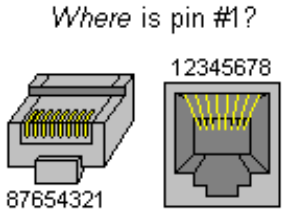
Category 5/ 6, UTP (Unshielded Twisted Pair); RJ-45 8P8C (8 position, 8 contact) connector
Twisting of the 2 wires in each of the 4 pairs minimizes interference (one is insulated by the other). Each pair also even have a different "twist rate" to minimize interference between them. Each pair is transmit +/-, receive +/- Shielded twisted pair surrounds each pair in metal shielding and uses a grounding wire.



The only difference between T568A and T568B wiring standards is that pairs 2 and 3 (orange and green) are swapped. Both configurations wire the pins "straight through", i.e., pins 1 through 8 on one end are connected to pins 1 through 8 on the other end.

As you can see below, a crossover cable for both T568A and T568B is ALMOST T568A wiring on one end and T568B on the other- making it easy to remember- HOWEVER- notice that pins 7 and 8 also switch to pins 4 and 5 (below, blue and brown switch places, as well as green and orange).
So crossover is 1 and 2 to 3 and 6, and 4 and 5 to 7 and 8

Straight-Through Ethernet Cable Pin Out for T568B

RJ45 Pin #	Wire Color	10/100Base-TX Signal	1000Base-T Signal
1	White/Orange	Transmit+	BI_DA+
2	Orange	Transmit-	BI_DA-
3	White/Green	Receive+	BI_DB+
4	Blue	Unused	BI_DC+
5	White/Blue	Unused	BI_DC-
6	Green	Receive-	BI_DB-
7	White/Brown	Unused	BI_DD+
8	Brown	Unused	BI_DD-

Straight-Through and PoE Ethernet Cable Pin Out for T568A

RJ45 Pin #	Wire Color	10/100Base-TX Signal	PoE
1	White/Green	Transmit+	Mode A +
2	Green	Transmit-	Mode A +
3	White/Orange	Receive+	Mode A -
4	Blue	Unused	Mode B +
5	White/Blue	Unused	Mode B +
6	Orange	Receive-	Mode A -
7	White/Brown	Unused	Mode B -
8	Brown	Unused	Mode B -

Crossover Cable Pin Outs for T568B

Pin # (END 1)	Wire Color	Pin # (END 2)	Wire Color
1	White/Orange	1	White/Green
2	Orange	2	Green
3	White/Green	3	White/Orange
4	Blue	4	White/Brown
5	White/Blue	5	Brown
6	Green	6	Orange
7	White/Brown	7	Blue
8	Brown	8	White/Blue

One other type of wiring is a rollover/ console cable for switch and routers using the EIA-TIA 232 serial COM port. It is just straight-through in reverse order- picture cutting the end off a straight-through cable, turn it over, and put on a new connector. Often USB to serial converter and rollover cables are used.

Crossover cables are necessary when endpoints transmit on the same pin pair, they need to be crossed for compatibility. Use crossover for "like devices" not unlike:
Transmits on Pins 1,2: workstation NICs, routers, cabled non-USB WAPs
Transmits on Pins 3,6: switches and hubs
Some devices have auto-MDIX to autosense cable type and make the link work. Often not present.

Category 5 cabling is meant for 100Base-TX, but was first used as 10Base-T (wired 2-pair instead of 4) for legacy equipment. Cat 5e is an updated version of Cat5, offers reduced crosstalk, intended for 1000BASE-T Cat6 cable is *preferred* for 1000BASE-T Ethernet networks. Some Cat6 is made of thicker wires (for example, 22 or 23 gauge instead of 24); more pair twisting gives thicker insulation for reduced crosstalk.

Copper Ethernet Cabling Types

10BASE2 (thinnet)	RG-58 coax	10 Mbps	185 meters
10BASE5 (thicknet)	RG-8 coax	10 Mbps	500 meters
10Base-T	Cat3 (POTS) or Cat5	10 Mbps	100 meters
100Base-T (fast ethernet)	Cat5	100 Mbit/s	100MHz
1000Base-T (gigabit ethernet)	Cat5e	1Gbit/s	100MHz
10GBase-T	Cat6	1Gbit/s	250MHz
10GBase-T	Cat6a	10Gbit/s	500MHz, shielded
10GBase-T	Cat7 (not TIA/EIA ratified)	10Gbit/s	600MHz, shielded

Cat 5/6/6a have different speed performance at different lengths and shorter is faster.
Cat5 can do 1000Base-T, but not guaranteed. Cat 5e/6 achieve maximum efficiency at 55 meters.
*When sizing copper ethernet cables remember that cable should not extend more than **100m (~328ft)**.*

Power over Ethernet (PoE)
Endspan means PoE is built into switch. Midspan means a Inline Power Injector is used to add power
Mode A (phantom): Power and data use same twisted pairs; Mode B: separate pairs for each power and data.
IEEE 802.3af (802.3at type1) specifies a max 15.4W, 802.3at (type 2) specifies a max of 30W (typically 25W)

Other Cabling Types and Specifications

All RG (Radio Guide) specs use a familiar CATV F-connector on coaxial cable. BASE means "baseband"
RG-6 coax is commonly used by local cable companies to connect individual homes to the distribution point. For higher frequency signals over longer distances (~70 meters). RG-6 replaced RG-9 with better shielding.
RG-59 low-freq, shorter distance, like component video; older shielding, susceptible to UHF interference, impedance of 75 Ohms. RG-6 was preferred for video.
RG-58 - early 10BASE2 max length 185 meters; impedance 50 Ohms. Better frequency range, shielding
RG-8- 10BASE5, 500 meters. RG-58 and -8 predicted to replace RG-6 and RG-59
[You may see RG-500 for heavy outdoor use (burial) - has a FAT core, 75 Ohms, super-long range]

Fiber Optics: *LX FX and S's can all do MMF - FX has full and half duplex (below)*

100Base-SX	100Mbps	200-550m	MMF (short wavelength laser)
100Base-FX	100Mbps	2km full duplex, 400m half-duplex	MMF
1000Base-LX	1000Mbps	10km SMF or 550m MMF	(both SMF and MMF)
1000Base-LH	1000Mbps	10km	SMF
1000Base-ZX	1000Mbps	70km	SMF
10GBase-SR and -SW	10 Gbps	300m (short reach)	MMF
10GBase-LW	10 Gbps	10km	SMF
10GBase-LR	10 Gbps	25km (long reach)	SMF
10GBase-ER and -EW	10 Gbps	40km (extended reach)	SMF
100GBASE-ER4	100 Gbps	40km	SMF
100GBASE-SR10	100 Gbps	100-125km	MMF

Advantages of fiber: difficult to monitor (tap), no RF interference, support long distances
Multimode (MMF) refers that different light frequencies bouncing along a fiber bundle; often uses LEDs (less expensive), so signal degrades at a shorter distance. The core is typically 62.5 microns or larger in diameter
Singlemode (SMF) uses a single fiber with single frequency of light; more expensive- lasers to make the distance and increase signal strength. Typically uses a small light carrying core of 8 to 10 microns in diameter.

Fiber Connectors:

ST (Straight Tip) SC (Subscriber Connector) LC (Local Connector) MT-RJ

The SC connector as called a subscriber, standard, or square connector.
The MTRJ goes by two names, the "Media Termination Recommended Jack" and "Mechanical Transfer Registered Jack". It has two fiber strands (that is, a transmit strand and a receive strand) included in a single connector. Despite the second nickname, it doesn't lock into place or anything.
The LC (Lucent/Local/Little Connector) connects to a terminating device by pushing the connector into the terminating device with a "click" and can be removed by depressing the tab on the connector to pull it out.
A Straight Tip (ST) connector is sometimes referred to as a bayonet connector; most commonly used with multimode; connects by pushing the connector in and then twisting the connector housing to lock it in place.

- Multimode Delay Distortion - on multi-mode fiber-optic cables when an initial transmission can arrive at the receiver after a second transmission
- Mode of Propagation: the path that light takes through a fiber-optic cable.
- A multiplexer combines a number of signals into a single signal for transmission over the medium.

Bulk Data Carrier Types

Bytes to bits in bandwidth conversions

"A megabit per second (abbreviated as Mbps, Mbit/s, or mbps) is a unit of data transfer rates equal to 1,000,000 bits per second (this equals 1,000 kilobits per second). Because there are 8 bits in a byte, a transfer speed of 8 megabits per second (8 Mbps) is equivalent to 1,000,000 bytes per second (approximately 976 KiB/s)"
1 Kbps = 1000/8=125 bytes; 1 Mbps = 1,000,000/8=125,000 bytes
Bytes are made up of eight bits, so one kilobyte equals eight kilobits
1KB per sec = 8 Kbps; 1MB per sec = 8 Mbps

T-carrier (T1- US/ Canada), and E-carrier (E1- Europe)
Transmission System Level 1 - For trunking, time-division multiplexing. The T-carrier system (T1 and T3) refers to copper transport corresponding to DS1 and DS3. DS0 supported twenty 2.4 kbit/s channels, ten 4.8 kbit/s channels, five 9.67 kbit/s channels, one 56 kbit/s channel, or one 64 kbit/s clear channel, which is where DSL and ISDN came in. The base DS0 represents a single voice call digitized at 8 kHz sample rate w/ 8-bit pulse-code modulation at 8000 samples/sec which comes out to 64kbit/s

T1/E1/DS1 - 24 channels (DS0's)- 64 kbit/s per channel 1.5Mbit/s total line rate, 8 bits for framing info. E1 - 32 channels 2.048 Mbit/s line rate
T3/E3/DS3 - 28 T1 circuits - 672 T1 channels - 44.736 Mbit/s. E3 = 16 E1 circuits, 512 channels, 33.368 Mbit/s
In T1/E1 more than one frame is sent at once. Two methods to grouping these frames together:
- Super Frame (SF): Combines 12 standard 193-bit frames into one.
- Extended Super Frame (ESF): Combines 24 standard 193-bit frames into one.

Data Capacity - The beer/soda can analogy:
Base DS0- single voice call digitized at 8 kHz sample rate w/ 8-bit PCM @ 8000 samples/sec = 64kbit/s

DS0	56/64Kbps	1 POTS line	Old modem		One can
DS1/T1	1.544 Mbps	1.536 Mbps			A case of beer (24 cans)
DS3/T3	44.736 Mbps	28 DS1's	672 DS0's		A pallet of beer with 28 cases
OC1	1 DS3/T3	***[End copper***	***and begin***	***SONET/SDH]***	A shrink-wrapped pallet
OC3	155.52 Mbps	3 DS3's	84 DS1's	2016 DS0's	A truck that can hold 3 pallets
OC12	622.08 Mbps	12 DS3's	336 DS1's	8064 DS0's	A railroad train car - 12 pallets
OC48	2488.32 Mbps	4 OC12's	48 DS3's	1344 DS1's	4 train cars x 12 pallets
OC192	9953.28 Mbps	16 OC12's	192 DS3's	5376 DS1's	16 train cars - 192,024 DS0's
OC768	39813.12 Mbps	64 OC12's	768 DS3's	21,504 DS1's	Train with 64 railroad cars

Rough calculations for downloading a 1GB file (including ISDN and DSL)

Connection	Speed	(Y:D:H:M:S)	Difference
56 K	56,000 bps	1:15:40:57	96% slower
128 K	128,000 bps	17:21:40	91% slower
256 K	256,000 bps	8:40:50	83% slower
512 K	512,000 bps	4:20:25	66% slower
768 K	768,000 bps	2:53:37	50% slower
T1, DS-1	1.544 Mbps	1:26:21	Baseline
T3, DS-3	44.736 Mbps	2:59	2,798% faster
OC-3	155.520 Mbps	51	9,973% faster
OC-12	622.080 Mbps	13	40,191% faster
OC-48	2.488 Gbps	3	161,040% faster
OC-192	10 Gbps	1	647,569% faster

SONET - Synchronous Transport Signals (STS)

Synchronous Optical networking (SONET) - ANSI - Synchronous Transport Signals (STS)
Synchronous Digital Hierarchy (SDH) - International equivalent - Synchronous Transport Modules (STM)

SONET	SDH	Bandwidth	Overhead
STS-1/ OC-1	STM-0	51.48Mbps	1.728Mbps
STS-3/ OC-3	STM-1	155.52Mbps	6.912Mbps
STS-12/ OC-12	STM-4	622.08Mbps	20.736Mbps
2.5G SONET/ STS-48/ OC-48	STM-16	2.488Gbps	82.944Mbps
5G SONET/ STS-96/ OC-96	STM-32	4.876Gbps	
10G SONET/ STS-192/ OC-192	STM-64	9.953Gbps	442.368 Mbps
STS-256/ OC-256	STM-128	13.271Gbps	
STS-768/ OC-768	STM-256	39.813Gbps	1.327104Gbps

ISDN - Integrated Services Digital Network - Delivered over T1/E1

ISDN has two levels of service:

BRI - Basic Rate Interface (2B+D):

2 64kbit/s bearer/ user (B) channels (throughput)
1 16kbit/s signaling/delta (D) channel (connection maintenance)

PRI - Primary Rate Interface - hooked up directly to the telco central office

- 23B + 1D on a T1 (1.544 Mbps)
- 30B + 1D + sync/alarm channel on an E1 (2.048 Mbps)
- Commonly to deliver Public Switched Telephone Network (PSTN) to digital PBX (23 lines in one)
- Fewer active B channels can be used for a fractional T1.
- Can be used flexibly and reassigned when necessary (such as video conferencing)
- More channels can be used with more T1s, within certain design limits (PRI pairing)
- PRI pairing uses NFAS (non-facility associated signalling) to accommodate itself

ISDN Terminology:

An R reference point resides between a non-ISDN device to a terminal adapter.
An S/T reference point resides between a NT1 and a terminal endpoint 1 (TE1).
A TA (terminal adapter) performs conversion between a non-ISDN device and a TE1 device.
A U reference point resides between a NT1 and the wall jack connecting back to an ISDN service provider.
A NT1 (network termination 1) device interconnects a four-wire ISDN circuit and a two-wire ISDN circuit.