C A B L I N G F A Q

Version 950305

This is a Frequently Asked Questions (FAQ) document for the comp.dcom.cabling newsgroup. Topics covered include the types of cables (fiber, coax, copper, unshielded twisted pair-UTP, shielded twisted pair), installation techniques, standards as well as fire and building safety codes.

Prepared and maintained by Peter Macaulay (pmac@fox.nstn.ca)
Constructive comments/updates are welcomed.

0.1 Recent Updates

The most recent changes are on the top of this list for easier identification of the new stuff (push down stack). Format of the version is year, month, day.

950305 - added rtfm.mit.edu approval, cable testing
950124 - added bending radius specs, ISDN cabling
950110 - added headers required for rtfm.mit posting
- expanded references with much help from Evan Gamblin

0.2 Copyright

0.3 Disclaimer

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THIS DOCUMENT IS A GUIDELINE ONLY -- SEEK PROFESSIONAL ADVICE, CHECK LOCAL BUILDING CODES AND APPLICABLE STANDARDS.

0.4 Acknowledgments

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TABLE OF CONTENTS

Subject: 1.0 Cable Types

Communications Cable: primarily for telephone cable
Class 2 Cable: signaling cable primarily for data communications
Riser: vertical shaft used to route cable between floors
Plenum: Heating, Ventilation, Air Conditioning (HVAC) air return area -- mostly drop ceilings. Also below raised floors (where the underfloor area is used for ventilation).

Subject: 2.0 Cable Ratings

(Or What Are Those Codes Printed On My Cables?)
In the Hollywood movie _Towering Infernio_ (starring O.J.Simpson) a fire spread from floor to floor using the building cables. This will not happen again (we hope) since everyone is using fire rated cables! These are important specifications if you are responsible for defining a cable installation.

If interfloor penetrations are properly _firestopped_, the cables can burn, but the fire will not pass the firestopping.

UL-910, FT-4 and FT-6 say nothing about the type or volume of toxic combustion products produced. All they cover is performance on a flamespread test.

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The US National Fire Protection Association (NFPA) revises the National Electrical Code (NEC) every 3 years. The NEC defines classifications of cable as per UL tests.

The Canadian Standards Association (CSA) defines Premise Communication Cord (PCC) standards for physical wire tests. These are printed on the cable as CSA-PCC-FT6.

FT4 = Flame Test 4 is described in CSA C22.2 0.3-1992
FT6 = Flame Test 6 is described in NFPA 262-1985 and ULC S102.4 Physical Wire Tests C22.2 214-M-1990. These CSA documents can be ordered from the CSA. See sources below.

<<>>

Subject: 3.0 National Electrical Code (NEC)

1993 National Electrical Code

Article 725, Class 2

725-38(b)1	CL2X	Class 2 cable, limited use
725-38(b)1	CL2	Class 2 cable
725-38(b)2	CL2R	Class 2 riser cable
725-38(b)3	CL2P	Class 2 plenum cable

Article 800

800-3(b)1	CMX	Communications cable limited use
800-3(b)1	CM	Communications cable
800-3(b)2	CMR	Communications riser cable
800-3(b)3	CMP	Communications plenum cable

OFNP (Optical Fiber Nonconductive Plenum)
OFNR (Optical Fiber Nonconductive Riser)

Subject: 4.0 Not Used (Blank)

Subject: 5.0 Specific Cable Classifications

CMS, CL2X (Restricted Cable) must be enclosed in conduit, up to 10 feet exposed; must pass UL 1581 VW-1 test

CM, CL2 (General Purpose Cable) for use in areas other than risers or plenums; must pass UL 1581 vertical tray test

CMR, CL2R (Riser Cable) for cable in vertical shafts; must pass UL test method 1666

CMP, CL2P (Plenum Cable) for use in plenum areas (air ducts); must pass UL 910 test for smoke and flame spread

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Subject: 6.0 Cable Conductors

Cable conductor gauge is specified as AWG (American Wire Gauge). A higher number is a smaller diameter. Telephone cable used indoors is typically 24 or 26 AWG, whereas household electrical wiring is typically 12 or 14 AWG.

Subject: 7.0 Vendor Specific Suggestions

AMP NETCONNECT Open Cabling System
HP SiteWire
AT&T PDS
DEC MMJ
IBM STP (Type 1, Type 2, etc)
Northern Telcom IBDN

Subject: 8.0 Cabling Standards

American National Standards Institute (ANSI)
Electronic Industry Association (EIA)
Telecommunications Industry Association (TIA)

Current specification is the ANSI/EIA/TIA-568-1991 Standard _Commercial Building Telecommunications Wiring Standard_ and two Tech Sys Bulletins:

Additional Cable Specifications for Unshielded Twisted-Pair Cables
EIA/TIA Tech Sys Bulletin TSB-36, Nov 1991
[Transmission Characteristics of Category 3-5 UTP cables]

Additional Transmission Specifications for UTP Connecting Hardware
EIA/TIA Tech Sys Bulletin TSB-40A, Dec 1993
(Performance of Connectors and Patch Panels Above 20 MHz)

Extended Specifications for 150-ohm STP Cables and Data Connectors - EIA/TIA Tech Sys Bulletin TSB-53, 1992 [Type 1A cable]

EIA-570: Residential and Light Commercial Telecommunications Wiring Standard - EIA/TIA, 1991

EIA-606: Telecommunications Administration Standard for Commercial Buildings - EIA/TIA (was PN-2290)

EIA-607: - Commercial Building Grounding and Bonding Requirements for Telecommunications - EIA/TIA

EIA/TIA PN-2840 - [draft for the EIA-568-A standard, incorporating TSB-36 and -40A, expected in early 1995]

EIA/TIA PN-2840A - [draft for next version of the EIA-568-A standard]

American National Standards Institute (ANSI)/
National Fire Protection Assoc. (NFPA):
70 National Electrical Code (1993)
78 Lightning Protection Code

Canadian Standards Association (CSA):
C22.1-1994 Canadian Electrical Code, Part 1

CAN/CSA-T527: Bonding and Grounding for Telecommunications in Commercial Buildings - Canadian Standards Assoc. [harmonized with EIA-607]

CAN/CSA-T528: Telecommunications Administration Standards for Commercial Buildings - CSA, Jan 1993 [harmonized with EIA-606]

CAN/CSA-T529-M91: Design Guidelines for Telecommunications Wiring System in Commercial Buildings, - CSA [harmonized with EIA-568]

CAN/CSA-T530-M90: Building Facilities, Design Guidelines for Telecommunications - CSA, 1990 [harmonized with EIA-569]

ISO/IEC 11801: [international equivalent of EIA-568 and CSA T-529, includes 120 ohm Screened Twisted Pair cable]

IEC 603-7, Part 7 - [Modular connector physical dimensions, mechanical and electrical characteristics. Level A: 750 mating cycles min; B: 2,500 min; C: 10,000 min.]

ISO 8877: Information Processing Systems - Interface Connector and Contact Assignment for ISDN Basic access interface located at reference points S and T - International Organization for Standardization [same pin/pair assignments for 8-line modular connector as EIA T-568A]

National Electrical Safety Code Handbook (NESC):
Institute of Electrical and Electronic Engineers (IEEE)/
American National Standards Institute (ANSI):
C2-1993 National Electrical Safety Code
ISBN 1-55937-210-9 (order # SH15172)
[In USA, governs the area between the property line and the building entrance]

National Research Council of Canada, Institute for Research in Construction (NRC-IRC):
National Building Code of Canada (1990) - order NRCC 30619
Supplement to the National Building Code of Canada (1990) - order NRCC 30629
National Fire Code of Canada (1990) - order NRCC 30621

A Guide to Premises Distribution
- NCR/AT&T order #555-400-021, Apr 1988

Building Network Design - Bell Canada, 1992

The Corporate Cabling Guide - M. McElroy,
Artech House, ISBN 0-89006-663-9, Dec 1992

Telecommunications Distribution Methods Manual (1050 pages)
- Building Industries Consulting Service International (BICSI), 1994

Universal Transport System Design Guide, Release II
- Siecor Corp, 1991 [fiber-optic cable plant]

Requirements Beyond Jacks and Cable: an Installation Guide
- Leviton Telecom, Second edition, T15-00004-003, Jan 1994

SiteWire Twisted-pair Installation Guide
- Hewlett-Packard, p/n 5959-2208, Jan 1988

SiteWire Planning Guide - Hewlett-Packard, p/n 5959-2201,
Sept 1989

Tech Ref Guide for Workgroup LANs
- Hewlett-Packard, p/n 5091-0663E, Apr 1991

Tech Ref Guide for Site LANs and MultiSite LANs
- Hewlett-Packard, p/n 5091-0666E, Apr 1991

Understanding Fiber Optics - J. Hecht
Howard Sams & Co., ISBN 0-672-27066-8, 1988

Optical Fiber Communications, I & II - S. Miller
Academic Press, ISBN 0-12-497350-7 & -5

Optical Fiber Splices and Connectors: Theory & Methods -
C. M. Miller, Marcel Dekker, 1986

Principles of Optical Fiber Measurements - D. Marcuse
Academic Press, ISBN 0-12-470-980-X, 1981

Single-Mode Fibers: Fundamentals - E. G. Neumann
Springer-Verlag, ISBN 0-387-18745-6, 1988

CATV Cable Construction Manual, 3rd edition - Comm/Scope Inc., 1980
[Outside Plant tools and procedures: trenching, boring, installing
aerial and buried cable]

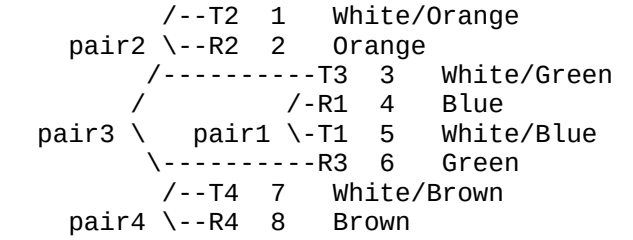
Marking Guide: Wire and Cable - Underwriters Labs, 1993
[How to interpret UL cable jacket markings]

Subject: 9.0 Standard EIA/TIA 568

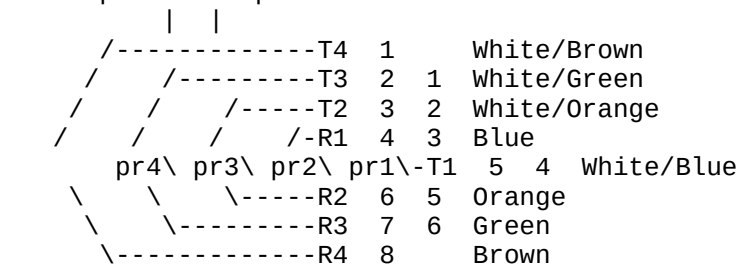
The ANSI/EIA/TIA-568-1991 Standard _Commercial Building
Telecommunications Wiring Standard_ defines pinouts;

9.1 Standard EIA/TIA T568A
(also called ISDN, previously called EIA)

9.2 Standard EIA/TIA T568B
(also called AT&T specification, previously called 258A)

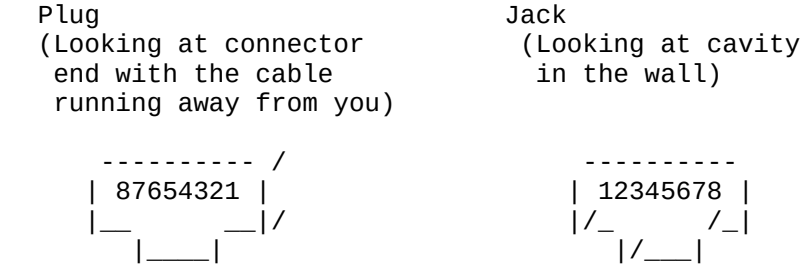


9.3 USOC (Universal Service Order Code)



Subject: 10.0 Birds and Bees (Plugs vs. Jacks)

The EIA/TIA specifies an RJ-45 (ISO 8877) connector for Unshielded Twisted Pair (UTP) cable. The plug is the male component crimped on the end of the cable while the jack is the female component in a wall plate or patch panel, etc. Here is the pin numbering to answer the question, where is pin one?



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Subject: 11.0 Standard Networking Configurations

     With reference to T568B above;
      ATM 155Mbps uses pairs 2 and 4 (pins 1-2, 7-8)
      Ethernet 10Base-T uses pairs 2 and 3 (pins 1-2, 3-6)
      Ethernet 100Base-T4 uses pairs 2 and 3 (4T+) (pins 1-2, 3-6)
      Ethernet 100Base-T8 uses pairs 1,2,3 and 4 (pins 4-5, 1-2, 3-6, 7-
8)
      Token-Ring uses pairs 1 and 3 (pins 4-5, 3-6)
      TP-PMD uses pairs 2 and 4 (pins 1-2, 7-8)
      100VG-AnyLAN uses pairs 1,2,3 and 4 (pins 4-5, 1-2, 3-6, 7-8)

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Subject: 12.0 Ethernet 10Base-T Cabling

     12.1 Ethernet 10Base-T Straight Thru patch cord (T568B colors);

         RJ45 Plug        RJ45 Plug
         =========        =========
         /--T2  1  ... White/Orange .... 1  TxData +
   pair2 \--R2  2  ... Orange ........... 2  TxData -
        /----------T3  3  ... White/Green ..... 3  RecvData +
       /           R1  4      Blue              4
       \  pair3    T1  5      White/Blue        5
        \----------R3  6  ... Green ........... 6  RecvData -
     T4  7      White/Brown       7
     R4  8      Brown             8

     12.2 Ethernet 10Base-T Crossover patch cord;
    This cable can be used to cascade hubs, or for connecting
    two Ethernet stations back-to-back without a hub (ideal for
    two station Doom!)  Note pin numbering in item 10.0 above.

     RJ45 Plug  1 Tx+ -------------- Rx+ 3  RJ45 Plug
         2 Tx- -------------- Rx- 6
         3 Rx+ -------------- Tx+ 1
         6 Rx- -------------- Tx- 2

     12.3 Ethernet 10Base-T to USOC Crossover patch cord;

      RJ45 8-pin Plug  1 ---White/Orange--- 2  USOC 6-pin Plug
    ^           2 ------Orange------ 5       ^
         3 ---White/Green---- 1
         6 ------Green------- 6

     12.4 Crossover Implementation
   A simple way to make a crossover patch cable is to take a
   dual-jack surface mount box and make the crossover between
   the two jacks. This allows using standard patch cables, and
   avoids the nuisance of having a crossover cable find its way
   into use in place of a regular patch cable.

     12.5 Stranded Patch Cables
```

The color code used in stranded patch cables is different from solid-conductor cables. For NorTel Digital Patch Cable (DPC), the coding is;
Pair 1: Green & Red
Pair 2: Yellow & Black
Pair 3: Blue & Orange
Pair 4: Brown & Gray

Subject: 13.0 Category Specifications

EIA/TIA Category Specification provide for the following cable transmission speeds with specifications (Note prior to Jan94 UL and Anixter developed a LEVEL system which has been dropped or harmonized with the CATEGORY system);

Category 1 = No performance criteria
Category 2 = Rated to 1 MHz (used for telephone wiring)
Category 3 = Rated to 16 MHz (used for Ethernet 10Base-T)
Category 4 = Rated to 20 MHz (used for Token-Ring, 10Base-T)
Category 5 = Rated to 100 MHz (used for 100Base-T, 10Base-T)

UL LAN Cable Certification Program - Underwriters Laboratories publication 200-120 30M/3/92, 1992 [characteristics of Cat 3-5 UTP]

Subject: 14.0 Sources for the EIA/TIA 568 Standards Documents

EIA Standards Sales Office -or-
Global Engineering Documents (east or west coast offices)
(See addresses in sources below)

Subject: 15.0 Cable Test Equipment

15.1 DVM
DVM = Digital Volt Meter (measures volts)

15.2 DMM
DMM = Digital Multi Meter (measures volts, ohm, capacitance, and some measure frequency)

15.3 TDR
TDR = Time Domain Reflectometer (measures cable lengths, locates impedance mismatches).

15.4 Tone Generator
Tone Generator and Inductive Amplifier = Used to trace cable pairs, follow cables hidden in walls or ceiling. The tone generator will typically put a 2 kHz audio tone on the cable under test, the inductive amp detects and plays this through a built-in speaker.

15.5 Wirmap Tester
Wiremap tester: checks a cable for open or short circuits, reversed

pairs, crossed pairs and split pairs.

A least-cost wiremap type tester that detects split pairs correctly (using a NEXT test) is the Fluke 610, at $400. MOD-TAP and UNICOM make a similar device.

15.6 Noise Tester
Noise tests, 10Base-T: the standard sets limits for how often noise events can occur, and their size, in several frequency ranges. Various handheld cable testers are able to perform these tests.

15.7 Butt-in
Butt-in set: a telephone handset that when placed in series with a battery (such as the one in a tone generator), allows voice communication over a copper cable pair. Can be used for temporary phone service in a wiring closet.

15.7 Fiber Testing
See section 20.7 for fiber optic test equipment.

Subject: 16.0 Cable Testers for Category 5

LANcat V by Datacom Technologies
Everett, WA
Tel: 800/468-5557

DSP100 by Fluke Corporation
P.O. Box 9090
Everett, WA 98206-9090
Tel: 206/356-5400 800/44-FLUKE

PentaScanner by Microtest, Inc
4747 North 22nd St,
Phoenix, AZ 85016
Tel: 602/952-6400 800/526-9675

WireScope100 by Scope Communications, Inc
100 Otis St,
Northboro, MA 01532
Tel: 508/393-1236

LANTech PRO by Wavetek, Inc
9145 Balboa Ave
San Diego, CA 92123
Tel: 619/279-2200 800/854-2708

At present some vendors are calling their instruments _CAT 5 conformance_ testing devices. Be aware that there is an on-going standards process to define field testing of CAT 5 cables. These standards or guidelines (currently called PN-3287) will not be complete until the June 1995 timeframe.

The TIA TSB number will be TSB-67 when PN-3287 is approved.

The standard is expected to define two accuracy levels of test equipment, and provide minimum performance standards for each. Current test equipment is likely to fall in the lower level. The higher class (_Accuracy Level II_) is intended for subsequent generations of test equipment capable of performing the increasingly numerous and stringent tests now being developed.

Subject: 17.0 Typical Wiring Layout

17.1 Wiring Layout

```
    ......Wiring Closet.............                ....User Work
Area....

[HUB]<=====>[PANEL]+=====+[BLOCK]+==============+[WALL]<=====>[STATION]
```

Where ...
HUB = concentrator
PANEL = RJ-45 Modular Patch Panel

BLOCK = Telco Splice Block (Typically 25-pair)

Crossconnect: NorTel BIX1A, AT&T 110 and similar crossconnect blocks accommodate 4-pair, 25-pair or larger cables on the same mount. The same type of mount can be used for the voice field as well as data.

Telephone-only (66) blocks are seldom used except for low-speed data circuits such as are used for IBM 3270 terminals. The newer types of crossconnect mentioned above cost about the same and accommodates growth much better. (The standard AT&T 110 and its BIX equivalent are rated at Cat 5).

LOBE CABLE = Cable run from user wall plate to wiring closet
WALL = User area wall face plate
STATION = User workstation network adapter
=====> = RJ-45 connector
=====+ = Punch down termination (also called an insulation-displacement/displacing connector, or IDC).

17.2 Crossconnect Field Colors
The color of label used on a crossconnect field identifies the field's function. The cabling administration standard (CSA T-528 & EIA-606) lists the colors and functions as:

Blue Horizontal voice cables
Brown Interbuilding backbone
Gray Second-level backbone
Green Network connections & auxiliary circuits
Orange Demarcation point, telephone cable from Central Office
Purple First-level backbone
Red Key-type telephone systems
Silver or

White Horizontal data cables, computer & PBX equipment
Yellow Auxiliary, maintenance & security alarms

Subject: 18.0 How Far Away Should Cable be Installed from an EMI Source

Northern Telecom IBDN User Manual contains an Appendix D titled _UTP Separation Guidelines From EMI Sources_. The values are the same as the cabling pathways standard, EIA-569, table 4.8-5.

CONDITION	Minimum Separation Distance from Power Source at 480V or less 5kVA		
Unshielded power lines or electrical equipment in proximity to open or non-metal pathways	5 in. (12.7 cm)	12 in. (30.5 cm)	24 in. (61 cm)
Unshielded power lines or electrical equipment in proximity to grounded metal conduit pathway	2.5 in. (6.4 cm)	6 in. (15.2 cm)	12 in. (30.5 cm)
Power lines enclosed in a grounded metal conduit (or equivalent shielding) in proximity to grounded metal conduit pathway	-	6 in. (15.2 cm)	12 in. (30.5 cm)
Transformers & electric motors	<------- 40-in (1.02 m) ----->		
Fluorescent lighting	<------- 12-in (30.5 cm) ---->		

Source: Integrated Building Distribution Network (IBDN) User Manual - Northern Telecom, doc # IBDN-UM-9105, 1991.

The EIA/TIA working group revising the EIA-569 standard is using the results of field and lab tests to update the recommendations. The target date for completion is Dec 1995.

Subject: 19.0 What is the Minimum Bending Radius for a Cable?

According to EIA SP-2840A (a draft version of EIA-568-x) the minimum bend radius for UTP is 4 x cable outside diameter, about one inch. For multipair cables the minimum bending radius is 10 x outside diameter.

SP-2840A gives minimum bend radii for Type 1A Shielded Twisted Pair (100 Mb/s STP) of 7.5 cm (3-in) for non-plenum cable, 15 cm (6-in) for the stiffer plenum-rated kind.

For fiber optic cables not in tension, the minimum bend radius is 10 x diameter; cables loaded in tension may not be bent at less than 20 x diameter. SP-2840A states that no f/o cable will be bent on a radius less than 3.0 cm (1.18-in).

The ISO DIS 11801 standard, Section 7.1 General specs for 100 ohm and 120 ohm balanced cable lists three different minimum bend radii. Minimum for pulling during installation is 8x cable diameter, min installed radius is 6x for riser cable, 4x for horizontal.

For fiber optic cables not in tension, the minimum bend radius is 10 x diameter; cables loaded in tension may not be bent at less than 20 x diameter. SP-2840A states that no f/o cable will be bent on a radius less than 3.0 cm (1.18-in).

Some manufacturers recommendations differ from the above, so it is worth checking the spec sheet for the cable you plan to use.

Subject: 20.0 Fiber Optic Cable

20.1 Multimode (MM) Fiber
Step index or graded index fiber. In North America the most common size is 62.5/125; in Europe, 50/125 is often used. These numbers represent the diameter of the core (62.5) and diameter of the cladding (125) in microns. Multimode fiber is typically used in applications such as local area networks, at distances less than 2 km.

20.2 Single Mode (SM) Fiber
Single mode fiber has a very small core. Typical values are 5-10 microns. Single mode fiber has a much higher capacity and allows longer distances than multimode fiber. Typically used for wide area networks such as telephone company switch to switch connections and cable TV (CATV).

20.3 Loose Buffer
The fiber is contained in a plastic tube for protection.
To give better waterproofing protection to the fiber, the space between the tubes is sometimes gel-filled. Typical applications are outside installations. One drawback of loose buffer construction is a larger bending radius. Gel-filled cable requires the installer to spend time cleaning and drying the individual cables, and cleaning up the site afterwards.

20.4 Tight Buffer
Buffer layers of plastic and yarn material are applied over the fiber.
Results in a smaller cable diameter with a smaller bending radius.
Typical applications are patch cords and local area network connections.
At least one mfr. produces this type of cable for inside/outside use.

20.5 Ribbon Cable
Typically 12 coated fibers are bonded together to form a ribbon. There are higher density ribbons (x100) which have the advantage of being mass-terminated into array connectors. A disadvantage is that they are often harder, and require special tools to terminate and splice.

20.6 Fiber Connectors
There are a lot of different types of connectors, but the ones commonly found in LAN/MAN/WAN installations are:

FSD - Fixed Shroud Device, such as the FDDI MIC dual-fiber connector.
SC - A push-pull connector. The international standard. The SC connectors are recommended in SP-2840A. The SC connector has the advantage (over ST) of being duplexed into a single connector clip with both transmit/receive fibers.
SMA - Threaded connector, not much used anymore because of losses that change with each disconnection and reconnection.
ST - Keyed, bayonet-style connector, very commonly used.

20.7 Fiber Optic Test Equipment
Continuity tester: used to identify a fiber, and detect a break. One type resembles a f/o connector attached to a flashlight.

Fault locator: used to determine exact location of a break. Works by shining a very bright visible light into the strand. At the break, this light is visible through the cable jacket.

Tone Generator and Tracer: used to identify a cable midspan or to locate a strand at its far end. Similar in purpose to the tone testers used on copper cable. The tone generator imposes a steady or warbling audio tone on light passing down the cable. The tracer detects and recovers the tone from light lost through the cable jacket as a result of bending the cable slightly.

Optical Source and Power Meter: used to measure the end-to-end loss through a f/o strand, or system of cable, connectors and patch cables. Measurements are more accurate than an OTDR.

Optical Time Domain Reflectometer (OTDR): used to measure the length of a cable, and detect any flaws in it. Can also be used to measure end-to-end loss, although less accurately than a power meter.

Fiber Talk set: allows using a pair of f/o strands as a telephone line.

Fiber Optic Testing, standards: see EIA-455-171 (FOTP-171), EIA 526-14.

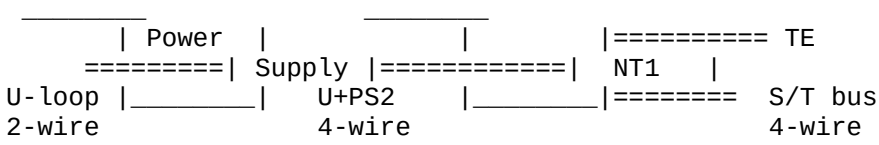
Subject: 21.0 ISDN Cabling

21.1 ISDN U-loop
ISDN Basic Rate Interface (BRI) is provided by a carrier from a central office (CO) switch to the customer premise with a two wire U-loop RJ-45 connector on the center pins 4-5.

RJ45 Plug
=========
1 N/C

2 N/C
3 N/C
4 U-loop network connection
5 U-loop network connection
6 N/C
7 N/C
8 N/C

21.2 ISDN Network Termination (NT)
The Network Termination is a Power Supply and NT1. In North America this functionality can be provided in the terminal equipment (i.e. ISDN digital modem) or separate as follows;



RJ45 Plug for U+PS2
==========
1 N/C
2 N/C
3 N/C
4 U-loop network connection
5 U-loop network connection
6 N/C
7 -48 VDC
8 -48 VDC Return

The ISDN cables can be silver satin patch cables (the kind that make 10Base-T Ethernet installers cringe). The S/T bus can also be silver satin but most installers use CAT 3 or CAT 5 with one drop per terminal equipment. It is true that only 4-wires are needed on the S/T bus but see below for optional power needs.

21.3 ISDN S/T Bus (Point-to-Point)
One logical terminal is on the S/T bus which can be 1km long.

21.4 ISDN S/T Bus (Short Passive)
Up to eight terminals on the S/T bus which can be within 100 to 200m.

21.5 ISDN S/T Bus (Extended Passive)
Up to eight terminals on the S/T bus which can be up to 500m.

21.6 ISDN S/T Bus (NT1 Star)
Up to eight terminals on the S/T bus which are wired from a central NT1 and can be up to 1km in length each.

21.7 ISDN S/T Bus Pinout
The S/T bus connects the NT1 with the terminal equipment. See section 10.0 for plug identification and pin numbering. Note, if power is not required an RJ11 (6-pin) plug could be used. Some NT1 devices have a switch to turn off power if it is not required by the terminal equipment. For safety reasons the power should not be put on the S/T bus if it is not required. Typically, ISDN PC cards do not require power from the S/T bus,

but ISDN telephones do require power from the S/T bus. Check your vendor equipment specifications carefully.

RJ45 Plug for ISDN S/T bus

1	N/C	
2	N/C	
3	White/Green	Receive +
4	Blue	Transmit+
5	White/Blue	Transmit-
6	Green	Receive -
7	White/Brown	-48VDC (option)
8	Brown	-48VDC Return (option)

21.8 ISDN Cabling Guidelines

The North American ISDN Users Forum (NIUF) has produced a document titled _ISDN Wiring and Powering Guidelines_ NIUF #433-94 which describes residence and small business ISDN cabling. See section 30.0 for the NIUF document ordering address.

Subject: 22.0 Testing Unshielded Twisted Pair Cables

22.1 Testing UTP Introduction

Many of the problems encountered in UTP cable plants are a result of miswired patch cables, jacks and crossconnects.

Horizontal and riser distribution cables and patch cables are wired straight through end-to-end -- pin 1 at one end should be connected to pin 1 at the other. (Crossover patch cables are an exception, as described later). Normally, jacks and crossconnects are designed so that the installer always punches down the cable pairs in a standard order, from left to right: pair 1 (Blue), pair 2 (Orange), pair 3 (Green) and pair 4 (Brown). The white striped lead is usually punched down first, followed by the solid color. The jack's internal wiring connects each pair to the correct pins, according to the assignment scheme for which the jack is designed: EIA-568A, 568B, USOC or whatever. (One source of problems is an installation in which USOC jacks are mixed with EIA-568A or 568B. Everything appears to be punched down correctly, but some cables work and others do not).

22.2 Wiremap Tests

Wiremap tests will check all lines in the cable for all of the following errors:

- Open: Lack of continuity between pins at both ends of the cable.
- Short: Two or more lines short-circuited together.
- Crossed pair: A pair is connected to different pins at each end (example: pair 1 is connected to pins 4&5 at one end, and pins 1&2 at the other).
- Reversed pair: The two lines in a pair are connected to opposite pins at each end of the cable (example: the line on pin 1 is connected to pin 2 at the other end, the line on pin 2 is connected to line 1). Also

called a polarity reversal or tip-and-ring reversal.

Split pair: One line from each of two pairs is connected as if it were a pair (example: the Blue and White-Orange lines are connected to pins 4&5, White-Blue and Orange to pins 3&6). The result is excessive Near End Crosstalk (NEXT), which wastes 10Base-T bandwidth and usually prevents 16 Mb/s token-ring from working at all.

22.3 Length Tests

Checking cable length is usually done using a time domain reflectometer (TDR), which transmits a pulse down the cable, and measures the elapsed time until it receives a reflection from the far end of the cable. Each type of cable transmits signals at something less than the speed of light. This factor is called the nominal velocity of propagation (NVP), expressed as a decimal fraction of the speed of light. (UTP has an NVP of approximately 0.59-0.65). From the elapsed time and the NVP, the TDR calculates the cable's length. A TDR may be a special-purpose unit such as the Tektronix 1503, or may be built into a handheld cable tester.

22.4 Testing for Impulse Noise

The 10Base-T standard defines limits for the voltage and number of occurrences/minute of impulse noise occurring in several frequency ranges. Many of the handheld cable testers include the capability to test for this.

22.5 Near-End Crosstalk (NEXT)

What's NEXT, you ask? Imagine yourself speaking into a telephone. Normally, as you speak you can hear the person on the other end and also hear yourself through the handset. Imagine how it would sound if your voice was amplified so it was louder than the other person's. Each time you spoke you'd be deaf to anything coming from the other end. A cable with inadequate immunity to NEXT couples so much of the signal being transmitted back onto the receive pair (or pairs) that incoming signals are unintelligible.

Cable and connecting hardware installed using poor practices can have their NEXT performance reduced by as much as a whole Category.

22.6 Attenuation

A signal traveling on a cable becomes weaker the further it travels. Each interconnection also reduces its strength. At some point the signal becomes too weak for the network hardware to interpret reliably.

Particularly at higher frequencies (10MHz and up) UTP cable attenuates signals much sooner than does co-axial or shielded twisted pair cable.

Knowing the attenuation (and NEXT) of a link allows you to determine whether it will function for a particular access method, and how much margin is available to accommodate increased losses due to temperature changes, aging, etc.

Forthcoming updates to cabling standards call for a number of new tests which will add to this list.

Subject: 23.0 - 29.0 Not Used (Blank)

These sections are blank for future topics.

Subject: 30.0 Sources of Additional Information

AMP
Addr: Harrisburg, PA 17105-3608
Tel: 1-800-722-1111
1-800-245-4356 (Faxback service, USA)
(905) 470-4425 Canada
(617) 270-3774 (Faxback service, Canada)

Anixter
(An international cable products distributor)
see _Anixter 199x Cabling Systems Catalog_
Addr: Anixter, Inc
4711 Golf Road
Skokie, IL 60076
Tel: (708) 677-2600
1-800-323-8167 USA
1-800-361-0250 Canada
32-3-457-3570 Europe
44-81-561-8118 UK
65-756-7011 Singapore

ANSI:
Addr: American National Standards Institute
11 W. 42nd St, 13th floor
New York, NY 10036
Tel: (212) 642-4900

AT&T Canada:
Addr: Network Cables Div
1255 route Transcanadienne
Dorval, QC H3P 2V4
Tel: (514) 421-8213
Fax: (514) 421-8224

AT&T documents:
Addr: AT&T Customer Information Center
Order Entry
2855 N. Franklin Road
Indianapolis, IN 46219 USA
Tel: (800) 432-6600 (USA)
(800) 255-1242 (CDN)
(317) 352-8557 (International)
Fax: (317) 352-8484

Belden Wire & Cable:

Addr: POB 1980
Richmond, IN 47375
Tel: (317) 983-5200

Bell Canada:
Addr: Bell Canada
Building Network Design
Floor 2, 2 Fieldway Road
Etobicoke, Ontario
Canada M8Z 3L2
Tel: (416) 234-4223
Fax: (416) 236-3033

Bell Communications Research (Bellcore):
Addr: Customer Service
60 New England Ave
Piscataway, NJ 08854
Tel: (800) 521-2673
Fax: (908) 336-2559

Berk-Tek: (copper & f/o cable)
Addr: 312 White Oak Rd
New Holland, PA 17557
Tel: (717) 354-6200, 1-800-BERK-TEK
Fax: (717) 354-7944

BICSI: A telecommunications cabling professional association.
Offers education, and administers the RCDD (Registered
Communications Distribution Designer) certification.
Addr: Building Industries Consulting Service International
10500 University Center Drive, Ste 100
Tampa, FL 33612-6415
Tel: (813) 979-1991, 1-800-BICSI-05
Fax: (813) 971-4311

Blackbox
Black Box Catalog: The Source for Connectivity (r)
Addr: Black Box Inc
P.O. Box 12800
Pittsburgh, PA 15241
Tel: 1-800-552-6816 USA
(412) 746-5500 Tech Support USA
(416) 736-8013 Tech Support Canada
Inet: info@blackbox.com

CABA:
Addr: Canadian Automated Buildings Association
M-20, 1200 Montreal Rd
Ottawa, ON K1A 0R6
Tel: (613) 990-7407
Fax: (613) 954-5984

CableTalk: (racks & physical cable management)
Addr: 18 Chelsea Lane
Brampton, ON L6T 3Y4
Tel: (800) 267-7282
(905) 791-9123

Fax: (905) 791-9126

Cabling Business:
Addr: Cabling Business Magazine
12035 Shiloh Road, Ste 350
Dallas, TX 75228
Tel: (214) 328-1717
Fax: (214) 319-6077

Cabling Installation & Maintenance Magazine:
Addr: Cabling Installation & Maintenance
Editorial Offices
One Technology Park Dr
POB 992
Westford, MA 01886
Tel: (508) 692-0700
Subscriptions:
Tel: (918) 832-9349
Fax: (918) 832-9295

CCITT: See ITU

Comm/Scope Inc.
Addr: POB 1729,
Hickory, NC 28603
Tel: (800) 982-1708 (USA)
(704) 324-2200
Fax: (704) 328-3400

Corning:
Addr: Corning Optical Fiber Information Center
1-800-525-2524
Guidelines - publication/newsletter on fiber technology
FiberFax-on-Demand: ???
Inet: fiber@corning.com

CSA:
Addr: Canadian Standards Association
178 Rexdale Blvd
Rexdale, Ont
Canada M9W 1R3
Tel: (416) 747-4000, Documents Orders: (416) 747-4044
Fax: (416) 747-2475

EIA:
Addr: EIA Standards Sales Office
2001 Pennsylvania Ave., N.W.
Washington, DC 20006
Tel: (202) 457-4966

GED:
Addr: Global Engineering Documents
1990 M Street W, Suite 400
Washington, DC 20036
Tel: (800) 854-7179 (CDN/USA)
(202) 429-2860 (International)
(714) 261-1455 (International)

Fax: (317) 352-8484

Global Engineering Documents (West Coast)
2805 McGaw Ave.
Irvine, CA 92714
800-854-7179

Graybar:
(An international cable products distributor)
1-800-825-5517
Tel: (519) 576-4050 in Ontario
Fax: (519) 576-2402

Hubbell:
Addr: Hubbell Premise Wiring Inc.
14 Lords Hill Rd
Stonington, CT 06378
Tel: (203) 535-8326
Fax: (203) 535-8328

IEC:
Addr: International Electrotechnical Commission
rue de Varembre, Case Postale 131,3
CH-1211
Geneva 20, Switzerland

ISO:
Addr: International Organization for Standardization
1, rue de Varembre, Case Postale 56
CH-1211
Geneva 20, Switzerland
Tel: +41 22 34 12 40

ITU:
(Previously called CCITT)
Addr: International Telephone Union
Place des Nations
CH-1211
Geneva 20, Switzerland

MOD-TAP:
(Cable and Equipment Suplier)
Addr: Mod-Tap
285 Ayer Rd, P.O. Box 706
Harvard, MA 01451
Tel: (508) 772-5630
Fax: (508) 772-2011

NFPA (US National Electrical Code (NEC) and other docs):
Addr: National Fire Protection Association
One Battery March Park, P.O. Box 9146
Quincy, MA 02269-9959
Tel: (800) 344-3555
Fax: (617) 984-7057

NIST:
Addr: U.S. Dept. of Commerce

National Institute of Standards and Technology
Technology Building 225
Gaithersburg, MD 20899

NIUF:
Addr: North American ISDN Users Forum
NIUF Secretariat
National Institute of Standards and Technology
Bldg 223, Room B364
Gaithersburg, MD 20899
Tel: (301) 975-2937
Fax: (301) 926-9675
Internet: sara@isdn.ncsl.nist.gov

Northern Telecom (cable and physical network products):
Addr: Business Networks Div.
105 Boulevard Laurentien
St. Laurent, QC H4N 2M3
Tel: (514) 744-8693, 1-800-262-9334
Fax: (514) 744-8644

NTIS:
Addr: U.S. Dept. of Commerce
National Technical Information Service
5285 Port Royal Rd
Springfield, VA 22161
Tel: (703) 487-4650
(800) 336-4700 (rush orders)
Fax: (703) 321-8547

NRC of Canada:
Addr: Client Services
Institute for Research in Construction
National Research Council of Canada
Ottawa, ON K1A 0R6
Tel: (613) 993-2463
Fax: (613) 952-7673

Ortronics:
Addr: 595 Greenhaven Rd
Pawcatuck, CT 06379
Tel: (203) 599-1760
Fax: (203) 599-1774

RCDD: See BICSI

Saunders Telecom: (racks, tray and accessories)
Addr: 8520 Wellsford Place
Santa Fe Springs, CA
Tel: (800) 927-3595
Fax: (310) 698-6510

SCC:
Addr: Standards Council of Canada
1200-45 O/Connor St
Ottawa, Ont Canada K1P 6N7
Tel: (613) 238-3222

Fax: (613) 995-4564

Siecor:
Addr: 489 Siecor Park, POB 489
Hickory, NC 28603-0489
Tel: (704) 327-5000
Fax: (704) 327-5973

Siemon:
The Siemon Co (Cabling System Supplier)
Addr: 76 Westbury Park Rd
Watertown, CT 06795
Tel: (203) 274-2523
Fax: (203) 945-4225

TIA:
Addr: Telecommunications Industries Association (TIA)
2500 Wilson Boulevard, Suite 300,
Arlington, VA 22201
Tel: (703) 907-7700
Fax: (703) 907-7727

UL:
Underwriters Labs (UL) documents:
Addr: Underwriters Labs Inc
333 Pfingsten Road,
Northbrook, Illinois 60062-2096 USA
Tel: (800) 676-9473 (from CDN/USA East coast)
(800) 786-9473 (from CDN/USA West coast)
(708) 272-8800 (International)
Fax: (708) 272-8129
Inet: 0002543343@mcimail.com
MCI Mail: 254-3343