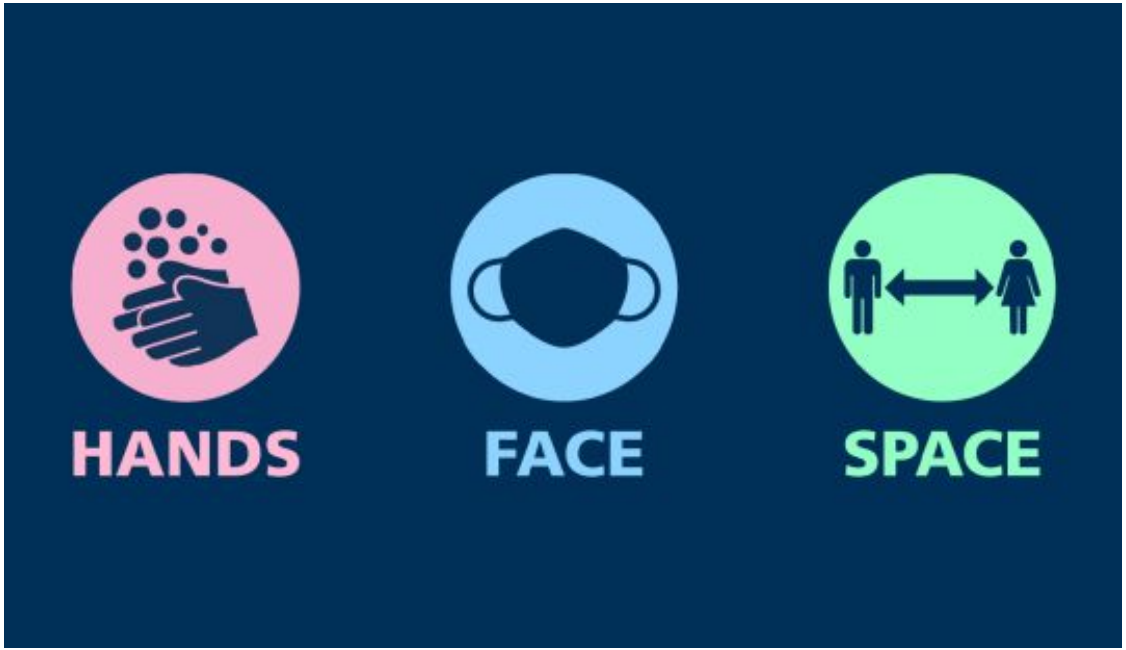
Cube Training

Introduction to CCTV

COVID-19



Introduction to CCTV Installation

What is CCTV?

Closed Circuit Television (CCTV):

This is the technology behind capturing images from a video source at one end of the circuit and transmitting it through some type of transmission media to a receiving unit on the other end, for the purpose of security and monitoring activities.

Introduction to CCTV Installation

The basic components of an analogue CCTV system:

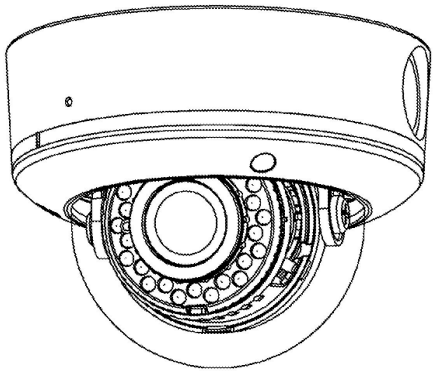
There are four basic components in a CCTV system:

- Video Source (Camera)
- Transmission medium
- Recording unit (DVR)
- Power Source

Introduction to CCTV Installation

The basic components of an analogue CCTV system:

- Video Source (Camera)
    - This is the device responsible for the monitoring and capturing of the image (video footages).



Introduction to CCTV Installation

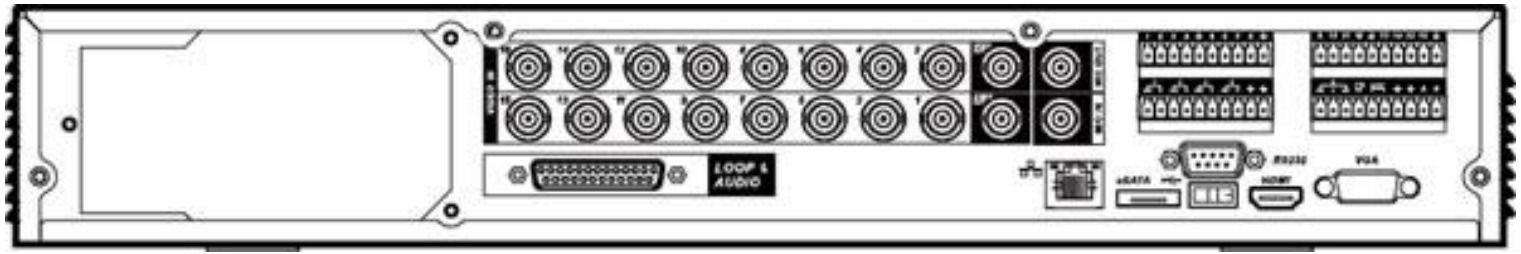
The basic components of an analogue CCTV system:

- Transmission Medium
    - The two types of cables used for the installation of Security Cameras and Digital Video Recorders (DVRs) are UTP Cables and **RG59** Coax Siamese cable.
    - Fibre Optics.

Introduction to CCTV Installation

The basic components of an analogue CCTV system:

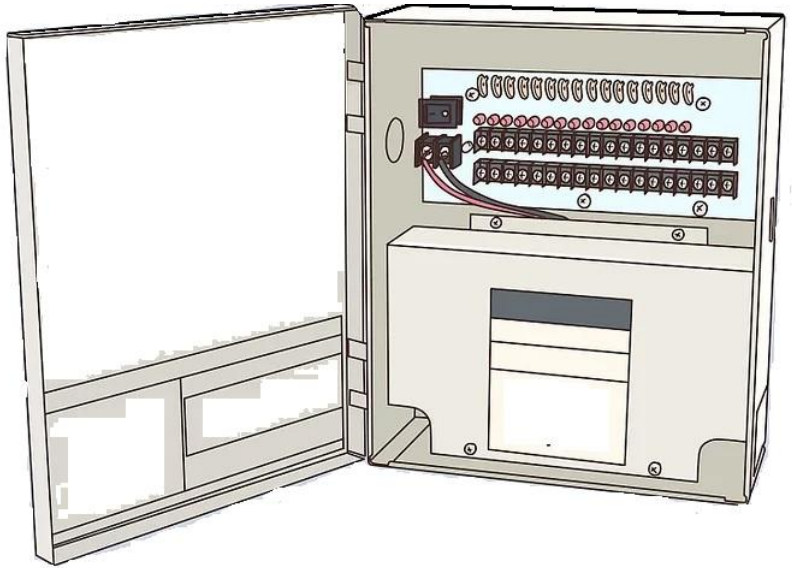
- Recording units
    - DVR (Digital Video Recorder)
    - NVR (Network Video Recorder)
    - Servers, Cloud Storage



Introduction to CCTV Installation

The basic components of an analogue CCTV system:

- Power supply unit



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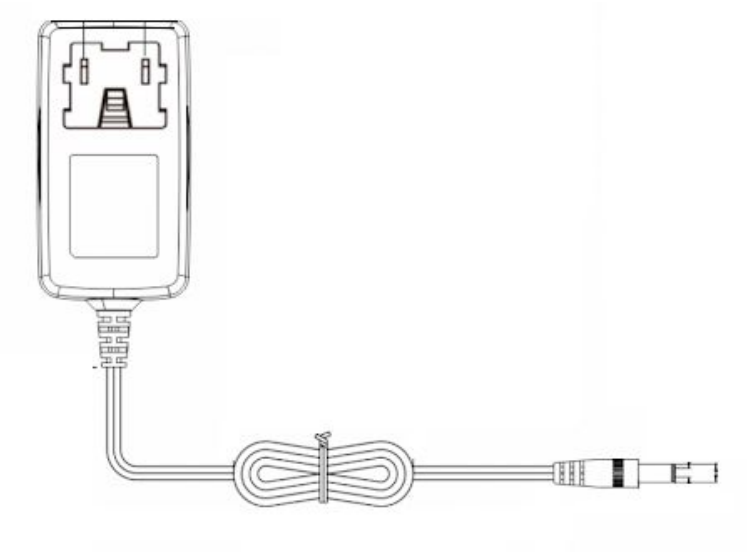
The basic components of an analogue CCTV system:

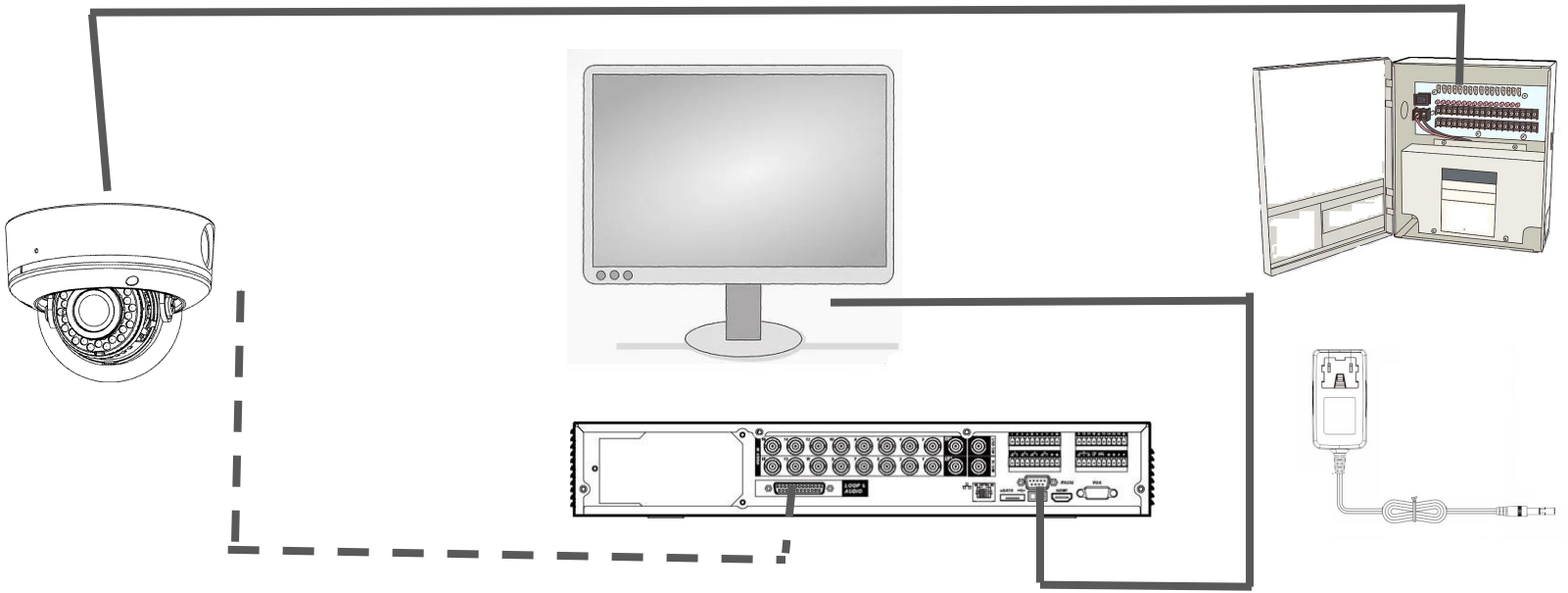
- Power supply unit



Introduction to CCTV Installation

The basic components of an analogue CCTV system:

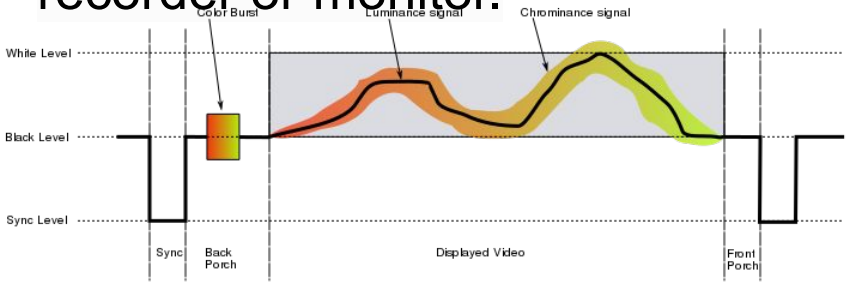
- Assembling a basic analogue CCTV system.



Introduction to CCTV Installation

Video signal

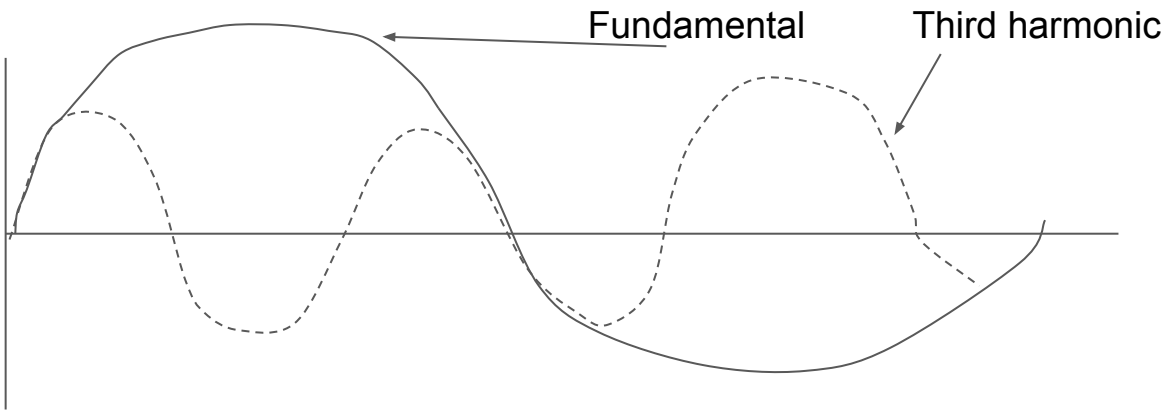
- Analogue camera
  - Analogue CCTV cameras which use an analog video signal that is transmitted over coaxial cable back to a video recorder or monitor.



Introduction to CCTV Installation

Video signal

- CCTV signals (Analogue) - An electronically produced square wave signal is actually built up from a sinusoidal wave and an infinite number of odd harmonics.



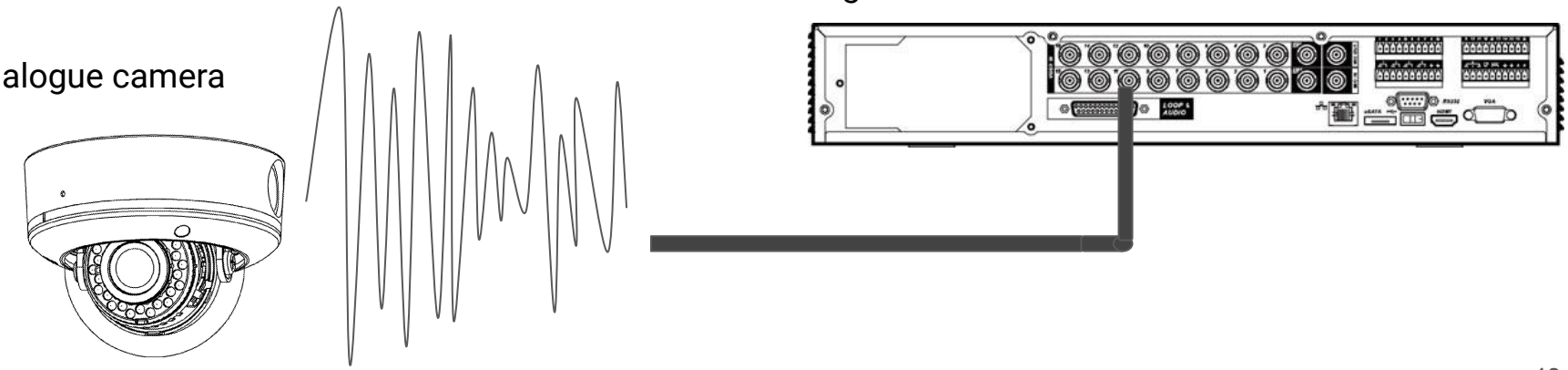
Introduction to CCTV Installation

Video signal

- CCTV signals (Analogue) - An electronically produced square wave signal is actually built up from a sinusoidal wave and an infinite number of odd harmonics.

Digital Video Recorder

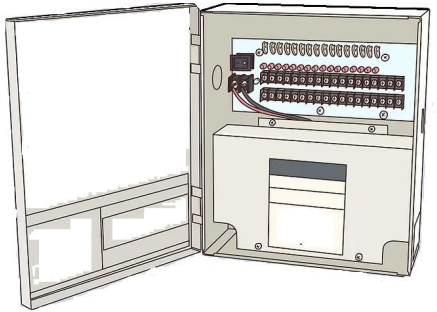
Analogue camera



Introduction to CCTV Installation

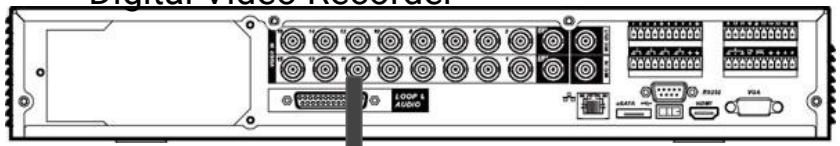
Video signal

Power supply unit

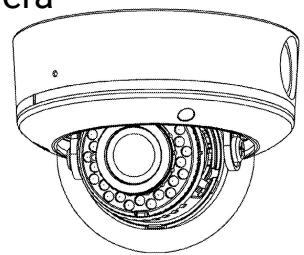


DC power cable 12V
DC or 24V AC

Digital Video Recorder



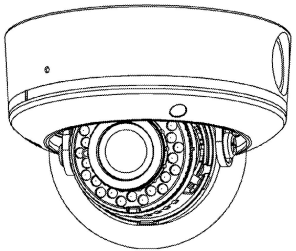
Camera



Coaxial cable

Introduction to CCTV Installation

Video signal



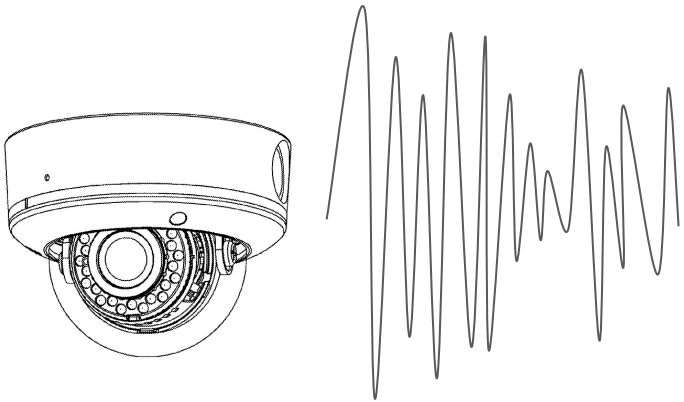
Signal - Analogue

Wave form

A sequence of electrical waves known as the television picture signal.

Introduction to CCTV Installation

Video signal



Analogue video is commonly distributed as a composite signal, this video information is generated by sampling the *intensity* of the original continuous analog video signal *I (x, y, t)* in three dimensions. The spatial component of the video signal is sampled in the horizontal and vertical dimensions *(x, y)*, and the temporal component is sampled in the time dimension *(t)*.

Introduction to CCTV Installation

Video signal

For coding and decoding purpose there are three different coding systems are used worldwide. These systems – PAL, NTSC and SECAM – are all mutually incompatible.

1. The NTSC (the National Television Standards Committee) system is used in North and South America and Japan.
2. SECAM (SEquentiel Couleur Avec Memoire) is used in France and Eastern Europe
3. PAL (Phase Alternating Line) is used in the UK and the rest of Europe.

Introduction to CCTV Installation

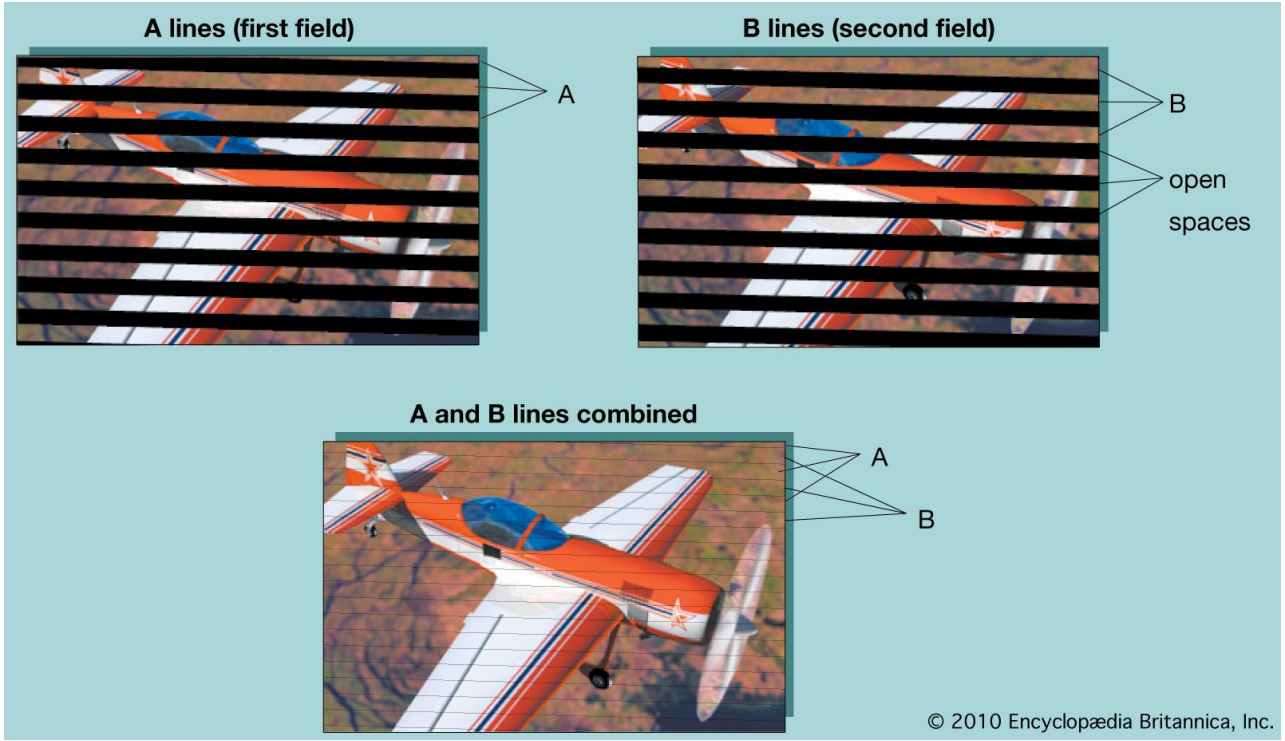
Video signal

Interlaced Scanning

This consists of two sets of lines. One set is scanned first, and the lines are so laid down that an equal empty space is maintained between lines. The second set is laid down after the first and is so positioned that its lines fall precisely in the empty spaces of the first set. The area of the image is thus scanned twice, but each point in the area is passed over only once. This is known as interlaced scanning, and it is used in all the standard television broadcast services of the world.

Introduction to CCTV Installation

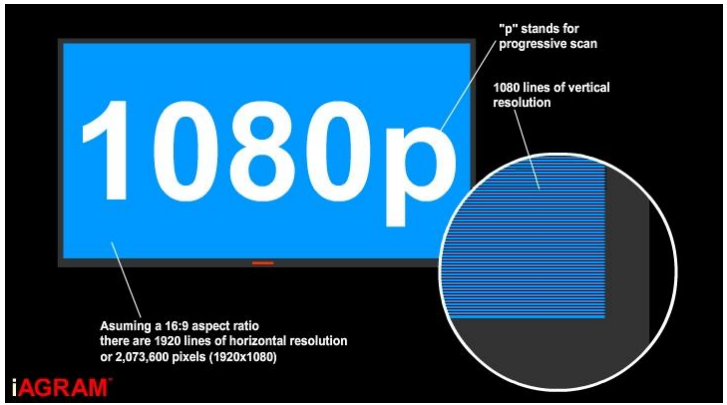
Video signal



Introduction to CCTV Installation

Progressive Scanning

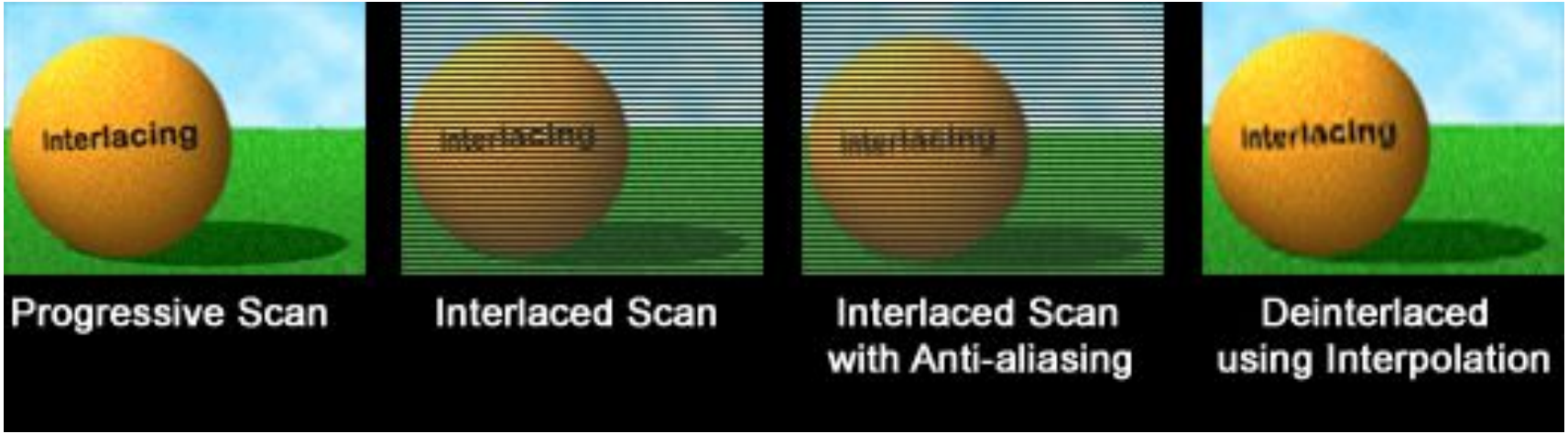
Progressive scanning is a format of displaying, storing, or transmitting moving images in which all the lines of each frame are drawn in sequence.



Source: Wikipedia

Introduction to CCTV Installation

Progressive Scanning Vs Interlaced Scanning



Source: Wikipedia

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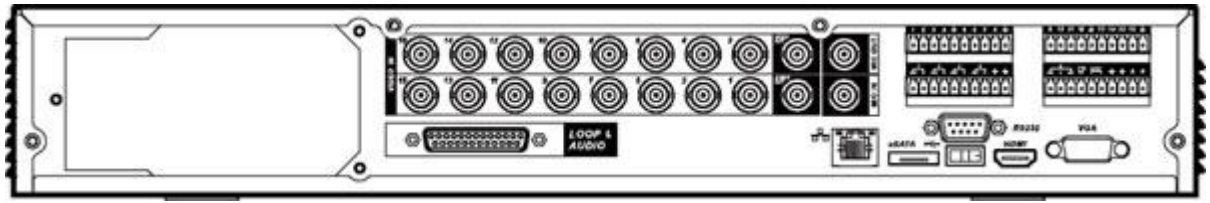


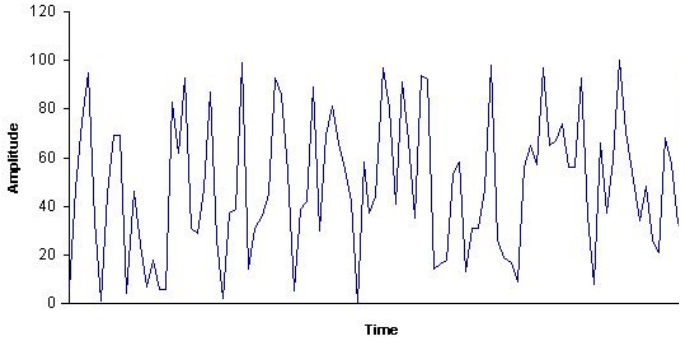
How does analog and digital recording work?

When we capture that video footages in a way that represents all the possible frequencies, we're **recording** in **analogue**; when we use DVR to translate the video into a series of numbers that approximate what we're seeing, we're **recording** in **digital**.

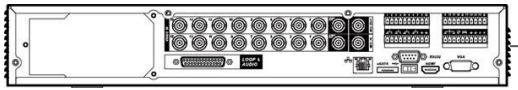
Introduction to CCTV Installation

Video signal

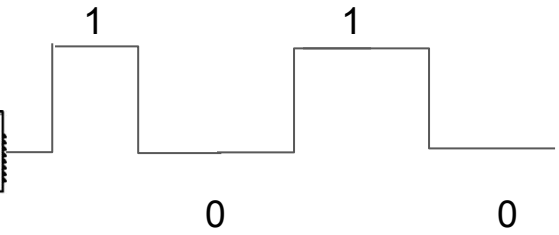
Analogue signal

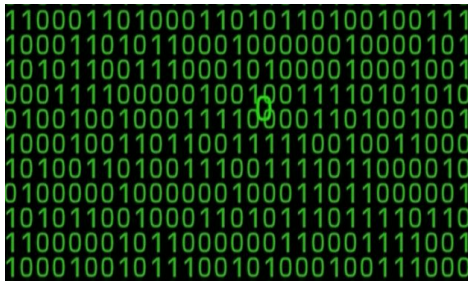


Digital Video Recorder (DVR)



Digital signal

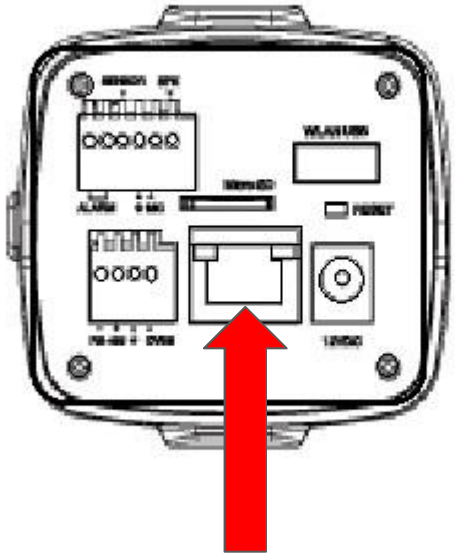




Introduction to CCTV Installation

Video signal

Digital camera

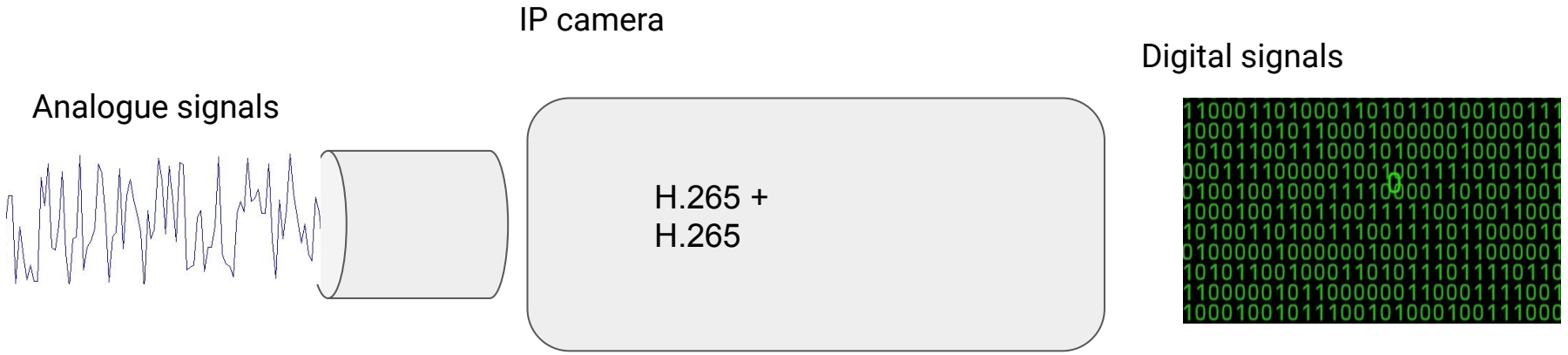


RJ45 Slot

Introduction to CCTV Installation

Video signal

Digital camera



Introduction to CCTV Installation

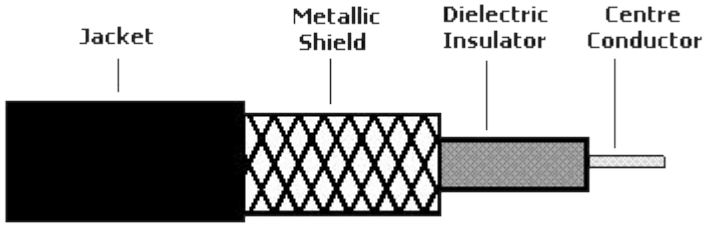
- What are the factors that determine the quality of a CCTV video image?
    - There are many factors affect video quality including
        - Type of the construction of cable
        - The cable length
        - The way the bends have been formed
        - The type and the quality of the connectors

Introduction to CCTV Installation

- 1. What are most common cables used in CCTV application?
    - The engineer should understand the characteristic of the cable, every cable have different characteristics.
    - The main types of cables used in CCTV applications.
        - Coaxial cable
        - Ethernet cable or network cable
        - Fibre-optic

Introduction to CCTV Installation

Coaxial cable



Introduction to CCTV Installation

Coaxial cable is the most common type of cable used in many CCTV application. The coaxial cable is designed to meet the unique propagation requirements of radio frequency signals, offering constant impedance over a range of frequencies and protection against unwanted noise.

The video signal travels through the inner core and return via the braided screen. The copper braid is not only the path for the video to return, but it also serves as a shield for any unwanted noise.

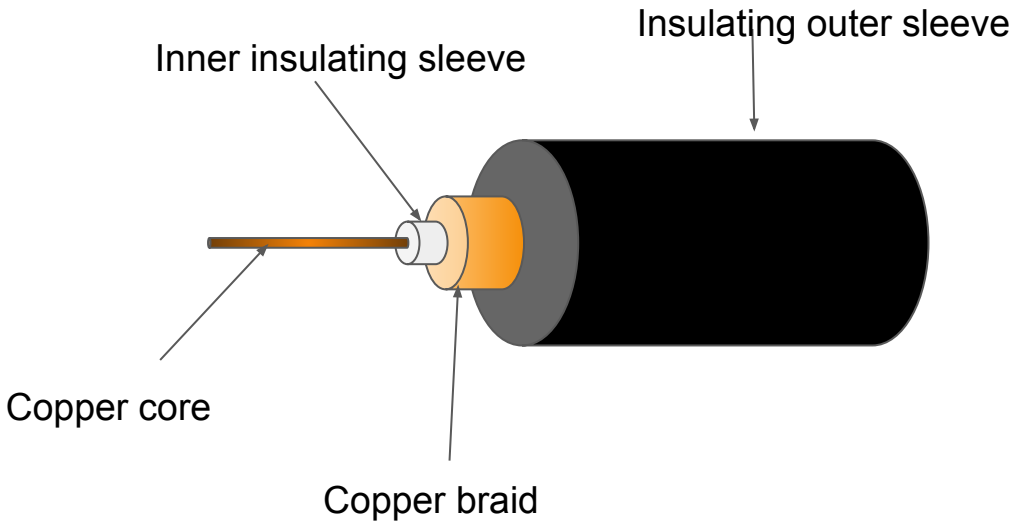
Introduction to CCTV Installation

The video signal travels through the inner core and return via the braided screen. The copper braid is not only the path for the video to return, but it also serves as a shield for any unwanted noise.

As the copper braid is earthed the return signal will use any path to return.

Introduction to CCTV Installation

How to maintain the integrity of the coaxial cable?
Let's look at the structure of a coaxial cable.



Introduction to CCTV Installation

Copper core

Inner copper is used to transmit video signal.

Introduction to CCTV Installation

Inner insulating sleeve

The inner sleeve of the coaxial cable performs an important role. It forms an insulation between inner core and copper braid. It also forms a dielectric between the conductors which introduces a capacitive element into the cable.

Introduction to CCTV Installation

Are there different types of coaxial cable?

Yes, not all coaxial cable has 75 Ohms impedance. CCTV equipment is designed to have 75 Ohms input and output impedances.

Introduction to CCTV Installation

How to maintain the integrity of the coaxial cable?

1. Coaxial cable is more than a simple piece of wire, and only functions correctly when certain criteria have been met.
   Never join two coaxial cable using connector blocks.
   As this may electrical sound fine, it breaks all the rules of RF theory and exposes the inner core to RFI.

2. The coaxial should be joined using couplers.
3. As CCTV equipments use 75 Ohms impedance, the correct coaxial cable to use is the one with 75 Ohms. e.g. RG59

Introduction to CCTV Installation

How to maintain the integrity of the coaxial cable?
3. There are number of coaxial cables which don't use 75 Ohms. For example RG58 uses 50 Ohms.

Cable type	Max run length	Impedance	Loss/100m At 5 MHz
URM - 70	250m	75 Ohms	3.31 dB
RG59	350m	75 Ohms	2.25 dB
RG-11	700m	75 Ohms	1.4 dB

Introduction to CCTV Installation

Copper braid

The signal returns via copper braid, however, it is not the case always. As this is earthed, the signal can return using any source.

The copper braid works as a shield for unwanted noise or EMI (Electromagnetic interference).

Introduction to CCTV Installation

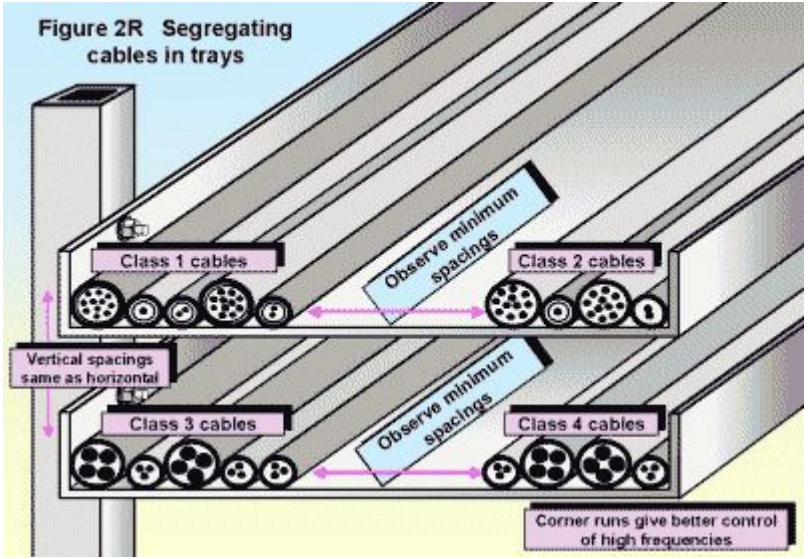
How to maintain the integrity of the coaxial cable?

4. All CCTV signal cable installation should comply with current codes of practice as laid down in BS 7671. Especially in relation to electrical segregation of low and high voltage cables.

5. In order to prevent damage to the inner sleeve, coaxial cable should not have any serve bends. The radius of all bends is no tighter than five times the diameter of the cable.

Introduction to CCTV Installation

How to maintain the integrity of the coaxial cable?

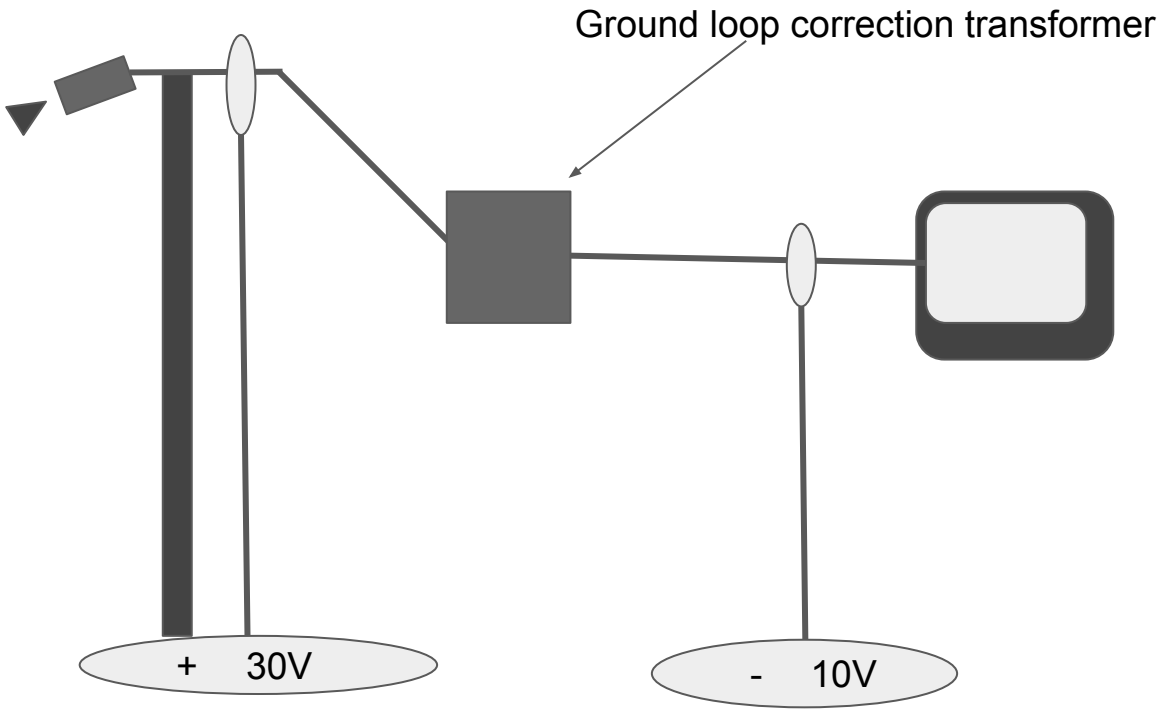


Introduction to CCTV Installation

How to maintain the integrity of the coaxial cable?

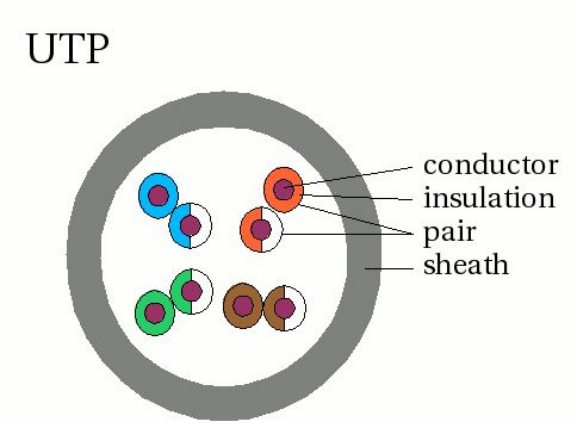
6. The difference between earthing can cause , the current will flow through the low impedance screen, this will cause ripple rolling vertically through the picture. This is known as hum bar.

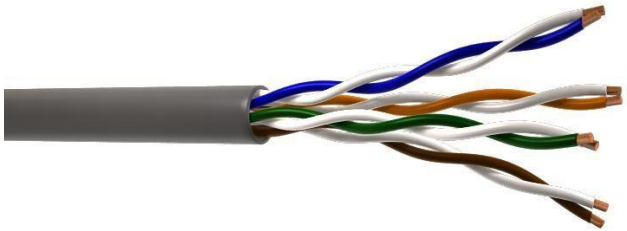
Introduction to CCTV Installation



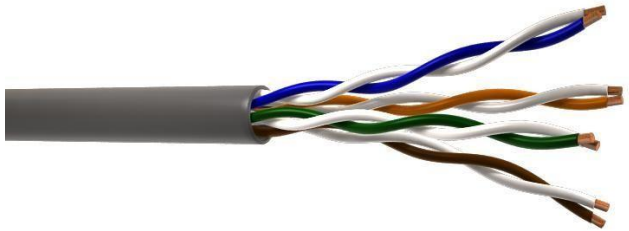
Introduction to CCTV Installation

Ethernet cable & Twisted pair cable





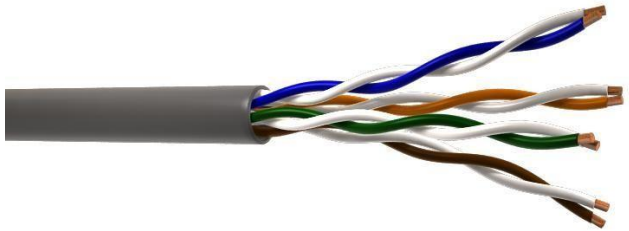
Introduction to CCTV Installation



As the name implies, this cable comprises two cores which are wrapped around each other. The number of twists per metre varies. It is better to connect video via the pair that has more twists.

In a UTP cable, the pin 1 and pin 2 or white orange and orange have more twists. Hence it is better to use them for video transmission.

Introduction to CCTV Installation



In most cases, twisted pair cable is not screened and known as an unshielded twisted pair (UTP). However, it is better to use screened network cable for CCTV or known as shielded pairs.

Introduction to CCTV Installation

What are the advantages of using Ethernet cable in a CCTV application?

The primary advantage of using a CAT cable is that much longer cable run is possible. It always works very well in situations where excess electromagnetic interference is present.

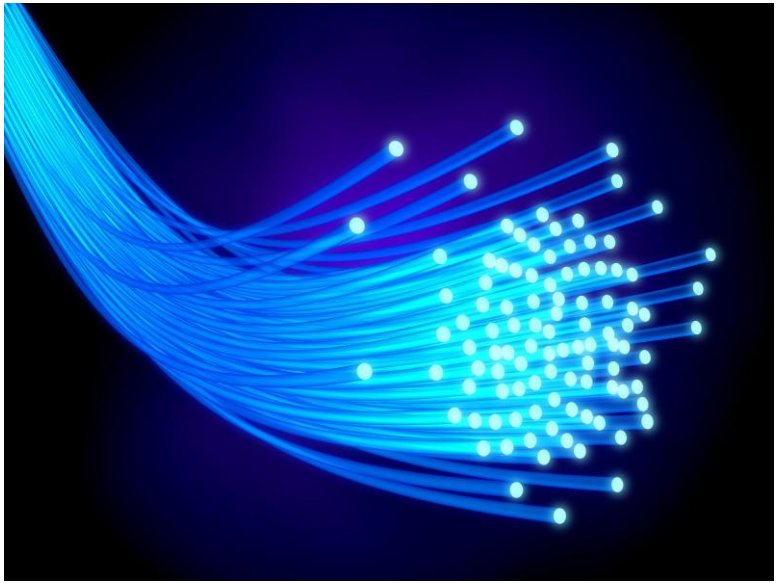
Introduction to CCTV Installation

What are the disadvantages of using Ethernet cable in a CCTV application?

- The balun is required.
- The wrong cable selection can lead to issues.
- It is relatively expensive.

Introduction to CCTV Installation

Fibre optics



Introduction to CCTV Installation

Fibre optics

The signal travels in the form of light through fibre-optics cables.
The signal travels in the form of light through fibre-optics cables.
The fibre optics cable has no problem with RFI, EMI, lighting etc.

The signal travels in the form of light through fibre-optics cables.
The fibre optics cable has no problem with RFI, EMI, lighting etc. It is almost impossible to tap into fibre optics.

Introduction to CCTV Installation

- 1. Exercise
    - Connect an analogue camera with a DVR and monitor.
        - Check the resolution
        - The maximum resolution with analogue camera is 0.4 M pixels.(720x576 = 414720)
        - 960H (960x576 = 552960)
        - Full HD is 2 M pixels - (1920x1080 = 2073600)

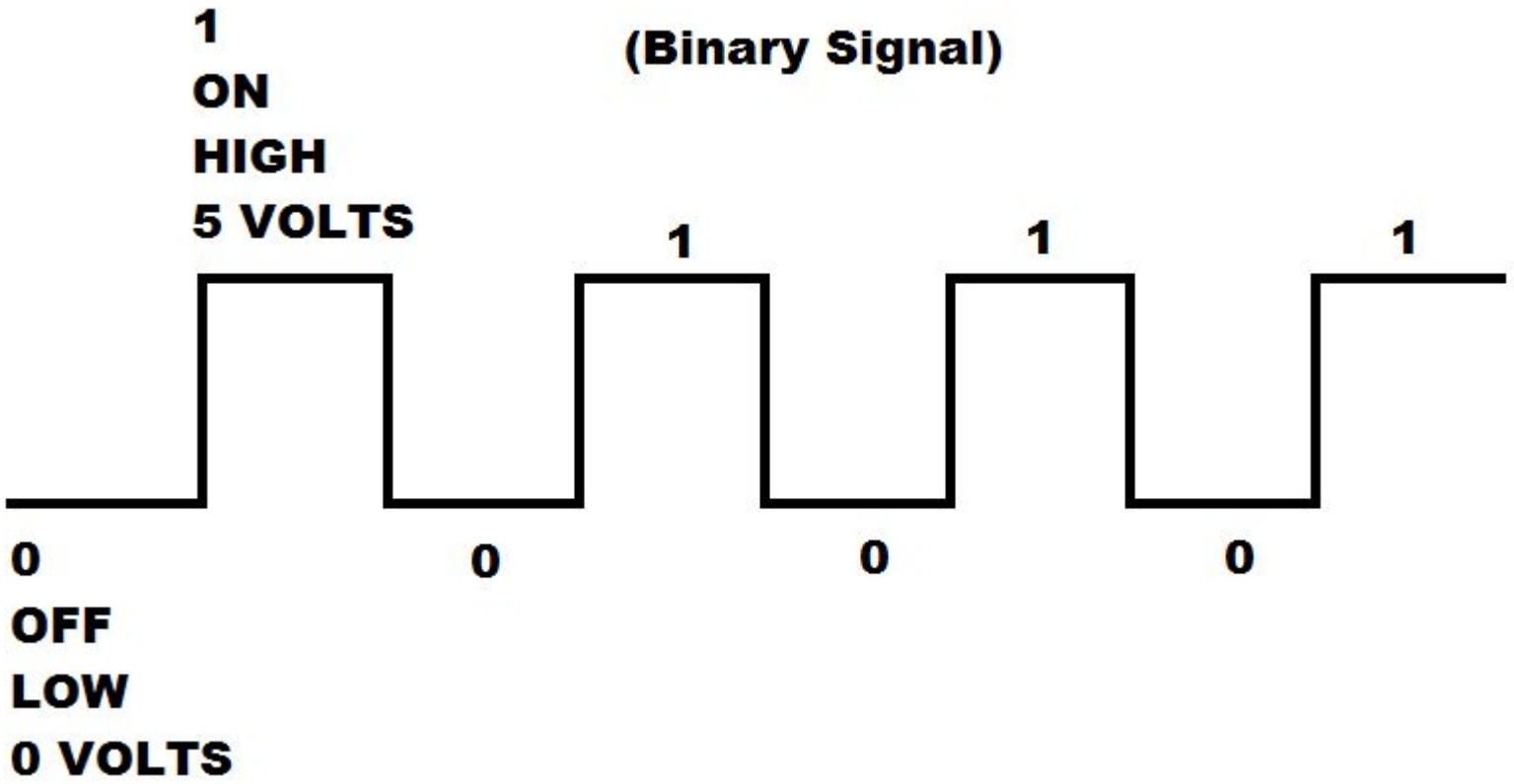
Introduction to CCTV Installation

- Challenges in analogue CCTV cameras
    - Low resolution
    - Maximum resolution is limited to 1000 TVL
    - Integration is difficult - e.g. Integrating with other security devices.
    - DVR is necessary to convert the analogue signals to digital. It is not possible to view analogue camera via internet without a DVR or server.

Introduction to CCTV Installation

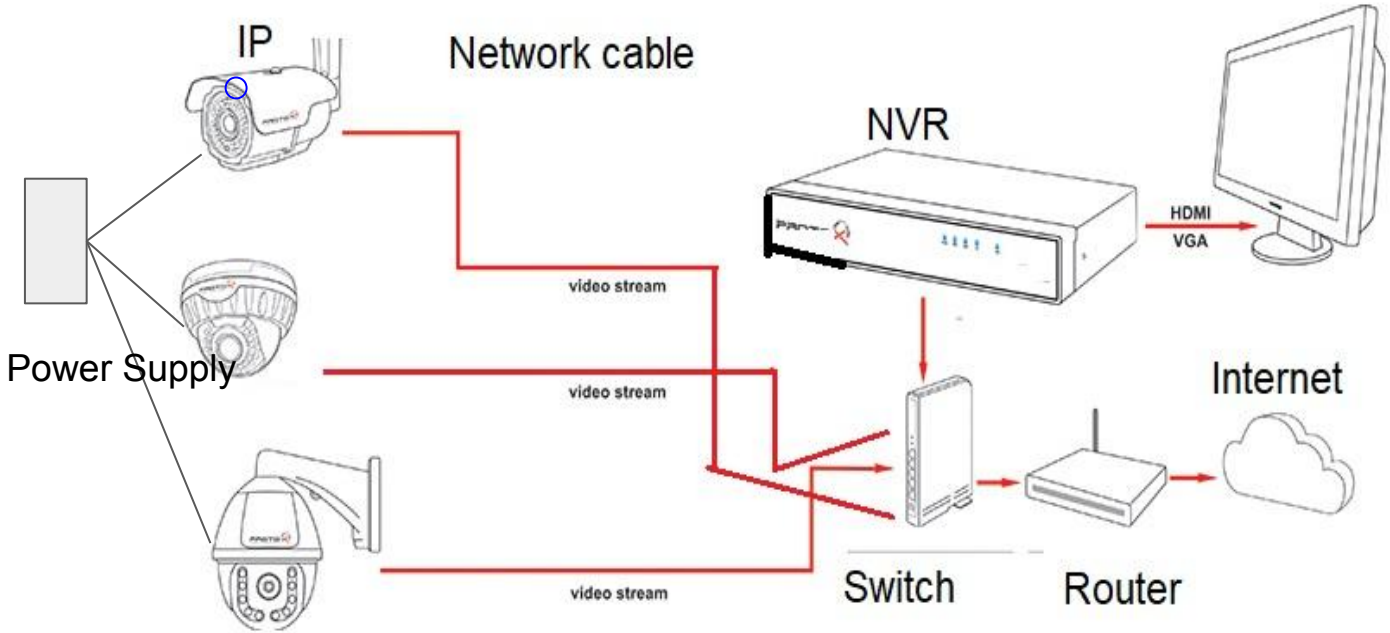
- 1. IP camera
    - An Internet protocol camera, or **IP camera**, is a type of digital video camera commonly employed for surveillance, and which, unlike analog closed circuit television (CCTV) cameras, can send and receive data via a computer network and the Internet

Introduction to CCTV Installation



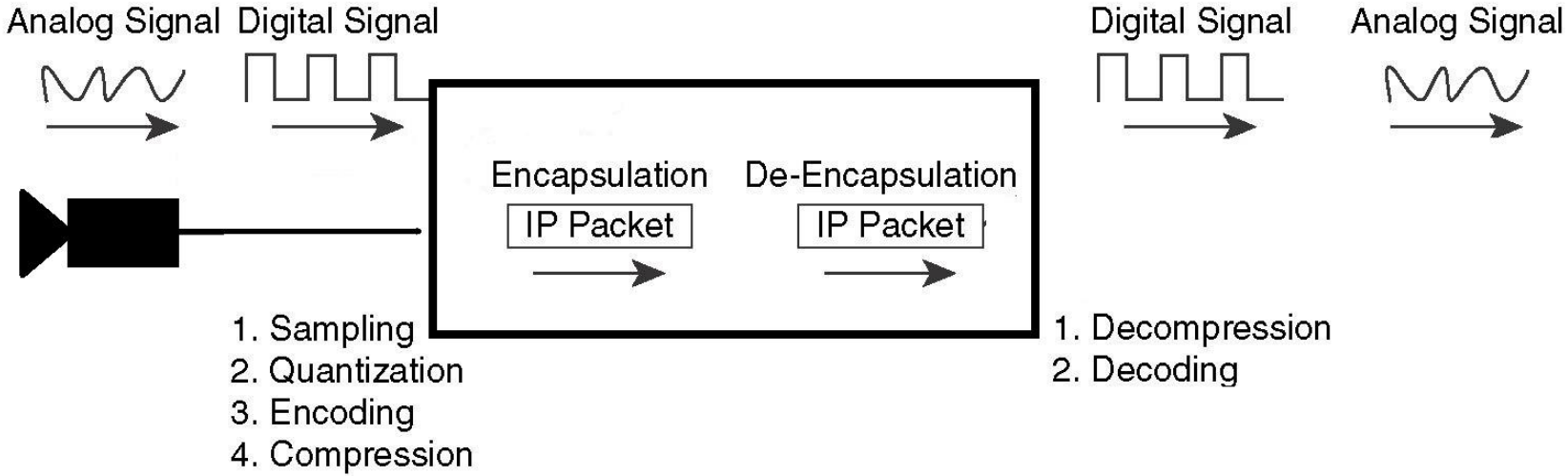
Introduction to CCTV Installation

- 1. Exercise IP camera installation



Introduction to CCTV Installation

- 1. IP video signal



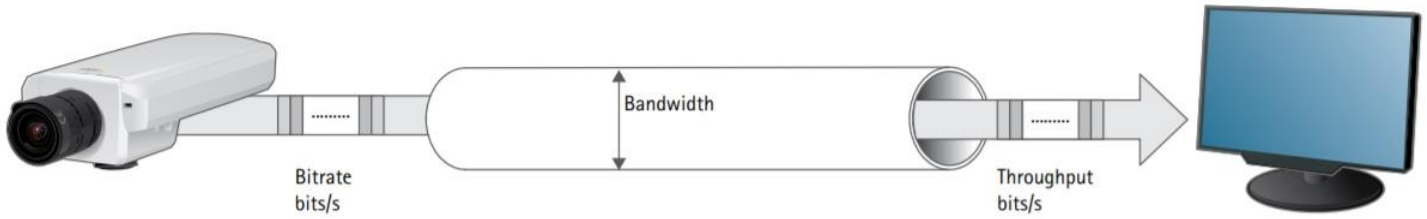
Introduction to CCTV Installation

- 1. IP video signal - Challenges

    - Latency - **latency** is a common problem in IP video surveillance system.
    - IP conflict - minimum computer network knowledge required.
    - Bigger storage requirement
    - Dependencies - Your router speed, internet speed and other factors can influence the performance.
    - Expensive

Introduction to CCTV Installation

- 1. IP video signal - Challenges



Introduction to CCTV Installation

- Transmission medium

  The means of transporting the captured video footages from the camera to the recording unit.

Questions?

15 minutes break

Tea or coffee??

Questions

1. What are the advantages of an IP CCTV system?
2. What are the advantages of an analogue system?
3. What are the common cables used in CCTV application?

Cube Training

Practical wiring

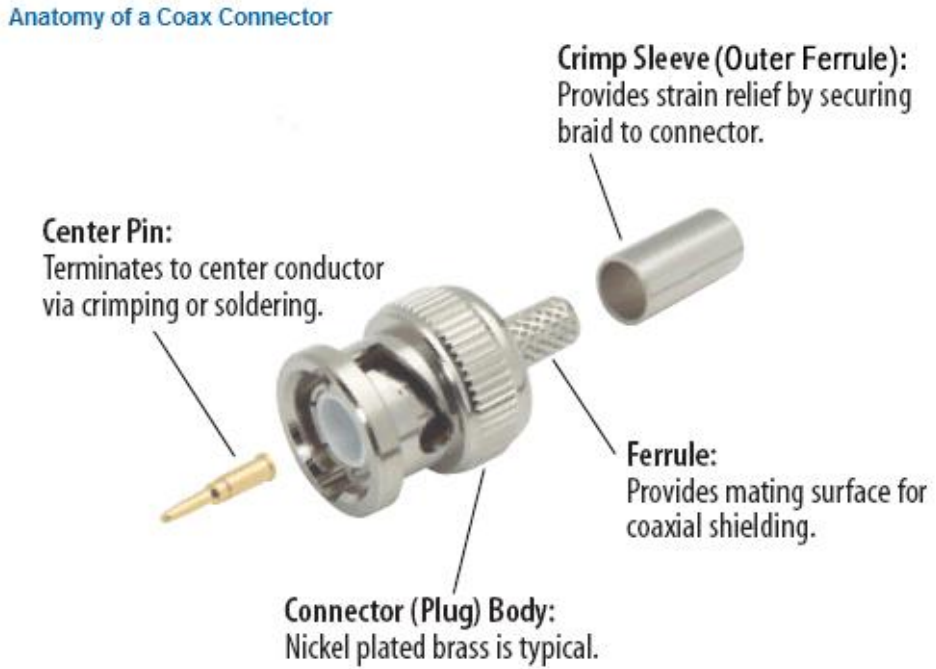
BNC - (Bayonet Neill–Concelman)

- 3 piece BNC
- Twisted BNC
- 2 pcs BNC

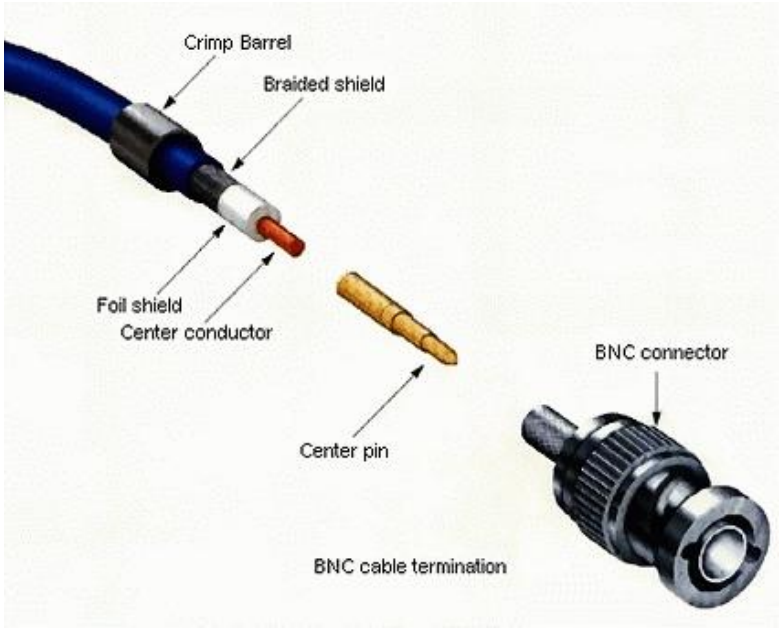
How to terminate BNC

Basic tools required for each type of BNC's.

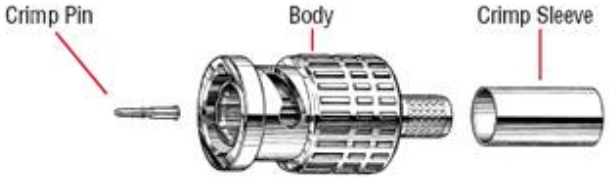
- BNC crimp
- Side cutters

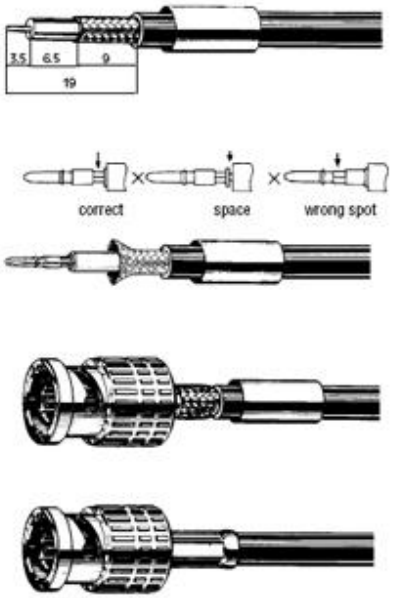


BNC termination



BNC Crimp

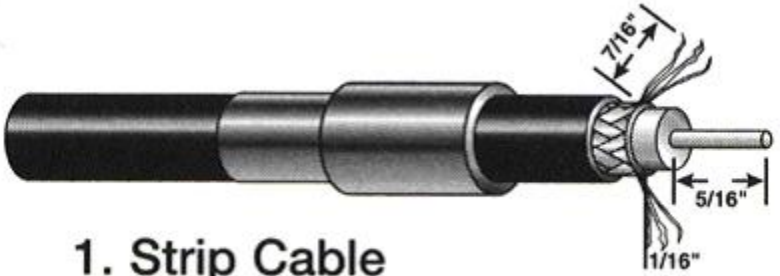




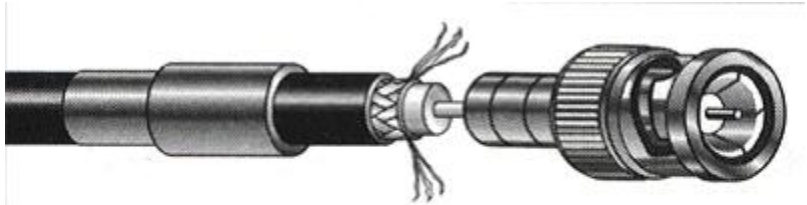
1. Slide crimp sleeve over cable.
2. Strip cable jacket using Canare TS-Series Coax Strippers (see mm dimensions)
3. Place contact pin on center conductor. Using the TC-1 hand tool and appropriate die set, crimp center pin as shown in diagram. (Do not leave a gap between rear of the pin and cable insulation end.)
4. Flair braided shield to aid insertion of connector body.
5. Push cable with crimped pin into body housing until you detect an audible "snap". (Jamming the pin may bend center conductor and damage connector dielectric.)
6. Lightly tug cable (@ 4.5 lbs/2.0 kgs) to verify that pin is properly seated in body housing.
7. Slide crimp sleeve up against the body and place in tool die.
8. Complete assembly by crimping down on sleeve to form hex.

Note: *Flair gap at sleeve end is normal and allows cable jacket extra flexing room.*

Crimping 2 piece BNC



1. Strip Cable



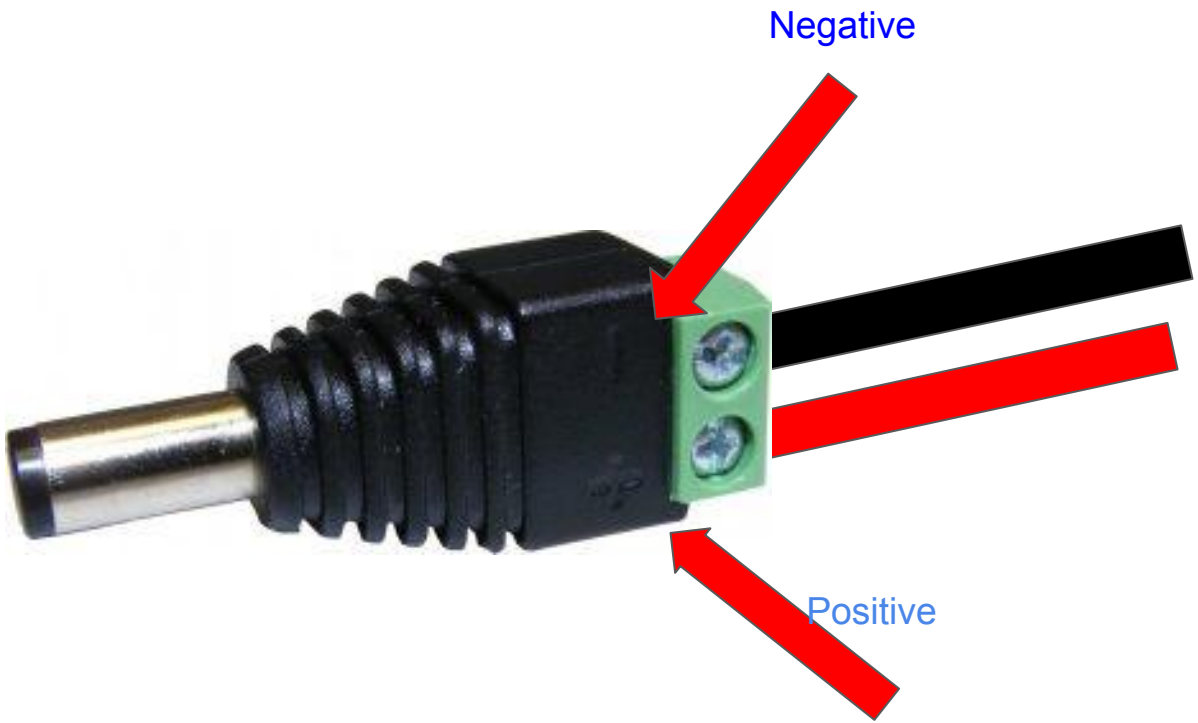
2. Twist body of connector on center conductor

Shotgun

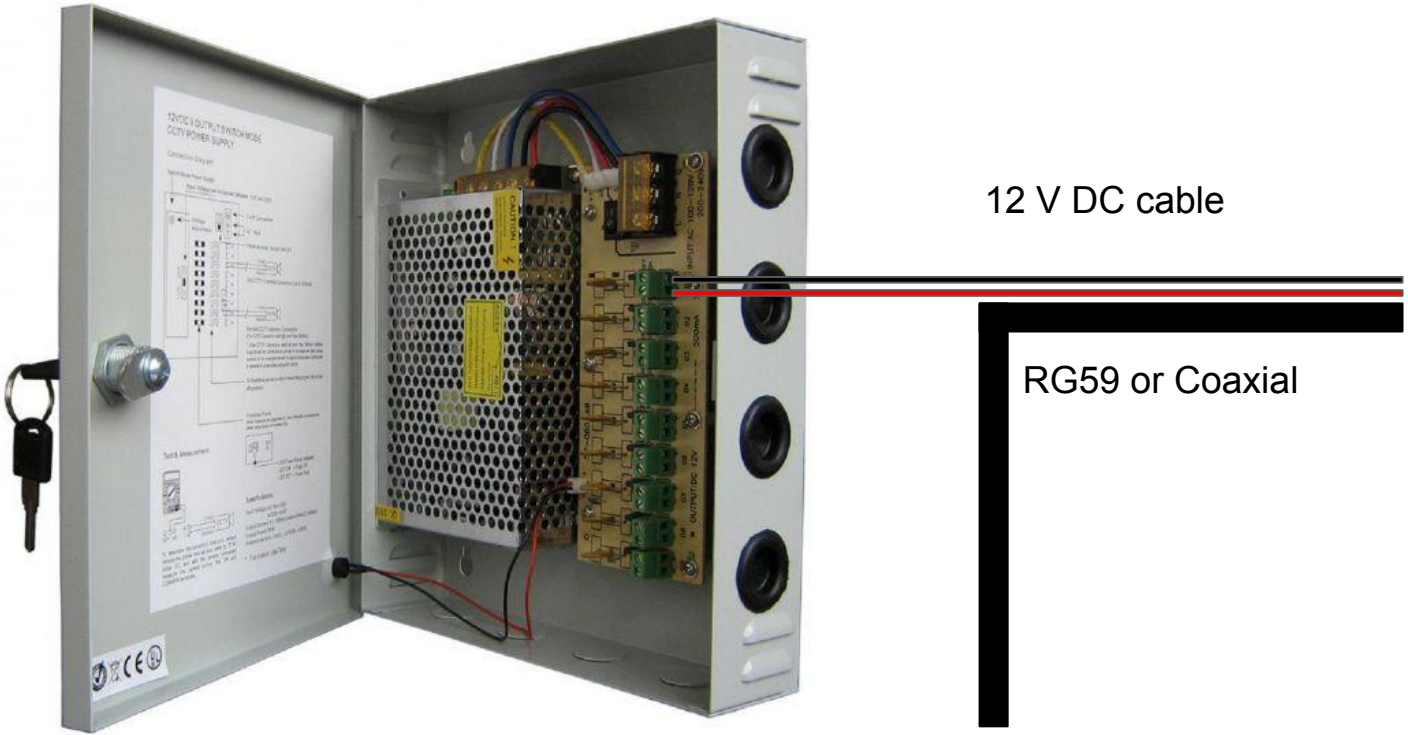
18 AWG used in most shotgun cable for power -

DC lead

Camera’s end



Power supply



CCTV Installation

Ethernet cable crimping

Tools required

CCTV Installation

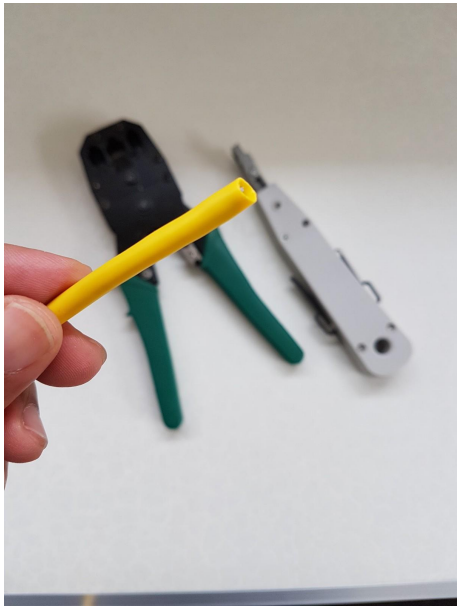
Ethernet cable crimping

Step 1 : Strip cable, measure how much of the outer sheath needs to be removed.

Strip at least 5 cm of outer sheath, make sure you do not damage the actual cables inside.

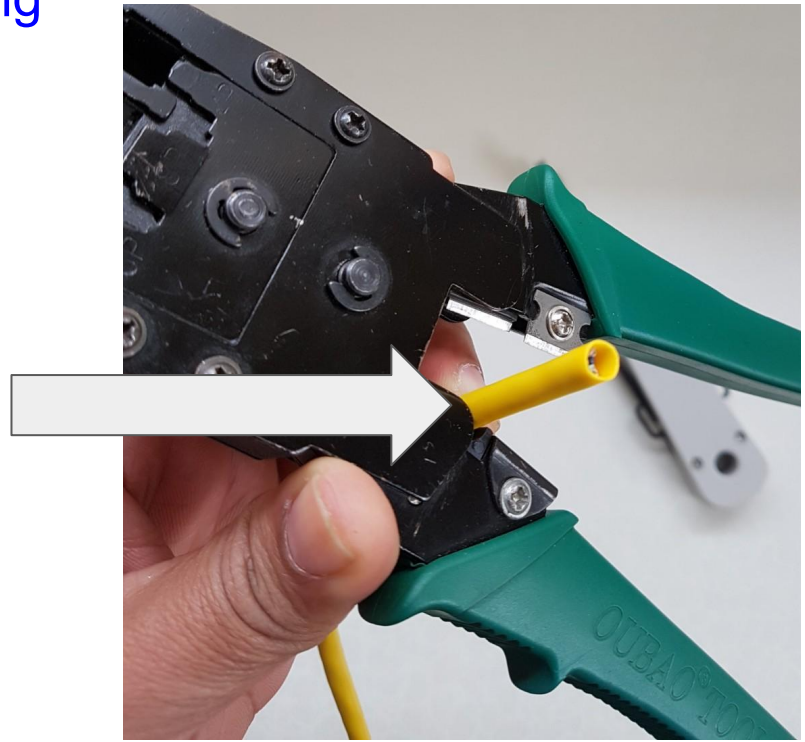
CCTV Installation

Step 2 - use the correct type of cable stripper.



CCTV Installation

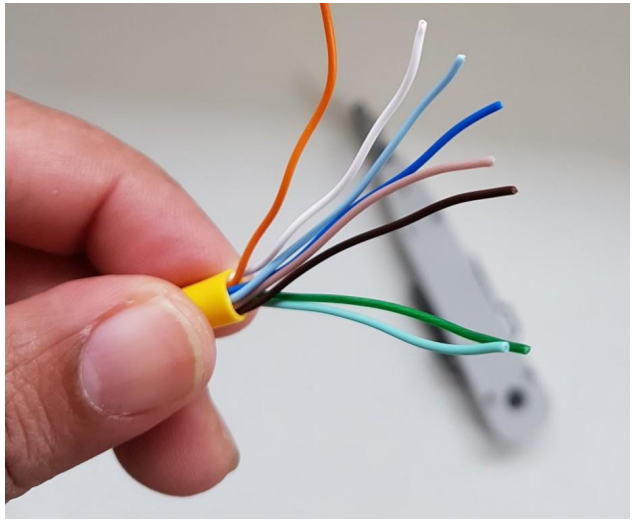
Ethernet cable crimping



CCTV Installation

Step 3

Untwist all of the conductors, and arrange them in the correct order.



CCTV Installation

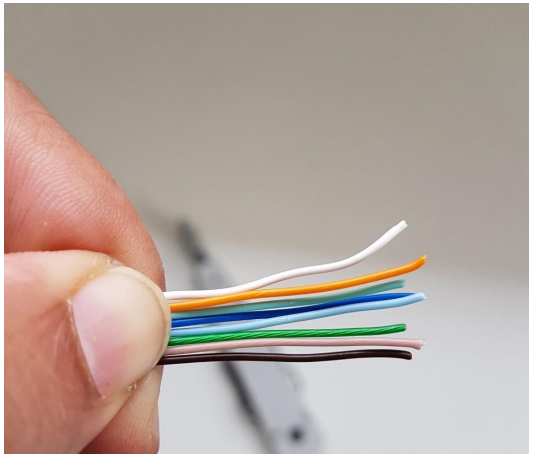
Step 3

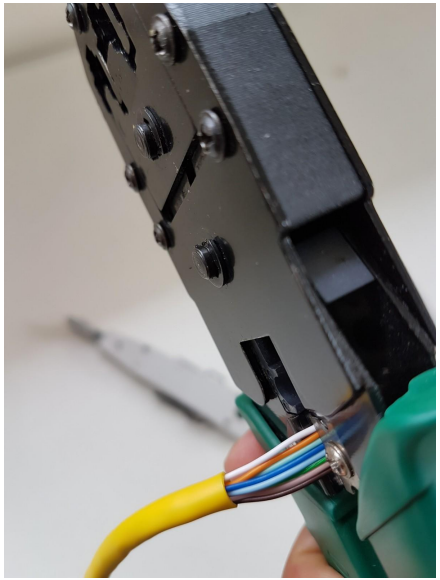
1. White-orange
2. Orange
3. White-green
4. Blue
5. White-blue
6. Green
7. White-brown
8. Brown

CCTV Installation

Step 4

Flatten them out with your fingers, chop them off to a length of 10 cm (Do not use normally side cutters)

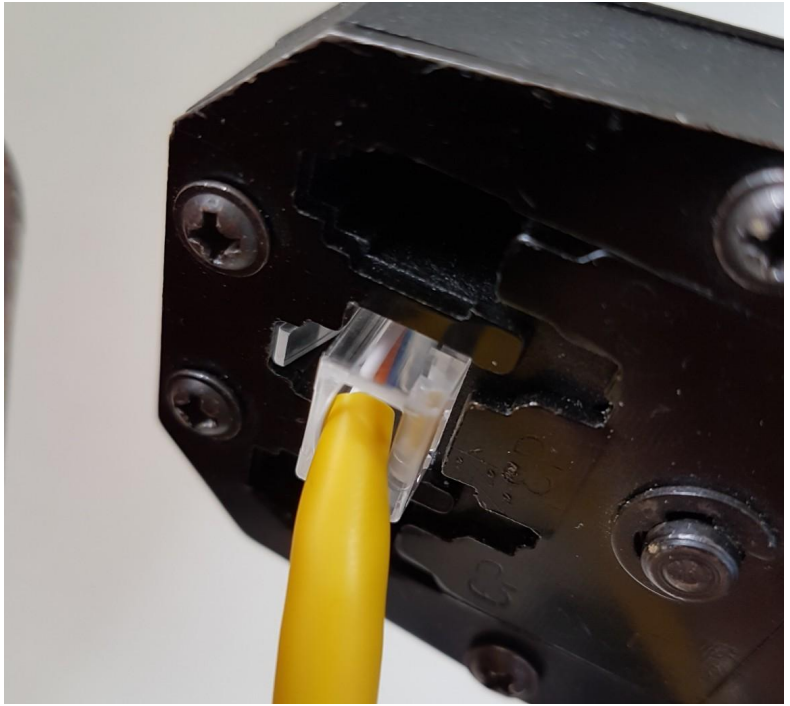




CCTV Installation

Step 5

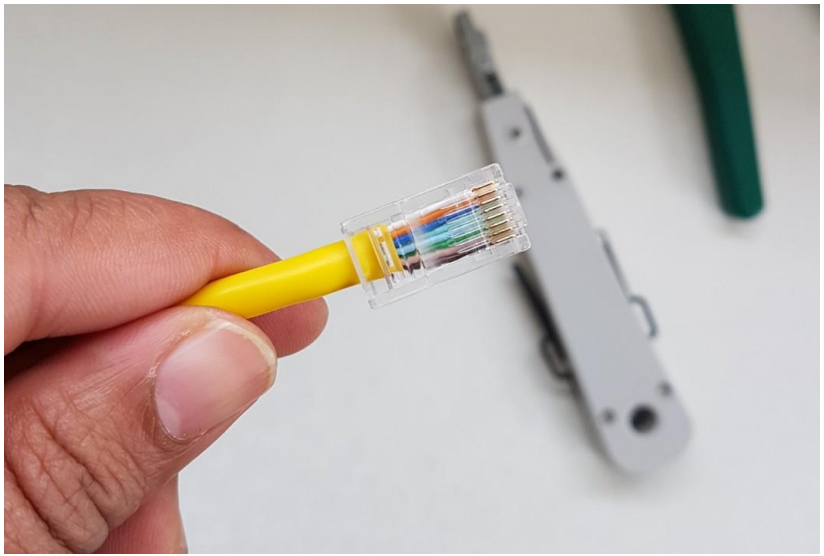
Push on the end on and crimp



CCTV Installation

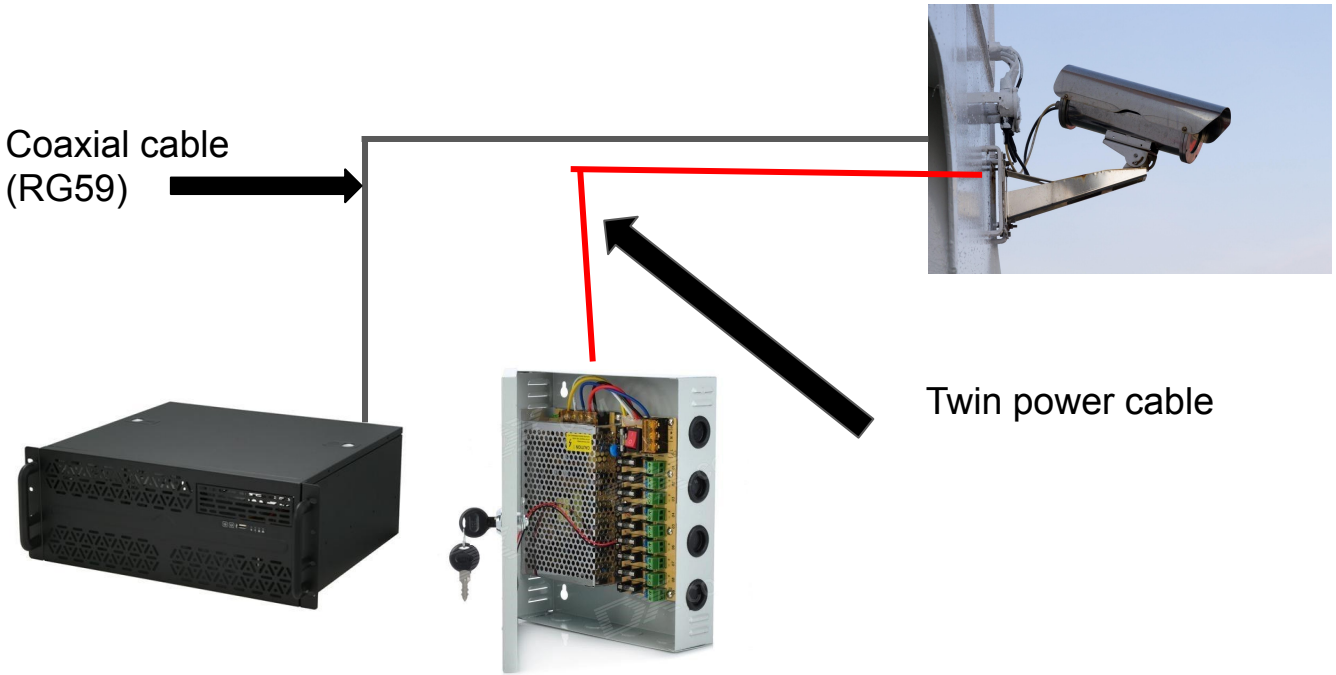
Step 6

All done



CCTV Installation

Basic analogue CCTV system



CCTV Installation

Questions?

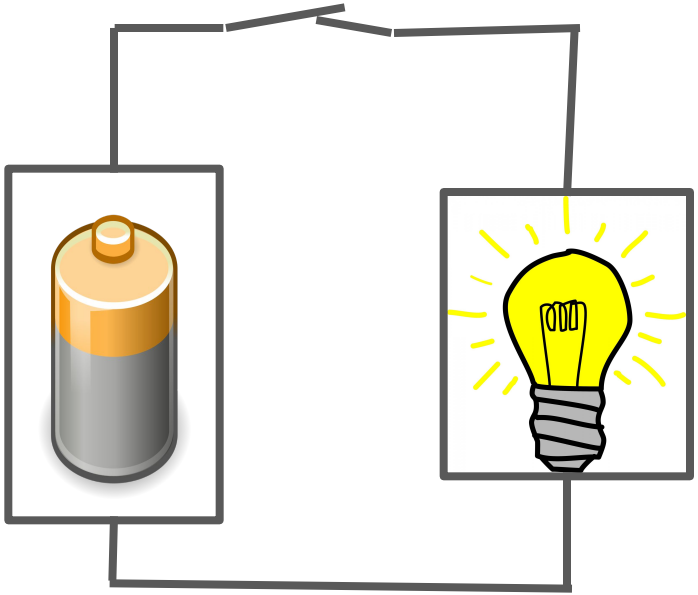
Electrical and CCTV installation

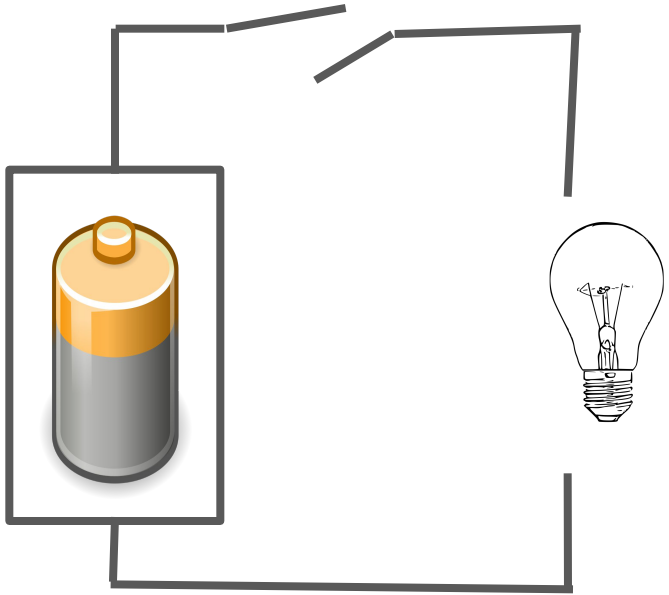
- Circuits

  What is a circuit?

  In electronics, a circuit is a closed path through which electrical currents can flow. The flow of electrical current through a flashlight illustrates the idea.

Electrical and CCTV installation





Electrical and CCTV installation

Three parts of the flashlight comprise the circuit: the battery, which supplies power, a bulb, which produces light when connected to the battery, and a switch, which can either be on (connected) or off (disconnected). The important feature of this circuit is that electrical currents flow through it in a loop, as illustrated in the right part of the figure above. The rules that govern the flow of electrical current are similar to the rules that govern the flow of certain types of fluids; and it is often helpful to draw analogies between these flows. The following figure illustrates the flow of blood through the human circulatory system.

Electrical and CCTV installation

- Voltage:

  Voltage is a difference in electrical potential between two different points in a circuit.

- Current:

  Current is a flow of electrical charge through a path in the circuit. A positive current in a direction is generated by negative charges (electrons) moving in the opposite direction.

Electrical and CCTV installation

- Resistance

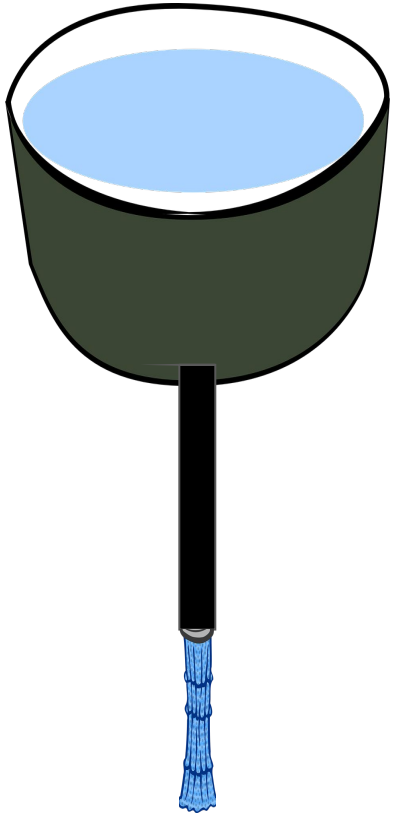
  Resistance is a material’s tendency to resist the flow of charge (current)

Electrical and CCTV installation

When describing voltage, current, and resistance, a common analogy is a water tank.

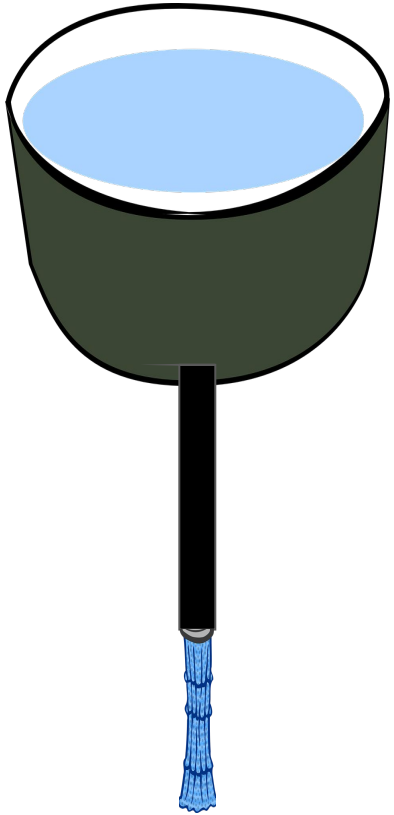
- Water = Charge
- Pressure = Voltage
- Flow = Current

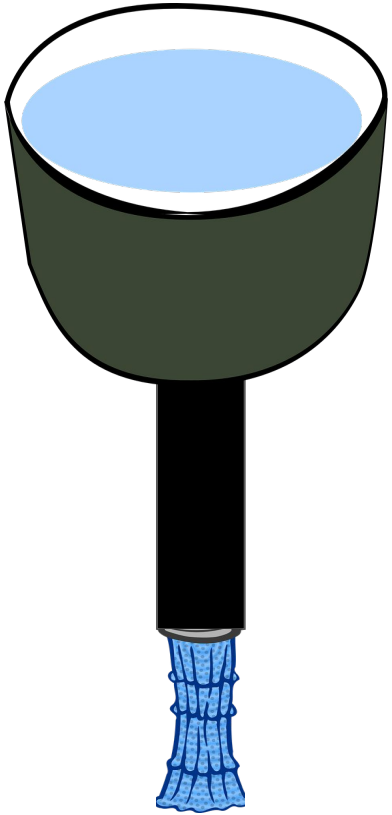
Electrical and CCTV installation



The pressure at the end of the hose can represent voltage.

Electrical and CCTV installation





Electrical and CCTV installation

We can think of the amount of water flowing through the hose from the tank as current. The higher the pressure, the higher the flow, and vice-versa.

Let’s say now that we have two tanks, each with a hose coming from the bottom. Each tank has the exact same amount of water, but the hose on one tank is narrower than the hose on the other.

Resistance

Consider again our two water tanks, one with a narrow pipe and one with a wide pipe. The narrow pipe has more resistance compared to wider pipe.

Electrical and CCTV installation

Ohm’s law

Ohm developed a formula combining the elements of voltage, current, and resistance:

$V = I R$

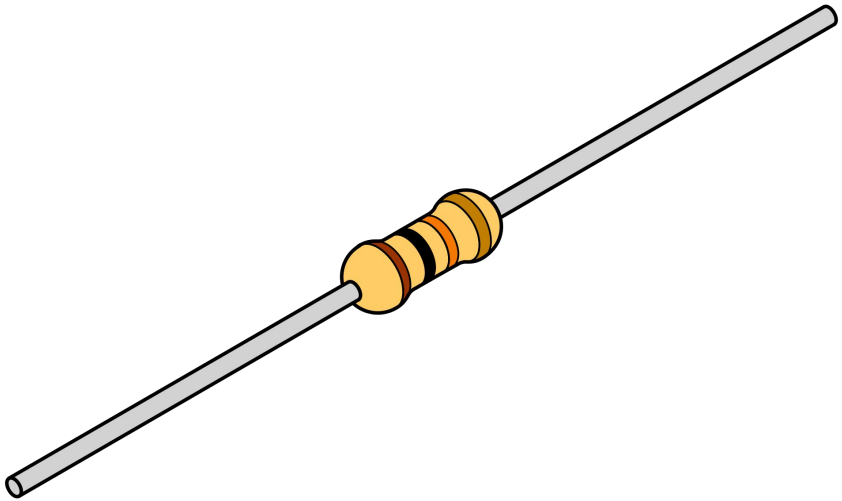
Where

V = Voltage in volts, I = Current in amps, R = Resistance in ohms

Electrical and CCTV installation

Resistors

Resistors are electronic components which have a specific, never-changing electrical resistance.



Electrical and CCTV installation

Resistors

- They are passive components, meaning they only consume power.
- Resistors are used to limit current.
- The electrical resistance of a resistor is measured in ohms.

Electrical and CCTV installation

Powering

7.3.3		**Powering**	
7.3.3	1	Consideration should be given to the power requirements of the system including: • Local or centrally powered • Mains or low voltage • Back up / Stand-by power in the event of mains failure.	BS EN 62676-4 Clauses 6.1, 12.8

Electrical and CCTV installation

Powering

- Local and centrally powered
- Backup power

Electrical and CCTV installation

Mains and low voltage

- What is BS7671?
  - Why it is important to a CCTV installer?
    - Cable segregation
    - Electrical safety
    - Troubleshooting
- What is mains?
- What is low voltage?

Electrical and CCTV installation

Backup and standby power

Why do you require backup power?

How to calculate total WATTS?

Electrical and CCTV installation

Backup and standby power

What is watts?

Watt = V x I

V = Voltage

I = Current

Electrical and CCTV installation

Backup and standby power

Watt

Example:

4 cameras require 8 watts (12 V DC) and the NVR requires 4 A 12V DC, calculate the total watts required to keep this system running for at least 30 minutes.

Electrical and CCTV installation

Mains

Unswitched spur

Electrical circuits

MCB’s, RCD’s & RCBO

Electrical and CCTV installation

What is voltage drop?

How to measure voltage drop using a multimeter?

Why voltage drop is important?

Electrical and CCTV installation

Voltage drop

Ohm's law

V = IR

V= voltage, I = current, R = resistance

Vd = (I x R)

Electrical and CCTV installation

CCTV power box

Exercise:

1. Measuring voltage
2. Understanding fuse rating
    a. Checking continuity with fuses
3. Electrical polarity
    a. Wiring red and black cable to power box
4. Wiring the CCTV power supply box to mains (unswitched spur is recommended)

Electrical and CCTV installation

4

Appendix 4 – Cable data-resistance, impedance and '$R_1 + R_2$' values

Table 4.1 Resistance of copper cables at 20°C.

Conductor nominal cross-sectional area (mm^2)	Maximum resistance of copper conductors at 20°C (Ω/km)
0.5	36
0.75	24.5
1	18.1
1.5	12.1
2.5	7.41
4	4.61
6	3.08

Electrical and fire alarm installation

Practical wiring of CCTV power supply -

Exercise 1

- Understanding the difference between
  - CCTV power supply box
  - Black power supply

- Wiring a black power supply with splitter.
  - Drawbacks of using a splitter.

Electrical and fire alarm installation

Practical wiring of CCTV power supply -

Electrical and fire alarm installation

Practical wiring of CCTV power supply -

Exercise 1

- Checking fuses
  - 0.5 A fuse
  - How to check whether the fuse is working.

- Checking the power supply box printed circuit board.
  - Checking power supply unit PCB DC outputs
- Hard wiring to main
  - Unswitched spur

Electrical and CCTV installation

Break

Questions?

Electrical and CCTV installation

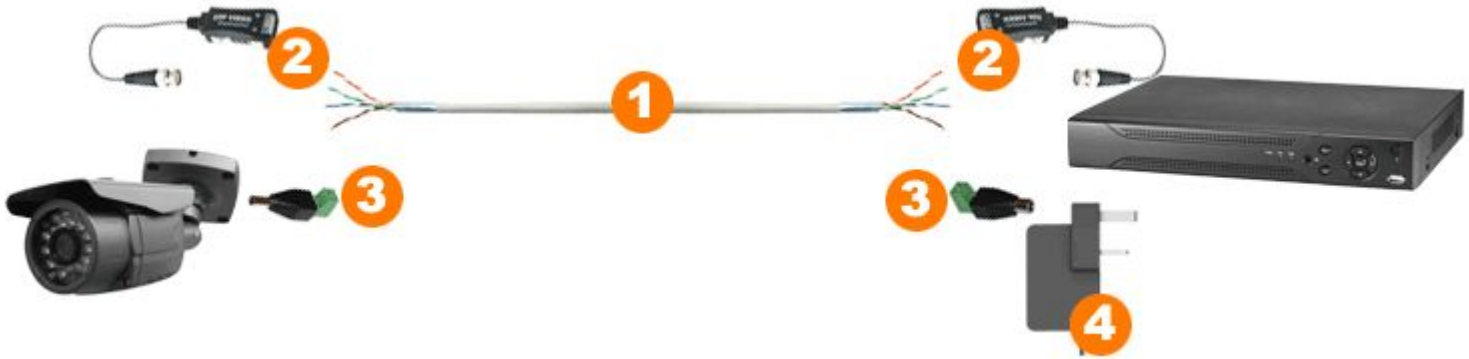
Cable Installation

CAT 5 in power installation

Electrical and CCTV installation

Cable Installation

CAT 5 in power installation



Electrical and CCTV installation

CAT5/Ethernet cable - analogue CCTV cameras

Practical wiring of analogue CCTV cameras using Ethernet cable -

Exercise 2

- Wiring camera end
  - Orange and white orange for video - (TIA568b, pin 1 and pin 2)
  - Blue and white blue for power - and brown and white brown for power +
  - How to use boot lace ferrules.

- The IP55 junction boxes are identified by their bellied cover and therefore extraordinary interior installation space. The combination of membrane and thread cable entries and the captive lid screws ensure an easy assembly and installation.

Electrical and CCTV installation

CAT5/Ethernet cable - analogue CCTV cameras

Practical wiring of analogue CCTV cameras using Ethernet cable -

Exercise 2

- The IP55 junction boxes are identified by their bellied cover and therefore extraordinary interior installation space. The combination of membrane and thread cable entries and the captive lid screws ensure an easy assembly and installation.

Electrical and CCTV installation

CAT5/Ethernet cable - analogue CCTV cameras

Practical wiring of analogue CCTV cameras using Ethernet cable -

Electrical and CCTV installation

Cable Installation

The requirements of BS 7671 (Requirements for electrical installations, IET Wiring Regulations) should be met using the edition current at the time of installation.

All interconnecting cables should be fixed and supported and installed to conform to good working practices.

Electrical and CCTV installation

Possible fixings and supports include:

• Conduit: when metal is used suitable bushes or grommets should be fixed to each end to prevent damage to the cable. When conduit is used to carry the cable it should terminate as close as possible to the unit to be connected.
• PVC or metal trunking: where trunking is used to carry the cable it should terminate as close as possible to the unit to be connected.
• Insulated clips
• Cable ties
• Catenary Cables: When overhead catenary wires with loop holders or plastic buckles are used the supporting wire should be securely attached to the building. Self-supporting catenary cables may be used provided they are correctly designed.

Electrical and CCTV installation

All cables should be of a type and size appropriate to the application and should take account of transmission rate, electrical interference and voltage drop.

Any plastic or PVC component used as part of the installation of cables should be suitable for the environment in which it is installed. Externally mounted ties and clips should be made of UV-resistant material.

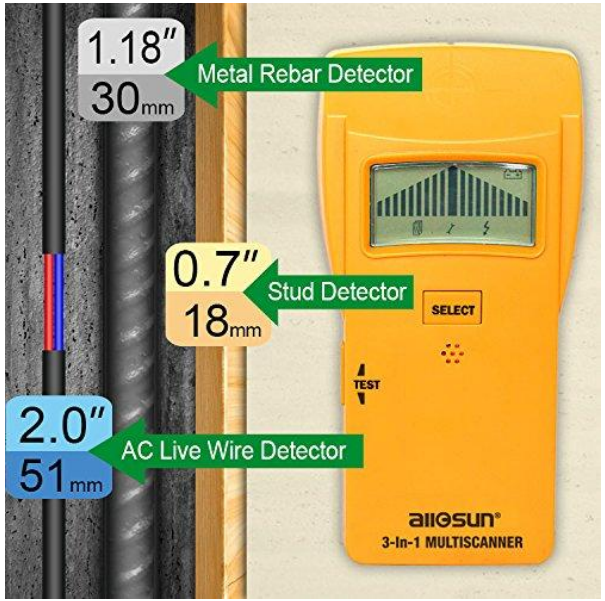
Environmental conditions such as dampness, excessive heat, risk of corrosion, mechanical or chemical damage, should be taken into account when determining the degree of protection required for cable runs.

Electrical and CCTV installation

Any cables used underground should be suitable for that purpose and have adequate protection from mechanical damage. Underground cables should provide a high level of resistance to dampness, chemical reactions, corrosion and rodents.

Electrical and CCTV installation

3 in 1 LCD Stud Wood Wall Center Scanner Finder Metal AC Live Wire Detector Tool



Electrical and CCTV installation

Question?

Electrical and CCTV installation

Troubleshooting

Electrical and CCTV installation

Troubleshooting

How to test for continuity with a digital multimeter?

Continuity testing overview

- Continuity is the presence of a complete path for current flow. A circuit is complete when its switch is closed.

Electrical and CCTV installation

Troubleshooting

How to test for continuity with a digital multimeter?

Continuity testing overview

- A digital multimeter Continuity Test mode can be used to test switches, fuses, electrical connections, conductors and other components. A good fuse, for example, should have continuity.
- A DMM emits an audible response (a beep) when it detects a complete path.

Electrical and CCTV installation

Troubleshooting

- Cable locator

  This tester is ideal for tracing cables in walls and underground, locating fuses/breakers on final circuits and locating interruptions and short-circuits in cables and electrical floor heating systems.

CCTV Lens

C mount and CS mount lens

CCTV Lenses are available in two different lens mounts. "C-Mount" lenses have a flange back distance of 17.526mm vs. 12.5mm for "CS-Mount" lenses. Many of today's cameras can accept either type of lens, but it is important to make sure that camera and lens are compatible and set up properly.

C-Mount lenses can be used on CS-Mount cameras by utilizing a 5mm adaptor or adjusting the camera for C-Mount lenses. Because of the shorter back focal distance, CS-Mount lenses can only be used on CS-Mount cameras. Your picture will be out of focus if you use a CS-Mount lens on a C-Mount camera.

CS and C mount

C/CS-Mount

● CCTV cameras have either a C-mount or CS-mount.

Standard

	C-mount	CS-mount
Flange focal length length (mm)	17.526*1	12.5*1
Diameter of screw thread (mm)	1-32UNF	

Interchangeability

	C-mount camera	CS-mount camera
C-mount lens	⍰	⍰*2
CS-mount lens	×	⍰

⍰1 Length in air
⍰2 Will need a C-mount adapter ring (5 mm) when fi tting a C-mount lens to a CS-mount camera.

C mount and CS mount lens

Figure: CS and C mount

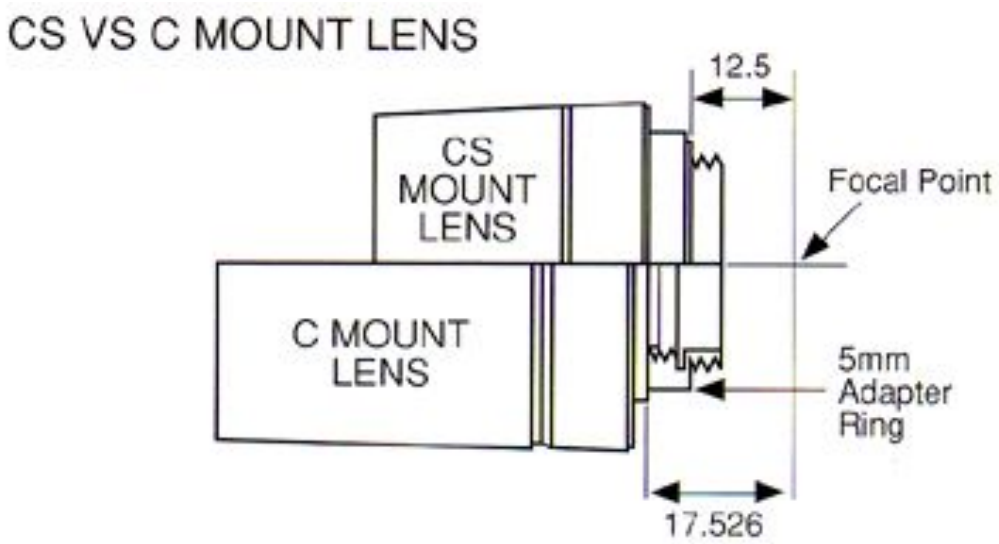
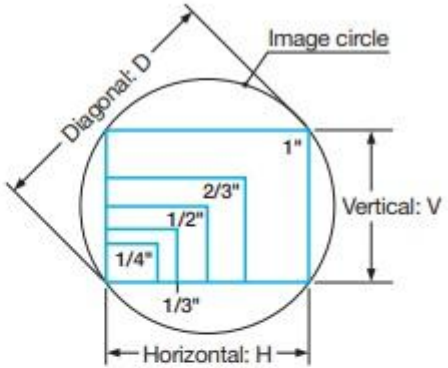


Image size

Image Sizes



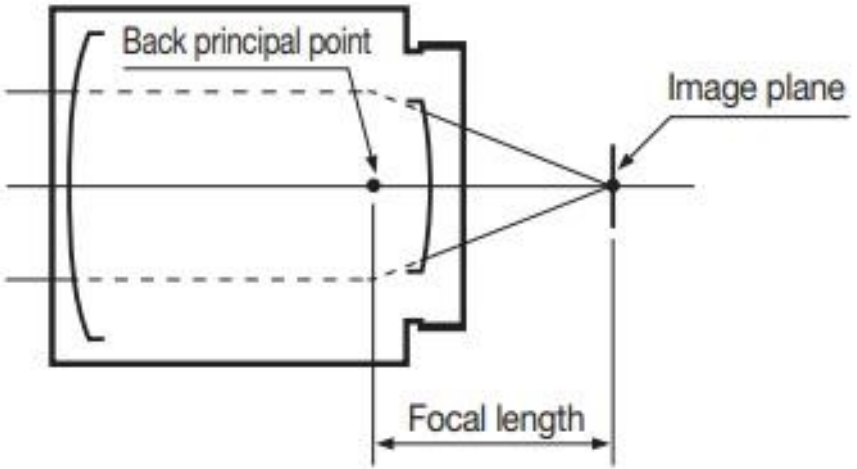
Product symbol	Image sensor	Image size (mm)		
		Horizontal: H	Vertical: V	Diagonal: D
C	1"	12.8	9.6	16.0
H	2/3"	8.8	6.6	11.0
D, S	1/2"	6.4	4.8	8.0
Y, T	1/3"	4.8	3.6	6.0
Q	1/4"	3.6	2.7	4.5
35 mm camera lens (Reference)	35 mm film	36.0	24.0	43.3

There are several types of imaging sensors for CCTV cameras, with different image sizes.

Focal Length

Focal Length

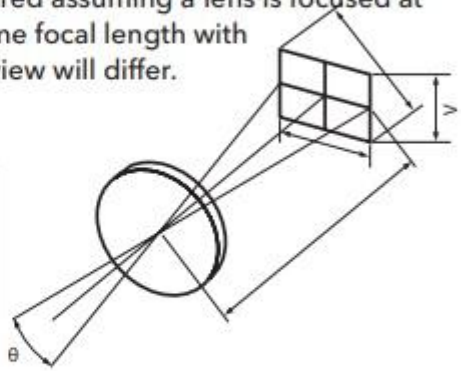
- The focal length will be the distance from the back principal point to the image plane. Lower the focal length wider the image.



Angle of view

Angle of View

● The angle of view is the object size that can be captured at a specified image size, which is represented by angular measure.
Normally the angle of view is measured assuming a lens is focused at infinity. When using a lens of the same focal length with a different image size, the angle of view will differ.



$$\theta = 2\tan^{-1}\frac{Y'}{2f}$$

θ : Angle of view
Y' : Image size
f : Focal length

Example

The angle of view when the sensor size of the camera is 1/2"and the focal length is 12.5 mm:

Y' : 6.4
f : 12.5

$$\theta = 2\tan^{-1}\frac{6.4}{2\times 12.5} = 28.72^{\circ}$$

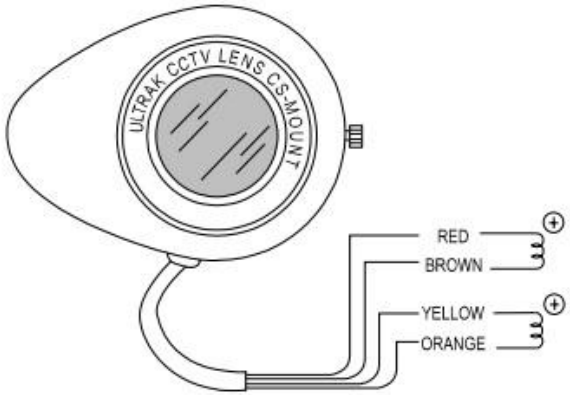
Vari-focal viewing angle

Format inch	Mount	Focal Length (mm)	Aperture (F)	Angle of View (HORIZONTAL) UNIT: (°)			
				2/3" (8.8×6.6mm)	1/2" (6.4×4.8mm)	1/3" (4.8×3.6mm)	1/4" (3.6×2.7mm)
1/3	CS	1.8-3.6	1.6-360C	-	-	144.2-79.4	109.5-59.6
1/3	CS	2.3-6	1.2-360	-	-	114.8-48.2	86.0-36.1
1/3	CS	2.9-8.2	1.0-360C	-	-	98.3-35.2	70.7-26.3
1/3	CS	2.9-8.2	1.0-360C	-	-	95.0-35.6	69.0-26.7
1/3	CS	3.5-10.5	1.0-360	-	-	81.6-27.2	59.4-20.4
1/3	CS	3.5-10.5	1.0-360	-	-	81.8-27.2	59.2-20.4
1/3	CS	2.8-12	1.3-360	-	-	102.2-23.7	74.2-17.8
1/3	CS	5-50	1.3-360C	-	-	51.8-5.6	39.2-4.3
1/3	CS	8.5-40	1.3-360C	-	-	33.5-7.1	24.4-5.3
1/2	CS	4.5-10	1.6-360C	-	81.3-38.2	60.4-28.7	33.6-16.1
1/2	CS	4.5-12.5	1.2-360	-	83.7-30.1	61.3-22.6	45.3-17.0
1/2	CS	10-30	1.4-360C	-	35.8-12.5	26.8-9.4	20.1-7.0

Motorised zoom lens

Format	Mount	Focal Length (mm)	Aperture (F)	Angle of View (HORIZONTAL) UNIT: (°)				
inch				2/3" (8.8×6.6mm)	1/1.8" (7.1×5.4mm)	1/2" (6.4×4.8mm)	1/3" (4.8×3.6mm)	1/4" (3.6×2.7mm)
1/3	CS	5.7-34.2	1.0 ~	-	-	-	45.9-8.1	34.8-6.2
1/3	CS	5.7-57	1.2 ~	-	-	-	44.6-4.8	34.2-3.7
1/3	CS	5.8-121.8	1.6 ~	-	-	-	44.8-2.3	33.8-1.8
1/3	CS	5.5-187	1.8 ~	-	-	-	46.6-1.5	35.2-1.1
1/2	C	8-48	1.2 ~	-	-	44.6-8.0	33.5-6.1	25.2-4.6
1/2	C	8-80	1.2 ~	-	-	44.0-4.7	33.3-3.5	25.0-2.6
1/2	C	12-120	1.8 ~	-	-	29.4-3.1	22.2-2.3	16.7-1.7
1/2	C	7.5-120	1.6 ~	-	-	46.6-3.2	35.3-2.4	26.6-1.8
1/2	C	7.5-120	1.6 ~	-	-	47.0-3.1	35.4-2.4	26.6-1.7
1/2	C	10-300	1.5 ~	-	-	35.5-1.25	26.8-0.94	20.1-0.71
1/2	C	12.5-750	3.8 ~	-	-	28.7-0.48	21.7-0.37	16.4-0.28
1/2	C	8-80	1.9 ~	-	-	44.81-4.45	34.62-3.38	26.39-2.55
1/2	C	10-210	1.6 ~	-	-	35.4-1.72	26.9-1.30	20.2-0.98
1/1.8	C	10-240	1.8 ~	-	39.0-1.7	35.2-1.6	26.5-1.2	-
2/3	C	15-360	F2.7 ~	32.3-1.4	26.3-1.2	23.6-1.0	-	-
2/3	C	21-500	F3.8 ~	23.5-1.0	18.9-0.8	17.1-0.8	-	-
1/2	C	10-350	1.5 ~	-	-	35.30-1.05	26.70-0.79	20.1-0.44
1/2	C	12.5-775	3.5 ~	-	-	28.77-0.47	21.8-0.35	16.41-0.26

Auto-Iris Lens



Auto irises **are** motorized, allowing them to automatically adjust the **iris** opening to the changing light throughout the day. There **are** two types of **auto** arises, DC-irises (the control for the motor is in the camera) and video irises (the control is in the lens itself)

CCTV Installation

Resolution and frames per second

Frames per second

Frame rate (expressed in **frames per second** or **fps**) is the frequency (rate) at which consecutive images called **frames** appear on a display

Real time FPS = 25 fps PAL and 25 fps NTSC

CCTV Installation

Resolution and frames per second

How many frames per second can the human eye really see?

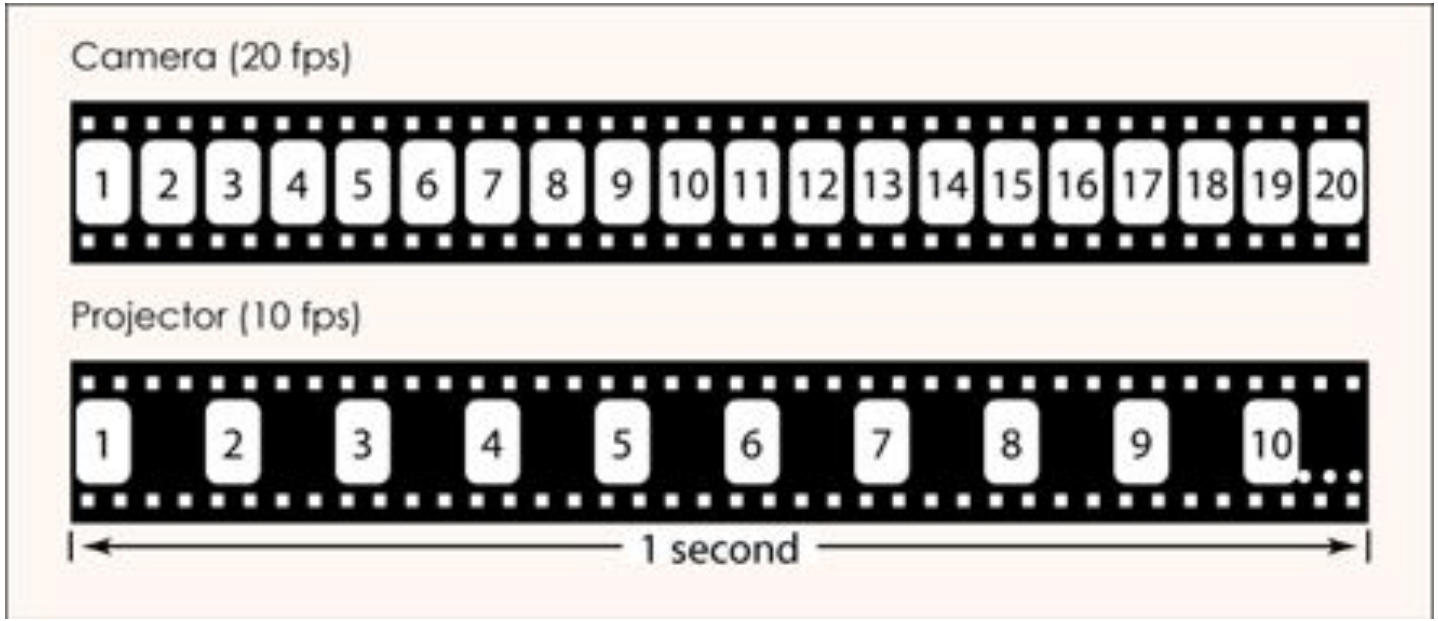
“I think typically, once you get up above 200 fps it just looks like regular, real-life motion,” says DeLong

The researchers claim that human can see above 200 fps, however, the response time can be far less.

As far as CCTV recording is concern 25 fps or 30 fps can be regarded as real-time.

CCTV Installation

Resolution and frames per second



CCTV Installation

Pixels

PPI can also describe the **resolution**, in **pixels**, of an image file. A 100×100 **pixel** image printed in a 1 **inch** square has a **resolution** of 100 **pixels per inch**.

- 4K UHD (3840x2160)
- Full HD (1920x1080)

The maximum resolution a conventional analog camera can provide after the video signal has been digitized in a digital video recorder or a video encoder is D1, which is **720x480 pixels** (NTSC) or **720x576 pixels** (PAL).

Introduction to CCTV Installation

1080p resolution vs 1080i

Both modes offer the same pixel **resolution**: 1920 x 1080. The difference is in the scan type they use. The p in **1080p** stands for progressive scan, and the i in **1080i** stands for interlaced.

1080p draws all pixels at once.

1080i and 1080p are higher resolutions than 720, but they aren't the same. You should go for 1080p because of the more efficient way it projects images onto the screen.

Exercise

1. Check the recording resolution with Qvis DVR
2. Check the recording resolution with Dhaua or Hikvision DVR

CCTV Installation

Comparison

VGA and 720p

CCTV Installation

CCTV camera resolution

Image Format	Horizontal Pixels	Vertical Pixels	Megapixels
CIF	320	240	0.1
VGA	640	480	0.3
WVGA	752	480	0.4
720P	1280	720	0.9
SXGA	1280	1024	1.3
UXGA	1600	1200	1.9
1080P	1920	1080	2.0
QXGA	2048	1536	3.1
QSXGA	2560	2048	5.2

CCTV Installation

CCTV camera resolution

480 TVL	500H*582V	0.29 megapixel	
1000TVL	1280*720	0.92 megapixel	
720P	1280*720	0.92 megapixel	
1080P	1920*1080	2.07 megapixel	
5MP	2592×1920	4.97 megapixel	

CCTV Storage

Cube Training

CCTV Camera Storage Calculation Formula

Storage Space (GB) = Bitrate (Kbps) * 1000/8 * 3600 * 24 * Cameras * Days/1000 000 000

For example, if you have 2 cameras whose maximum bitrate is 1024 Kbps and you want to record for 7 days nonstop, the required storage space = 1024 * 1000/8 * 3600 * 24 * 2 * 7/1000 000 000 = 154.8288 GB

CCTV Camera Storage Calculation Formula

The factors that determine CCTV camera storage.

- Resolution – The CCTV camera resolution is measured in vertical and horizontal pixel dimensions, such as CIF (352 x 240), 720P (1280 x 720), 1080p (1920 x 1080), 1440P (2560 x 1440) and etc.
- Compression – Video compression is a kind of technique that reduces the size of original video file formats and thus occupies less space than the original files. The popular video compression formats include H.264, MJPEG and MPEG4. (Read the comparison between the H.264 and MJPEG security cameras).
- Bitrate – The higher the camera bitrate is, the better the video quality. And it is affected by the resolution and compression formats. Lower resolution and highly compressed videos will require less bitrate.

CCTV Camera Storage Calculation Formula

The factors that determine CCTV camera storage.

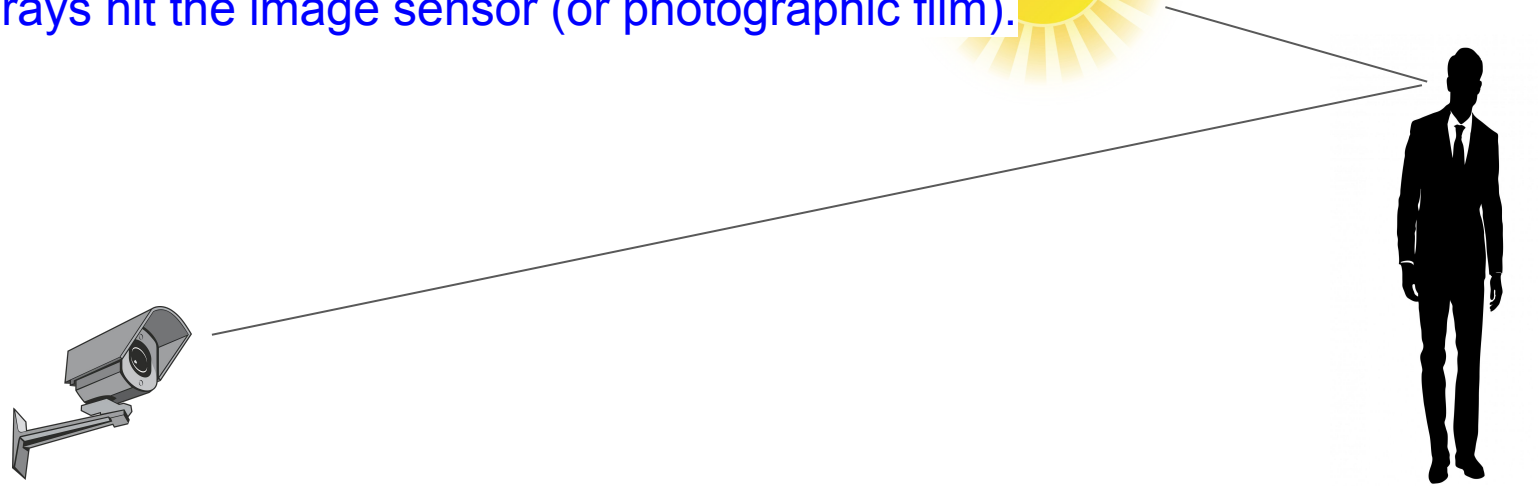
- Camera – The number of cameras you use can also impact the CCTV storage calculation. If you use multiple cameras simultaneously, more CCTV storage will be required.
- Days – The longer CCTV recording retention period is, the more storage space is required. When you utilize the CCTV storage calculation formula, note that it is calculated by days, so you might need to convert the hours to days if the camera records in hours.

CCTV camera lens

Cube Training
Unit 3

Light

The basic principle behind most photography is that you need light! Light emitted from a light source (artificial or natural) is reflected by an object and then enters the camera through the lens. An image of the object is captured when the light rays hit the image sensor (or photographic film).



Light

The essence of this principle is that without light, there will be no image, and poor light will result in a poor image. Anything reducing the light between the object and the sensor will impair image quality. Examples are windows that partially block light, smoked dome covers or lenses with poor optics and small apertures.

If the scene you wish to view is lacking in light, you may need to add some. Auxiliary lamps illuminating the object can often increase image quality considerably.

Also, consider the fact that a camera mounted and tested during daytime can give entirely different results at night, or as the seasons shift. Make sure you understand the entire range of light in your scenario, and set up your camera accordingly.

Basic camera settings

The opening or **aperture** of a lens, also known as the **iris**, greatly affects the amount of light reaching the sensor. The **f-number** of the lens is the quotient of the focal length of the lens and the diameter of the opening. For example, a 50 mm lens with a 25 mm aperture would have an f- number of 2.0, as 50/25=2. The higher the f-number, the smaller the opening will be, and vice versa. A lower f-number means that more light will reach the sensor.

The aperture also affects the **depth of field**, that is, how much of the scene that is in focus at the same time. A wide open lens will have a very shallow depth of field. Objects slightly closer to or further from the camera than the set focus point will be out of focus. By increasing the f-number (thus closing the aperture), the depth of field increases, and the objects can be brought back into focus.

Shutter speed

Another camera setting directly connected to the amount of light available in the scene is the **shutter speed**. This is the amount of time that the shutter is opened for, allowing light to enter and hit the sensor and create an image, for example 1/50th of a second. When there is more light available, the shutter does not need to stay open for as long, so faster shutter speeds are possible. As the light decreases, the shutter speed needs to be slower, to allow the sensor more time to get enough light to form an image. When the shutter speed is very slow, anything moving in the scene will appear blurred in the image, as the object's position changes during the capture. This is called **motion blur**, and has a negative effect on both image quality and usability of video.

Many cameras employ an internal boost of the image signal, called **gain.** To enable image capture in low light without affecting the shutter speed or the depth of field, the weak sensor signal can be electronically amplified, resulting in a brighter image. A side-effect of this is that tiny imperfections in the image are also amplified and are reproduced as image **noise**. This noise degrades image quality and generally requires more bandwidth for the video stream. Image noise also increases with rising temperatures, so adding active cooling to your camera can sometimes be useful.

Pixels

All digital images are made up of small picture elements, called **pixels**. A pixel is the smallest individual component of an image, and each has a specific color and intensity. The total amount of pixels in an image is referred to as the **resolution**. A resolution of 1920x1080 means there are 1920 columns and 1080 rows (2 073 600 pixels total) of pixels making up the image. Another term for this specific resolution is 2 megapixels, as there are roughly 2 million pixels in the image.

At a higher resolution, the camera can capture finer details in the scene, but since the value of each pixel needs to be stored and transferred in a video stream, the bandwidth requirement also increases. Depending on your operational requirements, you should adjust the resolution to provide sufficient image detail without exceeding your available bandwidth.

White balancing

The wavelength bias of a light source is called its **color temperature** and is measured in degrees Kelvin. If the camera knows the color temperature of the incoming light, it can adjust the image to keep white objects white – a function called **white balancing**. Many cameras try to automatically determine the color temperature and then set the white balance. You can also set the white balance to a fixed color temperature depending on the light fixtures in the scene, for example fluorescent lamps or tungsten bulbs.

Dynamic range

The difference between the darkest and brightest parts of a scene is called the **dynamic range**. If the dynamic range is wider than the capabilities of the camera's sensor, the dark parts will be rendered as all black, and the bright parts will be all white.

Some cameras feature a **Wide Dynamic Range mode (WDR)**, which uses various techniques to try to compensate for extremes of brightness in the scene. Try this setting if there are very dark and very bright areas in your scene. If possible, try to position and aim your cameras so as to avoid extreme variations in brightness.

Video compression

Digital video can be compressed to use less bandwidth for streaming and to save storage space. Compression involves applying a mathematical algorithm to the numerical values that make up the video stream. The output is considerably smaller than when not compressed, but the video stream must also be expanded by a reversing algorithm before it can be viewed.

Most algorithms or codecs (an abbreviation for compressor/decompressor) achieve this partly by discarding information of little significance. During decompression, this missing data is restored by approximation, making the end result slightly different than the original recording. This is called **lossy** compression, as it does actually lower the image fidelity. At low compression ratios, the human eye will not notice this loss, but at higher compression ratios (for low bandwidth), the image quality will deteriorate, with noticeable artifacts in the image.

Video compression

Different scenes can be compressed with varying results. A busy scene with a lot of motion will be more complex to compress, which results in more bandwidth being required, or an increase in image artifacts. You will need to tweak your compression settings until you find an acceptable trade-off between file size and image quality.

CCTV lens calculation

How to choose a CCTV Camera Lens?

You need to understand the following when choosing a cctv lens:

Focal Length

The Focal Length is measured in mm

Depth of Field

The Depth of View is the distance within which objects in a picture are in focus.

F Stop

CCTV lens calculation

How to choose a CCTV Camera Lens?

You need to understand the following when choosing a cctv lens:

F Stop

F Stop or Aperture has 2 measurements. When the lens is fully open (Maximum Aperture / Minimum F-Stop), just before the lens completely closes (Minimum Aperture / Maximum F-Stop).

F Stop – is the lenses ability to gather light depending on the aperture and focal length.

C or CS Mount

The 2 standard cctv camera lens mounts. The difference between the two is simply the distance between the lens and the ccd image sensor. C Mount – 17.5mm CS Mount – 12.5mm

CCTV lens calculation

How to choose a CCTV Camera Lens?

You need to understand the following when choosing a cctv lens:

Auto or Manual Iris

For changing light conditions (e.g. cameras positioned outdoors), Auto Iris lenses are needed.
For indoor use manual iris lenses are sufficient as light levels will not vary too much.

CCTV lens calculation

How to choose a CCTV Camera Lens?

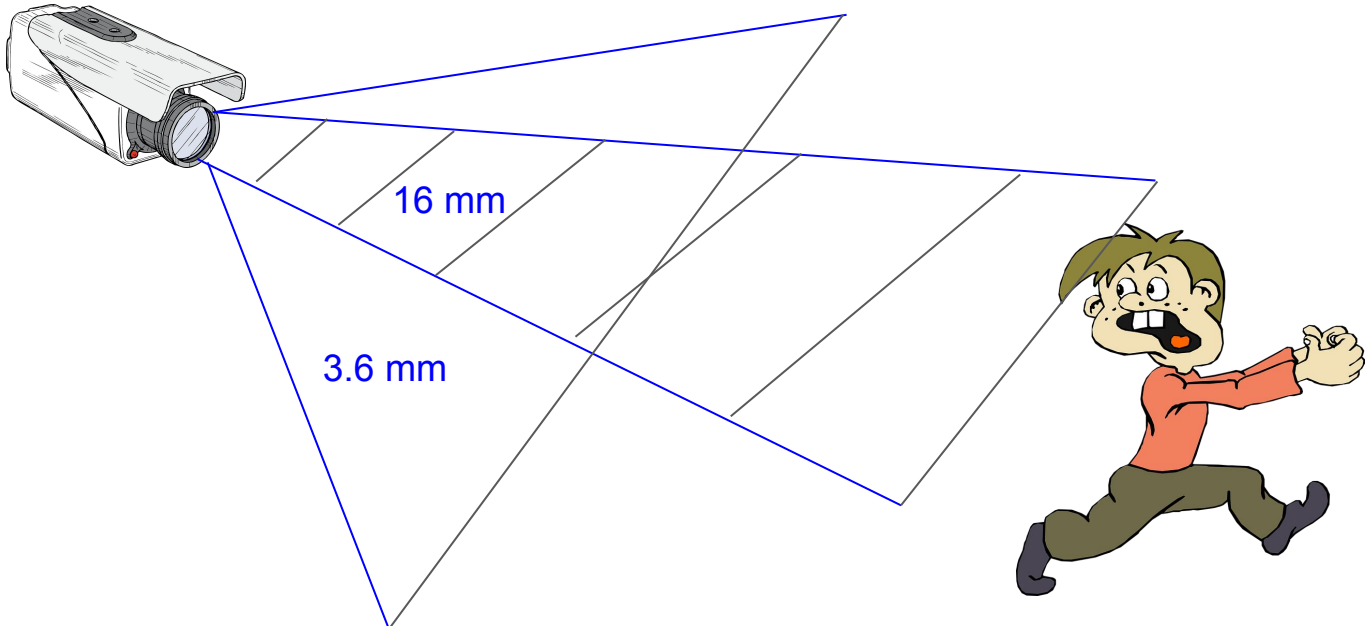
You need to understand the following when choosing a cctv lens:

$$\text{Focal length mm} = \text{Sensor width or height} \times \frac{\text{Distance between the object and camera}}{\text{Desired field of view height or width}}$$

CCTV lens calculation

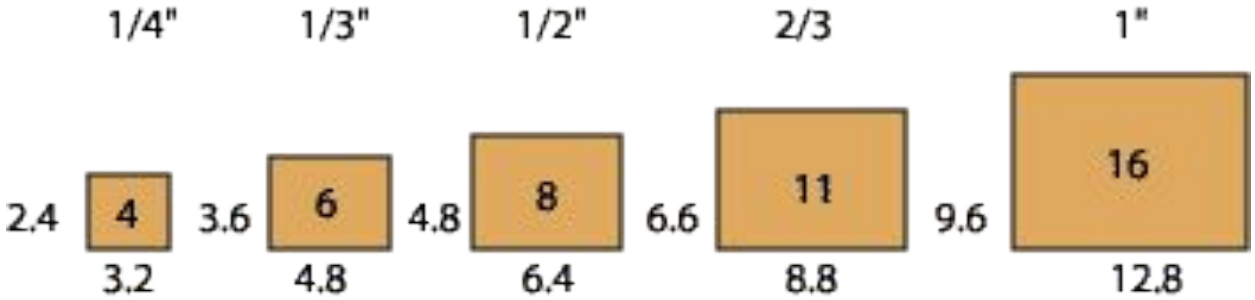
How to choose a CCTV Camera Lens?

You need to understand the following when choosing a cctv lens:



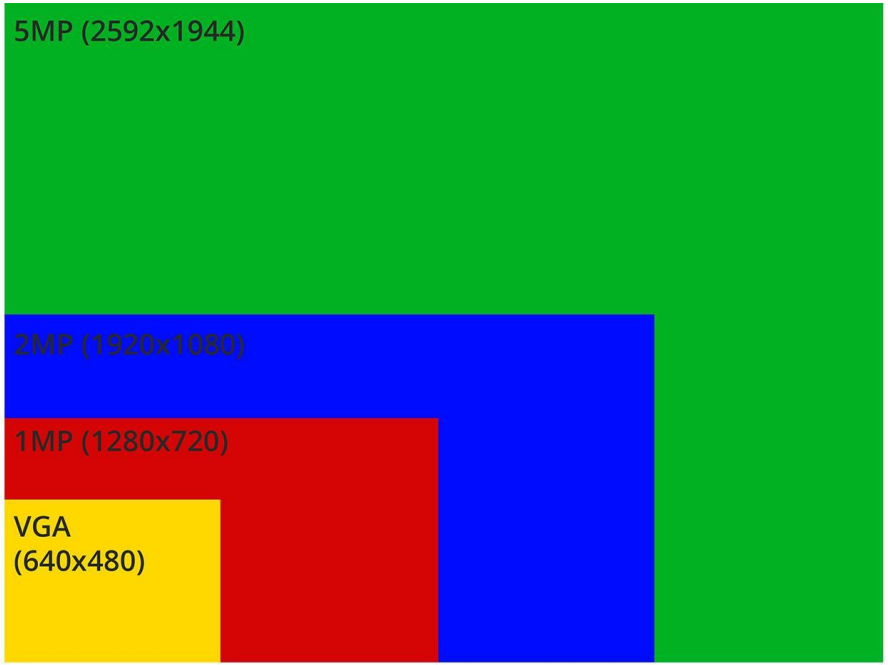
CCTV sensor size (CCD)

CCD camera sensor sizes



CCTV sensor size (CCD)

Camera recording resolution

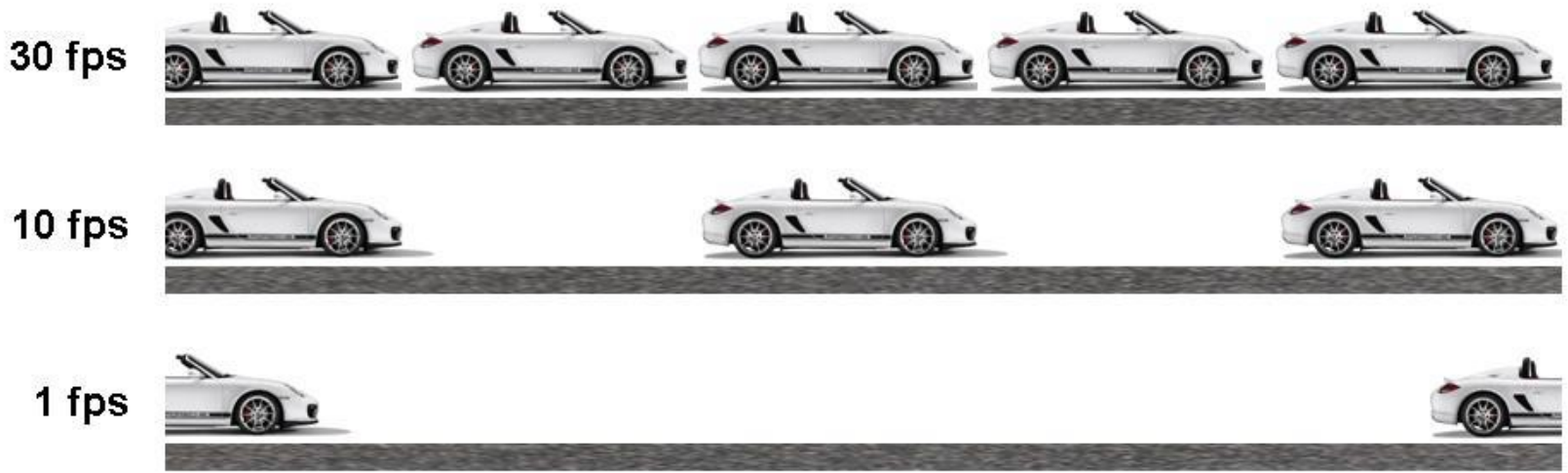


HIKVISION

Sensor size comparison
To scale, reduced from actual size

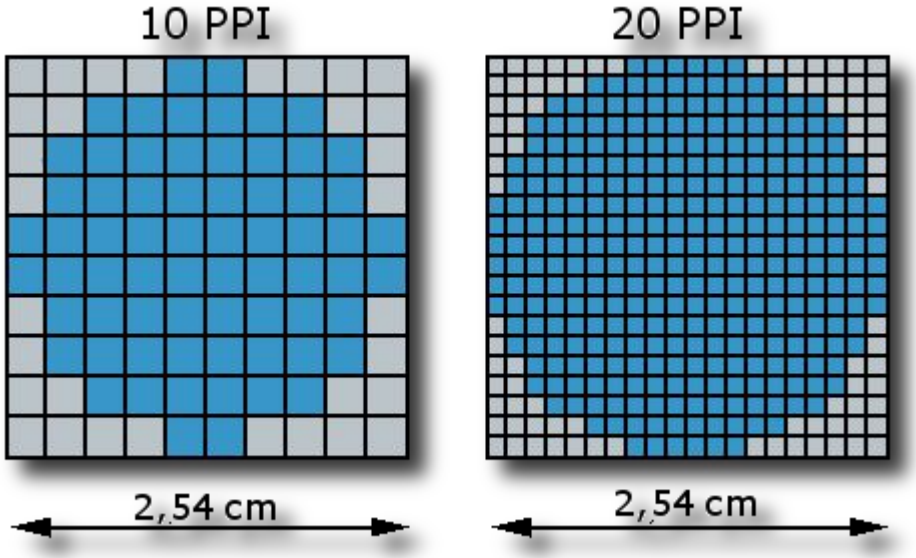
CCTV sensor size (CCD)

Frames per second (fps)



CCTV recording resolution

A **pixel** is the smallest unit of a digital image or graphic that can be displayed and represented on a digital display device.



CCTV recording resolution

Resolution	Pixels	Frame Rate	Bitrate (Kb/s)
1.0 MP*	1280x720 (720p)	7fps**	900 to 1800
		15fps	1600 to 3100
		30fps	3100 to 6200
1.3 MP	1280x960	7fps	1200 to 2400
		15fps	2100 to 4100
		30fps	4100 to 8200
2.0 MP	1920x1080 (1080p)	7fps	1500 to 3000
		15fps	2600 to 5200
		30fps	5200 to 10,300
3.0 MP	2048x1536	7fps	2400 to 4400
		15fps	4100 to 7700
		30fps	8200 to 15,400
5.0 MP	2560x1920	7fps	3500 to 5700
		15fps	6100 to 10,100
		30fps	12,100 to 16,400

* MP- Megapixel

** fps- Frames per second

CCTV recording resolution

PoE switch speed -

HARDWARE FEATURES OF TP-LINK TL-SG1008PE

Interface
8 10/100/1000Mbps RJ45 Ports
EIA/TIA-568 100Ω STP (maximum 100m)
100BASE-TX: UTP category 5, 5e cable (maximum 100m)
EIA/TIA-568 100Ω STP (maximum 100m)
1000BASE-T: UTP category 5, 5e, 6 or above cable (maximum 100m)
EIA/TIA-568 100Ω STP (maximum 100m)

CCTV recording resolution

CAT 6 Vs CAT 5

Cat6A is the newest iteration and utilizes an exceptionally thick plastic casing that helps further reduce crosstalk. The biggest distinguishing **difference between Cat6** and Cat6A **cables** is that Cat6A can maintain 10 Gigabit speeds for the full 328 feet (100 m) of Ethernet **cable**.

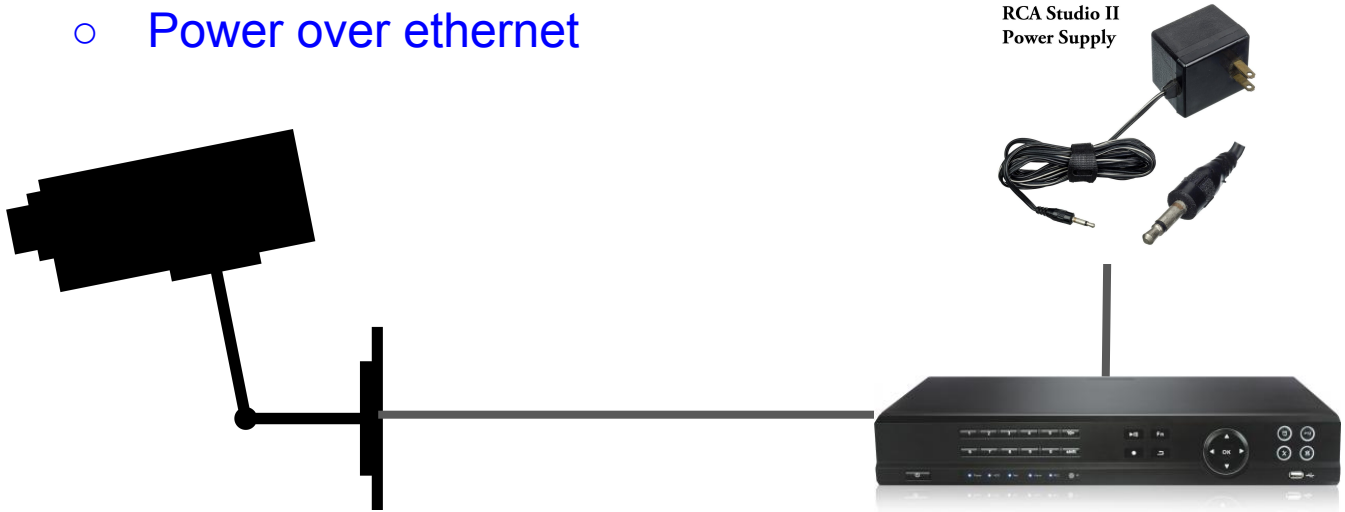
CCTV Installation - cable run

The most common types of cables used in CCTV installation are:

- Coaxial cable or known as RG59 - 100 metres for colour & 200 m for B & W
  - (* HD cameras can travel up to 500 metres using RG59)
- CAT 5 and CAT 6 - Each 1000BASE-T network segment can be a maximum length of 100 meters (328 feet), and must use Category 5 cable or better (including Cat 5e and Cat 6).
- Fibre optics - 4 km

CCTV Installation - cable run

- What is PoE?
  - Power over ethernet



Questions?

1. What is the maximum distance for power and data when using PoE?

100m (333ft) is the maximum distance between the Ethernet source and the Ethernet client. Please note this is *not* identical with the maximum length of an Ethernet cable.