

Types of Network Cabling

Types of Network Cabling

- Coaxial
- Twisted Pair
- Fiber Optic



Ethernet Standards

Ethernet Explained

- Ethernet is a network protocol that controls how data is transmitted over a LAN.
- It's referred to as the Institute of Electrical and Electronics Engineers (IEEE) 802.3 Standard.
- It supports networks built with coaxial, twisted-pair, and fiber-optic cabling.
- The original Ethernet standard supported 10Mbps speeds, but the latest supports much faster gigabit speeds.
- Ethernet uses CSMA/CD & CSMA/CA access methodology.



Ethernet N<Signaling>-X Naming

- Ethernet uses an “xx Base T” naming convention: **10Base-T**
 - **N**: Signaling Rate, i.e., Speed of the cable.
 - **<Signaling>**: Signaling Type: Baseband (Base) communication.
 - **X**: Type of cable (twisted pair or fiber).

Twisted Pair Standards

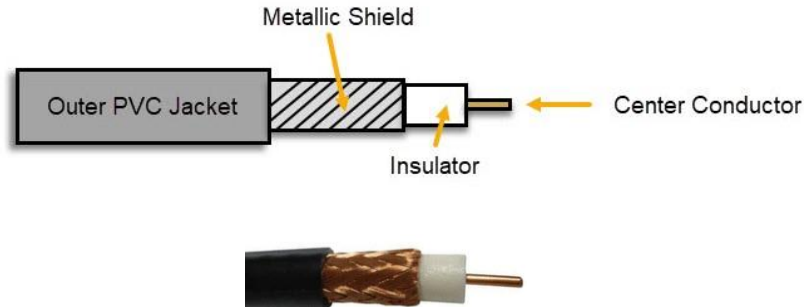
Cat	Network Type	Ethernet Standard	Speed	Max. Distance
Cat 3	Ethernet	10Base-T	10Mbps	100 meters
Cat 5	Fast Ethernet	100Base-TX	100Mbps	100 meters
Cat 5e	Gigabit Ethernet	1000Base-T	1Gbps	100 meters
Cat 6	Gigabit Ethernet	1000Base-T	1Gbps	100 meters
	10 Gigabit Ethernet	10GBase-T	10Gbps	55 meters
Cat 6a	10 Gigabit Ethernet	10GBase-T	10Gbps	100 meters
Cat 7	10 Gigabit Ethernet	10GBase-T	10Gbps	100 meters

Cat: Copper Cabling Standard.

Coaxial Cabling

Coaxial Cable

- Antiquated technology used in the 1980s. Coaxial cables are rarely used today, except for cable modem connections.
- Categorized as Radio Grade (RG)
 - **RG-6:** Used for modern cable TV and broadband cable modems.
 - **RG-8:** Used in early 10Base5 “Thick-net” Ethernet networks.
 - **RG-58:** Used in early 10Base2 “Thin-net” Ethernet networks.
 - **RG-59:** Used for closed-circuit TV (CCTV) networks
- Metallic shield helps protect against electromagnetic interference (EMI)



Coaxial Cable Connectors

F-Connector

- Screw-on connection
- RG-6 Cable TV and Broadband Cable Applications.



BNC Connector

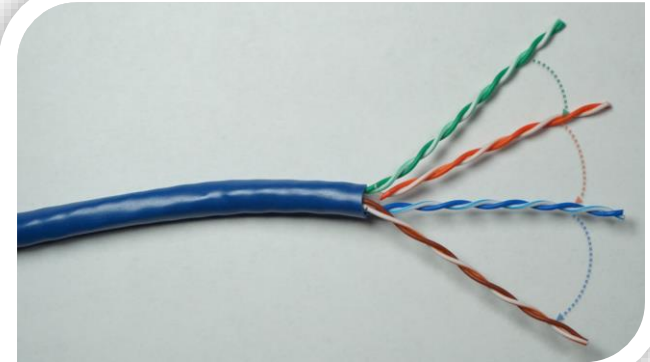
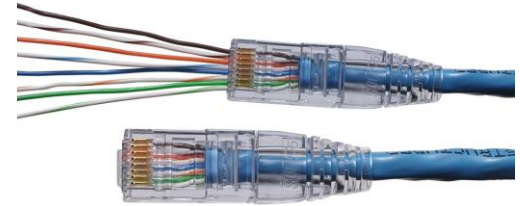
- Tension spring twist-on connection
- RG-8 “Thick-net” and RG-58 “Thin-net” network applications.



Twisted Pair Copper Network Cabling

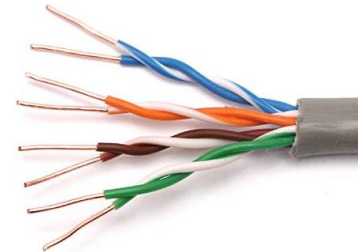
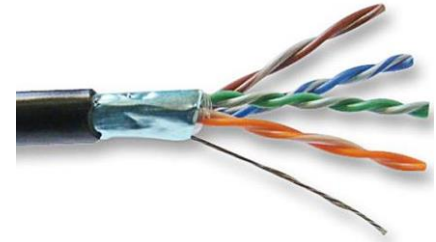
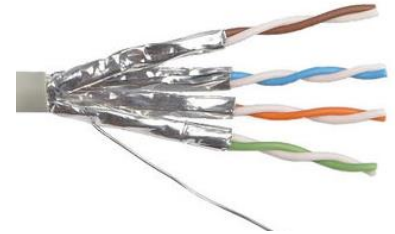
Twisted Pair Copper Cabling

- 4 Twisted Pairs of Wires with RJ-45 Connector
- Balanced pair operation
 - + & - Signals
 - Equal & Opposite Signal
- Why are they twisted?
 - To Help Reduce Interference
 - Crosstalk
 - Noise (Electromagnetic Interference)
- Security concerns
 - Signal Emanations
- 100 Meters Maximum Distance
 - Signal Attenuation



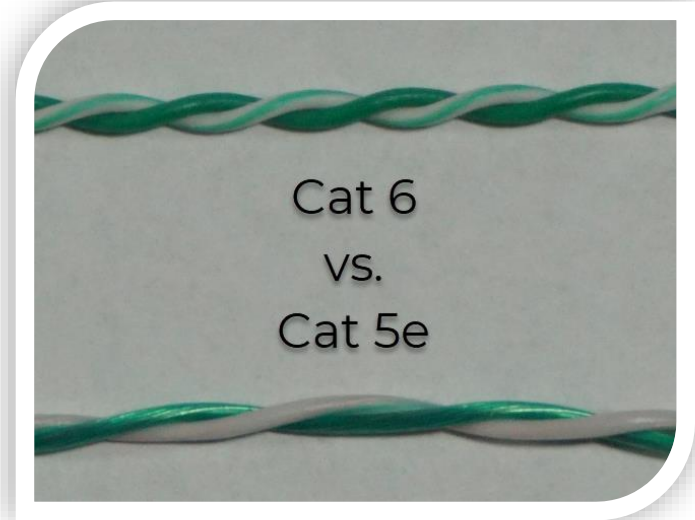
Shielded vs. Unshielded & EMI

- **Unshielded Twisted Pair (UTP)**
 - More susceptible to electromagnetic interference (EMI).
- **Shielded Twisted Pair (STP)**
 - Less susceptible to EMI & Crosstalk (if each pair shielded).
- **Electromagnetic Interference**
 - The disruption of an electronic device's operation when it's in the vicinity of an electromagnetic field caused by another electronic device (manufacturing equipment, microwave ovens, etc.).



Roles of Twists

- Increased twists per inch:
 - Reduces Crosstalk
 - Increases Signals
 - Supports Faster Speeds



Twisted Pair Standards

Cat	Network Type	Ethernet Standard	Speed	Max. Distance	Frequency
Cat 3	Ethernet	10Base-T	10Mbps	100 meters	16 MHz
Cat 5	Fast Ethernet	100Base-TX	100Mbps	100 meters	100 MHz
Cat 5e	Gigabit Ethernet	1000Base-T	1Gbps	100 meters	100 MHz
Cat 6	Gigabit Ethernet	1000Base-T	1Gbps	100 meters	250 MHz
	10 Gigabit Ethernet	10GBase-T	10Gbps	55 meters	
Cat 6a	10 Gigabit Ethernet	10GBase-T	10Gbps	100 meters	500 MHz
Cat 7	10 Gigabit Ethernet	10GBase-T	10Gbps	100 meters	600 MHz

Cat: Copper Cabling Standard.

Other Copper Cable Connectors

RJ-11

- 4-pin connection used for telephone connections.



DB-9

- 9-pin connection used for serial connections on networking devices



DB-25

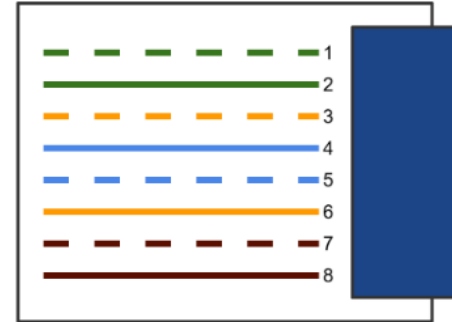
- 25-pin connection previously commonly used for serial printer connections.



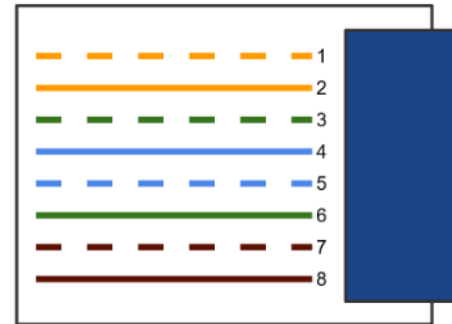
Wiring Standards: 568A & 568B and Cable Types

TIA/EIA 568A & 568B Wiring Standards

- Industry-standard that specifies the pin arrangement for RJ-45 connectors.
- Two Standards:
 - 568A & 568B
- 568B is newer and the recommended standard.
- Either can be used.
- Why are standards important?
 - Lower Costs
 - Increase Interoperability
 - Easier Maintenance



TIA/EIA 568A

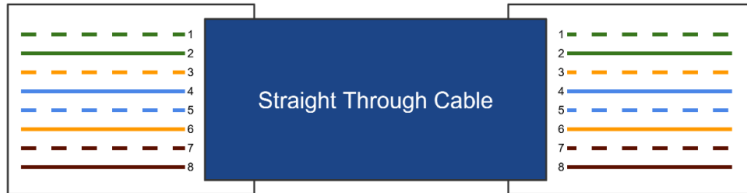


TIA/EIA 568B

Straight-Through & Crossover Cables

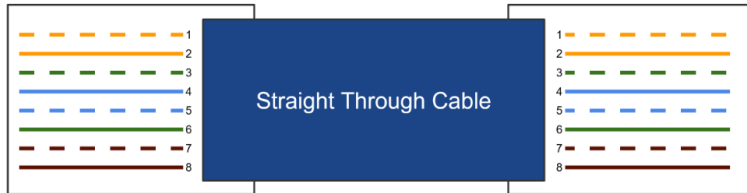
Straight-Through Cable

- Connecting “Unlike” Devices
 - Computer to Switch
 - Switch to Router



TIA/EIA 568A

TIA/EIA 568A



TIA/EIA 568B

TIA/EIA 568B

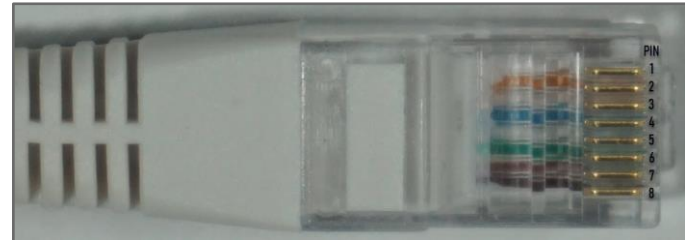
Crossover Cable

- Connecting “Like” Devices
 - Router to Router
 - Computer to Computer



TIA/EIA 568A

TIA/EIA 568B



Which Twisted Pairs Are Used?

Ethernet & Fast Ethernet

Cat 3 and Cat 5

Only Green and Orange Pairs Used:

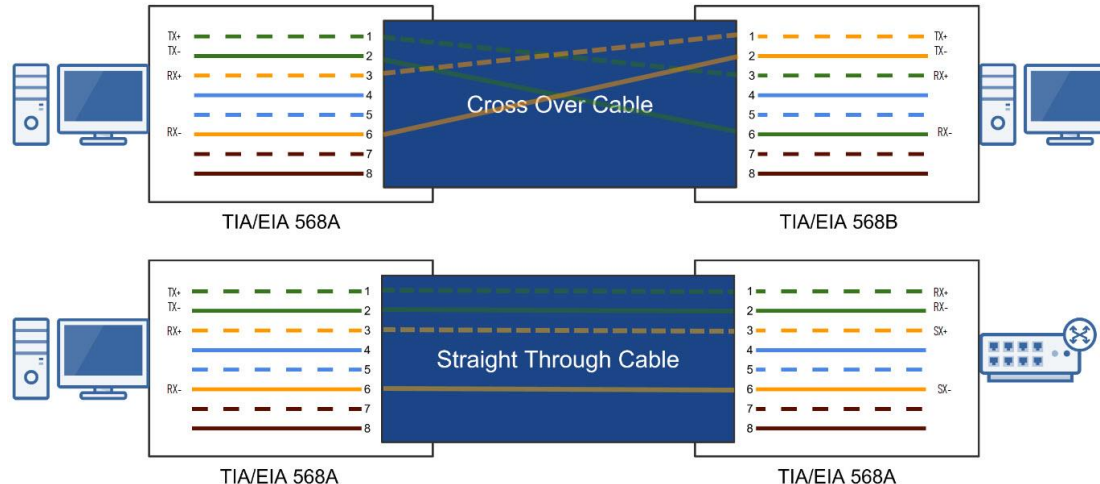
- Pins 1, 2, 3, and 6
 - One Pair to Transmit Data (TX)
 - One Pair to Receive Data (RX)

Gigabit & 10 Gigabit Ethernet

Cat 5e & Faster

All Four Pairs Used:

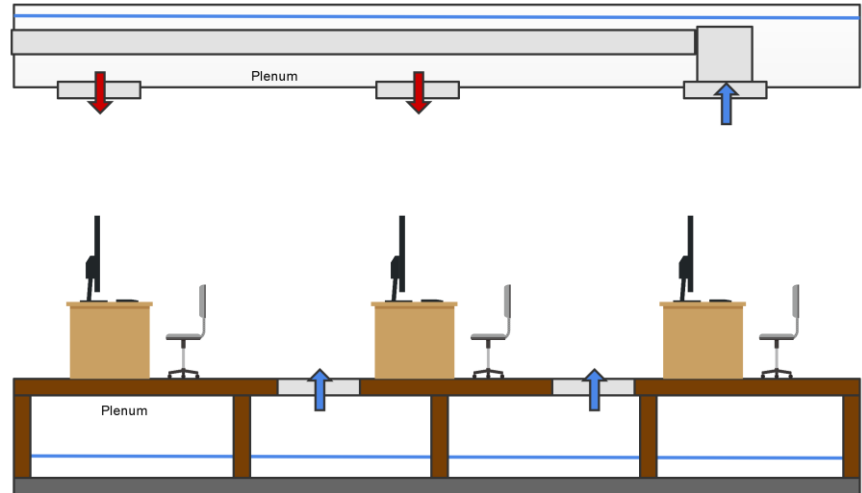
- Supports bi-directional data transmission on each pair of wires.



Plenum-Rated Cabling

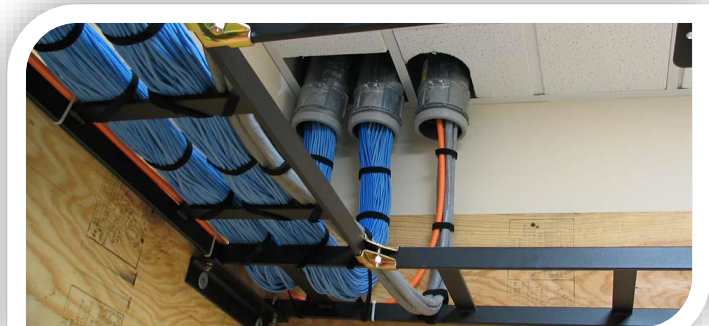
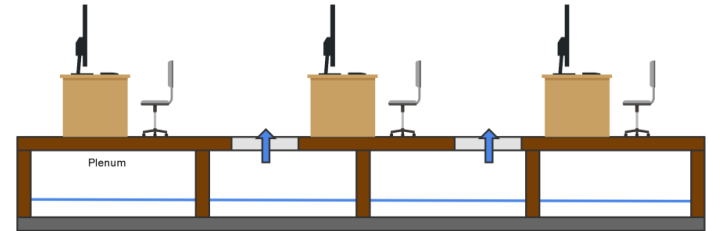
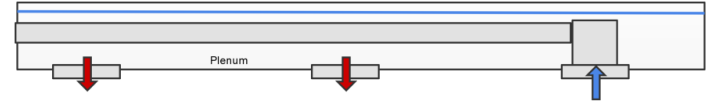
The Plenum

- The plenum is the open space above the ceiling or below a raised floor.
- A “plenum space” is the part of a building that enables air circulation by providing pathways for heated/air-conditioned and return airflows at a higher pressure than normal.
- All network cabling placed in the plenum should be “plenum-rated.”



Non-Plenum-Rated & Fire Hazard

- Non-plenum cable or polyvinyl chloride (PVC) cable is often much less expensive than plenum-rated cable.
- When PVC burns or smolders, it releases toxic fumes into the air (Hydrochloric Acid and Dioxin).
- The plenum air return would unknowingly circulate toxic air throughout an office.
- Sprinkler systems typically can't access the plenum area.
- Building codes often require Plenum Rated cable installed through any plenum space.



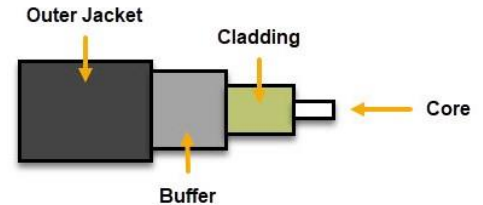
Plenum-Rated Cables

- Plenum-rated cables have a special insulation that has low smoke, low flame and non-toxic characteristics.
- Coated with nonflammable materials that minimize toxic fumes:
 - Teflon
 - Fluorinated ethylene polymer (FEP)
 - Low-Smoke PVC

Fiber Optic Network Cabling

Fiber Optic Cabling

- Glass or plastic fiber that carries light (photons)
 - **High Bandwidth:** Photons travel faster than electrons.
 - **Long Distances:** Less attenuation.
 - Immune to Electromagnetic Interference (EMI)
 - Doesn't Emit Signals
- Two Types
 - **Multi-mode Fiber (MMF)**
 - Shorter Distances (LAN / Building-to-Building)
 - Up to 2 Kilometers
 - **Single-mode Fiber (SMF)**
 - More expensive than multi-mode
 - Longer Distances (WAN / Across Town)
 - Up to 200 Kilometers

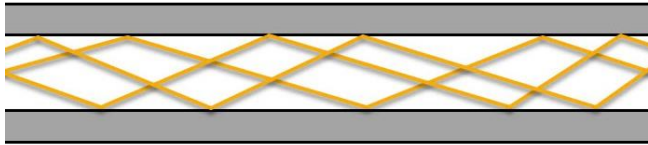


Informational Note: 9-micron Single-Mode Fiber can travel 75 miles at 400 Gbps

MMF versus SMF

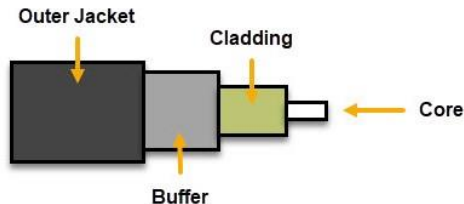
Multi-Mode Fiber (MMF)

- Many photons of light travel through the cable at once, and bounce off the walls, which reduces the distance and speed.
- Larger Core:** 50 to 62.5 microns



Single-Mode Fiber (SMF)

- A single direct photon of light travels through the cable, which allows greater distances and speed.
- Smaller Core:** 8 to 10 microns



Fiber Optic Cable Connectors

Lucent Connector (LC)

- Small form-factor design that has a flange on the top, similar to an RJ-45 connector.
- Commonly used in MMF & SMF gigabit and 10-gigabit Ethernet networks.



Subscriber Connector (SC)

- Square connector that uses a push-pull connector similar to A/V equipment.
- Commonly used in MMF & SMF gigabit Ethernet networks.



Straight Tip (ST)

- BNC style connector with a half-twist bayonet locking mechanism.
- Was used in MMF networks but not commonly used anymore.



Mech. Transfer Register Jack (MTRJ)

- Similar to the RJ-45 connector, and houses two fiber optics cables.
- Designed for MMF networks.



Why use Fiber?

- Fiber cable is more expensive than twisted pair, as is the equipment
- But you can perform much longer network cable runs with fiber.
 - 100m versus up to 200 Kilometers
- So you have decreased network equipment costs
 - Switches, routers, etc.
- Plus fiber is:
 - Immune to EMI and signal emanations
 - Has lower signal attenuation
 - Making it more reliable and secure
- Costs are steadily decreasing as more people adopt fiber

Networking Cable Selection Criteria

Cable Selection Criteria

Cost Constraints

- What is your budget?

Transmission Speed Requirements

- How fast does your network need to be?
- 10Mbps, 100Mbps, 1Gbps, 10Gbps?

Distance Requirements

- Electrical signals degrade relatively quickly (100 meters)
- Fiber can transmit over long distances

Noise & Interference Immunity (Crosstalk, EMI, Security)

- Interference is all around us: power cables, microwaves, mobile phones, motors, etc.