setup won't work properly, no matter how expensive the other parts are.

Let me explain how a camera works in simple terms. Inside every CCTV camera, there's a sensor. This sensor is what actually catches the light from the scene and turns it into electrical signals. These signals then travel through cables or through a network to a recorder or a display device. The better the sensor is, the clearer the images you'll get, especially in low light conditions.

Types of CCTV Cameras

There are several different types of CCTV cameras available, and each one is designed for different purposes and environments. Understanding these types helps you choose the right camera for a specific location.

Bullet CCTV Cameras

These are long and cylindrical in shape, kind of like a bullet, which is where they get their name. You'll usually see them pointing at a specific area because they're designed to focus in one direction. Bullet cameras are easy to install and very popular in small shops, warehouses, and offices. They're also quite affordable, which is why many people prefer them.

Figure 3 Standard wall mounted outdoor, IR infrared for night vision bullet camera

Dome CCTV Camera

Dome cameras feature a hemispherical cover that hides the lens direction. People can't easily tell which direction the dome camera is pointing just by looking at it. This makes dome cameras useful in places where you want security but don't want it to be too

obvious. You'll find dome cameras a lot in shopping malls, banks, and restaurants. They look more professional than bullet cameras.

Figure 4 Dome CCTV Camera

Box CCTV Camera

Box cameras are another type that you might come across. These are square or rectangular shaped. They give you more flexibility because you can attach different lenses to them, and you can point them in any direction. However, they're a bit bulkier, so they're not used as much in modern setups. You might find them in specialized surveillance situations.

Figure 5: a) Turret design with adjustable mounting b) C-mount with interchangeable lens system c) Compact mini design for covert surveillance box cameras

PTZ CCTV Camera

PTZ cameras stand for Pan-Tilt-Zoom cameras. These are special cameras that can move left and right, up and down, and they can zoom in on distant objects. Imagine having a person who can constantly watch an entire building by moving the camera around and zooming in on anything suspicious. That's what a PTZ camera does. They're more expensive than fixed cameras, but they're really useful for monitoring large areas like parking lots, airports, or outdoor grounds.

Figure 6 a) Pole mounted for large area outdoor surveillance b) Wall mounted for building perimeter monitoring c) Ceiling mounted for indoor large space monitoring

IP CCTV Camera

IP cameras are cameras that connect directly to a network, just like your computer or mobile phone does. Instead of sending video through a cable to a recorder, IP cameras send the video data over the internet or a local network. These are becoming very popular nowadays because they're flexible and you can access the footage from anywhere using your phone or computer. We'll talk more about IP cameras when we discuss networking.

Figure 7 a)Wireless Wi-Fi network camera b) Wired ethernet POE network camera c) 360 degree panoramic fisheye IP camera

Infrared (IR) and Thermal Cameras

Infrared or thermal cameras are used in places where it's dark or where you need to see heat signatures. Some are sensitive to infrared light, which is invisible to our eyes, but the camera can detect it. This helps capture clear footage even in complete darkness.

Other thermal cameras show you the heat patterns of objects and people. These are expensive but very useful for security in areas without lighting.

Image Quality and Resolution

The quality of the image that a camera produces is measured by something called resolution. Resolution is basically how many pixels, or tiny dots, make up the image. Higher resolution means more detail and clearer pictures. Most older CCTV cameras produce standard definition video, which is around 720 x 480 pixels. This gives okay quality, but you won't be able to see fine details if someone's face is far away. HD cameras, which stand for High Definition, produce images at 1280 * 720 or 1920 * 1080 pixels. These are much better and provide more details. You can recognize faces and read important details more easily with HD cameras.

Light Sensitivity

A camera's ability to work well in dark conditions depends on something called lux rating. Lux is a unit that measures light. A camera with low lux rating means it can see clearly even when there's very little light. For example, a camera with 0.1 lux rating can capture good images in near darkness. Cameras with high lux rating, like 50 lux or more, need brighter conditions to work well. The parking lot or a store need a camera with low lux rating. This saves you from having to install extra lighting. Infrared cameras are especially good for dark places because they can see in complete darkness using infrared light.

Frame Rate

When you watch a video, you're actually watching many still pictures, one after another, very quickly. The number of pictures shown in one second is called the frame rate, and it's measured in fps, which means frames per second. Most CCTV cameras work at 25 fps or 30 fps, which is smooth enough for normal surveillance. This means the camera captures 25 or 30 images every second. For areas where there's a lot of movement, like at an entrance or a busy street, higher frame rates like 60 fps are better because they capture faster movements more smoothly.

Choosing the Right Camera

When you're setting up a CCTV system, you need to think about several things before choosing your cameras. What area do you need to monitor? Is it indoors or outdoors? How much light is there usually? Do you need to identify people's faces or just know if someone is there? These questions will help you pick the right type and quality of camera. For outdoor areas with good lighting, a standard bullet camera with HD resolution works fine. For indoor areas like offices or shops, dome cameras are often better because they look nicer and don't stand out. For areas that are very dark or need monitoring at night, infrared cameras are the way to go. And if you need to watch a very large area, PTZ cameras are your best option even though they cost more.

2. Lenses

If the camera is the eye of a CCTV system, then the lens is like the pupil of that eye. The lens is what focuses light onto the camera's sensor and determines what the camera can see. A good quality lens is just as important as a good quality camera because the best camera can also give you poor images if the lens is not good. Let me explain what a lens does. Light comes from the scene you want to monitor, passes through the lens, and then hits the camera sensor. The lens focuses this light and also determines how much of the scene the camera can capture. Different lenses can see different areas. Some lenses can see a very wide area, while others can see only a narrow area but in great detail.

Focal Length

Focal length tells us how wide or narrow a camera's view will be. It is measured in millimeters (mm).

- A short focal length (like 2.8 mm or 3.6 mm) gives a wide view. The camera can see a large area, but objects look smaller and farther away. This is similar to the 0.5× mode in a mobile phone camera
- A long focal length (like 25 mm or 50 mm) gives a narrow view. The camera sees a smaller area, but objects look closer and larger. This is similar to 1× or zoom mode in a mobile camera
-

Types of Lenses

There are two main types of lenses used in CCTV cameras: fixed lenses and variable lenses.

Fixed Focal Length Lenses are the simplest and most affordable lenses. Once they are set, they cannot be changed. The focal length is fixed at the factory, and you cannot adjust it. Fixed lenses are used in most basic CCTV cameras like bullet cameras and dome cameras in shops and offices. They're cheap, reliable, and work well when you know exactly what area you want to monitor.

Varifocal Lenses are more flexible. These lenses allow you to adjust the focal length after the camera is installed. You can start with a wide view and then manually zoom in to focus on a specific area. Many professional installations use varifocal lenses because they give you flexibility. However, they are more expensive than fixed lenses.

Zoom Lenses are even more advanced. Some zoom lenses can be adjusted manually, while others are motorized and can be controlled remotely. Motorized zoom lenses are often used with PTZ cameras. You can zoom in and out from your monitor or even from your mobile phone if the system is networked. This is very useful for situations where you need to watch a large area and also need to zoom in to see details.

Common Focal Length Options

In India the CCTV installation systems commonly use these focal lengths:

i. **2.8 mm lens** provides the widest field of view, around 100 degrees or more. This is perfect for monitoring wide areas like corridors in offices, inside small shops, or large rooms. You can see almost everything, but the details are smaller.

ii. **3.6 mm lens** is one of the most popular choices. It gives a field of view of about 80 degrees, which is good for general purpose monitoring. You'll see this on most basic surveillance cameras in Indian shops and houses.

iii. **6 mm lens** narrows the view to about 50 degrees. This is useful when you want to focus on a more specific area, like an entrance door or a counter in a shop. People and objects appear larger and clearer.

iv. **↵mm lens** further narrows the view to about 30 degrees. This is used when you want to see details and identify people clearly. It's useful at shop counters, cash registers, or entry gates.

v. **12 mm lens** and above are considered telephoto lenses. They provide very narrow, focused views, sometimes only 15-20 degrees. These are used when you want to focus on a specific spot, like watching a particular shop window or monitoring a distant area. Things appear very large and close.

Lens Types Based on Design

Lenses are also classified based on their physical design and how they mount on the camera.

i. **C-mount lenses** are very common in professional CCTV installations. They have a standard connection that fits on box cameras and professional surveillance equipment. Many technicians prefer C-mount lenses because you can easily swap them if needed.

ii. **CS-mount lenses** are similar to C-mount but are physically smaller. They're often used in more modern and compact cameras.
iii. **M12 mount lenses** are smaller lenses used in compact and miniature cameras.

Lens Aperture

Another important specification is the lens aperture, which is shown as an f-number, like f/1.4 or f/2.0. The aperture controls how much light the lens lets through to the camera sensor. A smaller f-number means the lens lets in more light. So, f/1.4 is better than f/2.0 at gathering light. This matters a lot in dark environments. If you're monitoring a dark warehouse or an outdoor area at night, you want a lens with a low f-number because it will gather more light and give you clearer images. However, lenses with low f-numbers are more expensive.

Infrared Corrected Lenses

If you're using an infrared camera, you should use an infrared corrected lens. Regular lenses work well with visible light, but when infrared light is used, the focus point can be slightly different. An IR corrected lens adjusts for this, so your infrared camera will produce sharp images in complete darkness.

Choosing the Right Lens

Selecting the correct lens depends on what you want to monitor. Is it a large area or a small area? Do you need to see fine details or just know if someone is there? Is the area dark or well-lit? For a small shop that needs to monitor the entrance and inside, a 3.6 mm fixed lens works perfectly. For a large parking lot that you want to monitor in its entirety, you would use a 2.8 mm or even wider lens. For focusing on a specific counter or cash register where you want to see people's faces clearly, a 6 mm or ↤mm lens is better. The most important thing to remember is that the lens and camera work together. A good camera needs a good lens to produce clear, useful images. Taking time to choose the right lens for your situation will save you problems later and ensure your CCTV system works effectively.

Figure 2 Camera Component - Internal Parts Labeled

3. DVR and NVR Units

When your CCTV cameras capture video, that video needs to be recorded and stored somewhere so you can watch it later. This is where DVR and NVR units come in. Think of them as the brain and memory of your CCTV system. They control everything and save all the video footage that the cameras capture.

DVR stands for Digital Video Recorder. NVR stands for Network Video Recorder. Both do similar jobs, but they work differently and use different types of cameras. Understanding the difference between them is important because it affects how you set up your entire CCTV system.

DVR - Digital Video Recorder

A DVR unit is used with traditional analog cameras. When an analog camera captures a scene, it sends the video signal as an electrical current through a cable to the DVR. The DVR has a circuit board inside that which takes this analog signal and converts it into digital data. This digital data is then compressed and stored on a hard drive inside the DVR. Compression is important because it reduces the file size so you can store more video.

The DVR unit usually looks like a box with a front panel that has buttons and a display screen. On the back, you'll see multiple video input connectors where the camera cables attach. There's also a power connection, a network port if you want to connect it to the internet, and connectors for audio if you're using sound recording.

One major advantage of DVRs is that they're very affordable. Analog cameras and DVR systems are cheaper than IP cameras and NVR systems. This is why you still see many DVR systems in use in India, especially in smaller shops, offices, and houses. However, DVRs have some limitations. Analog video can only be sent through cables for a limited distance without signals distortion. Also, the resolution of analog cameras is not as high as modern IP cameras. Most analog systems can only record at standard definition or basic HD resolution, not 4K. And if you want to view your recordings from your mobile phone, you need to add extra network equipment.

NVR - Network Video Recorder

An NVR unit is used with IP cameras. IP cameras send their video over a network, either through ethernet cables or wireless Wi-Fi. The NVR receives video from these network cameras and stores it on its hard drive.

The way an NVR works is different from a DVR. IP cameras already send digital video, so the NVR doesn't need to convert anything. It just receives the digital data from the cameras over the network and saves it to storage. This is more efficient because there's no need for analog-to-digital conversion.

An NVR unit also looks like a box, similar to a DVR, but it has network ports instead of many video input connectors. The cameras connect to the NVR through your network, which could be your office network, home network, or even a wireless network. This gives

NVR systems a huge advantage: the cameras can be placed anywhere as long as they have a network connection.

NVR systems are very flexible. You can easily add more cameras without worrying about cable length limits. If you have an office building with multiple floors, you can install IP cameras on each floor, and they all connect to one NVR unit through your existing network infrastructure. You can also access the video from anywhere in the world using your phone or computer, as long as you have internet access. Another big advantage of NVR systems is video quality. IP cameras can send much higher resolution video, including 4K, which gives you very clear images with lots of detail. However, NVR systems are more expensive than DVR systems. Both the IP cameras and the NVR unit cost more than analog equipment. Also, setting up an NVR system requires more networking knowledge. You need to understand how networks work, how to assign IP addresses to cameras, and how to secure your system against hackers.

Recording Modes for DVR and NVR

Both DVR and NVR units offer different recording modes.

- Continuous Recording – 24×7 recording
- Motion-Based Recording – Records only when motion is detected
- Scheduled Recording – Records during selected time slots
- Event-Based Recording – Triggered by sensors or alarms

Storage & Retention

Both DVR and NVR units offer different recording modes

- Storage depends on resolution and number of cameras
- 1 TB HDD ≈ 7–10 days (4 cameras, Full HD)
- Large systems use 4–8 TB or more

The retention time is how long you keep the video before it gets deleted or overwritten. Many systems keep footage for 30 days before recording over the old footage.

Maintenance and Reliability

Both DVR and NVR units are designed to run continuously for years. However, they do need occasional maintenance. Hard drives can fail, so it's good practice to replace them after 3-5 years of continuous use. You should also keep the system clean and make sure it has good ventilation so it doesn't overheat. Regular backups of important footage are important. If your hard drive fails and you don't have a backup, you lose all your recorded video. Many professionals backup important video to external drives or cloud storage.

DVR vs NVR

Feature	DVR	NVR
Camera Type	Analog	IP (Network)
Video Quality	Low–Medium	High (Up to 4K)
Installation	Easy	Moderate–Complex
Cost	Low	High

Remote Access	Limited	Easy
Scalability	Limited	High

For a small setup with limited budget, a DVR system is fine. For a larger setup or if you need more flexibility and modern features, an NVR system is worth the extra cost. Many professionals today prefer NVR because it's more modern, more flexible, and better for future expansion. Some people even use both types in the same system, called a hybrid system. They might use DVR for some analog cameras and NVR for some IP cameras at the same location. However, managing two different types of systems requires more skill.

4. Storage Devices in a CCTV System

Storage devices are the components of a CCTV system where all recorded video footage is saved. They act as the memory of the surveillance system. If storage is not selected properly, important recordings may be lost, overwritten too quickly, or the system may fail during critical situations.

I. Hard Disk Drive (HDD)

In most CCTV systems, the primary storage device is a Hard Disk Drive (HDD) installed inside the DVR or NVR. These hard disks are specially designed for surveillance use and can operate continuously, 24 hours a day and throughout the year, without interruption. Unlike regular computer hard disks, surveillance-grade

HDDs are built to handle constant writing of video data and offer better reliability for long-term operation.

II. **Solid State Drives (SSDs)**

Some modern CCTVs also support Solid State Drives (SSDs) as a storage option. Unlike HDDs, SSDs do not have any moving parts, which makes them faster, silent, and more resistant to physical shock. They provide quick access to recorded footage and are highly reliable in terms of performance. However, SSDs are much more expensive than HDDs, especially for large storage capacities. Since CCTV systems require many hours or even weeks of continuous video recording, SSDs are generally used only in special or high-end applications, while HDDs remain the most commonly used storage device.

Storage Capacity and Backup Considerations

The storage capacity of a CCTV system is measured in Gigabytes (GB) and Terabytes (TB), and it determines how long video footage can be retained. The number of recording days depends on factors such as the number of cameras, video resolution, frame rate, and recording mode (continuous or motion-based). Larger systems may use multiple HDDs, Network Attached Storage (NAS), or dedicated video storage servers to meet higher storage requirements. External storage devices such as Universal Serial Bus (USB) drives and external HDDs are mainly used for backup and for sharing important video footage with concerned authorities. Proper selection and planning of storage ensure that important video evidence is available when needed and is not lost due to early overwriting.

5. **Monitors**

A monitor is the display screen where you see the video from your CCTV cameras. A good quality monitor helps you spot details clearly, while a poor monitor might make you miss important things. Monitors can be regular computer monitors or LED televisions, but surveillance-grade monitors are built stronger and designed to run continuously 24 hours a day. They have better color accuracy and connectors specifically for DVRs and NVRs.

Monitors are measured diagonally in inches. Common sizes are 19, 21, 24, and larger. CCTV systems at small shops need 19-21 inch monitors, while large operations need 24 inches or bigger to see fine details. Monitor resolution is measured in pixels. Common resolutions are 1280 x 1024, 1920 x 1080 (Full HD), and 2560 x 1440 (4K). If you have 4K cameras, use a 4K monitor to see all the detail.

A Full HD monitor works well for most CCTV systems. Some monitors show one camera at a time for detailed viewing, like monitoring a cash counter in a bank. Other monitors divide the screen into a grid showing 4, 6, 9, or 16 cameras at once. This multi-camera display is useful because one operator can watch many areas simultaneously. The DVR or NVR controls which cameras appear on the monitor.

Monitors connect to DVRs or NVRs using VGA, HDMI, or component video cables. Make sure your monitor has the right connectors for your equipment. Refresh rate (50-60 Hz) and response time (5-10 milliseconds) affect how smoothly the video appears, though these are less critical for CCTV than for computers. Brightness and contrast are important for seeing details in both dark and bright video. Monitor stands should allow height and angle adjustment.

6. Supporting Equipment

Supporting equipment includes cables, connectors, power supplies, and other accessories needed to connect and run a CCTV system. Without proper supporting equipment, your cameras, DVR, and monitor won't work together.

Cables and Connectors

Coaxial cables (BNC or RG59) carry video signals in analog systems. Ethernet cables (Cat5e or Cat6) are used for IP cameras and networks. Connectors like BNC, RCA, HDMI, and ethernet connectors join cables to equipment. Always use quality CCTV-rated cables because poor cables pick up electrical noise and interference.

Power Supplies

CCTV equipment needs electrical power. Power supplies convert AC from wall outlets into DC power that cameras and recorders need. Some cameras use 12V DC, others use 24V AC. Centralized power supplies power multiple cameras from one location, which is safer and more convenient than separate supplies for each camera.

Backup Power - UPS

An Uninterruptible Power Supply (UPS) is a battery that keeps your system running during power cuts. This is important because your DVR or NVR stops recording if power fails. UPS capacity depends on how much power you need and how long you want backup. Small UPS systems give 30 minutes backup, while larger ones give several hours.

Mounting Hardware

Cameras need secure mounting on walls, ceilings, poles, or corners. Metal brackets, angle brackets, and pole mounts support the camera weight and aim it correctly. For outdoor installations, use stainless steel or galvanized metal that won't rust. Cable clips and conduit keep cables organized and protected. Also, outdoor cameras need protective domes or covers to keep out rain, dust, and UV sunlight. Lens filters reduce glare and improve image quality without blocking the view.

Video Distribution and Network Equipment

Video splitters divide one signal to multiple monitors. PoE switches (Power over Ethernet) provide both data and power through one ethernet cable. Network switches distribute data to IP cameras. These items are necessary for systems with multiple cameras or displays.

What You Learned

1. You learned about different types of CCTV cameras and how to choose the right camera type and Len's focal length based on the area you need to monitor, and the level of detail required.
2. You understood the importance of camera specifications like resolution, lux rating, and frame rate (fps) in determining image quality and video smoothness.
3. You discovered the difference between DVR and NVR systems and learned that NVR systems offer better video quality and remote access but cost more.
4. You learned about storage devices such as HDDs and SSDs, and how to calculate storage capacity based on the number of cameras, resolution, and recording mode to ensure important footage is not overwritten.
5. You understood that monitors must be surveillance-grade with appropriate size and resolution to display camera footage clearly and can show either single or multiple camera feeds depending on your monitoring needs.
6. You learned about supporting equipment including cables, connectors, power supplies, UPS backup systems, and mounting hardware, and discovered that using quality CCTV-rated equipment prevents system failures and ensures reliable long-term operation.
7. You learned how power adapters convert AC from wall sockets to DC for CCTV

cameras and other electronic devices.

Points to Remember

1. Always choose the camera type and lens focal length based on the specific area you need to monitor.
2. Camera specifications matter: higher resolution provides clearer images, lower lux rating means better performance in darkness, and higher frame rate (fps) captures faster movements more smoothly.
3. DVR systems work with affordable analog cameras but have limited resolution and cable distance restrictions, while NVR systems use IP cameras for better quality and flexible installation but require more technical knowledge and cost more money.
4. Plan your storage capacity carefully by calculating the total based on the number of cameras, video resolution, frame rate, and recording mode
5. Use surveillance-grade monitors with appropriate size and resolution that matches your camera capabilities.
6. Always invest in quality supporting equipment including CCTV-rated cables, proper connectors, regulated power supplies, UPS backup systems, and secure mounting hardware

Practical Exercise: CCTV System Components and Installation

Objective

To understand different camera types, install and configure DVR/NVR systems, and connect cameras and monitors properly.

Activity 1: Differentiate Various Camera Types

Aim

To identify and understand the physical characteristics, features, and applications of different CCTV camera types.

Materials Required

- Different Camera samples
- Magnifying glass
- Measuring tape
- Notebook for observations

Step 1: Specification Comparison

For each camera, identify and record:

Camera	Shape	Size	Weight	Mounting	Connectors	Best

Type						Use
Bullet						
Dome						
Box						
PTZ						
IP						
Infrared						

Step 2: Field of View Comparison

Using lens specifications, compare field of view:

- Bullet camera with 3.6mm lens
- Dome camera with 2.8mm lens
- PTZ camera zoom range
- IP camera with 360° capability

Step 3: Application Matching

Match each camera type to appropriate locations:

Location	Best Camera Type	Reason	Lens Selection
Shop entrance			
Large parking lot			

Dark warehouse			
Shopping mall			
Outdoor perimeter			

Observations

1. Which camera is most affordable?
2. Which camera provides the widest field of view?
3. Which camera is best for night surveillance?
4. Which camera offers most flexibility?
5. Which camera requires network infrastructure?

Questions

1. What are the advantages and disadvantages of bullet cameras?
2. When would you choose a dome camera over a bullet camera?
3. Why are PTZ cameras more expensive?
4. What makes IP cameras different from analog cameras?

Activity 2: Install and Configure a DVR/NVR System

Aim

To understand the installation process and basic configuration of DVR and NVR sys

Materials Required

- DVR or NVR unit

- Power supply
- External monitor, keyboard and mouse
- Hard drive (if needed)
- Network cables (for NVR) and coaxial cables (for DVR)
- Keyboard and mouse
- Remote control
- User manual
- Notebook for observations

Procedure

Step 1: Hardware

Following the manufacturer's instructions:

- Place DVR/NVR in a secure, ventilated location
- Connect power supply
- Verify power indicator lights
- Check cooling fan operation
- Inspect all connectors

Step 2: Initial Configuration

Access system menu and con

Setting	Value	Notes

System date and time		
Admin password		
Recording resolution		
Frame rate		
Recording mode		
Retention period		

Step 3: Camera Channel

For each camera input:

- Label camera name
- Select video standard (PAL/NTSC)
- Set resolution
- Configure frame rate
- Enable/disable audio
- Test signal input

Step 4: Recording Se

Configure recording parameters:

Recording Mode	**Setting**	**When Used**
Continuous	Enable/Disable	
Motion Detection	Sensitivity Leve	
Scheduled	Time Slots	
Event-Based	Trigger Setting	

Step 5: Playback Testing

- Record sample footage (5-10 minutes)
- Access recorded video
- Test play, pause, rewind, forward
- Verify quality and clarity
- Check timestamp accuracy

Observations Table

Configuration Step	Status	Notes	Issues
Power connection	✓/✗		
Hard drive recognition	✓/✗		
Initial startup	✓/✗		
Menu access	✓/✗		
Camera detection	✓/✗		
Recording test	✓/✗		
Playback function	✓/✗		

Configuration Checklist

Item	Completed	Verified
Date/Time		

correct		
Admin password set		
All cameras labeled		
Recording mode selected		
Resolution configured		
Frame rate set		
Storage capacity checked		
Backup location configured		

Questions

1. What is the difference between DVR and NVR configuration?
2. How do you set appropriate recording modes for different areas?
3. Why is password security important?

4. How do you calculate required storage capacity?

Experiment 3: Connect Cameras and Monitor to DVR/NVR Systems

Aim

To develop skills in properly connecting cameras, monitors, and other equipment to DVR/NVR systems.

Materials Required

- Configured DVR or NVR unit
- 2-4 CCTV cameras (analog or IP)
- Monitors
- Cables: Coaxial cables (BNC) for DVR, ethernet cables for NVR, video c (HDMI, VGA, or component), power cables
- Cable clips and conduit and cable tester
- Screwdrivers, labelling tape and tools
- Multimeter

Procedure

Step 1: Connection Pla

Create a connection diagram showing:

- Camera locations, cable routes, DVR/NVR location, monitor placement, source location

Step 2: Camera Cable Connection

For analog systems:

- Prepare coaxial cables with BNC connectors
- Connect camera 1 BNC connector to DVR input 1
- Connect camera 2 to input 2
- Connect camera 3 to input 3 (if available)
- Verify secure connections
- Test signal with cable tester

Step 3: Camera Connection

For IP systems:

- Connect ethernet cables from cameras to network switch
- Configure IP addresses for each camera
- Connect network switch to NVR
- Verify network connectivity
- Check camera status in NVR menu

Step 4: Monitor Connection

- Identify available video output on DVR/NVR (HDMI, VGA, component)
- Connect appropriate cable from DVR/NVR to monitor

- Power on monitor
- Adjust display settings
- Verify all cameras appear on screen

Step 5: Power Conne

For DVR/NVR:

- Connect power cable to unit
- Connect to regulated power supply
- Verify power indicator
- Check for any error lights

For cameras:

- Connect to appropriate power source
- Verify 12V DC for analog cameras
- Verify PoE or 12V DC for IP cameras
- Check power indicator lights on cameras

Step 6: Live Feed Verification

- Access DVR/NVR main menu
- View all connected cameras
- Verify video quality from each camera
- Test pan/tilt/zoom if available
- Record sample from each camera

Connection Checklist

Connection	Type	Statu	Teste
Camera 1 → DVR/NVR			
Camera 2 → DVR/NVR			
Camera 3 → DVR/NVR			
Monitor → DVR/NVR			
Power → DVR/NVR			
Power → Cameras			

Cable Testing Results

Cable	From	To	Continuity	Signal Quality	Issue
Camera 1					
Camera 2					
Monitor					
Power					

Observations Table

Camera	Connected	Video Quality	Issue	Statu
Camera 1	Yes/No	Clear/Fuzzy		✓/✗
Camera 2	Yes/No	Clear/Fuzzy		✓/✗
Camera 3	Yes/No	Clear/Fuzzy		✓/✗

Monitor	Yes/No	Clear/Fuzzy		✓/✗

Troubleshooting Guide

Problem	Possible Cause	Soluti
No video on monitor		
Fuzzy image		
Camera not detected		
No power		
One camera not working		

Questions

1. What cable types are used for DVR and NVR systems?
2. Why is proper labeling of cables important?
3. How do you verify a cable connection is working?
4. What should you do if a camera doesn't appear on the monitor?
5. How do you test video quality?

Assignment Questions

1. Compare the installation process for DVR (analog) and NVR (IP) systems. Wh the key differences?
2. Design a connection diagram for a 4-camera system with:

- 2 bullet cameras at entrances
- 1 dome camera inside
- 1 PTZ camera for parking

  Show all connections, cable types, and power requirements.

3. If one camera is not showing on the DVR/NVR monitor, list five possible cause how you would troubleshoot each.
4. Describe the complete installation process from unboxing a new DVR/NVR u having all cameras displaying on the monitor.
5. Create a maintenance checklist for a newly installed CCTV system to ensure operation.

Fill in the Blanks

1. A CCTV camera captures video and converts it into _______ that can be rec or displayed.
2. _______ cameras are cylindrical and affordable, _______ cameras are dome for discreet use, and _______ cameras can pan, tilt, and zoom.
3. Camera _______ is measured in pixels, _______ rating measures low-light performance, and _______ is measured in millimeters to determine field of vi
4. DVR is used with _______ cameras, while NVR is used with _______ camer connect over networks.
5. _______ recording runs 24 hours daily, while _______ recording activates or when movement is detected.
6. Storage capacity depends on camera count, resolution, and _______, with

surveillance-grade _______ designed for continuous 24-hour operation.

7. Power supplies convert _______ from wall outlets into _______ for CCTV equipment, and a _______ provides backup power during outages.

Multiple Choice Questions

1. Which of the following camera types is best suited for monitoring a large parking zoom in on

   a) Bullet

   b) Dome

   c) PTZ

   d) Box camera

2. A CCTV system has a 3.6mm lens providing an 80-degree field of view. If you meters away, which focal length lens would

   a) 2.8mm

   b) 6mm

   c) 12mm

   d) 25mm lens

3. Which statement correctly explains the difference be

   a) Both use analog cameras

   b) DVR uses analog cameras with coaxial cables while

c) DVR provides 4K quality while

d) Both are identical except for their names

4. A 4-camera Full HD CCTV system records continuously 24 hours daily. If 1TI

much hard drive capacity would you recommend fo

a)

b)

c)

d) 16TB

5. You need to select a monitor for a security control room monitoring 16 cameras

the most critic

a) Monitor

b) Monitor color (bla

c) Monitor resolution matching c

d) Monitor brightness alone

6. In a DVR system, the coaxial cables can only transmit signals reliably up to a

Which component in an NVR system elir

a) Better

b) Network infrastructure allowing cameras a

c) Larger

d) Bigger hard drives

7. You are installing a CCTV system in a warehouse with extremely low lightin

combination of camera type and specification

a) Bullet camera with

b) Infrared camera with

c) Dome camera with

d) IP camera with standard sensitivity

↵ A CCTV system experiences frequent power cuts. You have configured it for

critical issue could occur, and what supporting equipm

a) No issue; motion

b) DVR/NVR could lose configuration during p

c) Cameras would overheat;

d) Monitor would malfunction; add HDMI cables

Short Answer Questions

1. Explain why a bullet camera is preferred for small shops and warehouses comp to other camera types.
2. A technician needs to monitor a 100-meter-long corridor in an office building ar identify people's faces clearly. What focal length lens would you recommend ar
3. List three main differences between DVR and NVR systems in terms of came quality, and installation complexity.
4. Calculate the total storage capacity needed for a CCTV system with:
   - 4 cameras recording at Full HD resolution

- Continuous recording 24 hours daily
- 30-day retention requirement

(Use: 1TB stores approximately 7-10 days for 4 Full HD cameras)

5. A CCTV installation requires connecting 4 analog cameras to a DVR unit, the the DVR to a monitor. List the types of cables and connectors needed for eac and explain why proper cable quality is important.

Session 2 →Tools and Testing Equipment→

4.1 Drill Machines and Safety Use

When you start working as a CCTV technician, one of the most important tools you will use is a drill machine. This powerful tool helps you make holes in walls, ceilings, and other surfaces where CCTV cameras and cables need to be installed. Without a drill

machine, installing cameras would be almost impossible because most mounting brackets require screws to hold them securely in place.

Electric drill machine with different drill bits used for CCTV installation

Understanding Drill Machines

A drill machine is an electric tool that rotates a sharp cutting bit at high speed to create holes in various materials. The basic parts of a drill machine include the motor, chuck (which holds the drill bit), trigger switch, and handle. Most modern drill machines are powered by rechargeable batteries, making them portable and easy to carry to different installation sites. Some drill machines also have a hammer function that helps drill through concrete and brick walls, which is very useful for CCTV installations in buildings.

There are different types of drill bits for different materials. Masonry bits are used for concrete and brick walls, wood bits for wooden surfaces, and metal bits for steel structures. As a CCTV technician, you will mainly use masonry bits because most cameras are mounted on concrete or brick walls. The size of the drill bit depends on the size of the screws and wall plugs you are using. Common sizes for CCTV work include 6mm, ↤mm, and 10mm diameter bits.

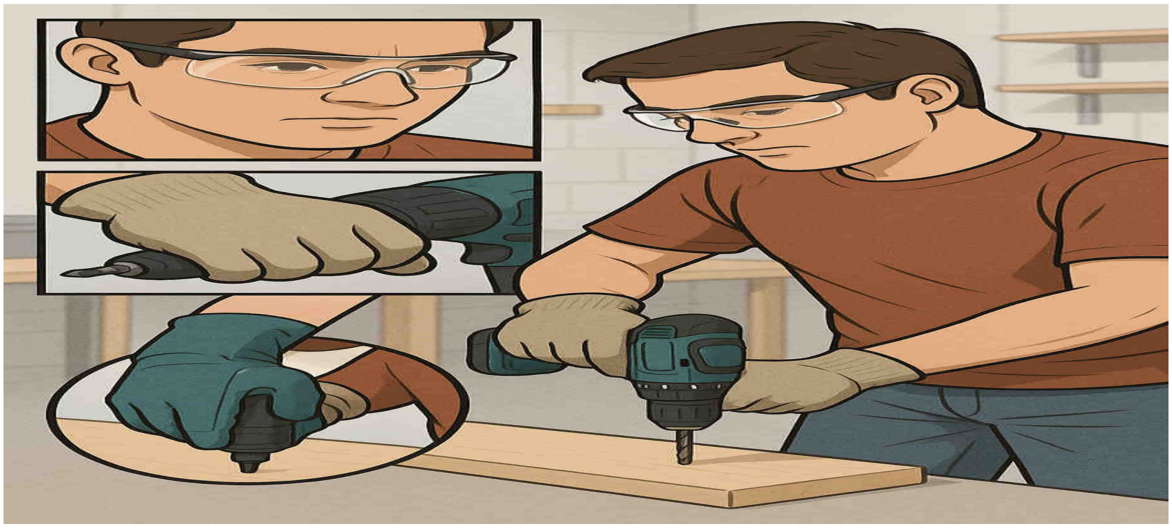
Proper Usage Techniques

Before you start drilling, always mark the exact spots where holes are needed. Use a pencil and measuring tape to ensure accurate placement. Hold the drill machine firmly with both hands - one on the main handle and the other supporting the body of the machine. This gives you better control and prevents the drill from slipping. When you press the trigger, start slowly and gradually increase the speed. This prevents the drill bit from wandering and helps create a clean, straight hole.

When drilling into walls, apply steady pressure but do not force the drill too hard. Let the drill bit do the work. If you push too hard, the bit might break or the drill might get stuck. For concrete walls, use the hammer function if your drill has one. This combination of rotation and hammering action makes drilling much easier and faster. Always drill perpendicular to the surface to ensure the hole is straight and the camera mount will sit properly.

Essential Safety Practices

Safety should always be your top priority when using drill machines. The rotating drill bit and high torque can cause serious injuries if not handled properly. Always wear safety glasses to protect your eyes from flying debris and dust particles. Small pieces of concrete, brick, or metal can shoot out during drilling and cause eye injuries. Safety gloves provide better grip and protect your hands from sharp edges and hot surfaces.



Safety equipment and proper drilling techniques for CCTV installation

Before starting work, check the drill machine for any damage. Ensure the drill bit is properly secured in the chuck and not loose. A loose bit can fly out during operation and cause injury. Keep the work area clean and well-lit so you can see clearly what you are doing. Remove any obstacles that might cause you to trip or lose balance while working.

Never wear loose clothing or jewelry that might get caught in the rotating parts. Tie back long hair and remove watches or chains. When drilling overhead, be extra careful about falling debris. Dust and small particles will fall down, so position yourself to avoid getting them in your eyes or breathing them in. Take frequent breaks to prevent fatigue, as tired workers are more likely to have accidents.

Maintenance and Care

Keep your drill machine clean and well-maintained for safe and efficient operation. After each use, wipe off dust and debris from the machine body and chuck. Store drill bits in a proper case to prevent them from getting damaged or lost. Check the battery charge regularly and recharge as needed. A weak battery can cause the drill to work poorly and may lead to accidents as you might apply extra force to compensate.

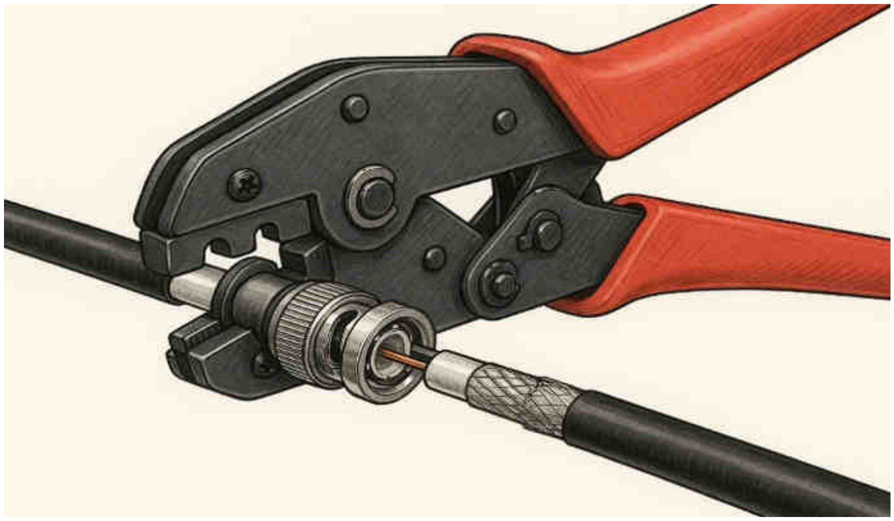
Regularly inspect drill bits for wear and damage. Dull or damaged bits require more force to cut and are more likely to break during use. Replace them promptly to maintain safe working conditions. By following these safety practices and proper usage techniques, you will be able to use drill machines effectively while protecting yourself and others around you.

4.2 Crimping Tools for BNC/RJ45

As a CCTV technician, you will frequently need to prepare cable connections that are reliable and long-lasting. Crimping tools are essential equipment that help you attach connectors to the ends of cables properly. These tools compress or →crimp→ metal contacts inside connectors to create strong electrical connections with cable wires. Without proper crimping, your CCTV system may have poor video quality, intermittent signals, or complete connection failures.

Understanding BNC Connectors and Crimping

BNC connectors are widely used in CCTV systems, especially with coaxial cables that carry video signals from analog cameras. BNC stands for Bayonet Neill-Concelman, named after its inventors. These connectors have a distinctive twist-lock mechanism that ensures secure connections. The BNC connector has two main parts - the center pin that carries the video signal and the outer metal sleeve that provides grounding and shielding.



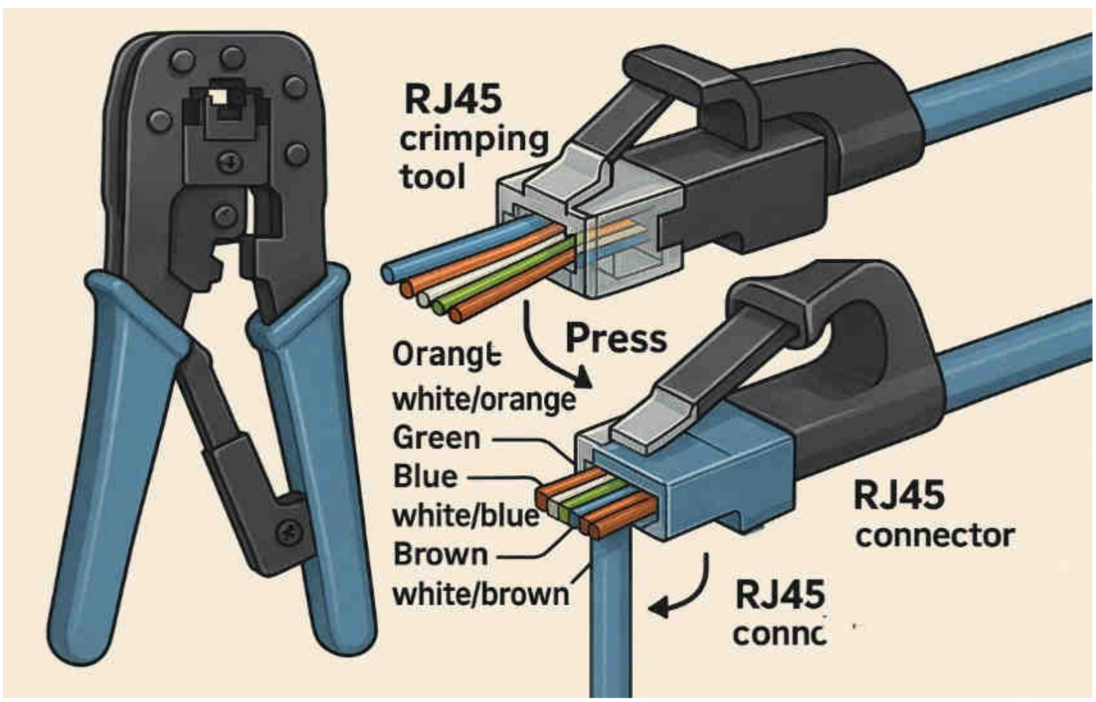
BNC crimping tool and connector used for CCTV coaxial cable connections

To prepare a BNC connection, you need a specialized BNC crimping tool. This tool has different sized dies or cavities that match the specific parts of the BNC connector. First, you strip the coaxial cable to expose the center conductor and braided shield. The center conductor goes into the center pin of the BNC connector, while the braided shield wraps around the connector body. The crimping tool then compresses these connections to make them permanent and secure.

The process requires careful preparation of the cable. You must strip the outer jacket to the correct length, usually about 6-↵millimeters. Then fold back the braided shield and strip the inner insulation to expose the center conductor. The center conductor should be just the right length - too long and it might short circuit, too short and it won't make good contact. After inserting all parts correctly, the crimping tool applies precise pressure to compress the metal contacts.

Working with RJ45 Connectors

RJ45 connectors are commonly used for network cables in modern IP-based CCTV systems. These rectangular plastic connectors have eight metal contacts arranged in a row, corresponding to the eight wires inside Cat5e or Cat6 network cables. IP cameras use these connections to send both video data and receive power through the same cable, a technology called Power over Ethernet (PoE).



RJ45 crimping tool and connector with ethernet cable wire arrangement

RJ45 crimping requires a different type of tool designed specifically for these connectors. The tool has a ratcheting mechanism that ensures consistent pressure and proper crimping every time. Network cables contain four pairs of twisted wires, each pair having different colors for identification. These wires must be arranged in a specific order according to wiring standards like T568A or T568B before being inserted into the RJ45 connector.

Preparing an RJ45 connection starts with stripping about 12-15 millimeters of the outer cable jacket. Be careful not to damage the individual wire insulation inside. Untwist the wire pairs and arrange them according to the chosen wiring standard. The most common standard for CCTV work is T568B, which has a specific color sequence: white-orange, orange, white-green, blue, white-blue, green, white-brown, brown.

Proper Crimping Techniques

Good crimping technique is crucial for reliable connections. Always use the correct crimping tool for each connector type - never try to use pliers or other improvised tools. Insert the connector fully into the crimping tool and ensure it sits properly in the die. Apply steady, firm pressure until the ratcheting mechanism releases, indicating the crimp is complete.

After crimping, always test your connections. Give the cable a gentle tug to ensure the connector is securely attached. Visual inspection is also important - properly crimped connectors should have evenly compressed contacts with no loose wires visible. For

RJ45 connectors, you should be able to see each colored wire through the clear plastic connector, confirming correct wiring order.

Quality and Maintenance

Quality crimping tools make a significant difference in connection reliability. Cheap tools often produce inconsistent results and may damage connectors. Professional-grade crimping tools have replaceable dies and calibrated pressure mechanisms that ensure consistent results. Keep your crimping tools clean and properly stored to maintain their accuracy.

Regular maintenance includes cleaning the tool dies and checking for wear. Damaged or worn dies can produce poor crimps that fail over time. Some advanced crimping tools have built-in wire strippers and cutting blades, making them very convenient for field work. Learning to use these tools properly will help you create professional-quality cable connections that provide years of reliable service in CCTV installations.

4.3 Cable Testers and Continuity Testers

After installing CCTV cables and making connections, you need to verify that everything is working correctly before connecting expensive cameras and recording equipment. Cable testers and continuity testers are essential tools that help you check if your cable installations are properly done. These testing devices can save you hours of troubleshooting time by quickly identifying problems in cable connections, wiring faults, and signal transmission issues.

Understanding Cable Testers

Cable testers are sophisticated electronic devices designed to check various types of cables used in CCTV systems. They can test both network cables (like Cat5e and Cat6) and coaxial cables used for analog cameras. Modern cable testers have digital displays that show detailed information about cable performance, including continuity, wire mapping, length measurement, and signal quality indicators.

Cable tester device used for testing network and coaxial cables in CCTV systems

When you connect a cable to a cable tester, it sends electrical signals through each wire and measures how well these signals travel from one end to the other. For network cables, the tester checks all eight wires to ensure they are connected correctly according to wiring standards. It can detect problems like crossed wires, broken connections, short circuits, and incorrect pin assignments. Some advanced testers can even measure the length of the cable, which is helpful when you need to know exactly how much cable you have installed.

For coaxial cables used with analog CCTV cameras, cable testers check the center conductor and the outer shield separately. They verify that both parts of the cable are intact and properly connected. The tester can identify breaks in the center wire, damage to the outer shielding, or poor connections at the BNC connectors. This information helps you locate and fix problems before they affect video quality.

Working with Continuity Testers

Continuity testers are simpler devices that check whether electrical connections are complete and unbroken. They work on a basic principle - if electricity can flow from one point to another through a wire or connection, the circuit has continuity. When continuity exists, the tester usually makes a beeping sound or lights up an indicator lamp. If there is a break in the wire or a poor connection, the tester remains silent and shows no indication.

Continuity tester with probe leads for checking electrical connections

These testers are particularly useful for checking individual wires and simple connections. For example, if you suspect that a particular wire in a network cable is broken, you can use a continuity tester to check just that wire. Touch one probe to the wire at one end of the cable and the other probe to the same wire at the other end. If the tester beeps, the wire is good. If it remains silent, there is a break somewhere in that wire.

Continuity testers are also helpful for checking the quality of crimped connections. After making a BNC or RJ45 connection, you can test whether the crimping process successfully joined the wire to the connector. Poor crimps might look good from the outside but have high resistance or intermittent connections that cause problems later.

Testing Procedures and Techniques

Proper testing requires following a systematic approach to ensure you don't miss any problems. Always test cables before final installation and again after all connections are made. Start by visually inspecting all connections for obvious problems like loose wires, damaged connectors, or incorrect crimping. Then use your testing equipment to verify electrical performance.

For network cables, connect both ends of the cable to the tester and run a complete test that checks all eight wires. Modern cable testers usually have two parts - a main unit and a remote unit. Connect one end of the cable to the main tester and the other end to the remote unit. The tester will automatically check each wire and display the results. Look for any wires that show →open→ (broken), →short→ (touching another wire), or →miswired→ (connected to wrong pins).

When testing coaxial cables, connect the cable to the appropriate inputs on your tester. Most cable testers have separate jacks for different types of cables. Run the test and check that both the center conductor and shield show good continuity and proper resistance values. Some testers can also check the impedance of coaxial cables, which should be 75 ohms for video applications.

Interpreting Test Results

Understanding what your test results mean is crucial for effective troubleshooting. Green lights or →PASS→ indicators generally mean the cable is good and ready for use. Red lights or →FAIL→ messages indicate problems that need to be fixed before the cable can be used reliably. Some testers provide detailed information about what specific problem was found, such as which wire is broken or where a short circuit exists.

Don't ignore marginal results or warnings. A cable that barely passes testing today might fail completely after being moved or exposed to temperature changes. It's better to replace questionable cables during installation rather than troubleshooting system failures later. Keep records of your test results, especially for large installations where you might need to trace problems months or years later.

Cable testers and continuity testers are investments that pay for themselves quickly by reducing installation time and preventing callback visits to fix problems. Learning to use these tools effectively will make you a more professional and efficient CCTV technician.

4.4 Measuring Tools and Multimeters

Accurate measurements are crucial for successful CCTV installations and troubleshooting. As a CCTV technician, you need both physical measuring tools to ensure proper camera placement and electrical measuring instruments to verify system performance. These tools help you work professionally and solve problems quickly when systems don't work as expected.

Essential Physical Measuring Tools

Physical measurements are the foundation of any good CCTV installation. Tape measures are your most basic but important tool for measuring distances between cameras, cable runs, and mounting heights. A good quality tape measure should be at least 25 feet long and have clear markings that are easy to read. Some modern tape measures have digital displays that show measurements electronically, which can be helpful in low light conditions.

Measuring tools including tape measure, level, and distance meter for accurate CCTV installations

Spirit levels help ensure that cameras are mounted straight and level. A crooked camera not only looks unprofessional but can also affect the viewing angle and coverage area. Most spirit levels have multiple bubble indicators - one for horizontal leveling and another for vertical alignment. Some levels also have 45-degree indicators for special mounting situations. Digital levels with LCD displays provide more precise readings and can be easier to read in various lighting conditions.

Laser distance meters have become very popular among professional installers because they provide accurate measurements quickly and can measure longer distances than tape measures. These electronic devices use laser beams to calculate distances and display results on digital screens. They are particularly useful for measuring ceiling heights, long cable runs, and distances to mounting points that are difficult to reach with traditional tape measures.

Understanding Multimeters

Multimeters are electronic measuring instruments that can measure multiple electrical properties including voltage, current, and resistance. They are essential tools for CCTV technicians because surveillance systems rely on proper electrical connections and power supply. Modern digital multimeters display readings on LCD screens and are much easier to read than older analog meters with moving needles.

Digital multimeter with test probes for measuring voltage, current, and resistance

The basic multimeter has several measurement functions selected by a rotary switch or push buttons. Voltage measurement (volts) tells you how much electrical pressure exists in a circuit. Current measurement (amperes or milliamperes) shows how much electricity is flowing through a circuit. Resistance measurement (ohms) indicates how much opposition there is to electrical flow, which helps identify broken wires or poor connections.

For CCTV work, you will primarily use the voltage measurement function to check power supplies and ensure cameras are receiving proper power. Most CCTV cameras operate on 12 volts DC, so you need to verify that power supplies are delivering the correct voltage. Low voltage can cause cameras to work poorly or not at all, while excessive voltage can damage expensive equipment.

Practical Applications in CCTV Systems

When installing power supplies for CCTV cameras, use your multimeter to check the output voltage before connecting any cameras. Touch the red probe to the positive terminal and the black probe to the negative terminal. The meter should show approximately 12 volts for most cameras. If the reading is significantly different, there may be a problem with the power supply that needs to be corrected.

Voltage drop is another important measurement in CCTV installations. When electricity travels through long cables, some voltage is lost due to wire resistance. Use your multimeter to measure voltage at the power supply and again at the camera end of the cable. If the voltage drops too much (more than 10% of the original voltage), you may need thicker cables or additional power supplies closer to the cameras.

Resistance measurements help identify cable problems and connection quality. A properly connected cable should show very low resistance, usually less than a few ohms for short runs. High resistance readings indicate poor connections, damaged cables, or corroded connectors. Infinite resistance (usually shown as →OL→ for overload) means there is a complete break in the circuit.

Safety and Proper Usage

Always follow safety procedures when using multimeters, especially when measuring voltage in live circuits. Never touch the metal tips of the test probes with your fingers while making measurements. Keep your hands behind the finger guards on the probes. Turn off power to circuits whenever possible before making measurements, but when you must measure live circuits, be extra careful to avoid short circuits between probe tips.

Before making any measurement, verify that your multimeter is set to the correct function and range. Start with higher ranges and work down to more sensitive settings to avoid damaging the meter. Many modern multimeters have auto-ranging features that automatically select appropriate measurement ranges, making them easier and safer to use.

Regular calibration and battery maintenance keep your measuring tools accurate and reliable. Replace multimeter batteries when low battery indicators appear, as weak batteries can cause incorrect readings. Store measuring tools properly to prevent damage and ensure they remain accurate over time. Quality measuring tools are investments that will serve you well throughout your career as a CCTV technician.

4.5 PPE (Gloves, Helmets, Goggles)

Personal Protective Equipment, commonly known as PPE, is essential safety gear that protects CCTV technicians from workplace injuries and health hazards. Working with electrical systems, power tools, and installation equipment exposes you to various risks including cuts, electrical shocks, falling objects, and eye injuries. Using proper PPE is not just a good practice - it is often required by law and company safety policies to ensure your protection while working.

Understanding the Importance of PPE

Every year, thousands of workers get injured on job sites because they were not wearing appropriate protective equipment. As a CCTV technician, you work with sharp tools, climb ladders, drill holes, and handle electrical equipment. These activities can cause serious injuries if proper precautions are not taken. PPE acts as your first line of defense against workplace accidents and can mean the difference between a minor incident and a life-changing injury.

Personal protective equipment (PPE) essential for CCTV technician safety

Many employers and job sites require workers to wear specific PPE before allowing them to enter work areas. Insurance companies also consider PPE usage when processing injury claims. Workers who get hurt while not wearing required safety equipment may not receive full compensation for their injuries. Beyond legal and financial reasons, wearing PPE shows that you are a professional who takes safety seriously, which can lead to better job opportunities and higher pay.

Safety Gloves for Hand Protection

Your hands are constantly exposed to hazards during CCTV installation work. Sharp cable ends can cause cuts, rough surfaces can scrape skin, and electrical components can cause shocks or burns. Safety gloves protect your hands while allowing you to maintain the dexterity needed for detailed work like crimping connectors and handling small electronic components.

Different types of gloves are designed for different hazards. Cut-resistant gloves have special fibers that prevent sharp objects from slicing through the material. These are ideal when working with cable stripping and cutting tools. Electrical-insulating gloves protect against electrical shock when working near live circuits. However, these thick gloves make detailed work difficult, so they are mainly used when testing or troubleshooting powered systems.

General work gloves made from leather or synthetic materials provide basic protection against scrapes, splinters, and minor cuts. These are suitable for most CCTV installation work including drilling, mounting cameras, and running cables. Choose gloves that fit properly - loose gloves can get caught in machinery while tight gloves restrict movement and cause hand fatigue.

Safety Helmets and Head Protection

Head injuries are among the most serious workplace accidents because they can cause permanent brain damage or death. Safety helmets, also called hard hats, protect your head from falling objects, bumping into overhead obstacles, and electrical hazards. When working on ladders or scaffolding, dropped tools or materials can fall with enough force to cause severe injuries to unprotected heads.

Modern safety helmets are lightweight and comfortable while providing excellent protection. They have hard outer shells that distribute impact forces and inner suspension systems that absorb shock. Some helmets have slots for attaching accessories like headlamps, face shields, or hearing protection. Choose helmets that meet safety standards and replace them after any significant impact or according to manufacturer recommendations.

Remember to inspect your helmet regularly for cracks, dents, or other damage that could reduce its protective effectiveness. UV exposure from sunlight can weaken helmet materials over time, so helmets used outdoors may need more frequent replacement. Proper helmet fit is crucial - adjust the suspension system so the helmet sits securely without being too tight or loose.

Safety Goggles and Eye Protection

Your eyes are extremely vulnerable to injury and cannot be repaired or replaced like other body parts. CCTV installation work exposes your eyes to flying debris from drilling, chemical splashes from cleaning solvents, and bright lights from welding or electrical arcs. Safety goggles create a protective barrier around your entire eye area, preventing foreign objects from causing damage.

CCTV technician properly equipped with safety gear during installation work

Different types of eye protection are designed for specific hazards. Impact-resistant goggles protect against flying particles and debris. Chemical splash goggles have sealed designs that prevent liquids from reaching your eyes. Welding goggles have darkened lenses that filter harmful radiation from bright arcs and flames. Some goggles have anti-fog coatings that prevent condensation from blocking your vision.

Safety glasses are lighter and more comfortable than goggles but provide less comprehensive protection. They are suitable for light-duty work where the risk of eye injury is lower. However, for drilling, grinding, or working with chemicals, full goggles provide better protection. Side shields on safety glasses help protect against objects coming from the sides.

Proper PPE Usage and Maintenance

Using PPE correctly is as important as having it. Always inspect your protective equipment before each use to ensure it is in good condition. Look for cracks, tears, or other damage that could reduce protection. Clean PPE regularly according to manufacturer instructions to prevent contamination and maintain effectiveness.

Store PPE properly when not in use to prevent damage and contamination. Keep gloves in clean, dry places away from sharp objects. Store helmets away from extreme temperatures and direct sunlight. Keep goggles in protective cases to prevent lens scratches. Replace PPE when it becomes damaged, worn out, or contaminated beyond cleaning.

Remember that PPE is your personal responsibility. Employers provide training and equipment, but you must choose to use it correctly every time. Developing good safety habits early in your career will protect you throughout your working life and demonstrate your professionalism to employers and customers.

What You Learned

1. Drill machines are essential tools for making holes in walls and surfaces for CCTV camera mounting brackets and cable installations.

2. Crimping tools attach BNC and RJ45 connectors to cables by compressing metal contacts to create secure electrical connections.
3. Cable testers and continuity testers check if cables are working properly and help identify wiring problems before connecting equipment.
4. Multimeters measure voltage, current, and resistance to verify electrical performance and troubleshoot CCTV system problems.
5. Measuring tools like tape measures, levels, and laser distance meters ensure accurate camera placement and professional installations.
6. Personal Protective Equipment (PPE) including gloves, helmets, and goggles protects technicians from workplace injuries and accidents.

Points to Remember

1. Always wear safety glasses and gloves when using drill machines to protect from flying debris and sharp surfaces.
2. Use the correct crimping tool for each connector type - BNC tools for coaxial cables and RJ45 tools for network cables.
3. Test all cable connections before final installation to avoid troubleshooting problems later.
4. Check power supply voltage with a multimeter before connecting cameras to prevent equipment damage.

5. Keep drill bits sharp and properly sized for different materials like concrete, wood, and metal.
6. Follow proper wire color sequences when crimping RJ45 connectors according to T568B standard.
7. Replace damaged or worn PPE immediately as it may not provide adequate protection.

↵ Store measuring tools and testing equipment properly to maintain accuracy and prevent damage.

Practical Exercises

1. Identify the Correct Drill Bit for Different Surfaces

Objective: To learn how to select appropriate drill bits for various materials encountered during CCTV installations.

Duration: 45 minutes

Materials Required:

- Sample drill bits (masonry, wood, metal, concrete)
- Different surface material samples (brick, concrete block, wood plank, metal sheet)
- Magnifying glass
- Chart paper for recording observations

Instructions:

Step 1: Drill Bit Examination (15 minutes)

- Examine different types of drill bits provided
- Observe the tip design, flute shape, and cutting edges of each bit
- Note the color coding and markings on different drill bits
- Record characteristics of masonry bits (carbide tip, wider flutes)
- Identify wood bits (pointed tip, deep spirals) and metal bits (black coating, sharp angles)

Step 2: Surface Material Analysis (15 minutes)

- Examine provided material samples (brick, concrete, wood, metal)
- Test hardness by scratching with a nail or coin
- Observe surface texture and density differences
- Record material properties in a comparison table
- Discuss why different materials need different drill bit designs

Step 3: Matching Exercise (10 minutes)

- Match each drill bit type to its appropriate surface material
- Explain your reasoning for each selection
- Discuss what happens if wrong drill bit is used
- Identify common mistakes technicians make in bit selection

Step 4: Assessment and Discussion (5 minutes)

- Present your matching results to the class
- Discuss real-world scenarios where bit selection is critical
- Share any observations about drill bit quality and maintenance

Assessment: Accuracy of bit identification, correct material matching, understanding of bit characteristics, and quality of explanations.

2. Identify and Compare BNC/RJ45 Crimping Tools

Objective: To recognize different types of crimping tools and understand their specific applications in CCTV work.

Duration: 50 minutes

Materials Required:

- Various crimping tools (BNC crimper, RJ45 crimper, universal crimper)
- Sample connectors (BNC, RJ45)
- Cable samples (coaxial, Cat5e)
- Tool specification sheets
- Comparison chart template

Instructions:

Step 1: Tool Identification (15 minutes)

- Examine different crimping tools provided
- Identify BNC crimping tools by their die shapes and size markings
- Recognize RJ45 crimpers by their rectangular crimping cavities
- Note any multi-function tools that can crimp different connector types
- Record tool model numbers and specifications

Step 2: Feature Analysis (15 minutes)

- Test the ratcheting mechanism on each tool
- Examine die quality and precision of crimping cavities

- Check for additional features like wire strippers or cable cutters
- Compare handle design and grip comfort
- Note any calibration marks or adjustment mechanisms

Step 3: Compatibility Testing (15 minutes)

- Match each tool with its appropriate connector type
- Test fit of connectors in crimping dies without actually crimping
- Identify tools that work with multiple connector sizes
- Compare tool quality by examining die precision and alignment
- Discuss price differences between professional and basic tools

Step 4: Tool Comparison Chart (5 minutes)

- Create a comparison chart listing tool features, applications, and quality ratings
- Include information about connector compatibility and ease of use
- Note any safety features or ergonomic designs
- Recommend best tools for different types of CCTV installation work

Assessment: Correct tool identification, understanding of applications, quality of comparison analysis, and practical recommendations.

3. Demonstrate Proper Safety Gear Usage and Handling

Objective: To practice correct usage, inspection, and maintenance of personal protective equipment (PPE).

Duration: 60 minutes

Materials Required:

- Various PPE items (safety glasses, goggles, gloves, helmets)
- PPE inspection checklist
- Simulated work scenarios
- Cleaning supplies for PPE maintenance

Instructions:

Step 1: PPE Inspection Practice (15 minutes)

- Examine each piece of PPE for defects, cracks, or wear
- Check helmet suspension systems and adjustment mechanisms
- Inspect goggle lenses for scratches and seal integrity
- Test glove flexibility and check for holes or tears
- Fill out inspection checklist for each item
- Identify PPE that should be replaced due to damage

Step 2: Proper Fitting and Adjustment (15 minutes)

- Practice adjusting safety helmets for secure, comfortable fit
- Learn proper way to wear safety goggles to prevent fogging
- Select appropriate glove sizes for different hand sizes
- Demonstrate correct positioning of safety glasses with side shields
- Practice quick donning and removal of PPE

Step 3: Scenario-Based PPE Selection (20 minutes)

Scenario A: Drilling overhead into concrete ceiling

- Select: Safety helmet, goggles, dust mask, work gloves
- Explain why each item is needed for this specific task

Scenario B: Crimping connectors at desk level

- Select: Safety glasses, cut-resistant gloves
- Discuss why heavy PPE might not be necessary

Scenario C: Testing electrical circuits with multimeter

- Select: Insulated gloves, safety glasses
- Explain electrical safety considerations

Step 4: PPE Maintenance and Storage (10 minutes)

- Demonstrate proper cleaning techniques for different PPE materials
- Practice correct storage methods to prevent damage
- Learn when to replace PPE based on usage and condition
- Create maintenance schedule for regular PPE inspection
- Discuss cost-effectiveness of proper PPE care

Key Skills Practiced:

- Visual inspection for defects
- Proper fitting and adjustment
- Scenario-appropriate PPE selection
- Maintenance and storage procedures
- Understanding of safety regulations

Assessment: Accuracy of PPE inspection, appropriate selection for scenarios, correct fitting demonstration, understanding of maintenance requirements, and safety awareness.

Practice Questions

Fill in the Blanks

1. A drill machine has different sized __________ or cavities that match the specific parts of drill bits for different materials.
2. __________ connectors are widely used in CCTV systems with coaxial cables and have a twist-lock mechanism.
3. Cable testers can detect problems like crossed wires, broken connections, and __________ circuits in network cables.
4. A __________ measures voltage, current, and resistance to verify electrical performance in CCTV systems.
5. __________ levels help ensure that cameras are mounted straight and provide proper viewing angles.

6. Personal Protective Equipment (PPE) acts as your first line of __________ against workplace accidents and injuries.

Fill in the Blanks - Answers

1. dies
2. BNC
3. short
4. multimeter
5. Spirit
6. defense

Multiple Choice Questions

1. Which drill bit type is best for drilling into concrete walls for CCTV camera mounting?

a) Wood drill bit

b) Metal drill bit

c) Masonry drill bit

d) Glass drill bit

2. What does BNC stand for in CCTV connectors?

a) Basic Network Connection

b) Bayonet Neill-Concelman

c) British National Connector

d) Binary Numeric Code

3. How many wires are inside a Cat5e network cable used for IP cameras?

a) 4 wires

b) 6 wires

c) ↵wires

d) 10 wires

4. What does a continuity tester check in electrical circuits?

a) Voltage levels

b) Current flow

c) Complete electrical connections

d) Power consumption

5. Which measuring tool uses laser beams to calculate distances?

a) Tape measure

b) Spirit level

c) Laser distance meter

d) Digital caliper

6. What voltage do most CCTV cameras operate on?

a) 5 volts DC

b) 12 volts DC

c) 24 volts AC

d) 220 volts AC

7. Which PPE is most important when drilling overhead?

a) Work gloves only

b) Safety glasses only

c) Safety helmet and goggles

d) Hearing protection only

8. What is the most common wiring standard for RJ45 connectors in CCTV work?

a) T568A

b) T568B

c) T568C

d) T568D

1. c) Masonry drill bit
2. b) Bayonet Neill-Concelman
3. c) ↵wires
4. c) Complete electrical connections
5. c) Laser distance meter
6. b) 12 volts DC
7. c) Safety helmet and goggles

↵. b) T568B

Short Answer Questions

1. List three types of drill bits and mention which materials they are used for.

2. Explain the difference between cable testers and continuity testers.

3. What safety precautions should be followed when using a multimeter on live circuits?

4. Why is it important to wear proper PPE during CCTV installation work?

5. Describe the proper procedure for crimping an RJ45 connector

UNIT 3- CABLES, CONNECTORS AND POWER SUPPLY

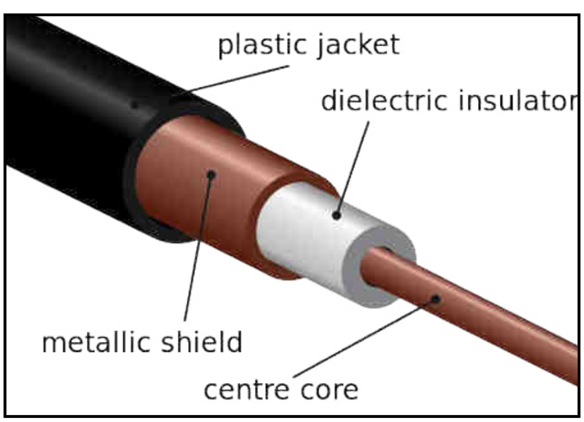
Session 3.1 Cable Types and Functions

The cables are the inherently required to provide reliable connections in any system installation. Their main function is to transmit electrical signals or data depending on the application. Different types of cables like power cables are used for electrical power supply, USB cables for charging, fiber optic cables for high-speed internet connections, coaxial cables for audio-video transmissions etc.

The cables required in CCTV camera installations depend on whether the system is analog (Audio High Definition (AHD), Transport Video Interface (TVI) or Composite Video Interface (CVI)) or IP-based. Coaxial cables RG59 are suited for AHD, IP-based network ethernet cables Cat 5/Cat 6 are used and Siamese cables are used for analog CCTV. All these cables are discussed in detail below.

3.1.1 Coaxial Cable (RG59)

A coaxial cable is an electrical cable which has a central conductor surrounded by a dielectric insulator, followed by a braided metallic sheet, enclosed in an outer insulating



layer as shown in the figure below. The plastic jacket the top cover which serves as the outer insulating layer. The central core and the metallic sheet share the same geometric axis, therefore the name coaxial.

Figure: Coaxial Cable

These cables are used to transmit high frequency signals with minimum interference and are commonly used in telecommunications and networking applications. These are an ideal choice to transmit radio frequency signals over long distances with minimum signal loss. The central conductor carries the electrical signal; the dielectric insulator stores the electrical and magnetic fields where as the outer metallic shield is grounded to prevent interference. The outer plastic jacket provides strength to the overall cable and increases its durability. There are various different standards of the coaxial cable like RG11, RG6, RG62 and RG59. The CCTV camera installation uses RG59 coaxial cable.

Technical specifications:

1. RG59 is typically used to transmit video signals over short-distances upto 100 feet. It suffers higher attenuation than RG6 cable, therefore it is used for short distance connections.
2. It is more flexible and thinner than other coaxial cables rendering it suitable for installation in confined and tight spaces.
3. Typically, the characteristic impedance of an RG59 cable is 75 ohms and an overall diameter of approximately $\frac{1}{4}$ inch.

4. The inner copper conductor has a diameter of 0.0253 inches (22 American Wire Gauge (AWG)).
5. The low-density polyethylene used as the dielectric has a capacitance of 22 pico-farads per foot.
6. The outer jacket is made of polyvinyl chloride.

3.1.2 Cat 5/Cat 6 for IP systems

Cat5 or Category 5 cable is a well-known standard used for Ethernet and networking. It refers to standard specifications and performance parameters set by Electronics Industry Association (EIA) and Telecommunications Industry Association (TIA). Generally used to connect computers over a Local Area Network (LAN), these are also used to connect IP-based CCTV cameras, gaming consoles, modems etc. This cable of an outer casing which consists of four pair of twisted copper wires, to prevent interference from electrical appliances and fluorescent lighting. Four pairs are equal to eight copper cables, where each pair of cables is color coded for easy identification. The figure below shows the Cat 5 cable and the connector RJ45 wire connections.

It supports a bandwidth of 100 MHz and therefore is suitable for data-rates up to 100 Mbps. Using RJ45 connectors, it ensures reliable connectivity up to 100 meters. The cable is highly flexible, extremely light weight and very easy to install. An improved version of Cat 5 is Cat 5e. Due to tighter twisting, it is more resistant to crosstalk and provides higher data-rates up to 1 Gbps. Typical twist rate in Cat 5 and Cat 5e is 1.5 to 2 twists per centi-meter. The diameter of Cat 5/ Cat 5e cables is normally 5.5 mm to 6.5

mm. The outer jacket of Cat 5 cables is normally made of PVC (polyvinyl chloride), but for safety critical applications LSZH (low-smoke zero halogen) is used, as it is known to emit very low smoke and other toxic gases in care of fire episodes.

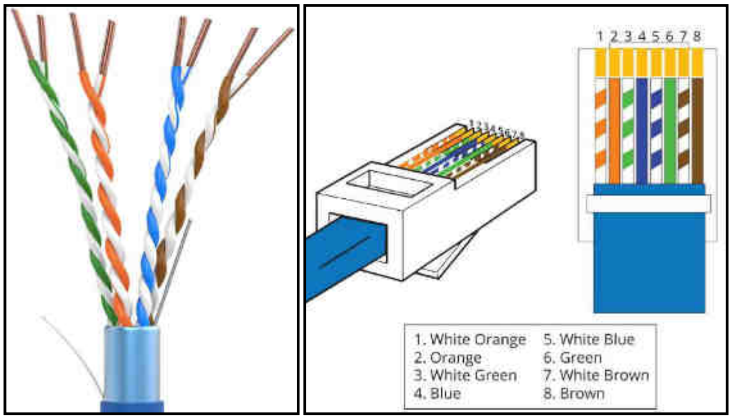


Figure: Cat 5 cable with 4-pair of twisted cables, and RJ 45 connector with color coding of Cat 5 cable.

Further high data rates up to 10 Gbps, and bandwidth of 250 MHz are supported by Cat 6 ethernet cables. These offer better speed, reduced interference and improved network reliability in comparison to Cat 5/ Cat 5e cables. The higher twist rates and a plastic spline (separator) between the twisted cables reduces crosstalk. The diameter of Cat 6 cable is around 5.8 mm – 6.8 mm. The Cat 6 cable along with the cross-sectional view of Cat 6 vs Cat 5 is shown in figure below. The shield separating the four pair of twisted cables for better crosstalk avoidance is visible as the center white area in the figure on the left side and as a cross mark on the figure on the right side.

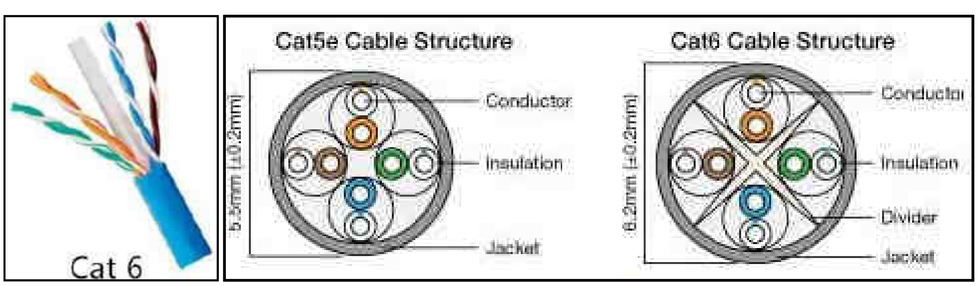


Figure: Cable structure of Cat 6

A comparative analysis of the cables is given below:

Table: Comparison of Cat 5, Cat 5e and Cat 6 Cables

Specification	**Cat 5**	**Cat 5e**	**Cat 6**
Speed	10 Mbps	1 Gbps	10 Gbps (up to 55 m)
Bandwidth	100 MHz	100 MHz	250 MHz
Crosstalk	Higher	Lower	Least
Interference	Moderate	Low	Least
Cost	Low	Low	Moderate
Structure	Basic Twist	Basic Twist	Tighter Twist with separator

3.1.3 Siamese cables – use in analog setups

Siamese cable is a versatile and widely used cable that combines both power and video transmission under one jacket for easy handling and installation. For video transmission it houses RG 59 coaxial cable; while for power it uses 2-core power wire, black for ground and red for +12V.

Figure: Siamese Cable

The RG 59 cables are approximately 6 mm in diameter; the power cables are 18 AWG sufficient to carry currents for CCTV cameras and are typically 4 mm in diameter. As a result, Siamese cables are thicker and harder to bend. These cables are suitable for connection ranges up to 200 m; signal amplifiers or boosters are required to further increase the transmission distance. Packing the power and video transmission cables together simplifies installation particularly in outdoor or large-scale surveillance systems. However, it can be used only for analog cameras and is not suited for IP cameras.

3.1.4 HDMI/VGA cables for monitors

The HDMI (High Definition Multimedia Interface) cables are used high speed digital transmission of audio and video signals, the cables are categorized as standard, mini and micro, as shown in the figure. It is a 19-pin connector with 4 pairs of twisted cables, 3 for data channels and one for clock. VGA (video graphics array) cable supports only analog video transmission and has a 15-pin connector (3 mini coaxial cables red, blue and green, and other wires for horizontal, vertical sync and ground line).

Figure: HDMI Cable/ VGA Cable

The VGA to HDMI is one of the most common cross port connections. The VGA analog output is connected to HDMI digital output; therefore, it needs a converter for the signal to be converted between analog and digital. The VGA to HDMI will require analog to digital converter, while HDMI to VGA will require digital to analog converter. Generally, VGA to HDMI is more expensive that their reverse counterparts. VGA carries only video signal, therefore for HDMI to VGA will require a separate audio jack output for sound. The pin diagrams of both HDMI and VGA are shown below:

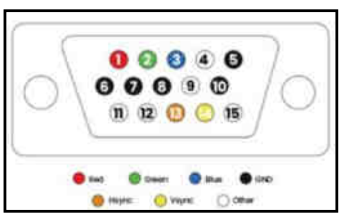


Figure: VGA Pin diagram

The pins 1,2,3 represent the three-color channels red, blue and green. Black is for the ground line and horizontal sync is pin no. 13 and vertical sync is pin no. 14

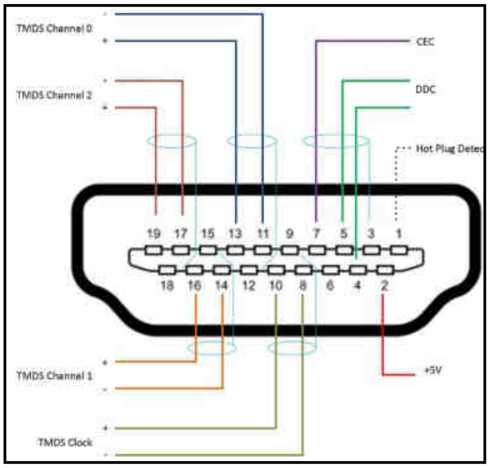


Figure: HDMI pin diagram (three TMDS channels at pin no. 11 & 13, 17 & 19, 14 & 16. Pin no. ↵and 10 for clock synchronization and pin no. 2 for +5 V)

Passive adapters mapping the wiring connections from VGA to HDMI ports or vice-versa fail as the two signals are incompatible. Note VGA works on analog signals while HDMI are digital signals. Analog and digital signals interconversion cannot be achieved using simple wire mapping. Active adapters are required to convert analog to digital or vice-versa. In either case the adapters can draw power from the HDMI pin no. 2 +5V.

3.1.5 Cable quality and shielding

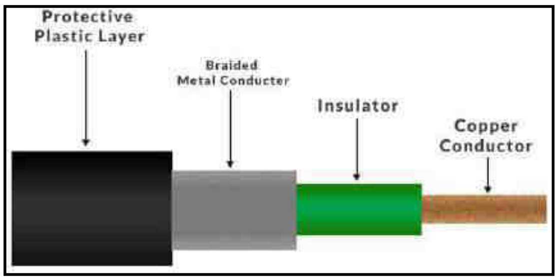
Cable quality and shielding directly affect signal quality and integrity, interference and the maximum transmission distance without the need for signal restoration using amplifiers. Cable quality and shielding determine the durability and flexibility of the cable and the maximum permissible connection distance without significant degradation in the signal quality. Copper is the best conductor which is used in cables because of its best conductivity and low signal loss per unit distance. The thickness of the conductor is measured in AWG (American Wire Gauge), higher AWG means thinner wires and considered low quality. Thicker wires are preferred because they offer lower resistance and less signal degradation per unit distance.

Dielectric materials determine signal shape and reduce attenuation therefore high-quality materials are used. Solid polyethylene (PE) or foamed polyethylene (FPE) is used as a dielectric in different coaxial, Cat 5 and ethernet cables. Ethernet cables might also use polypropylene (PP) as a dielectric. Generally, materials with low dielectric constant are preferred because these have lower signal attenuation.

Insulators play key role in preventing the signal distortion. Polyvinyl chloride (PVC) is a common choice as a general purposed insulator in consumer and indoor cables. But for buildings and public places where safety is important, LSZH is used as an insulator. It emits low smoke and toxic gases which is critical in case of fire incidents.

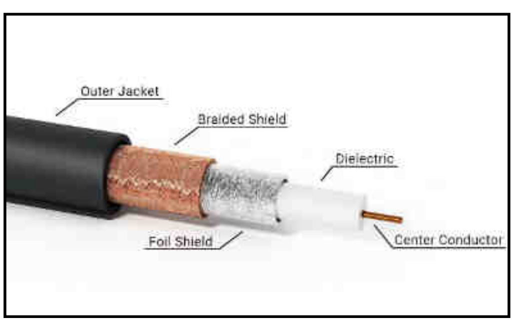
Shielding protects signals from electromagnetic interference and radio frequency interference. It is required to reduce crosstalk between adjacent conductors and thereby prevent signal contamination. It reduces the effect of noisy environments, nearby high frequency or power signals etc. Proper shielding not only limits the signal quality but also effects the cost and flexibility of the cable. CCTV cables housed in open environment require additional shielding to prevent damage from atmospheric conditions like variations in temperature and humidity, unforeseen circumstances like thunder storms, construction or renovation works in the surroundings etc. HDMI cables are high speed signals therefore require high quality shielding to prevent signal drop, flickering etc. VGA are analog signals which are extremely susceptible to noise therefore proper shielding, use of thicker conductors plays a crucial role in determining the signal quality. The shielding has:

1. **Single-shield:** one braid as used in RG59 and therefore have lower protection from electromagnetic interference. Cables with single shield are generally flexible and overall thinner. These are extremely popular in shorter runs, and low-interference areas.



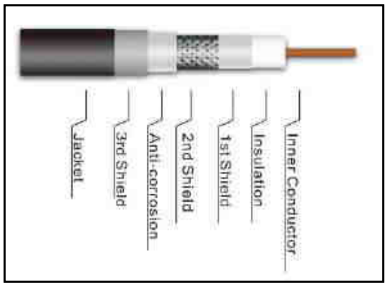
Single shield cable

2. **Dual-shield:** this type of shielding has one braided layer along with a foil. Commonly used in RG6 cables. As a result of double layer shielding, it provides better protection against interference. It is more flexible and easier to install as compared to quad shield, providing a reasonable trade-off between performance, cost and ease of installation. Double shield RG59 cables give better image quality with fewer interference artifacts. Especially used in scenarios where multiple cables shared conduits and trays.



Dual shield cable

3. **Quad shield:** it uses tow foils and two braids after the dielectric. This enhances it noise immunity and therefore used in industrial areas, lifts, transmitters where the interference is severe. Overall, the quad-shielded cable is thicker and stiff.



Quad shield

What You Learned:

1. Different types of CCTV cables: Coaxial cables, Cat 5 and Cat 6, HDMI/VGA.
2. Coaxial cables RG 59 are used for distances maximum up to 100 feet.
3. Cat 5 and Cat 6 are ethernet cables used for IP based CCTV cameras.
4. Siamese cables are for analog setups, bundling power and coaxial cables.
5. HDMI are for high-speed digital transmission, VGA for analog video signals.
6. HDMI to VGA or vice-versa requires an active powered converter.
7. Dielectric materials and shielding are used to prevent interference and signal degradation.

↵ Copper is the best choice for conducting material due to its low resistivity.

Points to Remember:

1. Signal quality degrades with distance. Therefore, cable length plays a crucial

role to ensure reliable connectivity.

2. Siamese cables houses both coaxial cable and power cables under a single jacket.
3. HDMI to VGA cross port connections can never be used without a converter.
4. VGA only supports video transmission.
5. HDMI to VGA will require separate audio jack and sound cable for audio.

Experiment-1: Demonstration of different types of coaxial cables.

Objective: To identify, compare, and evaluate single-shield, dual-shield, and quad-shield coaxial cables (RG59 and RG6) by examining their physical construction, measuring electrical properties (impedance, continuity).

Requirements:

1. Multimeter (digital, with continuity and resistance modes)
2. Ohmmeter or LCR meter (for impedance verification, optional)
3. Oscilloscope or signal generator (optional, for advanced testing)
4. Cable tester or continuity probe
5. Cable samples: RG59 single-shield (basic coax with one braid layer), RG59 dual-shield (foil + braid construction), RG6 dual-shield (larger diameter, better shielding), RG6 quad-shield (two foils + two braids, high performance)

Instructions:

PHYSICAL INSPECTION AND CONSTRUCTION

Step 1: Examine Cable Dimensions

1. Using a ruler or calipers, measure the outer diameter of each cable sample.

2. Record in a table (Example: RG59 ≈ 2.4 mm; RG6 ≈ 3.7 mm; quad-shield RG6 ≈ 4.2 mm).
3. Note jacket color, flexibility, and overall appearance.

Step 2: Cross-Section and Layer Analysis

1. Carefully cut a 3-5 cm section from each cable sample (preferably from samples already damaged or intended for destructive testing).
2. Using scissors or a utility knife, peel back the outer jacket to expose the shield layers.
3. Count and describe shield layers:
   - Single-shield: typically one copper braid layer
   - Dual-shield: one metallic foil + one copper braid
   - Quad-shield: two foil layers + two braid layers (layers may alternate)
4. Observe the dielectric (insulation) material (usually polyethylene or foam).
5. Inspect the center conductor (solid or stranded bare copper, copper-clad steel, or aluminum).
6. Using a magnifying glass, examine braid density and coverage percentage.
7. Record observations and take photographs if possible.

Step 3: Conductor Quality Assessment

1. Scrape or expose a small section of the center conductor on each cable.
2. Inspect color: bright copper indicates pure copper; dull or silvery suggests copper-clad steel or aluminum (lower quality and higher loss).

3. Measure conductor diameter using calipers (typical: RG59 ~0.73 mm, RG6 ~0.81 mm).
4. Record conductor type and diameter.

ELECTRICAL MEASUREMENTS

Step 1: Continuity Testing

1. Set multimeter to continuity mode (beep function).
2. For each cable sample (minimum 1 m length):
   - Strip ~5 mm insulation from both ends.
   - Test center conductor: probe one end to the other; verify beep (continuous path).
   - Test shield: probe braided outer shield from end to end; verify beep.
   - Test for shorts: probe center conductor to shield at one end; no beep indicates proper isolation.
3. Record pass/fail for each conductor and shield.
4. Repeat for at least three cables of each type.

Step 2: Resistance Measurements

1. Switch multimeter to resistance (Ω) mode, 200 Ω range.
2. Measure the resistance of the center conductor over a known length (e.g., 10 m):
   - Formula: Resistivity = (R × A) / L, where A = cross-section area, L = length
   - Compare results across cable types.

3. Measure shield resistance (braid and foil combined):
    - Lower resistance indicates better shielding effectiveness.
4. Record all values and note any anomalies.

Assessment:

1. *Construction and Design:* How do the number of shield layers and conductor quality relate to the cost and flexibility of each cable type?
2. *Electrical Performance:* Based on continuity and resistance tests, which cable type shows the best overall electrical characteristics? Why might higher-quality cables have lower resistance?

Experiment-2: Dual function of Siamese cable in analog setup

Objective:

To understand and experimentally verify the dual function of Siamese cable—simultaneous transmission of composite video and DC power—in an analog CCTV system. Evaluate voltage drop, and image quality.

Requirements:

1. Regulated DC power supply (12V DC, 2A minimum)
2. Analog CCTV camera (composite video output, 12V DC power input)
3. Siamese cable (RG59 with 2-conductor power pair, minimum 10 m length)
4. Reference cables: separate RG59 coax and 18 AWG 2-conductor power cable
5. Multimeter (DC voltage, current modes)

6. Clamp meter or inline ammeter (to measure current draw)
7. Oscilloscope or signal monitor (optional, to observe video waveform)

↵ BNC connectors and DC power connectors/terminals

↳ Coaxial cable stripper and crimper

Instructions

Step 1: Prepare and Terminate Siamese Cable

1. Cut a length of Siamese cable identical to the test distance (e.g., 10 m, 25 m, or 50 m).
2. At the camera end:
   - Strip ~10 mm of outer jacket.
   - Terminate the RG59 coax with a male BNC connector (solder the center conductor and solder/crimp the shield to the outer contact).
   - Strip and terminate the 2-conductor power pair with DC terminals (screw or solder type).
3. At the DVR/power supply end:
   - Terminate the coax with a female BNC adapter or monitor plug.
   - Terminate the power pair with connectors matching the power supply.
4. Verify all terminations are secure and properly insulated.

Step 2: Connect Siamese Cable and Observe Performance

1. Disconnect the separate video and power cables from the camera.
2. Connect the Siamese cable:
   - BNC video connector to camera's video output.

- Power pair to camera's 12V power input.
- Coax to DVR/monitor BNC input.
- Power pair to power supply output.

3. Power on the system and observe:
    - Does the camera light up?
    - Does the DVR display a live image?
    - Compare visual quality (brightness, noise, color) to baseline.
4. Take a screenshot or photograph of the DVR/monitor display.
5. Using the multimeter, measure:
    - Voltage at the camera power input (note any drop compared to baseline).
    - Current draw (compare to separate cable setup).

Step 3: Measure Voltage Drop Along the Siamese Cable

1. Set the multimeter to DC voltage mode (20V range).
2. Connect the black probe to ground (negative terminal of the power supply).
3. Measure voltage at the power supply output (should be 12.0V nominal).
4. Measure voltage at the camera's power input (after transmission through Siamese cable).
5. Calculate voltage drop: ΔV = Supply voltage − Camera input voltage.
6. Repeat measurements at different camera current loads (if possible, adjust DVR brightness or add a test load resistor):
    - No additional load

- 250 mA additional load (optional resistor or second camera)
- 500 mA additional load

7. Record all values and observe how voltage drop increases with distance and current.

Step 4: Evaluate Voltage Drop Impact

1. Note any observable changes in camera behavior as voltage drops:
    - Does the IR LED brightness decrease?
    - Does the image become darker or noisier?
    - Is there any flicker or loss of sync?
2. Compare acceptable voltage drop thresholds:
    - Typically, analog cameras tolerate 12V ± 10% (10.8V–13.2V).
    - Below 10.8V, performance degrades.

Assessment:

1. **Dual Function Principle**: Explain how Siamese cable carries both video and power without significant interference. What physical separation prevents cross-talk between the coax and power pair?
2. **Voltage Drop**: Based on your measurements, how does cable length affect voltage drop? At what cable length or current does the voltage drop become unacceptable (< 10.8V)?
3. **Signal Quality**: Compare the video quality (brightness, noise, artifacts) between separate cables and Siamese cable. Were there any observable differences? If yes, what caused them?

Experiment-3: Testing display connections in HDMI/VGA cables for monitors

Objective:

To systematically test, identify, and evaluate HDMI and VGA display cables for connectivity faults, electrical integrity, and performance in real-world monitor setups. Use multimeter continuity tests, dedicated cable testers, functional swap tests, and signal quality observations to determine which cables are reliable and which have intermittent or complete failures.

Requirements:

1. Multimeter (digital, with continuity and resistance modes)
2. VGA cable tester or continuity probe
3. HDMI cable tester (handheld with LED indicators, optional but recommended)
4. Personal computer or laptop with HDMI and VGA ports
5. Two or more monitors (at least one with VGA input, one with HDMI input; dual-input monitor ideal)
6. Test cables: 3–5 HDMI cables (mix of known-good and suspect)
7. Test cables: 3–5 VGA cables (mix of known-good and suspect)

↵. Display resolution test pattern software (freely available online)

↳. Oscilloscope or signal analyzer (optional, for advanced waveform analysis)

Part A: Visual Inspection and Physical Assessment

Step 1: Catalog and Inspect All Test Cables

1. For each cable, record in a table:

- Cable type (HDMI or VGA)
- Approximate length (measure if possible)
- Connector condition: visually inspect for bent/broken pins, corrosion, physical damage
- Cable jacket condition: check for cuts, kinks, crushing, or discoloration
- Flexibility and apparent wear

2. Using a magnifying glass, examine VGA connectors closely:
    - Count and identify all 15 pins
    - Note any bent, missing, or corroded pins
    - Check for debris or oxidation on contact surfaces
3. Examine HDMI connectors:
    - Verify symmetric form factor (Type A standard)
    - Check for loose or damaged shell
    - Inspect gold plating on contacts (should be shiny, not tarnished)

Part B: Electrical Continuity and Resistance Testing

Step 2: VGA Continuity Testing

1. Set multimeter to continuity mode (beep function).
2. For each VGA cable:
    - Locate the 15-pin VGA connector pin layout (reference diagram):
        - Pins 1, 2, 3: Red, Green, Blue (RGB video data)
        - Pins 5, 6, 7, 8, 10: Ground and sync returns

        - Pins 11, 12, 13, 14, 15: ID and other signals
    - Strip ~3 mm of insulation from the inner conductors at one end if necessary.
3. Test each video signal conductor (Pins 1, 2, 3):
    - Probe pin 1 at one end; touch probe to pin 1 at other end; verify beep (continuous).
    - Repeat for pins 2 and 3.
    - Record continuity for each: Pass/Fail.
4. Test ground and sync pins (Pins 5–10):
    - Probe pin 5 at one end; touch to pin 5 at the other; verify beep.
    - Test at least pins 5, 6, and 10 for shielding integrity.
    - Record results.
5. Test for shorts between adjacent pins:
    - Probe pins 1 and 2 (at same end); multimeter should **not** beep (open circuit).
    - If beep occurs, note as a short (cable fault).
    - Repeat between RGB pins and between RGB and ground; no shorts expected.

Step 3: HDMI Continuity Testing (if using dedicated HDMI tester)

1. If a handheld HDMI cable tester is available:
    - Plug one end of the test cable into the transmitter unit.
    - Plug the other end into the receiver unit.
    - Follow the tester's instructions (typically press a button to cycle

through all 19 pins).

    - LED indicators show: **Green** (pass), **Red** (open or short), **Yellow** (warning).

2. Record the result for each HDMI cable: Pass/Fail/Warning.
3. If the tester provides detailed pin-by-pin feedback, note which pins (if any) are problematic.

Step 4: Resistance Measurements

1. Set multimeter to resistance mode (200 Ω range for short cables; higher range for longer cables).
2. For each VGA cable, measure the resistance of:
    - Center conductor of Pin 1 (red signal): record resistance over full cable length
    - Center conductor of Pin 5 (ground): compare resistance (should be low, typically < 10 Ω for a 5 m cable)
3. Compare resistance values across cables:
    - Identical cable types should have similar resistance per meter
    - Unusually high resistance suggests corroded contacts or internal breaks
    - Very low resistance in ground suggests good shielding
4. For HDMI, if a dedicated tester is unavailable, measure overall resistance from one connector to the other using pins designated for ground; expect very low values (< 1 Ω typically).

Part C: Functional Testing on Live Monitors

Step 5: Establish Baseline with Known-Good Cable

1. Connect a known-good cable (from a working system or new cable) between your PC and a monitor:
   - For VGA: connect to PC's VGA output and monitor's VGA input
   - For HDMI: connect to PC's HDMI output and monitor's HDMI input
2. Boot the PC and configure display settings:
   - Set native resolution (typically 1920×1080 for modern monitors)
   - Set refresh rate (60 Hz standard)
3. Load a display test pattern (e.g., from testufo.com or similar):
   - Use a pattern with color gradients, text, and fine details
   - Observe and photograph the baseline image quality:
     - **Brightness**: uniform across screen, no dark corners
     - **Color accuracy**: reds, greens, blues vibrant and distinct
     - **Sharpness**: text and small details crisp and clear
     - **No artifacts**: no rolling bars, ghosting, or snow

Step 6: Cable Substitution Test – VGA

1. Keeping the PC and monitor settings identical, replace the baseline VGA cable.
2. Observe the display:
   - Does the monitor detect a signal (indicator light on)?
   - Does the image appear immediately, or is there a delay?

- **If no signal**: Note →No Display→ in the table and move to the next cable
- **If signal present**: Evaluate image quality:
  - Brightness (compare to baseline)
  - Color appearance (all three primaries present, or missing a color?)
  - Text clarity and sharpness
  - Presence of artifacts (rolling bars, noise, ghosting, flicker)

Part D: Signal Quality and Stress Testing

Step 7: Resolution and Refresh Rate Stress Test

1. Using a test cable, incrementally increase display resolution and refresh rate:
   - Start at 1920×1080@60 Hz (baseline)
   - Increase to 1920×1080@75 Hz
   - If supported, try 2560×1440@60 Hz or higher

Assessment:

1. **Physical-to-Electrical Correlation**: Did visible physical damage (bent pins, cuts, corrosion) always correlate with electrical test failures (open, short, high resistance)? Describe any exceptions.
2. **Electrical-to-Functional Correlation**: For cables that failed continuity tests, did they always fail to display an image? If some displayed partial images despite electrical faults, explain why (e.g., Pin 3 open yet red and green work).
3. **VGA Pin Function Analysis**: You tested pins 1, 2, 3 (RGB video). How did

failure of a single color channel manifest on the monitor display? Can you identify which pin corresponds to which color based on the image symptom?

4. **Resolution Dependency**: Did any cables work at 1920×1080@60 Hz but fail at higher resolutions or refresh rates? Why would higher bandwidth demand cause failures in cables that passed low-bandwidth tests?

Fill in the blanks:

1. RG59 coaxial cable has a characteristic impedance of ______ ohms and uses a ______ AWG solid copper center conductor.

2. 2. Cat6 Ethernet cables support up to ______ Gbps speeds over ______ meters with a bandwidth of ______ MHz due to tighter twists and plastic spline separator.

3. Siamese cable combines RG59 coax for ______ transmission with 18 AWG power pair (red +12V, black ______) for analog CCTV cameras.

4. In VGA connectors, pins 1, 2, and 3 carry the ______ color channels respectively, while pin 13 is ______ sync and pin 14 is ______ sync.

5. Active adapters for HDMI/VGA conversion draw power from HDMI pin no. ______ (+5V), while ______ shielding provides better EMI protection than single-shield RG59.

Objective Questions:

1. **Which cable type is specifically recommended for analog CCTV installations up to 100 feet due to its flexibility and 75Ω impedance?**

   a) Cat6

   b) RG59

   c) Siamese

   d) HDMI

2. **What is the primary structural difference between Cat5e and Cat6 cables that improves crosstalk performance?**

   a) Thicker jacket

   b) Plastic spline separator

   c) Solid copper conductors

   d) Quad shielding

3. **For HDMI-to-VGA conversion, why do passive adapters fail completely?**

   a) Insufficient shielding

   b) Analog-digital signal incompatibility

   c) Voltage mismatch

d) Pin count difference

4. **Which shielding type uses two foil layers and two braid layers, making it suitable for high-EMI industrial CCTV environments?**

   a) Single-shield

   b) Dual-shield

   c) Quad-shield

   d) Unshielded

5. **What is the maximum reliable transmission distance for Siamese cable in analog CCTV systems without signal boosters?**

   a) 50m

   b) 100m

   c) 200m

   d) 500m

Session 3.2 Connector Termination

3.2.1. BNC Crimping and Screw-on Methods

When working with CCTV systems, you need to connect coaxial cables to cameras, monitors, and recording devices. This is where BNC connectors come into play. BNC stands for Bayonet Neill-Concelman, named after the two engineers who invented it in the late 1940s. These connectors help you to join coaxial cables securely to transmit video signals without losing quality.

There are two main ways to attach BNC connectors to coaxial cables - crimping and screw-on methods. Each method has its own advantages and uses, and as a CCTV technician, you should understand both techniques well.

3.2.1.1. Understanding the Crimping Method

Crimping is like permanently squeezing the connector onto the cable using a special tool called a crimping tool. Think of it like using pliers to squeeze something very tightly, but with much more precision and force. The crimping method creates a strong, permanent connection that cannot come loose easily. When you crimp a BNC connector, you are essentially pressing metal parts together so tightly that they become one solid connection. This process involves two main steps - first crimping the centre pin to the inner conductor of the cable, and then crimping the outer sleeve to secure the whole connector to the cable.

One major advantage of crimped connections is that they handle vibration very well. If your camera is mounted on a pole that sways in the wind or on equipment that moves, crimped connectors will not come loose. They also provide excellent protection against moisture getting into the connection, which is crucial for outdoor installations.

3.2.1.2. Understanding the Screw-on Method

The screw-on method, also called twist-on method, is much simpler and faster to use. These connectors do not need any special tools - you can attach them using just your hands and basic cable stripping tools. The connector literally screws onto the prepared cable end by twisting it clockwise until tight. This method is popular because it saves time during installation. When you are working in the field and need to make connections quickly, screw-on connectors can be very convenient. They are also less expensive than crimp-on connectors and do not require you to carry heavy crimping tools.

However, screw-on connectors have some important limitations that you must understand. The main problem is that they can work loose over time, especially when there is vibration or movement. This can cause your video signal to become unstable or disappear completely at the worst possible moment.

Another significant issue with screw-on connectors is moisture protection. Because they are not sealed as tightly as crimped connectors, water and humidity can get inside the connection. This leads to corrosion of the cable and poor signal quality over time, particularly in outdoor installations.

3.2.1.3. Choosing the Right Method

Aspect	Crimping Method	Screw-on Method
Best Use	Permanent installations, especially outdoors and where cables may vibrate	Temporary connections, indoor use, or when frequent reconnections are needed
Reliability	Very reliable, rarely comes loose	Less secure, can loosen over time
Tools Required	Requires special crimping tool and cable stripper	No special tools needed; just hand tightening
Installation Time	More time-consuming and requires practice	Faster and simpler to install
Signal Quality	Generally better, minimal signal loss	May cause slightly more signal loss
Suitability for High-Definition Cameras	Preferred due to better signal quality	May affect performance if loosening or poor installation occurs
Resistance to Vibration	Excellent, holds tightly under vibrations	Poor, more likely to loosen with movement
Moisture	Better protection against	Less protection, more prone to

Aspect	Crimping Method	Screw-on Method
Protection	moisture and corrosion	corrosion outdoors
Cost	Slightly higher due to tools and time	Generally cheaper and tool-free
Learning Curve	Requires skill and practice	Easy to learn and use

This table summarizes the key points to help decide between crimping and screw-on BNC connector installation methods clearly.

As you develop your skills as a CCTV technician, you will learn to judge which method is appropriate for each job. Understanding both techniques and their trade-offs will make you more versatile and professional in your work. Remember that the extra time spent learning proper crimping techniques will pay off with fewer service calls and happier customers in the long run.

Figure 1: Tools and connectors for working with RG59 coaxial cable including crimping and stripping tools. (Reference: https://videos.cctvcamerapros.com/surveillance-system-installations/how-to-attach-crimp-on-f-connector-to-rg59-coaxial-cable.html)

3.2.2. RJ45 Connector Pinout (T568A/B)

When you work with modern CCTV systems, especially IP cameras and network video recorders, you will often need to work with network cables. These cables use special connectors called RJ45 connectors that look like larger versions of phone plugs. The RJ45 connector is the standard way to connect network devices, and understanding how to wire them correctly is essential for any CCTV technician.

Inside every network cable, you will find eight colored wires arranged in four pairs. These wires carry both data signals and power to your CCTV equipment. But these wires cannot just be put in any order - they must follow specific patterns called wiring standards to work properly.

3.2.21. Understanding T568A and T568B Standards

There are two main wiring standards for RJ45 connectors: T568A and T568B. Both standards were created by telecommunications organizations to make sure that network cables work the same way everywhere. Think of these standards like traffic rules - everyone must follow the same rules so that everything works smoothly and safely.

The main difference between T568A and T568B is quite simple. They use exactly the same eight coloured wires, but the green and orange pairs are switched around. In T568A, the green pair goes to positions 1 and 2, while the orange pair goes to positions 3 and 6. In T568B, this is reversed - the orange pair goes to positions 1 and 2, and the green pair goes to positions 3 and 6.

3.2.2.2. T568A Colour Sequence

In T568A wiring, the colours go in this exact order from position 1 to position 8: white with green stripe, solid green, white with orange stripe, solid blue, white with blue stripe, solid orange, white with brown stripe, and solid brown. This might seem like a lot to remember at first, but with practice, it becomes automatic.

3.2.2.3. T568B Colour Sequence

T568B follows a slightly different pattern: white with orange stripe, solid orange, white with green stripe, solid blue, white with blue stripe, solid green, white with brown stripe, and solid brown. Notice how the orange and green pairs have simply switched places compared to T568A.

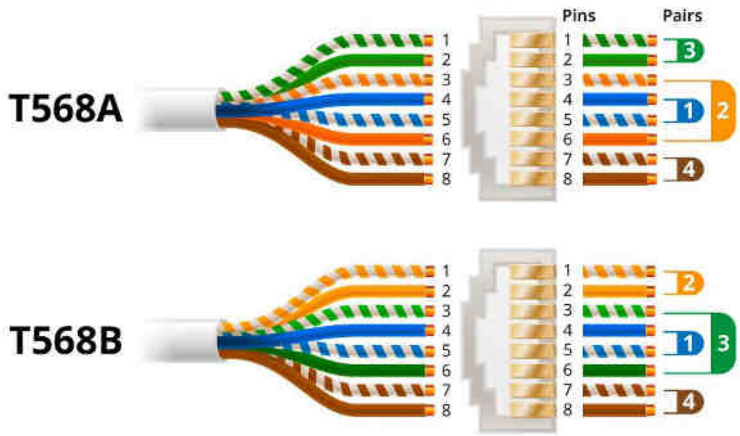


Figure 2: Wiring diagram for T568A and T568B RJ45 Ethernet cable standards showing color-coded wire pairs and pin assignments (Reference: https://www.flukenetworks.com/knowledge-base/application-or-standards-articles-copper/differences-between-wiring-codes-t568a-vs)

1.2.2.3. Why Two Different Standards Exist

You might wonder why we need two different standards when they do essentially the same job. The answer lies in history and compatibility. T568A was designed to work well with older telephone systems and provides better backward compatibility with equipment that was already installed. This makes it useful when you are working in buildings that have older wiring systems.

T568B became more popular because it matched the colour coding that telephone companies were already using, particularly the AT&T system that was common in the United States. Most commercial installations today use T568B because installers became familiar with it and it works perfectly for modern network equipment.

3.2.2.4. Choosing the Right Standard

For your CCTV installations, both standards work equally well in terms of performance. Modern IP cameras and network equipment can work with either standard without any problems. The most important rule is consistency - you must use the same standard at both ends of each cable.

If you are working in a building that already has network cabling, you should find out which standard was used and stick with it. Mixing T568A and T568B in the same installation can cause confusion during troubleshooting and maintenance, even though it might not cause immediate problems.

For new installations, T568B is generally recommended because it is more commonly used in commercial settings and most technicians are familiar with it. However, government buildings and some residential installations might require T568A, so always check the project specifications first.

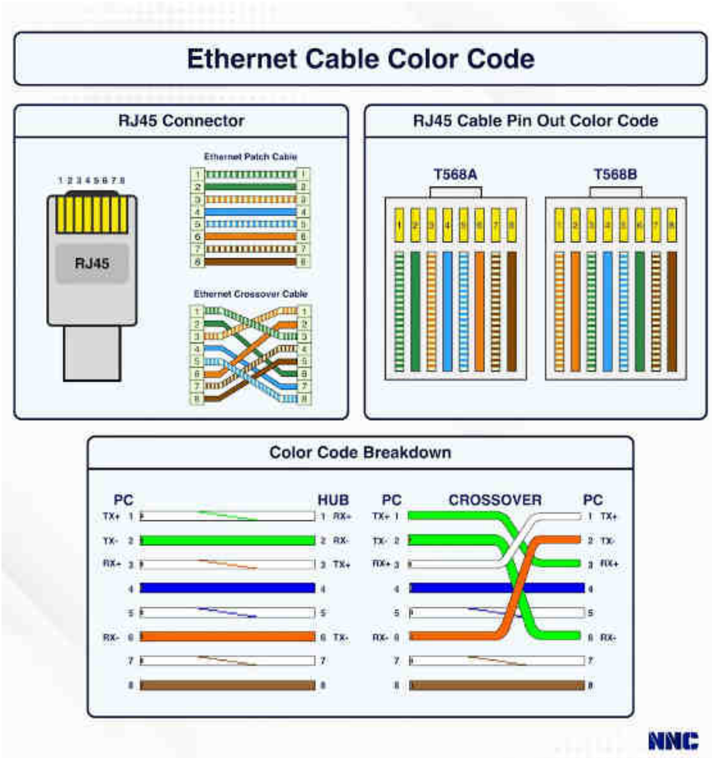


Figure-3: Ethernet cable wiring standards including RJ45 connector pin numbering, T568A and T568B colour codes, and crossover cable wiring explained. (Reference: https:// nassaunationalcable.com/blogs/infographics/ethernet-cable-color-code)

3.2.2.5. Straight-Through vs Crossover Cables

Understanding these two standards also helps you create different types of network cables. When both ends of a cable use the same standard (either T568A on both ends or T568B on both ends), you create what is called a straight-through cable. This is the most common type of cable used to connect CCTV cameras to switches or recorders.

Sometimes you might need to create a crossover cable, which has T568A wiring on one end and T568B on the other end. In older networking equipment, crossover cables were needed to connect similar devices directly to each other. However, most modern CCTV equipment has auto-sensing capabilities that eliminate the need for crossover cables.

3.2.2.6. Important Installation Tips

When terminating RJ45 connectors, the quality of your work directly affects the performance of your CCTV system. Poor termination can cause video loss, network dropouts, or power problems in PoE cameras. Always strip the cable jacket carefully, keep the wire pairs twisted as much as possible, and ensure all wires are fully inserted into the connector before crimping.

Remember that consistency is more important than which specific standard you choose. Document which standard you use in each installation so that future maintenance work can be done correctly. This professional approach will save time and prevent problems for both you and your customers.

As you gain experience, you will develop a preference for one standard over the other, but understanding both T568A and T568B will make you a more versatile and knowledgeable CCTV technician. Whether you are installing a single camera system for a home or a complex network of IP cameras for a large building, proper cable termination using these standards is fundamental to creating reliable CCTV installations.

3.2.3 Cable Length Limits and Testing

In CCTV systems, the choice of cable and its length play an important role in ensuring clear video transmission. Using cables longer than recommended can cause signal loss, poor video quality, or even complete failure of the system. Different types of cables have different length limits depending on how well they carry signals.

For analog CCTV cameras, coaxial cables like RG59 are commonly used. These cables can transmit video signals up to around 750 feet (about 228 meters) without significant signal loss. If the cable has to be longer than this, signal boosters or video amplifiers are needed to keep the picture clear. Thicker coaxial cables, like RG6, can carry signals a bit further, up to about 1000 feet (305 meters) before signal quality starts to drop.

For IP cameras, which use Ethernet cables like Cat5e and Cat6, the maximum cable length is generally around 100 meters (about 328 feet). Beyond this length, the network signal can weaken, causing camera disconnects or poor video quality. In such cases, network switches, Power over Ethernet (PoE) extenders, or media converters can be used to extend the range.

Testing cables is essential to ensure that they are working correctly and are not damaged. Simple cable testers check if all the wires inside the cable are connected properly and if there are any breaks or shorts. More advanced testers can measure signal strength, noise, and interference, which helps spot issues before installation.

By carefully choosing the right cable and keeping within the recommended length limits, CCTV systems will deliver clear and reliable video. Regular testing of cables also ensures the system stays fault-free for longer periods, reducing maintenance and troubleshooting.

3.2.4. Use of Cable Testers

Cable testers are essential tools that every CCTV technician must know how to use properly. These devices help you check whether your cables are working correctly and identify problems before they cause system failures. Think of a cable tester like a doctor's stethoscope - it helps you listen to the health of your cables and diagnose any issues that might affect your CCTV system.

3.2.4.1. Need of Cable Testers

A cable tester performs several important checks on your cables. The most basic function is continuity testing, which verifies that electrical signals can travel from one end of the cable to the other without interruption. This test tells you if there are any breaks or cuts in the wires inside the cable that would prevent video signals from reaching their destination.

Cable testers also check the wiring configuration, especially important for network cables used with IP cameras. They verify that all eight wires in an Ethernet cable are connected to the correct pins according to T568A or T568B standards. Wrong wiring can cause cameras to malfunction or fail to connect to the network entirely.

3.2.4.2. Types of Cable Testing

For CCTV work, you will encounter different types of cable testing depending on what kind of system you are installing. Basic continuity testing works for both coaxial cables used with analog cameras and Ethernet cables used with IP cameras. This simple test uses electrical pulses to check if signals can pass through the cable properly.

More advanced testing includes measuring cable length, which helps ensure you stay within the maximum distance limits discussed earlier. Some testers can even locate exactly where a break or fault occurs in a long cable run, saving you time when troubleshooting problems.

3.2.4.3. Working with Cable Testers

Using a cable tester is quite straightforward, but you must follow proper procedures. First, always ensure that the cables are disconnected from any powered equipment to avoid damaging the tester. Most cable testers have two parts - a main unit and a remote unit that you connect to opposite ends of the cable being tested.

For network cables, plug one end into the main tester and the other end into the remote unit. Turn on the tester and press the test button. The tester will send signals through each wire and display the results using LED lights or a digital screen. Green lights typically indicate good connections, while red lights or no lights indicate problems that need attention.

Reading Test Results

Understanding what the tester is telling you is crucial for effective troubleshooting. When testing network cables, the tester will check all eight wires individually. If all LEDs light up in the correct sequence (1-2-3-4-5-6-7-8), your cable is wired correctly. Missing LEDs indicate open circuits or broken wires, while LEDs lighting in the wrong order suggest miswiring.

For coaxial cables used with analog CCTV cameras, testing is simpler but equally important. A good coaxial cable will show continuity for both the center conductor and the shield. Some specialized coaxial testers can even detect the presence of video signals, helping you verify that cameras are actually transmitting pictures.

3.2.4.4. Benefits of Regular Testing

Regular cable testing prevents many common CCTV problems before they occur. By testing cables during installation, you can identify and fix wiring errors immediately rather than discovering them later when the system fails. This saves time, money, and frustration for both you and your customers.

Cable testing also helps with maintenance and troubleshooting existing systems. When a camera stops working, testing the cable can quickly tell you whether the problem is in the cable itself or somewhere else in the system. This systematic approach makes you more efficient and professional in your work.

Figure- 4: Network cable BNC tester device showing master and remote units for testing coaxial (BNC), RJ45, and RG59 cables (References:

Figure- 5: Network cable tester LED display showing continuity test results for pins 1 to

↵ on both receiver and emitter sides (Reference:

https://www.reddit.com/r/HomeNetworking/
comments/16n↵dot/what_does_this_ethernet_continuity_test_result/)

Figure- 6: The NOVAFA NF-8209 network cable tester displays cable length test results on its LCD screen, showing lengths in feet for different cable pairs. (Reference: https://www.reddit.com/r/HomeNetworking/comments/1j└p3f5/cable_length_test_results_help/)

What You Learned

1. BNC connectors can be installed using crimp-on or screw-on methods for connecting coaxial cables to CCTV systems.
2. Crimp-on BNC connectors provide more secure connections than twist-on connectors but require special crimping tools.
3. T568A and T568B are two wiring standards for RJ45 connectors that differ only in the placement of orange and green wire pairs.
4. T568B places orange wires on pins 1 and 2, while T568A places green wires on pins 1 and 2.
5. CAT5e and CAT6 cables have a maximum length limit of 100 meters (328 feet) for reliable data transmission.
6. Cable testers use Time Domain Reflectometry (TDR) technology to measure cable length and detect faults like opens and shorts.

Points to Remember

1. Always strip coaxial cable properly before installing BNC connectors to

ensure good signal transmission.

2. Use the correct crimping tool and die size for your specific cable type and connector.
3. Maintain consistency by using the same wiring standard (T568A or T568B) throughout your entire installation.
4. Never mix T568A and T568B standards on the same cable as this will cause signal problems.
5. The 100-meter cable length limit includes all patch cables, jacks, and couplers in the run.
6. Test all terminated cables with a cable tester before final installation to ensure proper wiring.
7. Twist-on BNC connectors are convenient but less reliable than properly crimped connectors.

↵ Cable length testers can identify the exact location of faults within the cable run.

Practical Exercises

1. **BNC Connector Installation and Signal Transmission**

   Objective: To learn the Cable Preparation, BNC Connector Installation and

Signal Transmission Testing.

Duration: 45 minutes.

Materials Required:

Tools and Equipment

- BNC crimping tool (RG59/RG6 compatible)
- RJ45 crimping tool with wire stripping capability
- Cable length tester (TDR-based tester recommended)
- RJ45 cable tester with main and remote units
- Wire strippers (adjustable)
- Coaxial cable stripper
- Cable cutter/scissors
- Screwdrivers (Phillips and flat-head)

Cables and Connectors

- Coaxial cable (RG59 or RG6) - 5 meters
- CAT5e or CAT6 cable - 10 meters
- BNC connectors (male) - 10 pieces
- RJ45 connectors (8P↤C) - 20 pieces
- Cable boots/strain reliefs

Procedure

Step 1: Cable Preparation

1. Measure and cut the coaxial cable to the required length (2 meters).

2. Strip the outer jacket approximately 10mm from the end using a coaxial cable stripper.
3. Fold back the braided shield carefully to expose the dielectric insulation.
4. Strip the dielectric to expose 2-3mm of the centre conductor.
5. Ensure the centre conductor is straight and free from nicks.

Step 2: BNC Connector Installation

1. Slide the connector body over the prepared cable end.
2. Insert the centre conductor into the centre pin of the BNC connector.
3. Fold the braided shield over the connector body.
4. Position the crimping tool over the connector body.
5. Apply firm, even pressure to crimp the connector securely.
6. Check the connection by gently tugging the cable.

Step 3: Signal Transmission Testing

1. Connect one end to a CCTV camera (or signal source).
2. Connect the other end to a monitor or DVR input.
3. Power on the system and verify video signal transmission.
4. Check for image clarity and signal quality.
5. Document any signal issues observed.

2. **CAT5e/CAT6 Cable Termination Using T568A/T568B Standards**

   Objective: Understanding the T568A and T568B wiring schemes for 8-

position modular connectors (RJ45). Learning how to maintain consistency throughout an installation.

Duration: 45 minutes

Procedure

Step 1: Cable Preparation

1. Cut the CAT5e/CAT6 cable to desired length (3 meters).
2. Strip the outer jacket 25mm (1 inch) from the end using wire strippers.
3. Untwist the wire pairs carefully, maintaining minimal untwisting.
4. Arrange wires according to T568B standard (or T568A if specified).
5. Trim wires to equal length approximately 12-15mm from jacket.

Step 2: RJ45 Connector Installation

1. Hold the wires in order between your fingers.
2. Insert wires into RJ45 connector ensuring each wire reaches the end.
3. Verify wire order before crimping.
4. Place connector in crimping tool with contacts facing away from you.
5. Apply firm, steady pressure until the tool releases.
6. Inspect the crimped connection for proper wire seating.

Step 3: Creating Different Cable Types

1. Straight-through cable: Use T568B on both ends.
2. Crossover cable: Use T568B on one end, T568A on the other.
3. Label each cable with its type and standard used.

3. **Cable Length Testing and Fault Detection**

   Objective: To identify faults such as opens, shorts, and impedance mismatches and to ensure proper cable performance.

   Duration: 45 minutes

Procedure

Step 1: Cable Length Measurement

1. Connect the cable to the TDR tester's main unit.
2. Select appropriate cable type (CAT5e/CAT6) on the tester.
3. Initiate length measurement function.
4. Record the measured length and compare with actual length.
5. Test multiple cable samples to verify tester accuracy.

Step 2: Fault Detection Testing

1. Create intentional faults in test cables:
   - Short circuit: Connect two wires together at the far end.
   - Open circuit: Cut one wire in the middle of the cable.
   - Split pair: Swap two wires in the middle of the cable.
2. Test each faulty cable and record tester results.
3. Note fault location and type as reported by the tester.
4. Document findings in the test log.

4. **Cable Continuity Testing with RJ45 Cable Tester**

Objective: To verifies that all wire pairs are properly connected and that there are no opens, shorts, or mis-wired connections. Checking the status of each wire pair with the help of cable testers.

Procedure

Step 1: Basic Continuity Test

1. Connect one end of the terminated cable to the main tester unit.
2. Connect the other end to the remote identifier unit.
3. Power on both units and select appropriate test mode.
4. Observe LED sequence on both units.
5. Record test results:
    - Pass: All LEDs light in sequence (1-2-3-4-5-6-7-8)
    - Fail: Missing, out-of-order, or continuously lit LEDs

Step 2: Advanced Testing

1. Test cable length.
2. Check for wire mapping errors (mis-wired pairs).
3. Test for shorts and opens at specific distances.
4. Verify proper shield continuity (for shielded cables).
5. Document all test parameters and results.

Step 3: Troubleshooting Failed Tests

1. Identify specific wire pair causing failure
2. Re-examine connector termination for that pair.
3. Check for damaged conductors or poor connections.

4. Re-terminate connectors as necessary.
5. Retest until achieving pass results.

Practice Questions

Fill in the Blanks

1. BNC connectors are commonly used in _______ CCTV systems and provide _______ ohm impedance matching for video signals.
2. The T568B wiring standard places the _______ wire on pin 1 and the _______ wire on pin 2 of an RJ45 connector.
3. The maximum cable length for CAT5e and CAT6 cables is _______ meters or _______ feet for reliable data transmission.
4. _______ BNC connectors provide more secure connections than _______ connectors but require special crimping tools.
5. Cable testers use _______ technology to measure cable length and detect faults such as _______ and shorts.
6. When terminating RJ45 connectors, the outer jacket should be stripped approximately _______ mm and wires should be trimmed to _______ mm length.

Answers:

1. analog, 75
2. white/orange, orange

3. 100, 328
4. Crimp-on, twist-on
5. Time Domain Reflectometry (TDR), opens
6. 25, 12-15

Multiple Choice Questions

1. Which wiring standard places green wires on pins 1 and 2 of an RJ45 connector?
a) T568A

b) T568B

c) T568C

d) Both A and B

2. What is the correct impedance for BNC connectors used in CCTV video applications?
a) 50 ohms

b) 75 ohms

c) 100 ohms

d) 120 ohms

3. Which method provides the most reliable BNC connector installation?

a) Twist-on method

b) Screw-on method

c) Crimp-on method

d) Push-on method

4. What happens if you mix T568A and T568B standards on the same cable?

a) Better signal quality

b) No effect on performance

c) Signal problems and transmission errors

d) Faster data transmission

5. Cable length testers identify faults using which technology?

a) Frequency Domain Analysis

b) Time Domain Reflectometry (TDR)

c) Signal Amplitude Measurement

d) Impedance Matching

6. The 100-meter cable length limit for Ethernet cables includes:

a) Only the main cable run

b) Main cable plus patch cables and connectors

c) Only patch cables

d) Only the cable between switches

Answers:

1. a) T568A
2. b) 75 ohms
3. c) Crimp-on method
4. c) Signal problems and transmission errors
5. b) Time Domain Reflectometry (TDR)

6. b) Main cable plus patch cables and connectors

Subjective Questions

1. Write down the various tools and their usage related to crimping and testing.
2. List out various safety measures while crimping and testing the wires.
3. Write down the wire colour sequences and the pin assignments.
4. Explain the testing procedure, fault types, and the steps for troubleshooting.
5. List out the RJ45 Termination Issues and Cable Tester Errors.

Unit 4: Site Survey & Camera Installation

Session 1 . Site Assessment

Site assessment is the first and most important step before installing any CCTV system. In this chapter, you will learn how to study a site carefully and collect all the necessary information in a planned way. You will understand how to use a standardized checklist, locate power points, identify risk zones, and study the field of view for each proposed camera position. You will also learn how to convert your observations into a clear installation plan with camera locations, cable routes, and equipment placement. These skills will help you work like a professional CCTV technician on real sites.

4.1 Site Visit Checklist

A site visit checklist is the most important tool for any CCTV technician before starting an installation project. This systematic list helps you gather all necessary information about the location where cameras will be installed. Without a proper checklist, you might miss crucial details that could cause problems during installation or affect system performance later. A well-prepared checklist ensures that you collect complete information in an organized manner and helps you provide accurate quotes to customers.

CCTV technician conducting site visit with survey checklist

Purpose of Site Visit Checklist

The main purpose of a site visit checklist is to document all important aspects of the installation site. When you visit a location for the first time, there are hundreds of details to notice and remember. Your human memory cannot reliably capture everything, especially when visiting multiple sites in a day. A systematic checklist acts like a guide that reminds you what to look for and provides a standard format for recording information.

Using a checklist also makes you appear more professional to customers. When they see you methodically examining their property and taking detailed notes, they gain confidence in your expertise. This professional approach often leads to better customer relationships and more business referrals. Additionally, having complete site information helps you avoid return visits to collect missing details, saving time and transportation costs.

Basic Information Section

Start your checklist by recording basic details about the site location. Write down the complete address including street number, area name, and nearest landmarks. Note the customer's name and contact information for future reference. Record the date and time of your visit, as lighting and activity conditions change throughout the day.

Document the type of building or property you are surveying. Is it a residential house, commercial office, retail shop, warehouse, or industrial facility? Different building types have different security needs and installation challenges. Note the building's age and construction type, as older buildings might have different electrical systems or structural limitations that affect camera mounting.


SITE SURVEY CHECKLIST FORM

LOCATION DETAILS

MEASUREMENTS

POWER POINTS

LIGHTING CONDITIONS

Sample site visit checklist form for CCTV installation planning

Physical Site Assessment

Carefully examine the physical characteristics of the installation area. Measure and record the dimensions of rooms, corridors, and outdoor spaces where cameras might be installed. Note ceiling heights, as this affects camera mounting options and cable requirements. Check wall materials - concrete, brick, drywall, or metal panels each require different mounting hardware and installation techniques.

Document existing structures that might affect camera placement. Look for pillars, beams, air conditioning units, lighting fixtures, and decorative elements that could obstruct camera views or create mounting challenges. Note the presence of false ceilings, cable trays, or conduits that might be used for running camera cables. Record any renovations or construction work planned for the near future that might affect the CCTV installation.

Environmental Conditions

Record environmental factors that affect camera performance and installation planning. Note lighting conditions throughout the day, including areas that are very bright, very dark, or have backlighting issues. Check for windows and glass doors that create glare problems or require special camera positioning. Document outdoor areas that need weather-resistant cameras and housings.

Assess environmental hazards such as high humidity areas, extreme temperatures, corrosive atmospheres, or vibration sources. These conditions require special camera types or protective housings. Note areas with potential electromagnetic interference from machinery, transformers, or radio equipment that might affect camera signals.

Security and Access Requirements

Document security-sensitive areas and special access requirements. Note restricted zones where only certain people are allowed, as these areas might need special camera coverage or access controls. Record existing security measures like guards, alarms, locks, and barriers that the CCTV system should integrate with or complement.

Check for areas where cameras might create privacy concerns, such as changing rooms, private offices, or residential bedrooms. Note legal restrictions or customer preferences about camera placement in certain areas. Document entry and exit points, cash handling areas, and valuable asset locations that need priority camera coverage.

Infrastructure Assessment

Examine existing infrastructure that affects CCTV installation. Check available space in electrical panels for additional breakers. Note the location of network equipment rooms or server areas where recording equipment might be installed. Document existing cable routes, conduits, and wire management systems that could be used for CCTV cables.

Record any special requirements like explosion-proof equipment for hazardous areas, marine-grade equipment for coastal locations, or vandal-resistant cameras for public areas. Note accessibility for future maintenance - are camera locations reachable with standard ladders, or do they require special equipment?

A comprehensive site visit checklist ensures that you gather all information needed for accurate system design, proper equipment selection, and realistic project planning. This preparation leads to successful installations that meet customer expectations and operate reliably for years to come.

4.2 Power Availability and Placement

Proper power supply is the backbone of any CCTV system. Without reliable electricity, even the best cameras and recording equipment cannot function. During site assessment, carefully evaluating power availability and planning power placement is crucial for successful installation. Poor power planning often leads to system failures, additional costs, and unhappy customers. Understanding electrical requirements helps you design systems that work reliably for many years.

Understanding Power Requirements

Most CCTV cameras operate on 12 volts DC power, though some professional cameras use 24 volts AC or Power over Ethernet (PoE). During site visits, you must identify what type of cameras will be installed and calculate their total power consumption. Each camera typically consumes between 5 to 15 watts of power, depending on its features like infrared LEDs, pan-tilt motors, and heaters for outdoor use.

Electrical power panel and outlets for CCTV power supply in Indian building

Recording equipment like DVRs and NVRs usually operate on 220 volts AC and consume more power than individual cameras. A typical 8-channel DVR consumes about 40-60 watts continuously. Monitors for viewing live cameras also need AC power and consume 20-100 watts depending on their size. Add up all these power requirements to determine the total electrical load your CCTV system will place on the building's electrical supply.

Assessing Existing Electrical Infrastructure

Start by locating the main electrical panel and checking available space for additional circuit breakers. Indian buildings typically use single-phase 220V supply for residential and small commercial applications. Examine the condition of existing wiring - old buildings might have outdated electrical systems that need upgrading before installing CCTV equipment.

Check the load capacity of existing electrical circuits. Most residential circuits in India are rated for 5, 10, or 15 amperes. Calculate whether existing circuits can handle additional CCTV equipment without overloading. Overloaded circuits can cause frequent power trips, voltage drops, and even fire hazards. It's often safer to install dedicated circuits for CCTV systems, especially in older buildings with limited electrical capacity.

Power Source Locations

Document all available power outlets near potential camera locations. In Indian homes and offices, power outlets are typically placed at standard heights - about 30cm above floor level for general use and 120cm for air conditioners and heavy appliances. Outdoor areas often have limited power outlets, requiring careful planning for camera power supplies.

Measuring distance from power source to camera location for proper power planning

Measure distances between power sources and planned camera locations. Long cable runs between power supplies and cameras can cause voltage drop, reducing camera performance or causing malfunctions. For 12V DC systems, try to keep power cable runs under 50 meters to avoid significant voltage loss. If longer distances are unavoidable, consider using higher voltage power supplies or installing additional power sources closer to cameras.

Power Supply Options

Centralized power supplies are commonly used in CCTV installations where multiple cameras operate from a single power source. These systems use one large power supply unit to feed several cameras through individual cables. This approach works well when cameras are clustered in one area and power source locations are limited.

Individual power adapters provide dedicated power to each camera from nearby electrical outlets. This method offers better reliability because failure of one adapter doesn't affect other cameras. However, it requires more electrical outlets and can be more expensive for large installations.

Power over Ethernet (PoE) systems combine data and power transmission through a single network cable. PoE is becoming popular for IP camera installations because it simplifies wiring and provides flexible power distribution. However, PoE requires compatible cameras and network switches, which may increase initial costs.

Planning Power Distribution

Create a power distribution plan that shows how electricity will reach each CCTV component. Mark existing power outlets on your site sketch and note their voltage and amperage ratings. Plan cable routes from power sources to cameras, avoiding areas where power cables might be damaged or create safety hazards.

Consider power backup requirements for critical installations. Many customers want their CCTV systems to work during power failures, requiring backup power solutions like uninterruptible power supplies (UPS) or generators. UPS systems typically provide backup power for 2-4 hours, which is sufficient for most residential and small commercial applications.

Safety and Code Compliance

All electrical work must comply with Indian electrical codes and safety standards. Power installations should be done by qualified electricians, especially for AC power connections and new circuit installations. Use proper electrical conduits to protect power cables from physical damage and environmental exposure.

Ground all electrical equipment properly to prevent electrical shock hazards. Install appropriate fuses or circuit breakers to protect CCTV equipment from electrical overloads. Use weatherproof electrical connections for outdoor installations to prevent water damage and electrical faults.

Documentation and Future Planning

Document all power-related information in your site assessment report. Include details about available power sources, required new electrical work, total power consumption, and backup power needs. This information helps create accurate project estimates and ensures that electrical contractors understand CCTV system requirements.

Consider future expansion when planning power distribution. Customers often want to add more cameras later, so design power systems with some extra capacity. Installing spare conduits and slightly larger power supplies during initial installation costs less than major electrical modifications later.

Proper power planning ensures that your CCTV installations operate reliably and meet customer expectations for system performance and dependability.

4.3. Identifying Risk Zones

When conducting a site survey for a CCTV installation, one of the most critical steps is identifying →Risk Zones." A risk zone is simply an area within a property that is more likely to experience security breaches, accidents, or theft. It is not enough to just install cameras in random corners; a professional technician must analyze the site to understand exactly where the threats are coming from. By identifying these zones correctly, you ensure that the CCTV system provides maximum security and value to the customer. If you miss a high-risk area, the entire purpose of the security system might fail, leaving the property vulnerable even after spending money on equipment.

To identify risk zones effectively, you need to think like a security expert—or sometimes, like an intruder. Ask yourself: If I wanted to enter this building unnoticed, where would I go? If I wanted to steal something, where is it kept? The answers to these questions will point you to the high-risk areas. These zones generally fall into four main classifications: Entry and Exit Points, High-Value Asset Areas, Public Interaction Areas, and Blind Spots.

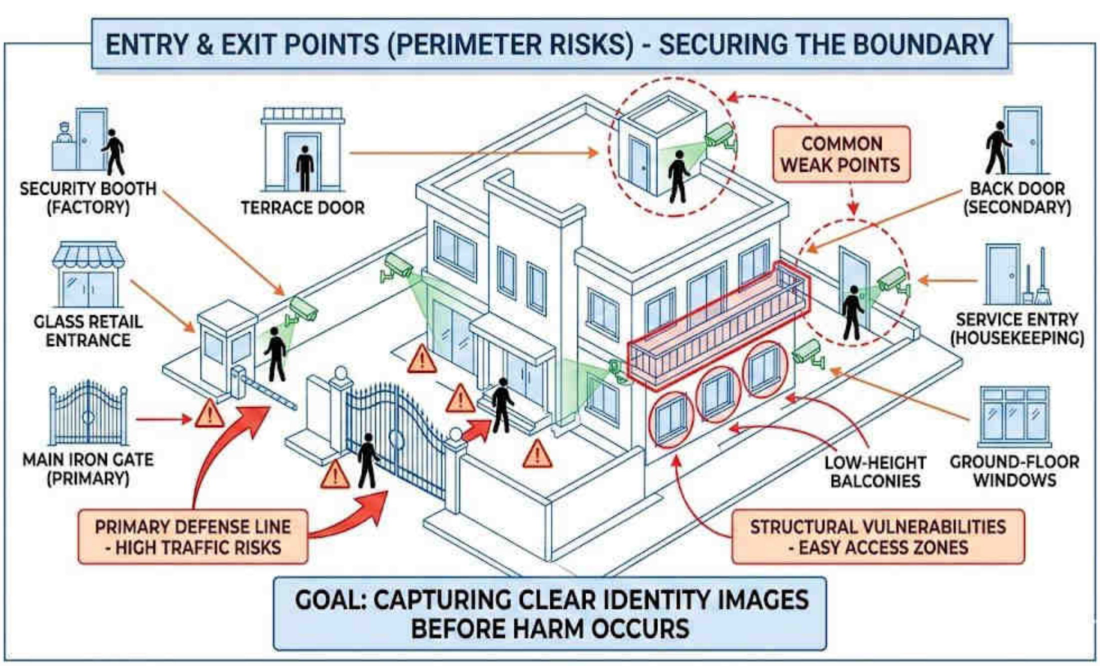
Entry and Exit Points (Perimeter Risks)

These are the most critical areas. If you can record a person entering the premises, you have their face and identity before they even commit a crime.

- **Main Gates and Doors:** This is where everyone enters. In an Indian context, this includes the main iron gate of a house, the glass door of a shop, or the reception area of an office.
- **Back Doors and Service Entries:** These are often neglected. In restaurants or hotels, the back door used by staff or for garbage disposal is a high-risk zone because it is often left unlocked and unmonitored.
- **Windows and Ventilators:** Ground-floor windows or accessible balconies are common entry points for burglars.

- **Boundary Walls:** Low boundary walls or areas near trees that can be climbed are significant risk zones in residential colonies.

The most crucial risk zones are the places where people enter or leave a property. This includes the main gate, which is the primary defense line. In an Indian context, this could be the main iron gate of a house, the glass entrance of a retail showroom, or the security booth of a factory. However, technicians often forget the secondary entry points, which are equally dangerous. Back doors, service entries used by housekeeping staff, and terrace doors are common weak points. Ground-floor windows or low-height balconies are also significant risk zones because burglars often use them for easy access. Capturing a clear image of a person at these entry points is vital because it establishes their identity before they can cause any harm inside.

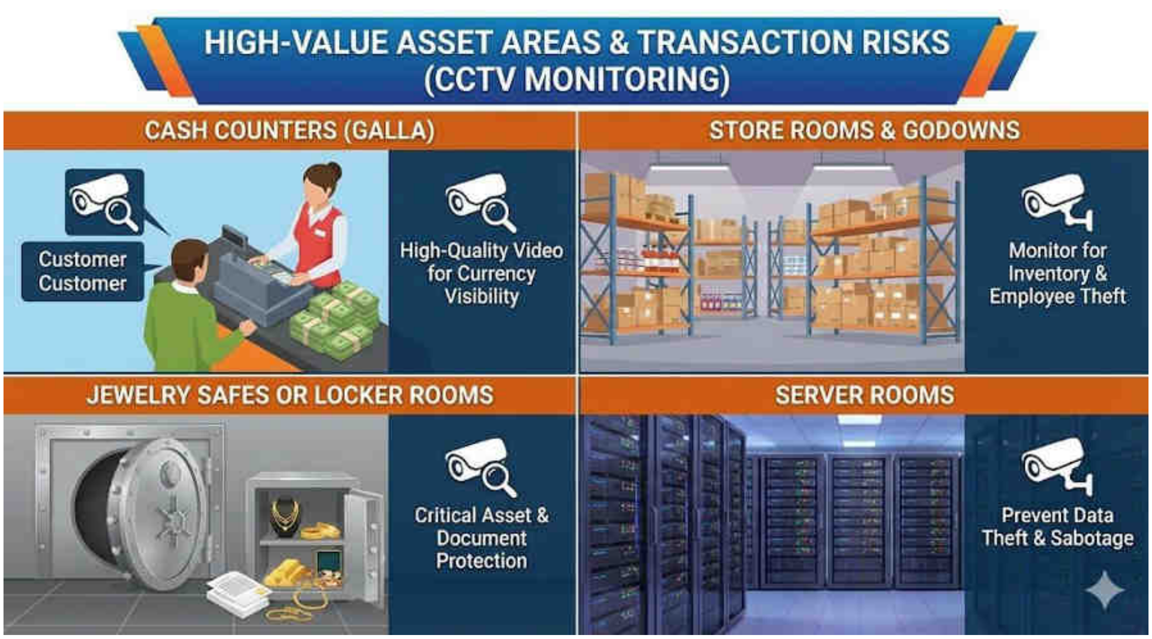


Graphical illustration of entry- exit points and weak risk zones

High-Value Asset Areas (Transaction Risks)

These are the places where valuable items or money are kept. The purpose of CCTV here is to prevent theft and monitor transactions.

- **Cash Counters (Galla):** In shops, showrooms, and banks, the cash counter is the highest risk zone. Cameras here need to be high quality to see currency notes clearly.
- **Store Rooms and Godowns:** This is where stock is kept. Employees or outsiders might try to steal goods from here.
- **Jewelry Safes or Locker Rooms:** In homes or banks, areas containing gold or documents are critical.
- **Server Rooms:** In offices, the room holding the computer data and expensive servers is a high-risk zone for data theft or sabotage.



High-Value Asset Areas

These are areas where money, jewelry, important documents, or expensive stock are stored. In a retail shop or a bank, the →Cash Counter→ or →Galla→ is the single highest risk zone. Cameras installed here must be high-definition to capture details like currency notes and hand movements. In offices, the server room—which holds all the digital data—is a critical asset area. For warehouses or factories, the loading docks where goods are shipped in and out are high-risk zones for internal theft or inventory shrinkage. Identifying these specific spots ensures that the most valuable items are under constant digital supervision.

Public Interaction and Traffic Areas

These areas are risky not because of theft, but because of safety, arguments, or accidents.

- **Corridors and Lobbies:** In schools or hospitals, these areas see a lot of movement. Fights, bullying, or accidents often happen here.
- **Waiting Areas:** Reception areas where visitors sit. Unattended bags or suspicious behavior can be spotted here.
- **Parking Lots:** Vehicle theft is very common in India. Parking areas for cars and two-wheelers are major risk zones. You need to identify where bikes are parked and where the cars enter/exit.

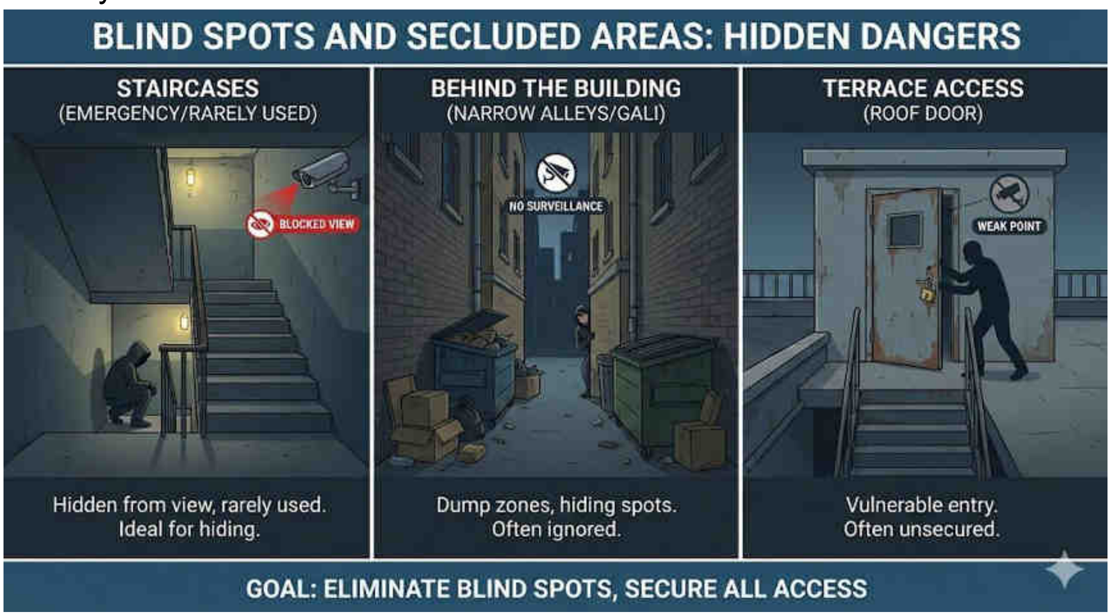
Public Interaction and Traffic Areas

Not all risk comes from theft; some comes from human behavior. Areas where people gather, wait, or move in large numbers are prone to accidents, arguments, or harassment. In schools, colleges, or hospitals, corridors and lobbies are high-traffic zones where bullying or disputes might occur. Waiting areas and reception desks are also important to monitor for suspicious activity, such as an unattended bag left behind. Parking lots are another major category of risk zones, especially for vehicle theft, which is a common issue in cities. Identifying where cars and bikes are parked allows you to place cameras that can capture license plates and deter potential thieves.

Blind Spots and Secluded Areas

A →Blind Spot→ is a place that is hidden from normal view. These are dangerous because criminals know they cannot be seen there.

- **Staircases:** Especially emergency staircases in malls or apartments that are rarely used.
- **Behind the Building:** Narrow alleys (gali) between two buildings often become garbage dumps or hiding spots for intruders.
- **Terrace Access:** The door leading to the roof is often a weak point in building security.



Blind Spots and Secluded Areas

you must look for →Blind Spots"—places that are hidden from plain sight. Criminals love these areas because they offer cover. Typical blind spots include the narrow alleys (gali) between buildings, areas behind large pillars, or staircases that are rarely used. In many residential buildings, the space behind the water tank on the roof or the area behind a large generator set can serve as a hiding spot. During your site visit, you must physically walk into these dark or hidden corners to assess if a camera is needed there. Lighting is a key factor here; a blind spot that is also dark at night is a double risk, often requiring specialized cameras with strong Infrared (night vision) capabilities.

Conducting the Assessment

Prioritizing the Zones

You cannot put a camera everywhere. It is too expensive. You must prioritize based on the level of risk.

- **Priority 1 (High Risk):** Main Entrance and Cash Counter. These must have cameras.
- **Priority 2 (Medium Risk):** Parking, Corridors, and Back Doors. These should have cameras.
- **Priority 3 (Low Risk):** General open areas or empty rooms. These can be skipped if the budget is low.

To perform this assessment practically, start your survey at the perimeter and work your way in. Walk the entire boundary of the property. Talk to the security guards or the property owners; their local knowledge is invaluable. Ask them questions like, →Where was the last break-in attempt?" or →Which areas feel unsafe at night?" Once you have identified all potential zones, classify them by priority. You cannot always cover every inch of a property due to budget constraints. Prioritize the →High Risk→ zones (Entry points, Cash counters) first, then the →Medium Risk→ zones (Parking, Lobbies), and finally the →Low Risk→ zones (General open areas). This structured approach ensures you design a smart, efficient, and cost-effective security plan.

4.4 Field of View Analysis

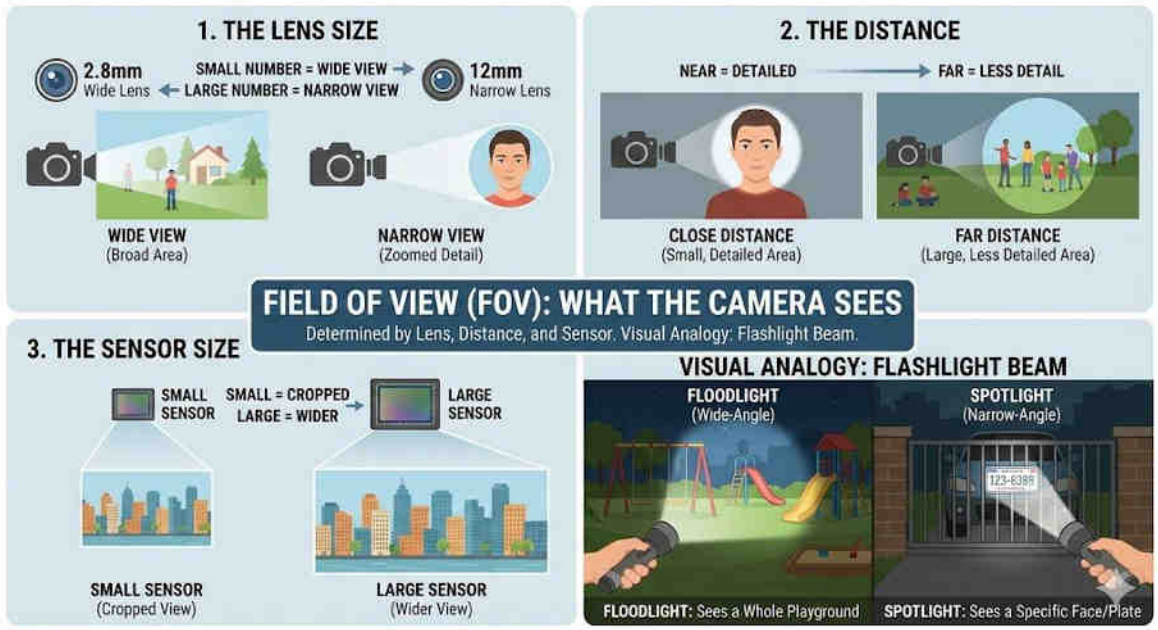
When you install a CCTV camera, it does not simply →see everything→ like a human eye. Each camera can cover only a limited area, known as its Field of View (FoV). Field of view analysis is the process of carefully checking what the camera can see and what it cannot see from a specific location. For a CCTV technician, this is a critical skill. If the FoV is not calculated correctly, you might end up with a system that has major blind spots, or images that are too zoomed out to identify a thief's face.

Field of View

The field of view is the specific area that will appear on the monitor screen. It is determined by three main factors:

1. The Lens Size: A smaller lens number (like 2.8mm) gives a wide view, while a larger number (like 6mm or 12mm) gives a zoomed-in, narrow view.
2. The Distance: How far the camera is from the object you want to see.
3. The Sensor Size: The electronic chip inside the camera that captures the image.

Think of it like a flashlight beam in a dark room. If you stand close to a wall, the light circle is small and bright (detailed). If you step back, the circle gets bigger (wide view) but dimmer (less detail). A wide-angle lens is like a floodlight—good for seeing a whole playground or parking lot. A narrow lens is like a spotlight—good for seeing a specific face or a number plate at a gate.



Field of view what camera sees

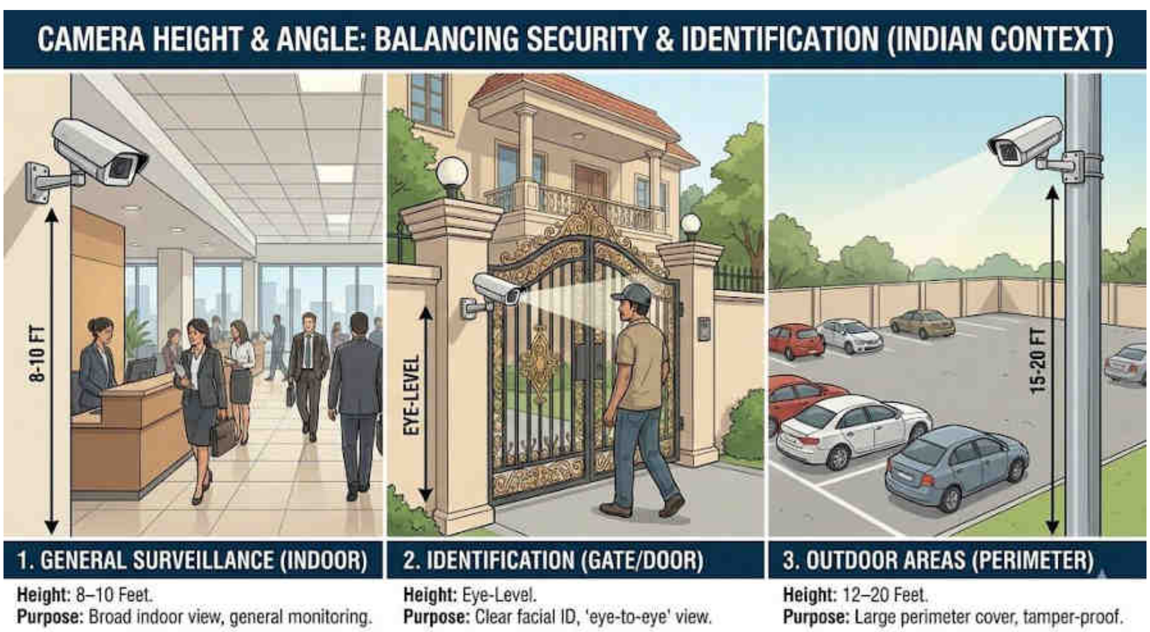
Before you drill a single hole, stand at the proposed camera location

- →*What is the target?"* Do you need to see a general crowd movement (like in a school corridor) or a specific detail (like a currency note at a cash counter)?
- →*Is the angle right?"* If the camera is too high, you will only see the tops of people's heads, not their faces. If it is too low, a truck or bus might block the view.
- →*Are there obstacles?"* Look for things that might block the camera later, like a ceiling fan, a hanging sign, or a tree that will grow leaves in the future.

Camera Height and Angle

In Indian conditions, finding the right height is a balance. If you mount a camera too low (below 7 feet), vandals can reach up and twist it or cover it with a cloth. If you mount it too high (above 15 feet), the face of a person wearing a cap or looking down will not be visible.

- For General Surveillance: A height of 8–10 feet is standard for indoor rooms.
- For Identification: At a gate or door, the camera should be lower and angled flatter to look →eye-to-eye→ with the entering person.
- For Outdoor Areas: Cameras are often mounted higher (12–20 feet) on poles to cover a large perimeter and prevent tampering.



Camera Height and Angle

Horizontal and Vertical Coverage

Technicians often forget that FoV has two dimensions.

- Horizontal FoV (Width): This is how wide the camera sees from left to right. This is important for covering a wide boundary wall or a long row of cashier desks.
- Vertical FoV (Height): This is how much the camera sees from floor to ceiling. This is crucial for entrance doors—you want to see the person's face (top) and what they might be carrying in their hands (middle), but you don't need to see too much of the empty ceiling.

Avoiding Blind Spots

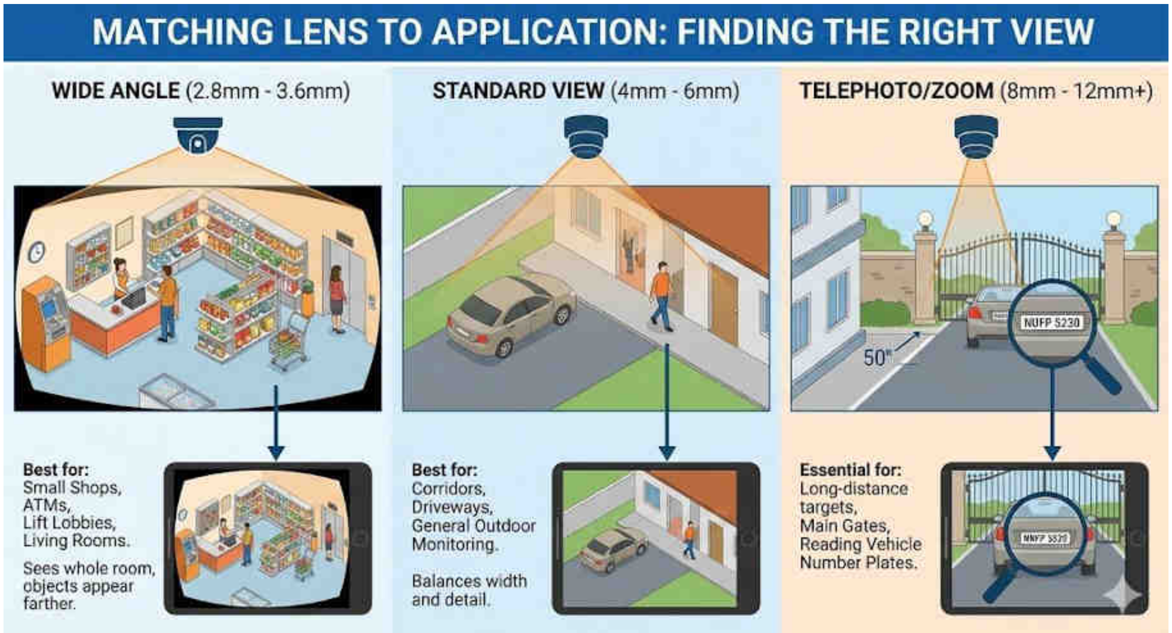
A blind spot is the dangerous space that the camera misses. Every camera has a blind spot directly underneath it. Other blind spots are created by pillars, almirahs, or open doors.

- The →Cross-Fire→ Solution: To eliminate blind spots in a square room or hallway, do not just put one camera in the middle. Instead, place two cameras in opposite corners facing each other. This way, Camera A sees the blind spot of Camera B, and vice versa.

Matching Lens to Application

- Wide Angle (2.8mm - 3.6mm): Best for small shops, ATM rooms, lift lobbies, and living rooms. It sees the whole room but makes objects look farther away.
- Standard View (4mm - 6mm): Good for corridors, driveways, and general outdoor monitoring. It balances width and detail.

- Telephoto/Zoom (8mm - 12mm+): Essential for long-distance targets like a main gate seen from a building 50 feet away, or for reading vehicle number plates.



Application of Lenses

Steps for Analysis on Site

1. Stand and Visualize: Stand exactly where you plan to mount the camera. Use your hands to frame the view like a director.
2. Check the Light: Look at where the sun or streetlights are. Avoid pointing the camera directly into a bright light source (backlighting), as this will make the subject look like a dark shadow.
3. Sketch the Cone: On your site map, draw a triangle coming out of the camera icon. This represents the cone of vision. If the triangles of your cameras don't overlap, you have blind spots.

Example (Indian Context)

Consider a typical Indian apartment parking lot. You need to see cars entering and leaving.

- Mistake: Placing a wide-angle camera high up on the 2nd floor balcony. *Result:* You see the whole parking lot, but the cars look like tiny toys. You cannot read a single number plate.
- Correct FoV Analysis: Install a dedicated camera at the gate, mounted lower (8 feet), with a narrower lens (6mm) focused *only* on the entry lane. This ensures that every car's number plate is large and readable. Then, keep the balcony camera for a general overview.

4.5. Creating an Installation Plan

After you have visited the site, checked the power supply, identified the risk zones, and analyzed the field of view, the final step of the site assessment is Creating an Installation Plan. This plan is like a →road map→ for the actual work. Without a plan, the installation work can become messy, take too much time, and cost more money than expected. A good plan helps you finish the job smoothly and professionally.

An installation plan is a document or a set of drawings that tells you exactly what to do, where to do it, and how to do it. It brings together all the information you collected during the site survey.

Why is an Installation Plan Important

Imagine starting to build a house without a blueprint. You wouldn't know where to put the walls or windows. Similarly, installing CCTV without a plan leads to confusion.

- Saves Time: You don't have to stop and think about where to run a cable or drill a hole. You already decided it on paper.
- Reduces Waste: You know exactly how much cable and pipe you need, so you don't cut too much or buy extra materials.
- Clear Communication: It helps you explain the work to the customer and to your helper or team members.

Components of a Good Installation Plan

A complete installation plan has four main parts:

1. The Camera Layout Map

This is the most visible part of the plan. It is a simple drawing of the building (floor plan) that shows:

- **Camera Locations:** Mark exactly where each camera will be mounted. Number them (Camera 1, Camera 2, etc.) so there is no confusion.
- **Camera Type:** Next to each mark, write what kind of camera it is (e.g., →Dome Camera," →Bullet Camera," →PTZ").
- **Coverage Direction:** Draw a small arrow or cone to show which way the camera will face. This reminds you of the Field of View analysis you did earlier.

2. The Cabling Route (Wiring Diagram)

Cables are the veins of the CCTV system. You need to plan how they will travel from the camera to the recorder (DVR/NVR).

- Path Selection: Decide where the cable will go. Will it run along the ceiling cornice? Will it go through a false ceiling? Will it be buried underground in a garden?
- Conduit Type: Decide what protection the cable needs. Use PVC pipes or casing-capping for indoor walls to look neat. Use flexible conduit or heavy-duty pipes for outdoor areas to protect against rain and sun.
- Cable Length Estimation: Measure the distance on your map to estimate the total length of cable needed. Always add a little extra (about 10%) for bends and connections.

3. Equipment Placement

You need to decide where the →brain→ of the system will sit.

- DVR/NVR Location: This should be in a safe, secure, and ventilated place. In a home, it might be near the TV cabinet. In an office, it should be in a lockable server rack or cupboard to prevent theft of the recording device itself.
- Monitor/Screen: Where will the user watch the footage? Plan the cable route from the DVR to the monitor (HDMI/VGA cable).
- Power Supply Unit (PSU): Decide where the central power supply will be placed. It is usually kept near the DVR for easy maintenance.

4.Material and Tools List (Bill of Materials)

Based on your map and measurements, make a final list of things . This is called a Bill of Materials (BOM).

- Hardware: Number of cameras, DVR, Hard Disk Drive (HDD).
- Cabling: Total meters of Coaxial or CAT6 cable.
- Connectors: Number of BNC connectors, DC pins, or RJ45 jacks.
- Mounting Accessories: Junction boxes (to hide connectors), screws, rawl plugs (gitti), and PVC pipes/casing.
- Tools Required: Drill machine, ladder, hammer, wire strippers, and crimping tool.

Steps to Create the Plan

1. Draw the Sketch: On a piece of paper, draw the boundaries of the rooms or the building. It doesn't have to be perfect art, just clear enough to understand.
2. Mark the Spots: Using a pencil, mark the camera points you decided on during the risk assessment.
3. Trace the Lines: Draw lines connecting each camera to the DVR location. Try to find the shortest and neatest path. Avoid running cables near high-voltage electrical wires to prevent interference.
4. Review with Customer: Show this rough plan to the customer. Ask them: *→Is it okay if we drill here?"* or *→Can we run the pipe along this beam?"* Getting their approval now prevents arguments later.
5. Finalize: Once agreed, make a clean copy of the plan. This is your guide for the installation day.

What You Learned

1. Site assessment is the first and most important step before installing a CCTV

system, and it helps you understand the building, surroundings, and security needs.

2. A standardized site visit checklist allows you to record all key details like entry/exit points, lighting, wall type, and existing infrastructure in a systematic way.
3. Power availability and placement directly affect where cameras, DVR/NVR, and monitors can be installed and how safe and reliable the system will be.
4. Identifying risk zones (high, medium, low risk areas) helps you decide which locations must be covered first for effective security.
5. Field of view analysis and a clear installation plan (with camera positions, cable routes, and equipment locations) ensure that there are minimum blind spots and that installation work is neat and efficient

Points to Remember

1. Always use a proper site assessment checklist instead of relying only on memory.
2. Note all entry and exit points, including main gates, back doors, staircases, and terrace access, during the site visit.
3. Check the number, location, and condition of power points before deciding camera and DVR locations.
4. Classify areas into high, medium, and low risk to prioritize camera coverage where it is most needed.

5. Check the field of view for each proposed camera position so that important areas are clearly visible and blind spots are minimized.
6. Draw a simple site sketch marking cameras, cable routes, power points, and equipment locations as part of the installation plan.
7. Discuss your proposed plan with the customer or site in-charge and take their approval before starting drilling and installation work.

Practical Exercises

1. Using a Standardized Checklist for Site Assessment

Objective: To learn how to systematically gather and record site information using a professional checklist.

Duration: 45 minutes

Materials Required:

- Blank Site Assessment Checklist forms (copies for each student)
- Clipboard and pen
- Measuring tape
- A designated area to survey (e.g., classroom, computer lab, or school corridor)

Instructions:

Step 1: Introduction to the Checklist (10 minutes)

- Review the provided →Site Assessment Checklist→ form.
- Discuss the importance of each section: Client Details, Site Type, Physical

Dimensions, and Existing Infrastructure.

- Understand the symbols used for marking (e.g., 'E' for Entrance, 'P' for Power Socket).

Step 2: Conducting the Survey (20 minutes)

- Students work in pairs. Each pair is assigned a specific area (e.g., →Front Gate Area→ or →Library").
- Walk through the assigned area and fill out the checklist.
- Measure the room dimensions (length, width, height) and record them.
- Note down wall types (concrete/brick/drywall) and ceiling type (false ceiling/concrete).
- Record lighting conditions (bright/dim/variable).

Step 3: Data Verification (10 minutes)

- Swap checklists with another pair.
- The other pair visits the site to verify if the details recorded are accurate.
- Check if any important details (like a hidden beam or a broken socket) were missed.

Step 4: Discussion (5 minutes)

- Return to class and discuss common observations.
- Teacher highlights why missing a detail (like wall material) can cause problems later (e.g., bringing the wrong drill bit).

Assessment: Completeness of the filled checklist, accuracy of measurements, and attention to detail.

2. Identifying Power Points and their Impact on Installation

Objective: To practice locating power sources and understanding how their location affects cable routing and camera placement.

Duration: 40 minutes

Materials Required:

- Site map or floor plan of a sample building (can be the school building)
- Colored markers (Red for power points, Blue for cameras)
- Ruler

Instructions:

Step 1: Power Point Hunting (15 minutes)

- Walk through the assigned area (e.g., Computer Lab).
- Identify all electrical switchboards and power sockets.
- Check the rating of the sockets (5 Amp vs. 15 Amp).
- Mark the location of each socket on the floor plan using a Red marker.
- Note if the power source has a backup (UPS/Inverter) connection.

Step 2: Distance Calculation (15 minutes)

- Proposed camera locations are given by the teacher (e.g., →Camera 1: Above Whiteboard").
- Measure the distance from the nearest power point to the camera location.
- Calculate the length of power cable needed.
- Discuss: Is the distance too long? (Recall: Long DC cables cause voltage drop).
- Decide: Should we use a local power adapter or run a centralized cable from the main supply?

Step 3: Impact Analysis (10 minutes)

- Discuss what happens if a power point is faulty or too far.
- Students propose a solution: →Install a new socket near the camera→ vs. →Extend the cable."
- Draw the final cable route on the map in Blue.

Assessment: Ability to correctly locate power sources, accurate distance estimation, and logical decision-making for power solutions.

3. Demonstrating Identification of Risk Zones

Objective: To develop the skill of analyzing a site to identify security vulnerabilities and high-risk areas.

Duration: 50 minutes

Materials Required:

- →Security Audit→ Worksheet
- Access to school grounds (Playground, Main Gate, Cycle Stand)
- Camera (or phone camera) for documentation (optional)

Instructions:

Step 1: The →Thief's Perspective→ Walk (15 minutes)

- The class moves to the school Main Gate or Parking Area.
- Students are asked to think like an intruder: →How would you sneak in?" or →What is easiest to steal?"
- Identify potential entry points (broken fences, low walls, unguarded back gates).

- Identify blind spots (areas hidden behind large trees, water tanks, or pillars).

Step 2: Zone Classification (20 minutes)

- Return to the classroom. On the worksheet, list the identified areas.
- Classify each area into:
    - High Risk: (e.g., Cycle Stand, Principal's Office, Exam Strong Room)
    - Medium Risk: (e.g., Staff Room Corridor, Water Cooler area)
    - Low Risk: (e.g., Open Playground)
- Justify the classification. Why is the Cycle Stand high risk? (Answer: Because cycles are valuable and easy to steal).

Step 3: Solution Mapping (15 minutes)

- On a simple sketch of the school, use color codes to mark these zones (Red = High, Yellow = Medium, Green = Low).
- Propose where cameras should be placed to cover the Red zones first.
- Discuss how to eliminate blind spots (e.g., →Trim the tree branches→ or →Add a second camera").

Assessment: Ability to identify genuine security risks, logical classification of zones, and practical suggestions for camera placement

Practice Questions

A. Fill in the Blanks (7)

1. A __________ __________ is used to record important information during a site visit before CCTV installation.
2. During site assessment, the technician should identify all main __________ and __________ points of the building.
3. The location of electrical __________ __________ affects where cameras, DVR/NVR, and monitors can be installed safely.
4. Areas with a higher chance of theft, damage, or unauthorized entry are called __________ __________.
5. __________ of __________ analysis means checking what the camera can see and what it cannot see from a given position.
6. A simple __________ __________ helps the technician plan camera positions, cable routes, and equipment placement.
7. During site assessment, the technician must also consider __________ conditions, such as lighting and weather, around outdoor camera locations.

B. Multiple Choice Questions (6)

1. What is the main purpose of a standardized site assessment checklist?

a) To fix cameras immediately

b) To record site details in a systematic way

c) To test DVR settings

d) To sell more cameras

2. Which of the following is NOT usually checked during a site assessment?

a) Entry and exit points

b) Wall and ceiling type

c) Student exam marks

d) Available power outlets

3. Why is it important to identify power points during site assessment?

a) To decorate the wall

b) To decide where to keep tools

c) To plan safe power supply for cameras and DVR

d) To reduce the number of cameras

4. A →risk zone→ is best described as:

a) A place where no one ever goes

b) An area with higher security threat or incident chance

c) A zone with strong Wi-Fi

d) A place used for storage only

5. Field of view analysis mainly helps the technician to:

a) Check internet speed

b) Decide camera color

c) Avoid blind spots and ensure proper coverage

d) Reduce cable cost only

6. Which document is most useful for creating an installation plan after a site assessment?

a) School timetable

b) Site layout / floor plan with notes

c) Product brochure

d) Attendance register

C. Short Answer Questions

1. What is a site assessment checklist, and why is it important before starting a CCTV installation?
2. During a site visit, what key things should a technician observe about power availability and placement?
3. Define a →risk zone→ and give two examples of risk zones in a school environment.
4. How does field of view analysis help in deciding the exact position and angle of a camera?
5. List any four items that you would include in a simple site sketch used for creating a CCTV installation plan.

Answer Key

Fill in the Blanks

1. site checklist / site assessment checklist
2. entry, exit
3. power points / power sockets
4. risk zones

5. field, view
6. site sketch / floor plan
7. environmental

Multiple Choice

1. b) To record site details in a systematic way
2. c) Student exam marks
3. c) To plan safe power supply for cameras and DVR
4. b) An area with higher security threat or incident chance
5. c) Avoid blind spots and ensure proper coverage
6. b) Site layout / floor plan with notes

Session-2 Camera Mounting Techniques

4.2.1. Mounting Places

When you start working with CCTV cameras, one of the first things you need to decide is where to put them. You have two main choices - mounting on walls or hanging from ceilings. Both ways work well, but they each have their own benefits and problems. Let's look at both options so you can understand which one works better in different situations.

4.2.1.1. Wall Mounting

Wall mounting means fixing your CCTV camera to a wall using screws and brackets. This is the most common way people install cameras because it's usually easier to do. When you mount a camera on a wall, you can put it at eye level or slightly higher, which gives you a good view of what's happening.

The biggest advantage of wall mounting is that it's simple to install. You just need to mark where the screws go, drill some holes, and fix the camera bracket to the wall. Wall mounting also makes it easier to hide the cables. You can run the wires through the wall or use cable covers to make everything look neat and tidy.

Most wall-mounted cameras are placed about 2.5 to 3 meters high. This height is good because it keeps the camera safe from people trying to damage it, but it's not so high that you can't see faces clearly. Wall mounting works really well for watching doorways, gates, and specific areas you want to keep an eye on.

However, wall mounting has some limitations too. The camera can only see in the direction it's pointed, so you might miss things happening on the sides. Also, if someone knows where the camera is, they might try to avoid that area or even damage the camera since it's easier to reach.

4.2.1.2. Ceiling Mounting

Ceiling mounting means hanging the camera from the roof or ceiling of a room or building. This method gives you a view from above, looking down at everything below. Ceiling-mounted cameras are often called dome cameras because they usually have a round, dome-shaped cover.

The main benefit of ceiling mounting is that you get a much wider view. A camera hanging from the ceiling can see in all directions around it, which means fewer blind spots where someone could hide. This makes ceiling mounting perfect for large open areas like shops, offices, or warehouses where you want to see everything that's happening.

Ceiling-mounted cameras are also harder for people to tamper with or damage because they're completely out of reach. They look more professional and blend in better with the building's design. Many people don't even notice ceiling cameras, which can be good for security.

But ceiling mounting can be more difficult to install. You need to make sure the ceiling is strong enough to hold the camera's weight. You also need to think carefully about cable management because it can be harder to hide wires when they're coming down from the ceiling.

Figure-1: Wall mount and ceiling mount security cameras (Reference: https://www.multybyte.com/blogs/wall-mount-vs-ceiling-mount-which-cctv-stand-is-better)

Making the Right Choice

Making a right decision is depends on what you're trying to achieve. If you want to watch a specific area like a door or window, wall mounting usually works better. It's easier to install and gives you a clear, direct view of what you want to see.

If you need to monitor a large open area and want to see everything that's happening, ceiling mounting is often the better choice. It gives you wider coverage and better security for the camera itself.

Sometimes you might use both methods in the same security system. For example, you could use wall-mounted cameras to watch entrances and ceiling-mounted cameras to monitor large indoor spaces. The important thing is to think about what each area needs and choose the mounting method that works best for that specific location.

Remember that both mounting methods can work well when installed properly. The key is understanding the advantages and disadvantages of each approach and matching them to your specific security needs.

4.2.2. Waterproofing and Cable Routing

When you install CCTV cameras outdoors, protecting them from weather and managing cables properly becomes very important. Rain, dust, and moisture can damage your cameras and cables if you don't take the right steps to protect them. Good waterproofing and smart cable routing will make your CCTV system work better and last longer.

IP Ratings

Before you start waterproofing your cameras, you need to understand IP ratings. IP stands for Ingress Protection, and it tells you how well a camera can resist dust and water. The IP rating has two numbers - the first one shows protection against solid things like dust, and the second shows protection against water.

Most outdoor CCTV cameras have ratings like IP65, IP66, or IP67. An IP65 camera protects against dust and water sprays from any direction. IP66 cameras can handle powerful water jets, which makes them good for areas with heavy rain. IP67 cameras offer the best protection - they can even be underwater for short periods without getting damaged.

When you choose a camera for outdoor use, always pick one with at least IP65 rating. If your area gets very heavy rain or if the camera might get splashed with water regularly, go for IP66 or IP67.

Protecting Camera Connections

The camera itself might be waterproof, but the cable connections are usually the weakest part of your system. Water loves to get into these connections and cause problems. You need to protect these connection points very carefully.

The most important step is using waterproof connectors. These special connectors have rubber seals that stop water from getting in. If you're using ethernet cables for your IP cameras, get waterproof RJ45 connectors that completely seal the connection point.

Another good way to protect connections is by using dielectric grease. This special grease goes inside the connector and pushes water away. It's especially important if you live in a very humid place where moisture is always in the air. Many camera companies won't fix water damage under warranty, so using this grease can save you money later.

Junction boxes provide excellent protection for your cable connections. These weatherproof boxes completely hide the connection from rain and dust. You can run your cables into the box, make the connections inside, and then seal everything up. This keeps water completely away from the most vulnerable parts.

Cable Routing Techniques

How you run your cables is just as important as the cameras themselves. Poor cable routing can lead to water damage, physical damage, and a messy-looking installation. Always plan your cable routes before you start installing anything.

The best approach is to run cables downward from the camera whenever possible. This stops water from flowing toward the connection points. Never create low spots where water can collect and pool around your cables. Water naturally flows downward, so work with gravity instead of against it.

Using conduit is one of the best ways to protect your cables. PVC conduit creates a protective tunnel around your cables, keeping them safe from weather, animals, and accidental damage. Choose outdoor-rated conduit that can handle temperature changes and UV light from the sun.

For the neatest installation, try to follow existing structures on your building. Run cables along gutters, under eaves, or through soffits where they're naturally protected. This not only protects the cables but also makes your installation look more professional.

Choosing the Right Cables

Not all cables work well outdoors. You need cables that are specifically designed to handle weather and temperature changes. For ethernet connections, use solid CAT5e or CAT6 cables that are outdoor-rated. These cables have special coverings that resist UV light and moisture.

The covering on outdoor cables is usually thicker and made from materials that don't break down in sunlight. Indoor cables will crack and fail quickly if you use them outside, so always buy the right type for your installation.

Consider the distance your cables need to travel. Ethernet cables can only carry signals reliably for about 100 meters. If you need to go further, you might need special equipment to boost the signal or switch to fiber optic cables.

Installation Best Practices

When installing your cables, avoid tight bends and kinks that can damage the wires inside.

1. Use proper cable clips to secure cables to walls and structures, but don't over-tighten them.
2. The clips should hold the cable firmly but not squeeze it.
3. Test your cables before you seal everything up.
4. Always leave some extra cable length for adjustments. This gives you room to work when making connections and allows for small movements in the camera position.

5. Apply silicone sealant around any holes where cables enter walls or junction boxes. This creates a waterproof barrier that stops moisture from following the cable path into your building.
6. Use high-quality exterior-grade silicone that won't crack or shrink over time.

4.2.3. Focus and Angle Adjustments

When you install a CCTV camera, getting the focus and angle just right is essential. If the focus is off, your images will be blurry. If the angle is wrong, you might miss important areas. This section explains how to adjust focus and angle so your camera captures clear, useful footage.

Every CCTV camera lens has a focus ring. On fixed-lens cameras, this ring is set at the factory. But on varifocal cameras, you can twist the ring to change the focal length. A shorter focal length gives you a wider view but less detail on distant objects. A longer focal length narrows the view but lets you see farther away more clearly. For example, a 2.8 mm setting shows a broad scene up close, while a 12 mm setting zooms in on distant areas. By twisting the focus ring, you can balance how much you want to see versus how far you need to see.

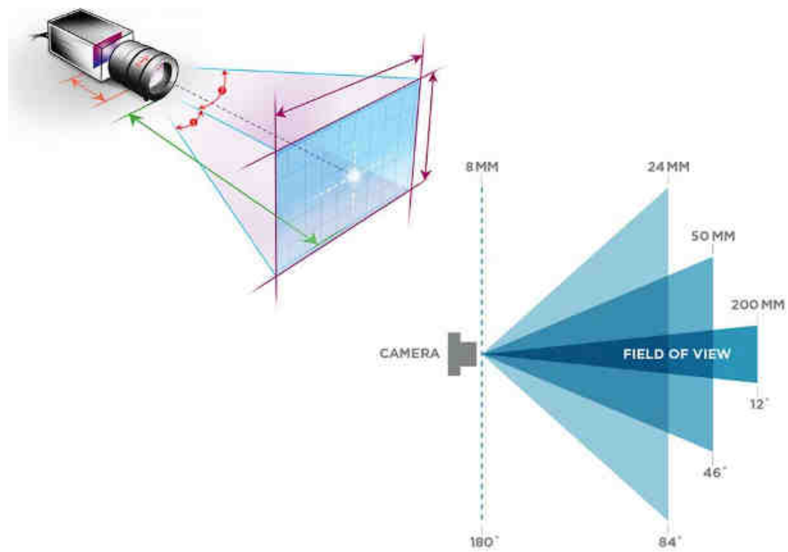


Figure-1: Diagram showing CCTV camera field of view angles for different focal lengths and the projection of focus area for lens adjustments(Reference: https://kintronics.com/the-field-of-view-for-ip-camera-systems/)

To adjust, first point the camera at the critical area—like a doorway or entrance. Have someone walk or stand where people will appear. Then slowly turn the focus ring until the person's face is sharp. If your camera has a zoom control, adjust zoom first, then fine-tune focus. Always use the live video feed on your monitor or smartphone to check clarity. Small tweaks can make a big difference.

Angle adjustment involves three movements: pan, tilt, and rotate.

1. Pan means moving the camera left or right.
2. Tilt means moving it up or down.

3. Rotate (sometimes called roll) means twisting the camera to level the horizon.

Most cameras use an adjustable bracket that lets you loosen screws, move the camera, and then tighten screws to lock the position. To set angles, loosen the bracket screws just enough to move the camera by hand. First, tilt it to cover the vertical range you need. Then pan it so it sweeps across the horizontal field. Finally, rotate the camera body so the image isn't skewed.

A good practice is to start with a "straight-on" view before making fine adjustments. Point the camera so the horizon line in your scene is level and the camera looks directly at the center of the area you want. Then watch the live feed to see blind spots—areas the camera can't see. Adjust pan and tilt to close those gaps. Make sure the camera isn't pointing too much at the sky or ground; this wastes detail. Keep key areas in the middle of the frame for the best image quality.

Some cameras offer remote focus and angle control through software. These allow you to change zoom, focus, and pan/tilt electronically. While convenient, they may lack the precision of manual adjustments. Always test remote settings by walking through the scene.

After setting focus and angle, secure all bracket screws firmly. Loose screws can let the camera drift over time. Check complete coverage by reviewing recordings at different times of day. Lighting changes can affect focus and field of view, so make final tweaks under normal lighting conditions.

4.2.4. **Infrared (IR) Cameras**

Infrared (IR) cameras detect and visualize thermal radiation emitted by objects, translating temperature variations into a visible image. Unlike conventional cameras that capture reflected visible light, IR cameras operate within the long-wavelength infrared spectrum (typically 7–14 μm), enabling them to see heat signatures.

4.2.4.1. Principle of Operation

Every object above absolute zero emits infrared radiation proportional to its surface temperature. An IR camera's lens focuses this radiation onto an infrared detector array, which generates electrical signals converted into a thermal image (thermogram). Bright areas in the thermogram correspond to hotter regions, while darker areas indicate cooler temperatures.

4.2.4.2. Key Components

- Optics: Special germanium or chalcogenide lenses transparent to IR wavelengths.
- Detector: Uncooled microbolometer arrays or cooled photon detectors, with microbolometers most common in commercial units.
- Signal Processing: Converts raw detector data into a calibrated temperature map, applies palette colorization, and overlays visual enhancements.
- Display/User Interface: Shows live thermograms, temperature annotations, and allows setting of alarm thresholds and spot measurements.

Figure-4.1: Handheld professional thermal imaging infrared (IR) camera displaying a thermal image on its screen

4.2.4.3. Types of IR Cameras

- Uncooled Cameras: Use microbolometer sensors operating at ambient temperature. They are compact, cost-effective, and require minimal maintenance.

- Cooled Cameras: House the detector in a cryogenic cooler to reduce thermal noise, offering higher sensitivity, faster frame rates, and the ability to detect minute temperature differences, but at higher cost and complexity.

4.2.4.4. Applications

Infrared cameras serve across diverse fields:

- Industrial Inspection: Detecting overheating electrical components, bearing faults, and insulation defects.
- Building Diagnostics: Locating heat leaks, moisture intrusion, and structural voids.
- Security & Surveillance: Night-vision monitoring and perimeter security in zero-light conditions.
- Medical & Veterinary: Non-contact fever screening and blood flow analysis.
- Research & Development: Thermal characterization of electronics, materials testing, and fluid dynamics studies.

4.2.4.5. Advantages

- Non-Contact Measurement: Allows safe temperature monitoring from a distance without disturbing the subject.
- All-Day Operation: Functions in complete darkness, through smoke, and light obscurants.
- Rapid Scanning: Provides instantaneous thermal maps for quick diagnostics.

4.2.4.6. Limitations

- Emissivity Dependency: Accurate temperature readings require knowing the object’s emissivity, which varies with surface material and finish.
- Limited Spectral Range: Cannot penetrate glass, so IR cameras cannot see through standard windows.
- Cost & Complexity: High-performance cooled systems are expensive and require periodic maintenance.

4.2.4.7. Best Practices

- Calibration: Perform regular calibration against known temperature references to ensure measurement accuracy.
- Emissivity Adjustment: Use proper emissivity settings or apply emissivity tape for reliable readings.
- Environmental Considerations: Minimize reflections and account for ambient temperature influences when conducting measurements.

Infrared cameras are powerful diagnostic tools that reveal thermal patterns invisible to the naked eye, enabling predictive maintenance, enhanced safety, and deeper insights across industrial, scientific, and security domains.

4.2.5 Labelling and Documentation

When installing CCTV systems, clear labelling and thorough documentation are as important as choosing the right camera or running cables. Good labelling helps technicians and users quickly identify each component, making maintenance and troubleshooting much easier. Documentation records what was done, where it is, and why it matters. Together, these practices save time, reduce mistakes, and ensure the system works smoothly over its lifetime.

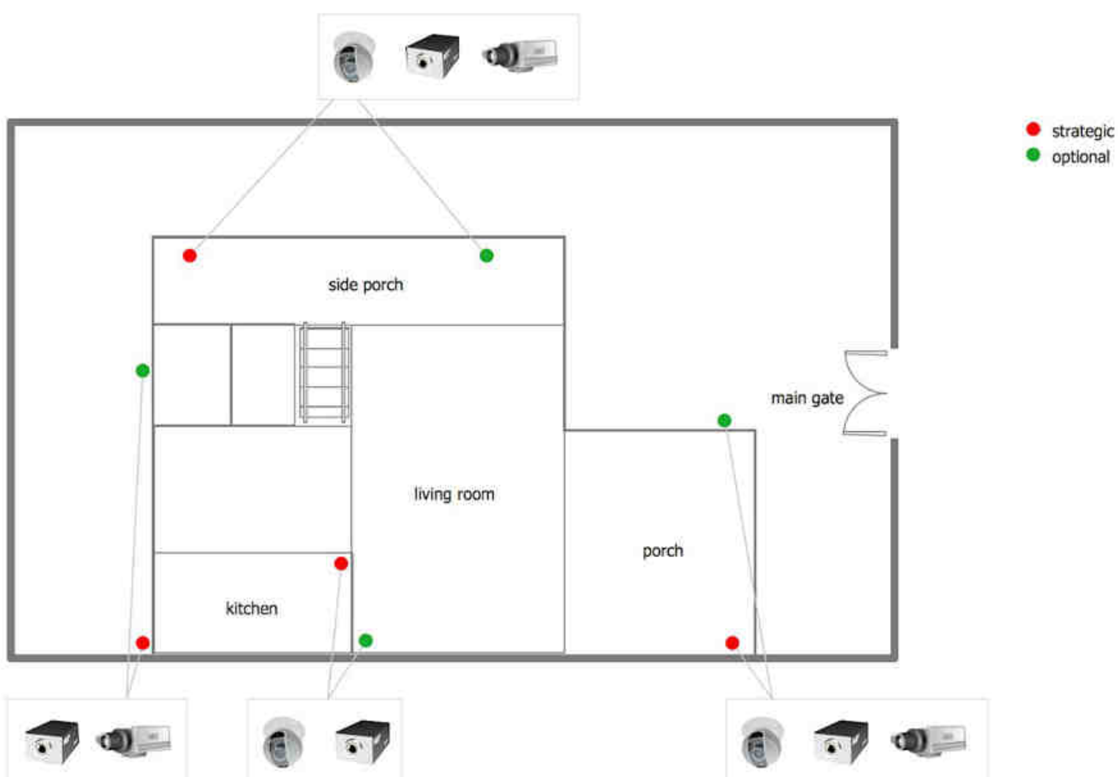
First, labelling. Every camera, junction box, and cable should carry a unique label. Start by assigning simple codes, such as “C1” for Camera 1, “J1” for Junction Box 1, and so on. Use durable labels designed for outdoor use if the equipment is outside. For indoor installations, stick-on plastic labels or printed tags work well. Labels must be legible and placed in a spot where they are easy to read but do not interfere with the cable connections or the camera’s field of view.

Labelling cables is equally important. At both ends of a cable run, attach labels that match the camera and junction box codes. For example, the cable running to Camera 3 could be labelled “C3–J2,” indicating it connects Camera 3 to Junction Box 2. This way, if a cable needs replacement or testing, you can trace it quickly without guessing. Color-coded sleeves around cables can further speed up identification. Use different colours for power cables, video cables, and network cables. A consistent colour scheme prevents confusion, especially in complex installations.

Next, documentation. A well-organized document clearly describes the entire system. Begin with a system overview: list all cameras, their codes, mounting locations, and types (such as fixed, PTZ, or infrared). A simple table works best:

Camera Code	Location	Type	Cable Label
C1	Front Gate	Fixed	C1–J1
C2	Rear Door	PTZ	C2–J1
C3	Parking Lot	IR	C3–J2

This table lets anyone glance quickly and know what is installed and where. After the overview, include a wiring diagram showing how cables run from cameras to junction boxes and from boxes to the recorder or network switch. Hand-drawn or computer-generated diagrams both work—clarity is key.



Fiigure-4.2: Floor plan with recommended CCTV camera placement showing strategic (red) and optional (green) locations with respective camera types.

Add a section for configuration details. Note each camera's IP address or channel number, video resolution, frame rate, and any special settings like motion detection zones or privacy masks. Record login credentials and password change dates. This information is vital when accessing cameras remotely or updating settings later on.

Configuration Details Section Template

Camera Configuration Record

Project Name: ____________________________

Site Location: ____________________________

Date: ____________________________

Technician: ____________________________

1. Camera Identification
    - Camera Code: _____________
    - Mount Location: _____________
    - Camera Type (Fixed/PTZ/IR): _____________

2. Network Settings
    - IP Address: _____________
    - Subnet Mask: _____________
    - Default Gateway: _____________
    - VLAN (if any): _____________
3. Video Settings
    - Channel Number: _____________
    - Resolution (e.g., 1080p, 4K): _____________
    - Frame Rate (fps): _____________
    - Compression Format (H.264/H.265): _____________
4. Special Features
    - Motion Detection Zones:
    - Zone 1: _____________
    - Zone 2: _____________
    - Zone 3: _____________
    - Privacy Masks:
    - Mask Area 1: _____________
    - Mask Area 2: _____________
    - Day/Night Mode: [ ] Auto [ ] Day [ ] Night
5. User Access
    - Admin Username: _____________
    - Initial Password: _____________

- Password Last Changed: ____________
- Password Expiry Interval (days): ____________

6. Remote Access
   - DDNS Hostname (if used): ____________
   - Port Forwarding (HTTP/RTSP ports): ____________
   - HTTPS Enabled: [ ] Yes [ ] No
7. Notes & Remarks

Finally, keep a maintenance log. Every time you perform a system check, clean camera lenses, adjust focus, or repair cables, write down the date and the work done. For example: “2025-09-15: Cleaned lens on C2; adjusted PTZ preset positions.” A history of maintenance helps spot recurring issues and proves that the system is well cared for, which can be important for warranties or service contracts.

CCTV Maintenance Log Report Template

Project Name: ____________________________

Site Location: ____________________________

System ID/Ref.: __________________________

Report Prepared By: ______________________

Date of Report: __________________________

1. Maintenance Overview
   - Report Period: From ________________ to ________________

- Total Scheduled Visits: __________
- Total Unscheduled Visits: ________

2. Maintenance Activities Table

Date	**Technician**	**Camera Code(s)**	**Activity Type**	**Details of Work Performed**	**Observations & Follow-up Actions**
YYYY-MM-DD	Name	C1, C3	Routine Inspection	Cleaned lenses; checked mount stability	No issues
YYYY-MM-DD	Name	PTZ2	Focus Adjustment	Adjusted focus and zoom presets	Presets updated
YYYY-MM-DD	Name	C4	Cable Repair	Replaced damaged coaxial cable segment	Tested continuity—pass
YYYY-MM-DD	Name	C2	Lens Cleaning	Removed dust and smudges from dome cover	Recommend monthly cleaning
YYYY-	Name	All	Firmware	Updated	Confirmed

Date	Technician	Camera Code(s)	Activity Type	Details of Work Performed	Observations & Follow-up Actions
MM-DD		cameras	Update	firmware to v2.1.0	stable operation
YYYY-MM-DD	Name	C5	IR Calibration	Verified IR cutoff and focus at night mode	Infrared performance normal

3. Summary of Findings
   - Number of cameras serviced: _______
   - Common issues addressed: ___________________________
   - Parts replaced: ___________________________
   - Firmware/software updates applied: ___________________________
4. Recommendations
   - Next scheduled maintenance: __________________ (Date)
   - Suggested frequency for lens cleaning: ___________
   - Any potential system upgrades: __________________
   - Training needs for staff: _________________________
5. Signatures

   Technician: ___________________________ Date: _______________

   Supervisor/Client: _____________________ Date: _______________

Effective labelling and documentation may seem like extra work at first, but they bring huge benefits. When a camera goes offline, you won't waste time hunting through cables. When new staff join, they'll understand the system quickly. When you upgrade or expand, you will know exactly where each component sits. In the long run, clear labels and detailed records make your CCTV installation reliable, maintainable, and professional.

What You Learned

1. Wall mounts keep cameras low and close to walls.
2. Ceiling mounts give a wider field of view.
3. Waterproofing protects outdoor cameras from rain.
4. Proper cable routing hides and secures cables.
5. Adjusting focus and angle ensures clear images.
6. Infrared cameras need correct IR range and sensitivity.

Points to Remember

1. Always choose the right mount for your location.
2. Use sealant and gaskets for outdoor waterproofing.
3. Keep cables away from sharp edges and heat sources.
4. Test focus and angle at different times of day.
5. Check IR illumination does not blind nearby objects.

6. Label cameras and cables immediately after installation.
7. Document all settings, IP addresses, and layouts.

↵ Update documentation after any system change.

Practice Exercises

Practical Exercise 4.3: Advanced Camera Mounting and Testing

These exercises build on basic mounting skills by adding demonstrations of glare, cable protection, IR testing, and thorough documentation. Follow each step carefully and record your observations in your logbook.

Exercise 1: Focus, Angle, and Glare Demonstration

Objective: Compare focus and glare issues for wall versus ceiling mounts.
Materials: Fixed-focus dome camera, polished glass panel, white wall, monitor, ladder, cloth.
Steps:

1. Mount the camera on the wall 1 m from the glass panel and power it on.
2. View the scene on the monitor. Note reflections or glare caused by the glass.
3. Adjust the focus ring until the wall texture is sharp, then angle the camera down 10° and up 10°. Record image clarity and glare intensity.
4. Remount the camera on the ceiling 1 m from the glass and repeat steps 2–3.

5. Compare which mount position reduces glare and maintains focus.
6. Cover the glass with a cloth and repeat to see how glare changes.

Exercise 2: Neat Cable Routing and Weather Protection

Objective: Practice routing cables neatly and protecting them outdoors.
Materials: Outdoor dome camera, junction box, CAT6 cable, cable clips, silicone sealant, flexible conduit, PVC pipe, hacksaw.
Steps:

1. Mount the outdoor camera and junction box under a small overhang.
2. Strip 50 mm of cable jacket and feed the cable into the box through a grommet.
3. Apply silicone sealant around the entry point to waterproof it.
4. Measure and cut flexible conduit to cover the cable run along the wall. Secure with clips every 30 cm.
5. At the bottom of the run, transition into PVC pipe using an elbow joint. Seal pipe ends with weatherproof tape.
6. Inspect all seals and conduit connections, then test video signal stability.

Exercise 3: IR Range Testing

Objective: Determine the effective IR illumination range and image quality.
Materials: IR-enabled bullet camera, infrared illuminator (if external), reflective target (white board), volunteer, dark room.
Steps:

1. Place the reflective board at 2 m from the camera. Switch off lights.
2. Enable IR mode and view the board’s reflection on the monitor. Note

brightness and detail.

3. Move the board to 5 m, then ↵m. At each distance, record image clarity and any overexposure.
4. Ask the volunteer to walk slowly at 3 m, 6 m, and ↳m. Observe how well the camera captures their movement.
5. Adjust the IR sensitivity or illuminator power to optimize image at maximum usable range.
6. Log the maximum distance at which clear images appear without white-out.

Exercise 4: Labeling and Documentation Demonstration

Objective: Show how to label equipment and maintain organized records. Materials: Preinstalled CCTV system (five cameras), label printer, cable tags, printed wiring diagram, configuration logbook.
Steps:

1. Use the label printer to create camera housing labels (C1–C5) and matching cable tags.
2. Attach labels to each camera and to both ends of its cable.
3. Update the wiring diagram with camera codes, cable paths, and junction box IDs.
4. In the configuration logbook, record each camera's IP or channel, resolution, frame rate, motion zones, and password change date.
5. Date and sign the documentation, then file it in the project folder.
6. Present the labeled system and documentation to the instructor, explaining

how each record entry supports future maintenance.

Expected Outcomes:

- You will see how mount position affects glare and focus.
- You will practice professional cable routing and waterproofing.
- You will determine the effective IR range and learn to adjust illumination.
- You will reinforce the importance of clear labeling and comprehensive documentation.
- You will understand how each step contributes to a reliable, maintainable CCTV installation.

Practice Questions

Assessment Questions: Camera Mounting Techniques

Fill in the Blanks (5 Questions)

1. A camera mounted on the _____ gives a wider field of view than a wall mount.
2. To protect outdoor installations, cables must be routed through _____ or PVC piping.
3. Adjusting the camera's _____ ring ensures the image is sharp and clear.
4. Infrared cameras rely on _____ illumination to capture images in darkness.
5. Each camera and its cable ends should be labeled with a unique _____ for

easy identification.

Multiple Choice Questions (6 Questions)

1. Which mount is best for covering a large open area from above?

   a) Wall mount

   b) Ceiling mount

   c) Table mount

   d) Tripod mount

2. What is the main purpose of using flexible conduit on outdoor cable runs?

   a) To increase cable speed

   b) To protect cables from weather and damage

   c) To make cables invisible

   d) To improve video resolution

3. When adjusting a fixed-focus camera, you should first:

   a) Change its IP address

   b) Rotate the focus ring until the image is sharp

   c) Paint the camera housing

   d) Swap the lens with another camera

4. An IR camera's effective range is tested by:

   a) Counting the cable length

   b) Using reflective targets or a person walking at various distances

   c) Measuring the height of its mount

d) Checking the power supply voltage

5. Which label example correctly matches a camera and its junction box?

   a) C1–J1

   b) CAM–BOX

   c) IR–DOC

   d) VID–NET

6. Good documentation includes all of the following EXCEPT:

   a) Camera IP addresses

   b) Motion detection zones

   c) Password change dates

   d) Paint color of the camera housing

Subjective Questions

1. Explain two advantages and one disadvantage of ceiling mounts compared to wall mounts.
2. Describe the steps you would follow to waterproof a cable entry point at an outdoor junction box.
3. Outline how you would adjust focus and tilt on a camera to eliminate glare from a nearby window.
4. Discuss why infrared cameras require proper IR power settings and how overexposure can affect image quality.
5. Explain the importance of labeling each camera and cable, and describe a

simple labeling scheme you would use.

6. Describe what information you would record in your documentation after installing and configuring five CCTV cameras on a site.

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Session 3 Basic Troubleshooting and Maintenance

CCTV installation is crucial as it guarantees good video quality and proper surveillance. Improper installations can affect video quality and even lead to system failures. This chapter section is dedicated to discussing common failures in CCTV installation. Their knowledge is important to ensure error-free, reliable and durable CCTV systems. Effective CCTV troubleshooting starts with power verification, followed by cable integrity, grounding, and configuration checks.

4.3.1 Common installation faults and fixes

Common faults in CCTV installations include blackout (no video) often caused due to loose connections of power cables or BNC, snowing videos due to improper shielding, interference and long running cables, intermittent dropouts (loose terminations or moisture), and/or night vision failure (dirty lens or LED burnout).

Camera Position: It is important to ensure cameras are installed at proper heights, neither too high nor too low. Wrong viewing angles, lead to blind spots which are exploited in case of malicious activities. For proper videos the camera's field of view should avoid direct sunlight or headlights, obstructions arising from trees, poles and signages. Overall, this leads to poor or unusable footage, unnecessary glare and un-identification.

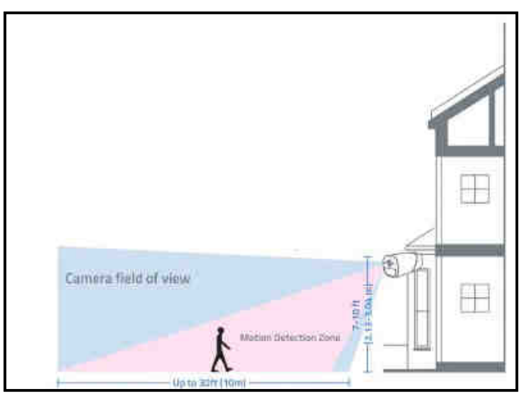

Figure: Too high camera installation

Cable quality and length: Poor cable connections or using cable lengths beyond limits result in degraded signal quality. As a result, CCTV captured videos are noisy, or ghosting (double or shadow images), or complete signal loss. Noisy images have grains (white and black), rolling bars or horizontal lines because of poor cable quality or longer than permissible cable length. Loose BNC connections, improper impedance matching of RG59 cables, and/or loose crimps often lead to ghost images. Broken cables normally result in complete loss of video signal.

Fixes start with power cycle, clean connections, and cable swaps; replace with dual-shield RG59 Siamese for better reliability.

Power Supply Issues: Voltage fluctuations often cause cameras to reboot, flickering video or night failures. This could also arise due to improper load sharing among electrical loads or voltage drops resulting from longer cable runs.

Improper Settings: Improper IR settings, shutter speeds, misconfiguration of auto-settings in CCTV, wrong video standards, firmware mismatch, lack of testing and documentation are few among various factors which result in inefficient CCTV installations due to lack of knowledge and technical expertise. These factors result in degraded video quality, or no video at all. Certain factors can be identified and corrected from the video quality, while others are difficult to troubleshoot thereby increasing the system downtime.

Environmental factors: Humidity and temperature variations affect camera lens and cables. Moisture entering the cameras and connections leads to corrosion, system failures or blurred images. Poor cable sealing at the junction boxes hampers connectivity.

A summary of common faults and resulting affects which can be used as key troubleshooting points are:

Fault Type	***Main Symptoms***
Wrong Camera Angle	Blind spots
Poor cables	Noisy video
Grounding Issues	Rolling bars
Power problems	Camera resets
Bad connectors	Intermittent signal loss
IP reflection	White night images

Efficient troubleshooting is an art and requires proper technical expertise. You begin with basic inspection of the system ultimately diving deep to resolve the problem. The basic steps in troubleshooting and fixing any CCTV installations are:

1. Look for loose connections, measure voltages using multimeters. Verify all power cables are properly connected with each delivering correct voltage levels at all nodes.

2. Investigate the cables and connectors to find any breaks in the video transmission and ensure fault-free video path. Use multimeters to test cable continuity. Cameras can be checked for proper operation by installing them in known paths.
3. Thoroughly inspect the cables for any cuts, bends or breakage. Ensure that the shielding is intact, length specifications are adhered and connections are dry/waterproof.
4. Grounding connections should be reviewed. There should be a single ground connection and avoid any loops in the grounding. Temporarily disconnect the ground to oversee any grounding loops.
5. Ensure that all equipment's are fault-free.

4.3.2 Preventive maintenance routines

A good and healthy system is a result of period maintenance/service routines. All the equipment's undergo periodic maintenance checks to capture and repair faults before they lead to system failure. Preventive measures and maintenance significantly reduce failures.

Routine maintenance practices include:

1. ***Periodic cleansing schedules:*** lens needs to be cleaned periodically using a micro-fiber cloth. Clean any dust, spider webs or moisture in the housing.
2. ***Connector tightening:*** BNC, LAN and other connections should be screened periodically and tightened for proper connections.
3. ***Power system maintenance:*** UPS, SMPS supply and power cables should be monitored to ensure appropriate power supply across all nodes.

4. ***Routinely monitor cable routes*** for healthy cables and connections enroute, and replace brittle and cracked insulations.
5. ***Recording health check:*** playback previous recordings randomly to ensure the storage is not broken. Check for date-time settings for accuracy, and HDD status and duration of different recordings.
6. ***Ensure stable firmware and software.*** Software and firmware should be regularly updated with proper matching of versions between hardware and related software support. Authentication passwords should be changed periodically to avoid unauthorized access or system hacks.

Preventive maintenance routines are scheduled either monthly, quarterly and/or annually. Lens cleaning, power tests and cable health are activities that are scheduled monthly. Quarterly activities include power supply measurements, shielding near interference sources and verification of DVR recordings. Aging cables, firmware updates and full system test and verification are annual maintenance activities.

4.3.3 Customer-friendly troubleshooting

Customer friendly, non-technical troubleshooting approach refers to how the installers and service engineers should represent the problems and solutions to the customers in a calming, reassuring and easy to understand ways. Customer-friendly troubleshooting requires that you judge the background of the customer before dealing and explaining them about the problem. Non-technical people will not bother about technical specifications and therefore scientific reasoning should be avoided. Technical persons might however be interested in what is happening with the system and how you are going to proceed towards problem resolution, therefore such customers need to be tackled with appropriate scientific reasoning. There might be instances where customers report problems faced as serious issues but for technicians the solutions will be trivial.

As you first interact with the customer start with re-assurance. Patiently explain that the issue faced by them is very common usually easy to fix. Then begin with investigating the basics. Usually, it is less worrisome for customers when they hear the problem is easy to fix and manageable. A lost camera display could be related to power supply, which can be simply explained by drawing an analogy; as mobile needs charger the camera also needs steady power supply. As a technician you will look for proper functioning of SMPS and the voltage being delivered to camera, you could also use a multimeter to measure voltages. Customers with technical background could be explained based on the voltage levels being observed on the multimeter.

A complaint like sometimes video appears sometimes it doesn't. The intermittent video signal disappearance is mostly related to loosely connected cables. Check and tighten appropriate cable joints. Avoid explaining the technical details like impedance matching, shielding. Complaints related to noisy or wavy images will be like the video is not clear, hazy or black/white/gray lines are appearing on the screen. The possible cause could be interference with electrical power supply cables. Hence try identifying the routes of cables and try re-routing. A simple explain could be the electrical cables were interfering with the camera signals, rather than technical jargon like ground loop interference, electromagnetic interference etc.

Any disruptive night camera video signals, are often complained as the camera does not function properly during night-time, it is black at night. This is mostly related to reflective objects, IR LEDs. A proper fix could be cleaning the lens and analyzing reflective or blocking objects in the vicinity of the camera. The camera switched to IR mode in the night which needs IR LEDs to be fault-free. A simple explanation could be camera works in a different mode during the night-time. Let me ensure that everything is well with that mode of functioning.

Complains related to playback feature are often related to storage and memory. Simply explain that camera is fine but there could be an issue with memory, where again an analogy with the phone memory can be drawn. Just as phone stores data and images, camera also does. The playback is replaying the stored content and therefore a memory issue.

Rather than blaming, give preventive advice like cameras should be kept dust free, ensure cleaning the lens periodically, keeps the cables dry and prevent any moisture, avoid touching the cables often, do not fiddle with power supply etc. Problems statements converted to advisory have better impact on people and builds confidence.

After you are done with the problem identification and resolution, confirm with the customers. Ask them is their problem resolved, let them reply with yes and no. Finally, before leaving re-assure them that service is just a call away in case, they face issues later or problem rekindles.

4.3.4 Clean a Camera Lens and Check IR LEDs

Dirty camera lenses are one of the most common causes of poor video quality. Over time, dust, spider webs, water droplets, and dirt accumulate on lenses, creating a layer that blocks light and reduces image clarity. The video becomes fuzzy, blurry, or washed-out, and customers often think the camera is broken when it just needs cleaning.

Cleaning a lens requires care because the optical coating is delicate. Using wrong materials or aggressive cleaning can scratch the lens permanently, making the problem worse. This is why proper technique and correct materials are essential.

Infrared LEDs provide night vision by illuminating the scene with invisible infrared light that the camera can detect. When IR LEDs get dusty or burn out, night vision fails completely and customers see black footage at night. Checking IR LEDs regularly prevents this problem from affecting customers unexpectedly.

The key point to remember is that lens cleaning and IR LED checking should be part of your regular maintenance schedule, not something you do only when customers complain. Monthly or quarterly maintenance prevents problems before they start and keeps video quality consistently high.

4.3.5 Simulate and Fix a No-Video Error

No-video error occurs when the monitor shows a black screen or displays →no signal→ even though the camera should be transmitting. This is the most common problem technicians face, and the good news is it's usually caused by simple issues that are easy to fix once you know where to look.

The most important principle in troubleshooting is to work systematically from the simplest possibilities to more complex ones. Never assume a major component has failed until you've checked the basics like power and connections.

Power supply issues are the first thing to verify. If the DVR/NVR has no power or if power isn't reaching the camera, no video will appear. Loose connections are the second most common cause. A slightly loose BNC connector can cause intermittent or complete signal loss. After checking power and connections, examine the cables themselves for physical damage like cuts or sharp bends that break the internal conductors.

Sometimes the problem isn't hardware but software configuration. A camera might be disabled in the DVR/NVR settings, or the DVR might be looking at the wrong input channel. Resetting the equipment often resolves software-related issues.

The key troubleshooting skill is knowing how to use a multimeter to measure voltage, test continuity, and check resistance. These simple measurements tell you whether power is present, whether cables are intact, and whether connectors have good electrical contact.

4.3.6 Diagnose a Loose Connector and Re-crimp

Loose or damaged connectors are responsible for many CCTV system problems. A loose connector might cause intermittent video loss, fuzzy images, intermittent dropouts, or complete signal failure. When you suspect a connector problem, careful inspection and proper repair through re-crimping will restore the connection.

A properly connected BNC connector should be tight with no visible gap between the connector and cable jacket. When you gently wiggle the connector by the connector body itself (not the cable), it should not move at all. Wiggling indicates a loose connection that needs tightening or re-crimping.

Corrosion appears as green, white, or blue discoloration on connectors or cable ends. Corrosion occurs when moisture enters connectors and causes oxidation of the metal surfaces. This increases electrical resistance and degrades signal quality. Corroded connectors should be cleaned if the corrosion is light, or replaced if severe.

Re-crimping means removing a damaged connector and securely attaching a new one to the cable. This is an essential field skill. Proper crimping creates a permanent, reliable connection between the connector and cable. Poor crimping work leads to intermittent failures that are frustrating for customers and dangerous for your reputation as a technician.

The most common crimping mistakes result from improper cable preparation. If you don't strip the cable jacket and shield correctly, the connector won't make proper contact with the cable. If you cut too much jacket, there's not enough material for the connector to grip. If you cut too little, the insulation prevents electrical contact. Getting the preparation exactly right is what separates good technicians from poor ones.

After re-crimping, always test the connection with a multimeter before reconnecting to equipment. A poor re-crimp might look acceptable visually but still have high resistance that causes intermittent failures. Testing ensures quality work.

What You Learned

1. You learned that common CCTV faults include blackout (loose connections), snowy video (poor shielding), intermittent dropouts (moisture), and night

vision failure (dirty lens or burned-out IR LEDs).

2. You discovered that systematic troubleshooting starts with power verification (12V at camera), then BNC connector inspection via wiggle test, followed by cable continuity testing with a multimeter.
3. You understood that camera position, field of view, and cable routing away from electrical interference, sunlight, and moisture are critical for maintaining video quality and preventing blind spots.
4. You learned that preventive maintenance routines scheduled monthly (lens cleaning, connector tightening) and quarterly (cable inspection, DVR verification) prevent most system failures.
5. You discovered that customer-friendly troubleshooting uses simple analogies instead of technical jargon, starting with reassurance and gradually investigating from basic to complex issues.
6. You understood that proper lens cleaning, IR LED testing using a smartphone camera, and correct re-crimping techniques with multimeter verification are essential maintenance skills.

Points to Remember

1. Always verify power supply voltage at the camera (12V DC ±1V) first when troubleshooting no-video errors.
2. A loose BNC connector causes flickering video; use the →wiggle test→ to

identify and re-seat or re-crimp the connection.

3. Snowy video with rolling bars indicates cable interference; move camera cables 2-3 feet away from electrical mains cables.
4. Use microfiber cloth and camera-specific cleaning solution for lens cleaning—never use paper towels or tap water.
5. Test infrared LEDs using a smartphone camera in darkness; purple/red dots indicate working LEDs, no glow suggests failure.
6. Schedule preventive maintenance monthly (lens cleaning, connector inspection) and quarterly (cable inspection, DVR verification).
7. Explain problems to non-technical customers using simple analogies; avoid technical jargon like →impedance→ or →EMI."

↵ After re-crimping, test resistance with a multimeter—<1 ohm is good, >5 ohms indicates a poor crimp requiring redo.

↳ Corrosion on connectors indicates moisture damage; clean light corrosion or replace severely corroded connectors.

10. Ensure single ground connection with no ground loops to prevent rolling bars and intermittent failures.

Experiment-1: Spotting and Fixing Typical CCTV Setup Errors

Objective:

To identify common CCTV installation faults through systematic visual inspection, electrical testing, and performance evaluation, then apply targeted fixes to restore optimal system operation. Diagnose no-video, snowy image, IR failure, voltage drop, and interference issues, learning professional troubleshooting workflows used by CCTV technicians.

Requirements:

1. Analog CCTV camera with IR LEDs (mounted on test bench)
2. DVR with composite BNC inputs and signal strength meters
3. Regulated 12V DC power supply (2A minimum)
4. Siamese cables: RG59 single-shield (good condition), RG59 single-shield (intentionally damaged), RG59 dual-shield (reference)
5. Fault simulators:
    - Loose BNC connector (half-crimped, intermittent contact)
    - Dirty camera lens (fingerprints, dust accumulation)
    - Low voltage power supply (adjustable, set to 10V for testing)
    - EMI source (nearby mains cable or fluorescent light fixture)
    - Disconnected IR board jumper (disables IR LEDs)
    - Water-damaged cable section (simulated with tape/moisture)
    - Kinked cable (simulated signal loss)
6. Digital multimeter (DC voltage, continuity, resistance modes)
7. CCTV cable tester (BNC continuity probe)

Instructions:

Step 1: Document All Intentional Faults

1. Power on the complete CCTV system with all predetermined faults active

(loose BNC, low voltage, dirty lens, disconnected IR, etc.).

2. On the DVR monitor, observe and record the initial status of each camera:
    - **No signal**: Black screen, no image detected
    - **Snowy/noisy image**: Visible grain, rolling bars, or flicker
    - **Dark image**: Dim picture with or without IR illumination
    - **Intermittent dropouts**: Signal appears and disappears
    - **Color shift or artifacts**: Unusual hues, ghosting, or sync loss

Step 2: Video Connection and BNC Integrity Testing

1. Visually inspect all BNC connectors (camera ends and DVR ends):
    - Look for loose, half-crimped, or corroded connectors
    - Gently wiggle each BNC plug while observing the DVR monitor
    - If picture flickers when wiggled, connection is intermittent
2. Use a cable tester:
    - Attach the BNC cable to the tester
    - Verify continuity beep (center conductor connected end-to-end)
    - Verify shield is grounded (outer contact connected)
    - No beep = open circuit (broken internal conductor)

Step 3: Optical and Environmental Assessment

1. Visually examine each camera lens:
    - Look for fingerprints, dust, or condensation on the glass
    - Note any visible debris blocking the lens center

2. Clean the lens with microfiber cloth:
    - Gently wipe in circular motions from center outward
    - Avoid pressing hard (may scratch coating)

Step 4: IR Night Vision Functionality Test

1. Dim or turn off room lights; cover the camera lens completely (black cloth or cap)
2. Using a smartphone camera:
    - Aim at the camera lens from 10–20cm distance
    - In total darkness, a working IR LED shows as faint purple/red dots on the phone screen
    - No glow = IR LED failure or disconnected IR board

Assessment:

1. **Troubleshooting Sequence**: In what order did you approach the faults (power → BNC → optical → IR)? Why is this sequence logical for CCTV technicians?
2. **Symptom-to-Fault Correlation**: How did each visible symptom (no video, snow, dark image) correlate to its root electrical cause? Provide specific examples from your testing.
3. **Shielding Effectiveness**: Based on your EMI stress test, explain how single-shield vs. dual-shield cables performed differently. Why does foil shielding improve high-frequency rejection?
4. **Voltage Impact**: How did decreasing voltage from 12V to 10.2V affect camera brightness and IR LED performance? At what voltage threshold did

image quality become unacceptable?

5. **Installation Best Practices**: List five preventive maintenance steps that would have prevented these faults in a new installation.

Experiment-2: Demonstrate customer friendly troubleshooting

Objective: To develop and practice professional, customer-friendly troubleshooting techniques that minimize technical jargon, empower non-technical users to resolve common CCTV faults independently, and establish efficient remote support workflows. Students will role-play technician-customer interactions, create plain-English explanations for faults (no video, snowy image, IR failure), design visual communication aids, and document step-by-step guidance suitable for phone/video support scenarios.

Requirements:

1. 3 →Customer→ actors or volunteer students with assigned personas:

- Persona 1: Homeowner (non-technical, anxious about system failure)
- Persona 2: Small office manager (mildly technical, busy, wants quick fix)
- Persona 3: Retail owner (frustrated, needs night vision for security)

2. Customer Card scenarios:

Scenario 1: →Front door camera went black yesterday, others work fine→

Scenario 2: →Garage cam is all snowy/grainy, looks like bad TV signal→

Scenario 3: →Night vision stopped working, can't see license plates at night→

Instructions:

Step 1: Scenario: Homeowner calls: →*Hi, my front door camera just went black. The other cameras are fine. I'm worried about a break-in tonight."*

Technician Goal: Resolve with power cycle within 3 minutes; empower customer for future

Script:

CUSTOMER: →Front door camera went black yesterday..."

TECH: →Don't worry, this is usually very simple. Let me ask you a few quick questions.

Is there a small light on the camera itself—usually green or blue?"

CUSTOMER: →No, it's completely dark."

TECH: →Perfect← That tells me it's a power problem. Here's what we're going to do:

Can you see where the camera power cable plugs in? It's usually a round connector.

Unplug that connector from the camera—just pull it gently. Wait 10 seconds.

Now plug it back in firmly until you hear a click.

Look at the camera—any light now?"

[If light appears:]

TECH: →Excellent← You just did a power cycle. Look at your DVR monitor—

is the front door picture back?"

[If still no light:]

TECH: →OK, let's check the DVR side. Walk over to where the DVR power plug is.

Can you unplug that too? Wait 30 seconds—I know it seems long, but that

resets the whole system. Plug it back in and give it 60 seconds to restart.

Any green lights on the DVR now? Good← Give it another 30 seconds to boot up.

Check the front door camera on the screen—back?"

[If resolved:]

TECH: →Perfect← You've got full night vision coverage now. That was a simple power glitch.

If this happens again, try the same steps. You've got my number—don't hesitate to call."

[If not resolved:]

TECH: →Let me schedule a visit for tomorrow. But in the meantime, the other cameras are

watching, so you're not completely unprotected. I'll bring a new power adapter and check the cable."

Step-2: **Scenario**: Office manager calls: →*The garage camera keeps showing static-like snow. It's really hard to see who comes in the loading dock."*

Technician Goal: Resolve with BNC reseat and cable reroute within 5 minutes

Script:

CUSTOMER: →Garage camera is all snowy..."

TECH: →I can help← That snowy look—it's like old TV static, right?

That usually means interference or a loose connection."

[Pause for customer confirmation]

TECH: →Here's what I'll explain: Your camera sends video through a cable to the DVR.

If that cable is too close to power lines or if the connection isn't tight,

it picks up electrical noise—like interference."

[Show laminated →Good vs. Snowy→ card via camera or describe:]

TECH: →Imagine the difference between clear reception and a radio with static.

That's what we're fixing."

[First approach: Check BNC connection]

TECH: →On your DVR—the piece with the monitor screen—find the cable from the garage

camera. It's a round connector, probably labeled or taped. Grab the connector and gently wiggle it.

Watch the garage picture on the screen while you wiggle. Does the snow get worse or does it clear up momentarily?"

[If worse with wiggle:]

TECH: →That's the problem← The connection is loose. Push that connector in firmly until it clicks tight. You should feel resistance.

Now wiggle it again—is the picture clearer?"

[If confirmed, ask to check cable routing:]

TECH: →Great← Now let's keep it clear. The garage camera cable—can you see it?

Is it running close to any big power cords, thick black cables, or lighting?

If yes, gently move the camera cable away about 2-3 feet. This prevents electromagnetic interference. Reroute it along the wall or use a separate path if possible."

[Final verification:]

TECH: →Look at the garage picture now. Any snow? Better? Perfect← You've just fixed it.

The key was a tight connection plus distance from power interference.

If snow comes back, remember: first check that BNC connector is tight,

and move the cable away from power lines."

Step-3: **Scenario**: Retail owner calls: →*The back parking lot camera isn't working at night. I can't see license plates. It's a security issue*←→

Technician Goal: Diagnose and restore IR within 6 minutes or schedule service

Script:

CUSTOMER: →Back lot camera fails at night, can't see anything←→

TECH: →I understand—license plate visibility is critical. This is usually one of two things:

either the night vision (IR) isn't working, or there's not enough light.

Let me walk you through a quick test."

[Set up phone camera test:]

TECH: →I'm going to teach you a trick. In a dark room or at night, your smartphone can

see infrared light that human eyes can't.

Can you get to the camera? In complete darkness—maybe close the door or go outside at night.

Take your smartphone camera—just the back camera, not selfie mode. Point it at

the camera lens from about one foot away.

In the camera app view, look closely at the camera lens. If night vision is working, you'll see purple or red dots around the lens edge. Those are infrared LEDs."

[Customer performs test:]

TECH: →Seeing any purple/red glow?"

[If YES - IR is working:]

TECH: →Great← The camera's night vision is on. The issue might be lens cleanliness

or camera position.

First: Can you see the camera lens itself? Is it dirty, covered in dust, or do you see fingerprints?

If yes, gently wipe the lens with a soft cloth—like a microfiber eyeglass cloth if you have one. Wipe gently in circular motions from center outward. Don't press hard."

[Test image after cleaning:]

TECH: →Look at your DVR monitor showing that camera at night. Better now? That's usually half the problem—lens buildup."

[If NO - IR not working:]

TECH: →OK, the infrared LEDs aren't glowing. That's the issue. Usually it's one of three things:

First: Check if IR is enabled in camera settings. Do you have a menu on your DVR where you can adjust camera settings? Look for 'IR Mode' or 'Night Vision' and make sure it says 'ON' or 'Auto'."

[If settings are on:]

TECH: →Settings look good. This might be a power issue. Night vision uses more electricity than daytime video. Let me ask: Is this camera on a long cable run—like 30+ meters

from the DVR?

If yes, the voltage might be dropping. IR LEDs need strong power to work.

We can upgrade the power supply or use a different cable type."

[Decision point:]

TECH: →Here's what I recommend:

- If the lens cleaning helped, great← Clean it weekly—dirt is enemy #1 for IR.
- If IR is off, try enabling it in settings and reboot the DVR.
- If IR still won't turn on after 5 minutes of troubleshooting, I should visit and test the voltage/IR board. Can I schedule for tomorrow?"

[Final tip:]

TECH: →Pro tip for future: Clean the camera lens every month—dust and spider webs

destroy night vision. Mark it on your calendar. That one habit prevents 90%

of night vision problems."

Step-4: Collect Customer Feedback

CUSTOMER FEEDBACK FORM

Technician Name: ___________________________

Date/Time: ________________________________

Issue Resolved? Y / N / Partial

Communication Clarity:

☐ Very clear (5) ☐ Clear (4) ☐ Acceptable (3) ☐ Confusing (2) ☐ Very confusing (1)

Technician Empathy:

☐ Very supportive (5) ☐ Good (4) ☐ Neutral (3) ☐ Impatient (2) ☐ Rude (1)

Speed to Resolution:

☐ < 3 min (5) ☐ 3-5 min (4) ☐ 5-10 min (3) ☐ > 10 min (2) ☐ Unresolved (1)

Would you recommend this technician? Y / N

Best part of support: __________________________________

Could improve: ____

Overall Rating: ☆☆☆☆☆ (1-5 stars)

Step 5: Create Case Summary:

CASE SUMMARY ══════════════════════════════ Customer: Retail Owner (Back lot camera) Initial Issue: No night vision, can't see license plates Root Cause: IR LEDs not enabled + dirty lens Technician Actions: - Phone camera IR glow test (confirmed LEDs working) - Customer enabled IR mode in DVR settings - Cleaned lens with provided cloth Time to Resolution: 6 minutes (no site visit needed) Customer Satisfaction: ☆☆☆☆☆ Outcome: Prevented $150 service visit, empowered customer
Experiment-3: Demonstrate the step-by-step process to resolve a missing video feed Objective: To systematically diagnose and resolve a →no video→ fault in CCTV systems using a structured troubleshooting workflow that prioritizes power verification, connector integrity, and signal continuity. Requirements: 1. Analog CCTV camera with power LED indicator 2. DVR with composite BNC inputs and signal strength display 3. Regulated 12V DC power supply (adjustable 0-15V for testing) 4. Siamese cable (RG59, minimum 10m length) Instructions:

Step 1: Verify Power Supply Output

1. Locate the DVR power supply (usually a wall adapter or internal unit with external cables)
2. Set multimeter to DC voltage mode (20V range)
3. Measure voltage at the power supply output terminals:
    - Red probe on positive (+12V or marked +)
    - Black probe on negative (GND or marked -)
    - Expected reading: 12.0V ± 1V (11-13V acceptable)
4. Record the reading: _________ V

Step 2: Verify Power at the Camera

This is the most critical measurement:

1. Locate the camera power input connector (usually Molex, DC jack, or screw terminal)
2. Set multimeter to DC voltage mode
3. **Without disconnecting the camera**, probe the positive and negative leads:
    - Positive lead: red probe on +12V terminal
    - Negative lead: black probe on GND terminal

Step 3: Visually Inspect BNC Connectors

1. Locate the BNC connectors:
    - At the camera: BNC male connector (center pin protruding)
    - At the DVR: BNC female connector (or cable-mounted female connector)

2. Inspect both ends:
    - **At camera**: Is center pin present and straight? Outer shell intact?
    - **At DVR**: Any visible looseness? Shell cracked?

Step 4: Perform the →Wiggle Test→

This simple test reveals loose connections:

1. Have the DVR monitor visible and displaying the no-video camera feed
2. Gently grasp the BNC connector at the DVR end
3. Slowly wiggle/rotate the connector while watching the DVR monitor:
    - **If image flickers or appears**: Connection is loose← Re-seat firmly.
    - **If no change**: Connection is either tight or the cable is broken

Step 5: Perform Continuity Test (Cable Tester or Multimeter)

A continuity test confirms the internal cable is intact (not broken).

Option A: Using a cable tester (preferred):

1. Disconnect the coax cable from both ends
2. Attach one end to the transmitter; other end to the receiver
3. Press the test button; LEDs indicate:
    - **Green LED** = Cable OK (center and shield continuous)
    - **Red LED** = Open circuit (broken conductor) or short (shield touching center)
    - **No LED** = Tester not working; try multimeter

Experiment-4: Demonstrate how to spot and fix bad crimps or loose connectors

Objective:

To learn to identify visual and functional indicators of poor crimp quality and loose connectors, and develop practical skills to diagnose and repair common crimp and connector defects.

Requirements:

1. Magnifying glass or digital microscope (10x magnification minimum)
2. Wire strippers (appropriate for cable gauge)
3. Flashlight or LED inspection lamp
4. Flashlight or LED inspection lamp
5. Measuring ruler or calipers
6. Digital multimeters
7. Cable testers

Instructions

Step 1: Visual Inspection of Crimped Connections

1.1 Examining a Good Crimp

1. Obtain a sample of a properly crimped connection
2. Use the magnifying glass to inspect the crimp from multiple angles
3. Observations:
    - **Wire Coverage:** Verify that a significant number of wire strands are securely enclosed within the crimp terminal
    - **Metal-to-Metal Contact:** Confirm solid contact between wire strands and terminal material
    - **Crimp Shape:** Check that the crimp forms a uniform, homogeneous

metal structure

- **Terminal Integrity:** Verify no deformities, cracks, or burrs are present
- **Insulation Seat:** Confirm the insulation is cleanly seated without gaps or displacement

1.2 Identifying Bad Crimps

	Visual Indicators
ping	Few wire strands inside terminal; loose fit; visible gaps between wire a
ing	Deformation or crushing of terminal; cracks in terminal; indenta insulation
nt	Terminal not centered on wire; uneven crimp height; asymmetrical in
Wire	Individual strands extending beyond crimp terminal
Rough Edges	Sharp protrusions on terminal edges or cut-off tab area

Step 2: Mechanical Testing - Pull Force Test

2.1 Conducting a Tensile (Pull) Test

The pull test evaluates whether a crimped terminal can withstand mechanical stress.

1. Select a crimped cable specimen and secure one end in the pull tester's gripping attachment
2. Secure the other end to a fixed point or the tester's load cell
3. Activate the tester and apply steady, increasing force until:

- The terminal separates from the wire, OR
- The wire breaks, OR
- You reach the terminal's specified breaking force

4. Record the peak force required to break or separate the connection

2.2 Manual Tug Test

For quick field assessment without specialized equipment:

1. Grasp the cable firmly near the connector
2. Apply steady pulling force for 5-10 seconds
3. Observe for:
    - **Good connection:** No movement; terminal stays firmly attached to wire
    - **Loose connection:** Visible movement; terminal shifts relative to wire; clicking sensation

Step 3: Electrical Testing Using a Multimeter

3.1 Continuity Test

1. Set the multimeter to continuity mode (beeper symbol if available)
2. For a single connection:
    - Place one probe at one end of the wire
    - Place the other probe at the opposite end of the crimp terminal
    - A beep or near-zero reading indicates good continuity
    - No beep or infinite resistance indicates an open circuit (failed crimp)

3.2 Resistance Test

High resistance indicates poor contact or a weak crimp.

1. Switch the multimeter to resistance (ohms) mode
2. Place probes across the crimp connection
3. Record the resistance reading:
    - **Good connection:** < 1 ohm (typically 0.1-0.5 ohms)
    - **Marginal connection:** 1-5 ohms
    - **Poor connection:** > 5 ohms

Assessment:

1. List three visual indicators of an under-crimped connection and explain why each indicates a problem.
2. What is the difference between an open circuit and a short circuit, and how would a multimeter display show each condition?
3. A technician measures a resistance of ↵ohms across a crimp connection. The specification is < 1 ohm. What does this indicate, and what corrective action should be taken?

Fill in the Blanks

1. The most common cause of →no-video→ error in CCTV systems is a ________ or ________ power supply.
2. A ________ connector means the BNC connection is loose and may cause intermittent signal loss or flickering video.

3. When a camera lens becomes dirty with dust or fingerprints, the video appears _______, blurry, or washed-out.
4. Infrared LEDs can be tested using a _______ camera, which can detect invisible infrared light that human eyes cannot see.
5. A _______ test involves gently wiggling a BNC connector while watching the DVR monitor to check if the connection is loose or broken.
6. Using a _______ to measure voltage at the camera power input and test cable _______ is the most critical step in troubleshooting no-video errors.
7. After re-crimping a connector, always test it with a _______ to ensure good electrical contact before reconnecting to equipment.

Multiple Choice Questions

1. Which of the following is the first step in troubleshooting a no-video error?

   a) Check cable connections

   b) Verify power supply voltage

   c) Replace the camera

   d) Reset the DVR
2. A customer reports that one camera shows a black screen while other cameras work fine. What is the most likely cause?

   a) The DVR is broken

b) Power or connection issue with that specific camera

c) All cameras need firmware update

d) The monitor needs replacement

3. When you wiggle a BNC connector and the video flickers on the DVR monitor, this indicates:

a) The cable is broken

b) The connection is loose

c) The camera lens is dirty

d) The power supply is failing

4. How can you check if infrared LEDs are working without specialized equipment?

a) Look directly at the camera at night

b) Use a smartphone camera to see the infrared glow

c) Measure voltage with a multimeter

d) Check the DVR settings only

5. A technician measures 10.2V at the camera when 12V is required. What problem might this cause?

a) No problem, this is normal variation

b) Camera brightness decreases and IR LEDs may fail

c) Video becomes snowy

d) Cable connectors loosen

6. What is the purpose of the →wiggle test"?

a) To clean the connector

b) To check if the connection is loose

c) To measure voltage

d) To test cable continuity

7. A multimeter reading of 0.3 ohms across a crimp connection indicates:

a) Poor connection (needs replacement)

b) Good connection (low resistance)

c) Open circuit (broken wire)

d) Short circuit (conductor touching shield)

↵ When explaining a problem to a non-technical customer, what should you avoid?

a) Simple analogies

b) Technical jargon like →impedance matching→ or →EMI→

c) Clear language

d) Reassurance

Short Answer Questions

1. Explain the systematic troubleshooting approach for a no-video error. Why is it important to check power and connections before assuming a major component has failed?
2. A customer complains that their night vision camera stopped working at night

but works fine during the day. What are three possible causes, and how would you diagnose each one?

3. When cleaning a camera lens, what materials should you use and why? What materials should you avoid and what damage could they cause?
4. Describe the customer-friendly way to explain a loose BNC connector problem to a non-technical homeowner. What simple analogy could you help them understand the issue?
5. You need to re-crimp a BNC connector on an RG59 cable. List the three most common mistakes that cause failed crimps and explain why each one is problematic.
6. After re-crimping a connector, a technician measures 15 ohms resistance across the crimp connection. The specification is <1 ohm. What does this indicate about the crimp quality, and what corrective action should be taken?

Answer key

UNIT 1: Introduction to CCTV Systems & Basics of Electronics

Session 1: Overview of CCTV System

Fill in the Blanks –

1. Closed Circuit Television
2. Germany, 1942
3. Binoculars
4. VCR
5. Infrared
6. Digital
7. Artificial, Facial

Multiple Choice Questions

1. b) Video signals travel only to specific monitors
2. c) Germany
3. b) They were very expensive and had poor image quality
4. b) Digital Video Recorders (DVRs)

5. b) To act as a deterrent to prevent crimes
6. c) Radio broadcasting

Session 2: Basics of Electronics

Fill in the Blanks – Answer Key

1. Volts
2. Amperes
3. Resistance
4. 50
5. 12
6. Fuse

Multiple Choice Questions – Answer Key

1. c) Ohms
2. b) DC (Direct Current)
3. a) 6 ohms
4. b) Switch Mode Power Supply
5. d) Rubber
6. b) Camera may get damaged
7. b) 50 Hz

↵ c) Rectifier circuit

UNIT 2: CCTV System Components & Tools

Session 1: Key Hardware Components

Fill in the Blanks

1. eye
2. Pan Tilt Zoom.
3. pixels.
4. lux
5. Digital Video Recorder.
6. Network Video Recorder.
7. network.

↵ millimeters (mm).

Multiple Choice Questions

1. d) PTZ camera
2. b) Dome camera
3. a) DVR
4. b) NVR
5. a) Wide field of view
6. c) Clearer image

UNIT 2 – Session 2: Tools & Testing Equipment

Fill in the Blanks

1. Drill Machine
2. Crimping Tool
3. Crimping Tool
4. Cable Tester
5. Multimeter
6. Personal Protective Equipment
7. Eyes

↵ Electric current

MCQ

1. b) Drill Machine
2. a) Crimping Tool
3. c) Cable Tester
4. d) Multimeter
5. a) Gloves
6. b) Cable connection
7. c) Head

↵ a) Wear PPE

UNIT 3: Cables, Connectors & Power Supply

SESSION 1: Cable Types & Functions

Fill in the Blanks

1. RG59
2. Coaxial cable
3. CAT5/CAT6
4. Siamese cable
5. HDMI
6. Shielding
7. Ethernet

↵ Analog

MCQ

1. a) RG59
2. b) IP cameras
3. c) Video and power
4. d) DVR/NVR to monitor
5. a) Reduce interference
6. b) Network cable

SESSION 2: Connector Termination

Fill in the Blanks

1. BNC
2. RJ45
3. T568A
4. T568B
5. Crimping
6. Cable Tester
7. Pinout

↵ Signal transmission

MCQ

1. b) BNC
2. a) Ethernet cable
3. c) Wiring standards
4. d) Crimping
5. b) Continuity
6. a) No network connection

UNIT 4: Site Survey & Camera Installation

SESSION 1: Site Survey & Planning

Fill in the Blanks

1. Site survey
2. Field of view
3. Blind spots
4. Mounting height
5. Lighting conditions
6. Risk areas
7. Installation plan

↵ Checklist

MCQ

1. a) Site survey
2. b) Area covered by the camera
3. c) Area not visible to the camera
4. d) Better coverage
5. a) Image quality
6. b) Organize camera placement

SESSION 2: Camera Mounting & Troubleshooting

Fill in the Blanks – Answers

1. Wall mount
2. Ceiling mount
3. Bracket
4. Infrared (IR)
5. Power supply
6. Loose connection
7. Troubleshooting

↵ Maintenance

MCQ

1. b) Ceiling
2. a) Wall
3. c) Loose cable
4. d) Night vision
5. a) Maintenance
6. b) Identify and fix faults

Session 3: System Testing, Documentation & Handover

Fill in the Blanks – Answers

1. Testing
2. Checklist
3. Recording
4. Backup
5. Documentation
6. User manual
7. Demonstration

↵ Client

MCQ

1. a) Ensure proper functioning
2. b) Test all cameras
3. c) External storage device
4. d) Installation details
5. a) System understanding
6. b) Successful testing

Glossary

1. CCTV – Closed-Circuit Television used for surveillance.
2. DVR – Digital Video Recorder for analog systems.
3. NVR – Network Video Recorder for IP systems.
4. IP Camera – Camera that transmits video over a network.
5. Coaxial Cable – Cable used in analog CCTV systems.
6. RJ45 – Connector used in Ethernet cables.
7. BNC Connector – Connector used for coaxial cable.

↵ PoE – Power over Ethernet technology.

↳ HDD – Hard Disk Drive used for storage.

10. SMPS – Switched Mode Power Supply.
11. Router – Device that connects network devices.

12. LAN – Local Area Network.

13. WAN – Wide Area Network.

14. Ohm’s Law – Relationship between voltage, current, and resistance.

15. Multimeter – Device to measure electrical values.

16. Crimping Tool – Tool used to attach connectors.

17. IR (Infrared) – Technology used for night vision.

1↵. Video Compression – Reducing file size of video data.

1↳. Site Survey – Inspection of installation location.

20. Preventive Maintenance – Routine checking to avoid faults.

Short Terminologies

1. Voltage – Electrical pressure.
2. Current – Flow of electricity.
3. Resistance – Opposition to current flow.
4. AC – Alternating current.
5. DC – Direct current.
6. Lens – Controls camera focus and angle.
7. Resolution – Clarity of video image.
8. Frame Rate (FPS) – Frames per second in video.
9. Bandwidth – Data transfer capacity.
10. Cloud Storage – Online video storage.
11. Firmware – Software inside hardware device.
12. DHCP – Automatic IP assignment system.
13. Static IP – Fixed IP address.
14. Port Forwarding – Allow remote camera access.
15. PTZ Camera – Pan-Tilt-Zoom camera.
16. Bullet Camera – Cylindrical CCTV camera.
17. Dome Camera – Dome-shaped CCTV camera.
18. Fisheye Camera – Wide-angle camera.
19. Analytics – Video data analysis.
20. Encryption – Securing data from unauthorized access.