TECHNICAL REPORT

ISO/IEC TR 12075

First edition
1994-04

Information technology – Customer premises cabling – Planning and installation guide to support ISO/IEC 8802-5 token ring stations

Technologie de l'information – Câblage des locaux de clients – Guide de planification et d'installation pour les stations en anneau à jetons de l'ISO/CEI 8802-5

Numéro de référence
Reference number
IEC/ISO TR 12075(E): 1994

ISO/IEC Copyright Office • Case Postale 131 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Clause	Page

Clause | Page

Figures

Tables

Foreword

ISO (the International Organization for Standardization) and IEC (teh International Electrotechnical Commision) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical commitees establisshed by their respective organizations to deal with particular field of thechnical activity. ISO and IEC technical commitees collaborate in fields of mutual interest. Other international organizations, govermental and non-govermental, in liason with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC1.

ISO/IEC 12075, which is atechnical report of type 3, has been prepared by ISO/IEC Joint Technical Committee JTC 1/SC 25.

The main task of technical committes is to prepare International Standards. In exceptional circumstances a technical committee may propose the publication of a technical report of one of the following types:

- type 1, when the required support cannot be obtained for the publication of an International Standard, despite repeated efforts;

- type 2, when the subject is still inder technical development or where for any other reason there is the future but not immediste possibility of an agreement on an International Stanndard;

- type 3, when a technical commitee has collected data of a different kind from that which is normally published as an International Standard ("state of the art" for example).

Technical reports of types 1 and 2 are subject to review within three years of publication, to decide wether they can be transformed into International Standards. Technical reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid og useful.

In many cases, information in this technical report is subject to change. The working group expect to re-issue and update this report on a periodic basis to supply the international community with the latest information on evolving standardization activities.

Information technology - Customer premises cabling

Planning and installation guide to support ISO/IEC 8802-5 token ring stations

1 Scope

The purpose of this technical report is to sypplement the token ring standard ISO/IEC 8802-5, and the annex "Information technology - Local and metropolitan area networks - Token ring access method and physical layer specification - Recommended practice for use of unshielded twisted pair cable (UTP) for token ring data transmission at 4 Mbps." with information relating to suitable transmission media and installation guidance, without placing undue constraint on implementers regarding detailed sizing and configuration. The recommendations and topologies outlined here draw on and are complementary to the ISO/IEC generic cabling Standard, 11801, under development at the approval of this guide.

This report therefore includes the following:

- a description and recommended values of characteristics of the appropriate elements within a token ring network;
- the cabling system topology with recommended distances;
- transmission requirements of suitable medium for 4 and 16 Mbit/s token rings;
- guidelines for the design, planning and installation of cabling systems to support 4 and 16 Mbit/s token rings;
- guidance on documentation and labelling to support token rings.

The procedure to check the suitability of installed cabling to support 4 or 16 Mbit/s token rings is a topic for future study.

This technical report addresses the use of both shielded and unshielded lobe cabling. Unless otherwise noted within the text, all cabling recommendations specifically refer to using 150 Ω shielded twisted pair lobe cabling.

When ISO 8802-5 is reissued this report should be updated to realign with both that guide and the Generic wiring standard.

1.1 Normative references

The following normative documents contain provisions which, through reference in the text, constitute provisions of this technical report. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on this technical report are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 96-1: 1986, Radio-frequencey cables-Part 1: General requirements and measuring methods.

IEC 603-7: 1990, Connetors for frequencies below 3 MHz for use with printed boards - Part 7: Detail specification for connectors, 8-way, included fixed and free connectors with common mating features.

ISO/IEC 8802-5: 1992,Information processing systems - Local and metropolitan area networks - Part 5: Token ring access method and physical layer specifications.

ISO/IEC 11801: General cabling standard (under consideration)

2 Definitions and abbreviations

BD **Building Distributor:** The combination of functional elements (e.g . patch panels, multiplexers). Used to connect between the building and campus cables.

Balanced cable: A cable consisting of one or more symmetrical cable elements. Construction of conductors belonging to a transmission circuit are identical and twisted together using a certain lay.

Back-up path: Spare transmission path in trunk cabling, normally usedfor signal transmission only when there is a failure on the main ring path.

Bridge: MAC sublayer interconnector of rings.

Cabling: The collection of all cables, connectors, patch panels and other passive components which compromise the telecommunication infrastructure.

Cable: An assembly of one or more cable elements contained within a common sheath or tube.

Cable element: A number of insulated conductors or optical fibres. Examples of cable elements are: pair, shielded pair, quad, shielded quad.

CD **Campus Distributor:** Premises main distributor

Channel: Data path from any transmitting station's Medium Interface Connector (MIC) to the next downstream receivers MIC, including possibly, its own. (Also referred to as Transmission Path)

Concentrator: A device which provides the function of multiple Trunk C oupling Units (TCUs). Token ring concentrators interface to the main transmission path with two ports, ring-in and ring-out. Data Terminal Equipment (DTEs) are attached to the concentrators' lobe attachment ports via lobe cabling.

Converter: Special type of repeater which converts signals using diffe rent media types.

Distributor: See Telecommunication Closet.

Drive Distance: The maximum distance a signal can propagate along a channel from transmitter to receiver, and still be within specification. Drive distance is a function of line losses and component losses such as those from connectors and TCUs. Line losses can be characterized as losses with a square root of frequency characteristic, and component losses can be characterized as having a fixed component plus a square root of frequency component.

DTE **Data Terminal Equipment:** Any device which attaches to the LAN and communicates via the LAN protocols on that LAN.

DTE attachment cable: A short flexible cable (generally less than 3 meters), connecting the DTE to the MIC.

Equivalent station count: Complex devices and links which contain more than a single retiming circuit must be characterised by the number of retiming circuits they contain. This count is called "Equivalent Station Count".

HD — Horizontal Distributor: The telecommunication distributor which houses the termination for the horizontal cabling.

Horizontal cabling: The horizontal cabling subsystem extends from a floor distributor to the telecommunications closet outlet(s) connected to it. The subsystem includes the horizontal cables, the mechanical termination of horizontal cables at the floor distributor, the cross connections at the floor distributor and the telecommunications closet outlets.

Hybrid cable: A cable consisting of a combination of two or more cable elements of different characteristic.

IEEE — Institute of Electrical and Electronics Engineers

IEC — International Electrotechnical Commission

ISO — International Organisation for Standardisation

LAN — Local Area Network

Link: A section of the token ring transmission path, without station attachments, bounded by repeaters or converters. A link is characterized by its latency and associated accumulated jitter. At its input and output it must be able to receive any valid receive level signal, and must transmit signals conformant with the transmit specifications at a MIC. The link may or may not use proprietary signalling within it. Neither transmission parameters nor signal coding are defined for the link.

Lobe cabling: The cabling used to interconnect the MICs to the TCUs. This cabling includes all horizontal cabling, patch cables and possible work area cabling between TO and MIC. The lobe cable only carries signals when the station attached to the lobe is active on the ring.

LLC — Logical Link Control

Main ring path: Primary transmission path in the trunk cabling. The Main Ring Path carries the data in the primary direction. (Contrast with Back-up path)

Medium: The cabling on which the message may be transmitted.

MAC — Medium Access Control: The portion of the terminal that controls and mediates the access to the ring.

MIC — Medium Interface Connector: The connector situated between the terminal and trunk coupling unit (TCU) at which all transmitted and received signals are specified. It is one of the connectors of the mated pair at the measurement reference point. Typically, the DTE attachment cable is connected to the wall outlet, and this connection point is the MIC. Otherwise, the MIC is generally at the data connector end of the attachment cable. Other physically identical connectors used elsewhere in the system are not referred to in this guide as MIC connectors.

NEXT — Near End Cross Talk

Pair: A cable element which consist of two insulated conductors forming a transmission line circuit.

Patch cables: Short flexible cables required to connect fixed cabling and active and passive components in a telecommunications closet.

Patch panel: Termination point for building cabling in a telecommunications closet. Attachment of that cabling to repeaters and concentrators is typically done with short sections of cable called patch cables.

PHY Physical Layer

Repeater: Physical layer interconnector of rings. Provides for physical containment of the channels, dividing the ring into segments. A repeater can receive any valid token ring signal and retransmit it with the same characteristics and voltage levels as a transmitting station.

Router: Network layer interconnector of LANs (rings, buses, etc.)

Ring in: The port of an element that receives signal from the main ring path on the trunk cable, and provides connectivity to the ring out port of the immediate upstream element.

Ring out: The port of an element that transmits the output signal to the main ring path on the trunk cable, and provides connectivity to the Ring In port of the immediate downstream element.

Ring segment: Section of transmission path bounded by repeaters or converters. Ring segment boundaries are critical for determining the transmission limits that apply to the devices within the segment, because no transmission channels cross the ring segment boundaries.

Shielded cable: An assembly of one ore more cable elements wrapped by an overall static shield contained within a common sheath or tube.

Shielded pair: A cable element which compromises two insulated conductors forming a transmission line circuit and twisted together covered by a static shield.

Shielded star quad: A cable element which compromises four insulated conductors twisted together, two diametrically facing conductors forming a transmission line circuit and over which is applied a static shield.

STP Shielded Twisted Pair cable: Shielded twisted pair cable is normally used to mean shielded twisted pair cables or shielded quad cables independent of their characteristic impedance. However, when used in this guide the expression refers specially to those shielded twisted pair or shielded quad cables with a high frequency characteristic impedance of 150 Ω ± 15 Ω. In addition to having an overall shield, the individual pairs may be shielded.

Star quad: A star quad consists of four conductors twisted together for the length of the cable. Opposite conductors must be used as a pair.

TO Telecommunications Outlet: A connecting point, in a fixed position, where the horizontal cabling terminates. The telecommunication outlet provides the interface to the work area cabling.

Trunk cable: The transmission medium for interconnection of concentrators and TCUs providing a main signal path and a back-up signal path, exclusive of the lobe cabling.

TCU Trunk Coupling Unit: A physical means that enables a station to connect to a trunk cable. The trunk coupling unit contains the means for inserting the station into the ring or, conversely, bypassing the station.

TC Telecommunications Closet (distributor): The space provided in a building where the horizontal and backbone cabling terminates. The Telecommunication Closet houses the TCUs, concentrators, repeaters etc. in addition to housing the equipment associated with the telecommunication wiring system. The Telecommunications Closet is sometime referred to as a Distributor.

Trunk path: That portion of the transmission path which always carries signals independent of which stations are active on the ring and which are not.

UTP Unshielded twisted pair: UTP normally refers to unshielded twisted pair cables or star quad cables independent of their characteristic impedance. However, when used in this guide, UTP or unshielded twisted pair refers specifically to those unshielded twisted pair cables or star quad cables which meet the specifications of 100 Ω Category 3 UTP. Shielded cables meeting the 100 Ω Category 3 specifications are included with in this definition.

Work area cabling: Additional cabling required to go from the outlet to the DTE attachment cable when the DTE is not placed near the outlet.

3 Topology in principle

3.1 System overview

The token ring network is a physical star connected to a logical ring that accommodates (allows for) the connection of up to 250 attaching devices (processors, printers controllers, repeaters, converters etc.) per ring through specially designed adapters installed in the attaching devices. The ring is established by connecting all attaching devices to Trunk Coupling Units (TCUs) using the transmission media described in clause 5. During operation the TCUs will establish a logical ring of all active attached devices and will bypass all inactive attached devices. The attaching device interfaces with the adapter to use the ring for sending and receiving data. The ring is used as follows:

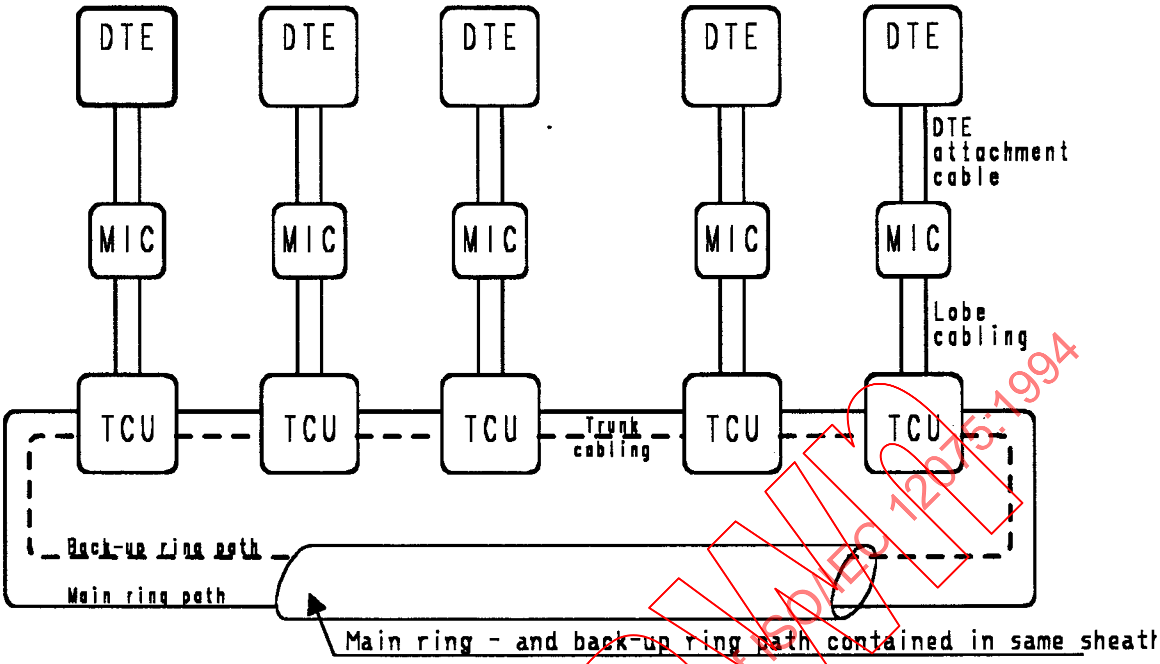
> The attaching device notifies the adapter that it has a message to send. Upon receipt of a token, the adapter appends the message, together with both the sender's and the recipient's addresses on the token circulating around the ring. The token then becomes a frame.

The token ring network is a baseband system. Messages are transmitted and received at a rate of either 4 or 16 Megabits per second (Mbit/s). The data rate at which a single ring operates is determined by the data rate of the adapters in the attaching devices. All attaching devices on a single ring must have adapters that operate at the same data rate. All normal network operations are performed without user intervention once the message has been directed to the adapter. The operator of the attaching device does not have to be aware of routing and protocol procedures.

This report focuses on the guidelines for establishing single rings. It is possible to create a network that consists of individual rings interconnected with bridges or routers. With such a configuration, messages are passed from an attached device on one ring through a bridge or routed to an attached device on another ring. For a short discussion of design considerations with bridges see 3.3.

3.2 Basic topology

The basic topology for token-ring networks as defined by ISO 8802-5 is a set of trunk coupling units (TCUs) connected together in a ring via trunk cabling as shown in figure 1. All discussions of token ring topology dealt with location of the ring components and are independent of their state, i.e. the configuration is independent of which devices are active at any particular time.



NOTE: Trunk-, lobe- and DTE cables contain two data-paths.

Figure 1 - Basic topology for token ring circuits

The cabling interconnecting TCUs is defined as the trunk cabling. Connected to each TCU is lobe cabling which terminates in a Medium Interface Connector (MIC).

Typically, the lobe cabling consists of the following:

- a patch cable from the TCU to the horizontal cabling.
- the horizontal cabling from the telecommunications closet to the telecommunications outlet.
- any work area cabling from the outlet to the DTE's MIC.

The TCU has two states, the insert state and the bypass state. In the bypass state, the TCU directly routes the incoming signal port to the trunk cable to the outgoing signal on the trunk cable. When a DTE is actively participating in the ring, the incoming signal from the trunk cable is routed to the DTE's receiver via a first signal path of the lobe cable. The DTE then transmits via a second signal path in the lobe cabling to the outgoing signal path on the trunk cable (see figure 2).

Connected to each MIC is a DTE. In actual implementation, horizontal cabling normally runs from the work area to centralised telecommunication closets. The TCUs may be built singly or combined; as multi-TCU concentrators.

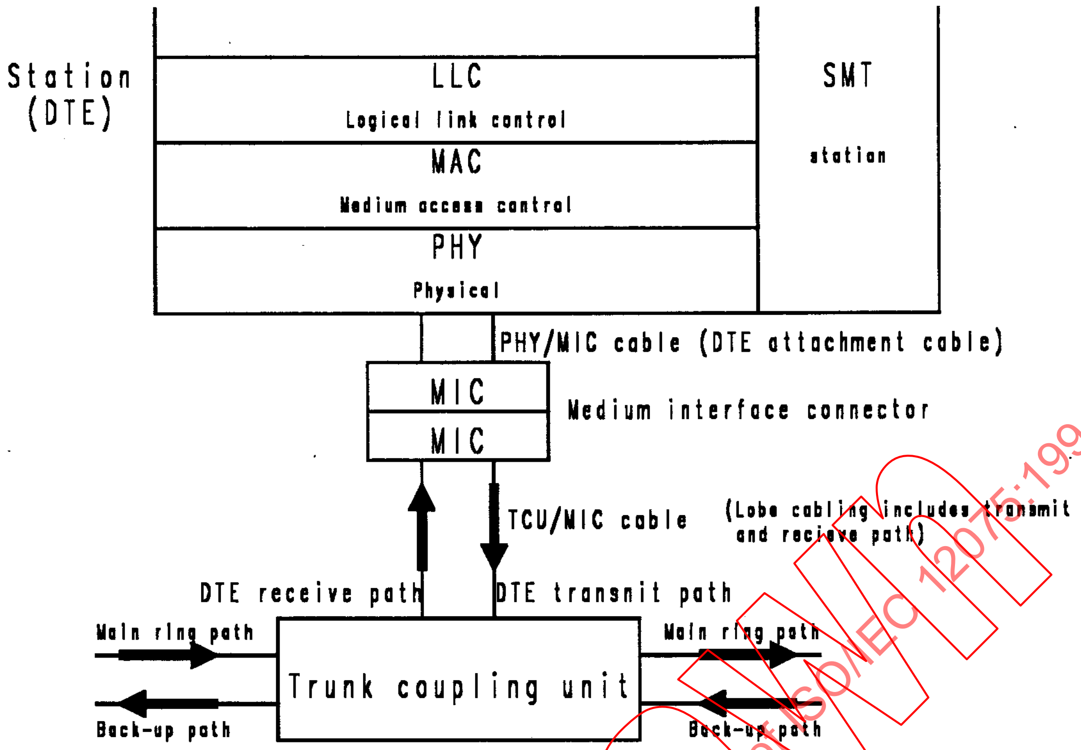


Figure 2 - Partitioning of PHY and medium

Figure 3 shows a representative token ring network spanning two telecommunications closets, one per floor. All attaching devices are electrically attached to concentrators in one of the telecommunications closets. As seen in the figure, the major elements of the token ring cabling system are:

1) The horizontal cabling system: the cabling between the telecommunications outlets and the patch panels in the telecommunications closet.

2) Optional work area cables used to connect the MIC to the outlet.

3) DTE Attachment cables used to connect the DTE to the MIC.

4) Patch panels usually located in telecommunications closets, where the horizontal cables terminate.

5) The patch cables which are used:
- from devices including concentrators to the fixed cabling;
- as inter-connect cables;
- as trunk cabling between devices (e.g. connecting the concentrators together).

6) Equipment racks in the telecommunications closet to hold the patch panels and the components in this room (concentrators, repeaters, etc.).

7) The TCUs (concentrators).

8) Permanently installed trunk cabling to connect widely separated TCUs and concentrators.

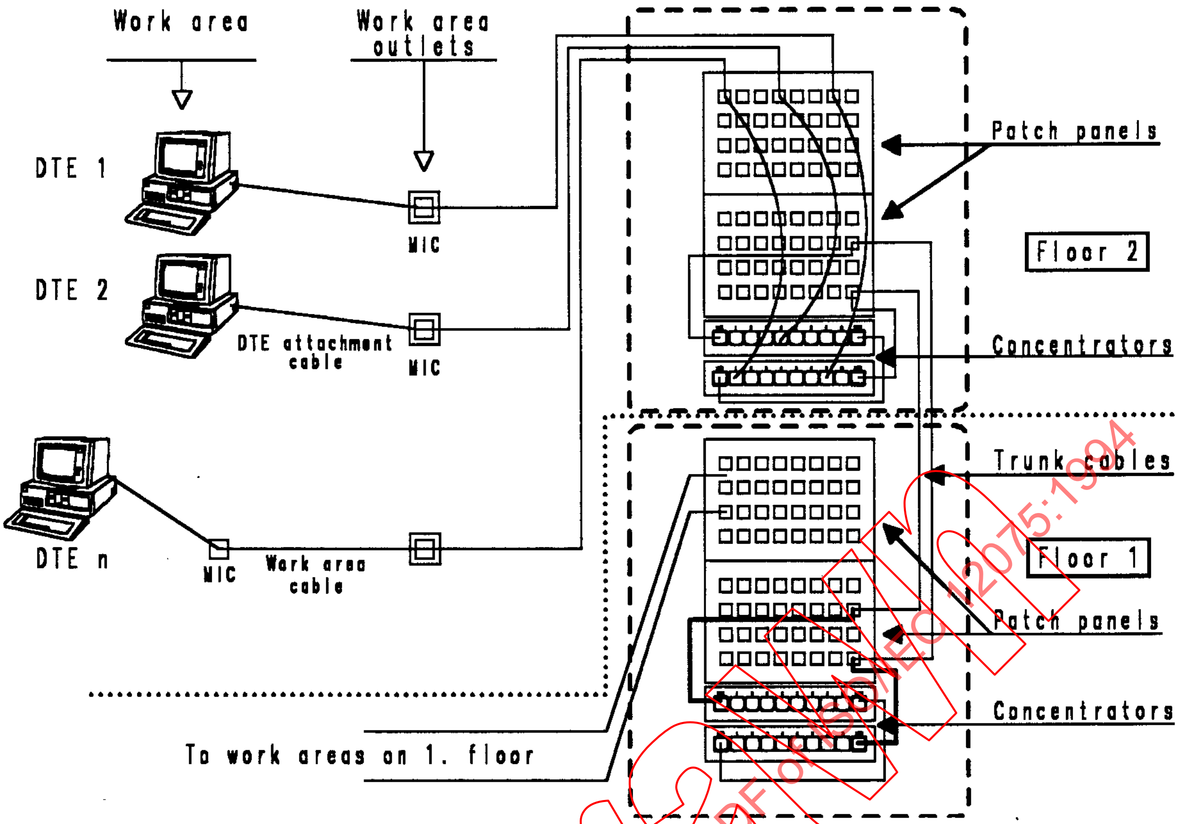


Figure 3 - Basic Topology for Token Ring Circuits

The lobe cabling includes all cable segments between the TCU and the associated MIC. Included within the lobe cabling are the signalling paths to and from the DTE. Both these paths are bypassed (not part of the ring path) when the attaching device is inactive, i.e. not participating on the ring.

The trunk cable contains two signalling paths, a main ring path, and a back-up path which is normally unused (see figure 4). The back-up path is exploited during network problem determination and network restoration actions in the following way: If there is a suspected or known broken cable between telecommunications closets, the signal is either automatically or manually diverted from the broken segment to the back-up path. Some trunk cable devices such as concentrators and repeaters can automatically detect a broken ring segment and reroute the signal onto the back-up path, isolating the broken segment. Where these devices are not employed, the broken cable is disconnected at each termination point. Since the copper data connectors used for token ring LANs are self shorting (see figure 5), the signal will wrap to the trunk cabling's second transmission path, the back-up path. The trunk cabling will still form a logical ring with the signal wrapping at the two self shorted data connectors. When the broken cable is repaired or replaced and reconnected, the ring will again utilise only the main ring path in the trunk cabling. A detailed understanding of these problem determination and restoration procedures is necessary in planning the design of a token ring since the path that the data may have to take under these conditions is different from the normal path. Therefore, ring design must accommodate it. In some commercially available systems, engineering aids (maximum distance tables) do not account for trunk cabling breaks. These systems have a main ring path consisting of patch cables interconnecting TCUs and concentrators, and do not foresee the back-up path in the trunk cabling.

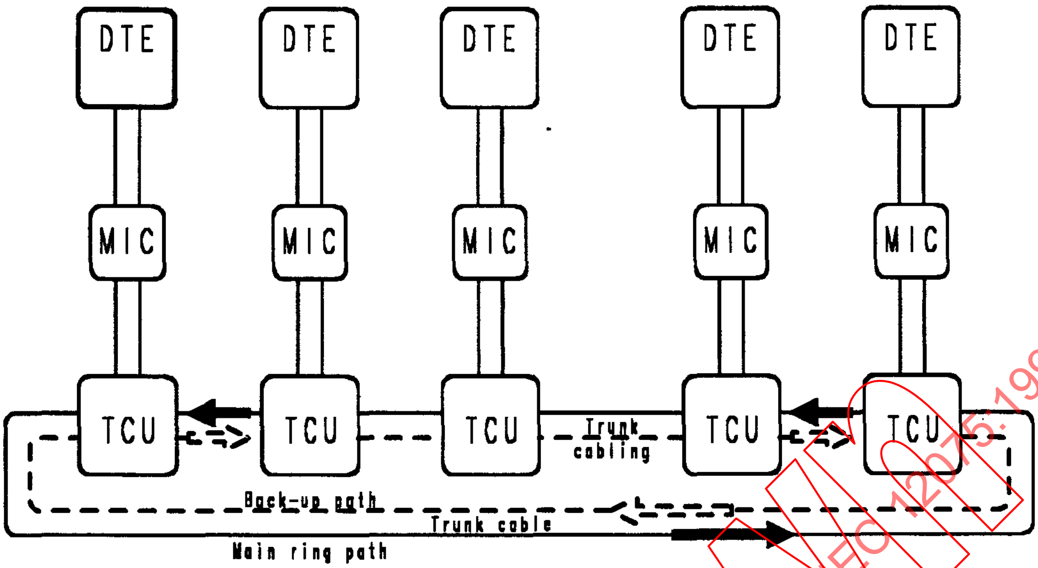


Figure 4 - Trunk cabling with back-up paths

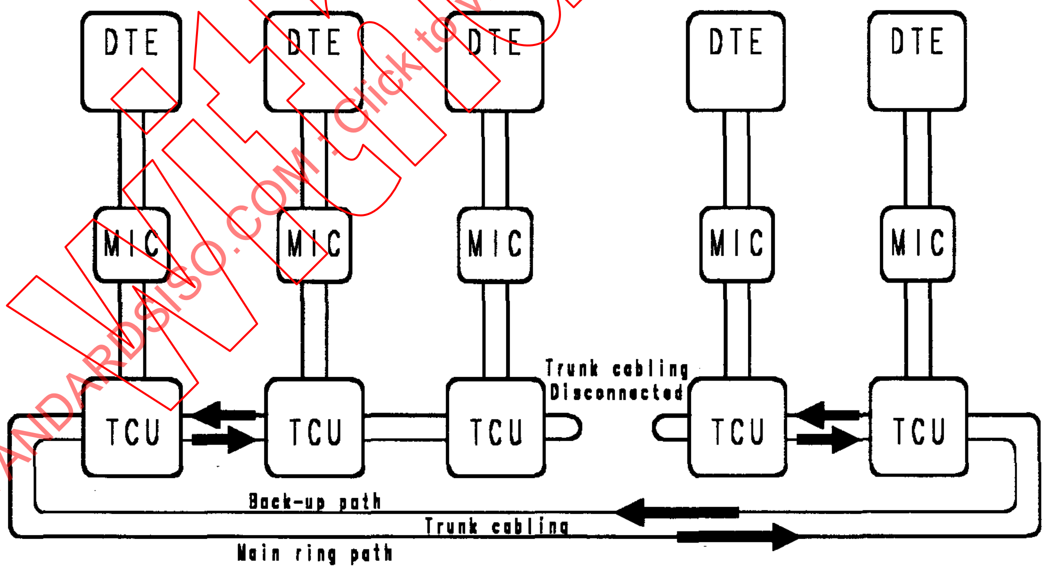


Figure 5 - Trunk cabling with back-up path in use

As the main ring path grows in size, the requirement to use repeaters or active links emerges. This requirement is based on the need to maintain adequate signal characteristics at each active station on the ring independent of the activity status of each of the rest of the stations on the ring. The ISO 8802-5 standard specifies the signaling requirements at the MIC on the lobe cabling, and mentions the use of repeaters, but otherwise leaves open the specification of signal propagation on the main ring path. The minimum receive signal levels shall be maintained for rings that have been reconfigured to enable the performance of problem determination and restoration procedures. Note that some commercially available repeaters use the back-up path available in the trunk cable by automatically wrapping signal from the main ring path to the back-up path and vice versa in cases of power outages and main ring path failures.

Rings containing repeaters and converters, as seen in figure 6, are logically split into ring segments and links for purposes of determining allowable configurations. At the ring segment boundary there is a requirement that all incoming signals meet the ISO 8802-5 receive signal specifications and all outgoing signals meet the ISO 8802-5 transmit signal specifications. This requirement is applicable to the main ring path (in the trunk cabling) and to any back-up path.

On a link, any propagation which satisfies overall network bit error rate and accepts and delivers allowable signal levels within the jitter requirements of the system, may be used. Each link be capable of receiving any signal that has valid receive voltage levels, and transmit onto the trunk cable signals with valid transmit levels.

Since accumulated jitter is a basic characteristic of the ring, the active links also be characterised by the amount of accumulated jitter added to the ring. This characterisation is done by stating the added jitter in terms of equivalent stations added to the ring. Added delay, if significant, also be specified.

Within a ring segment, transmission limits are determined by the maximum attenuation of any signal within that segment. In addition to the cable attenuation, segment attenuation can include the losses associated with any or all of the TCUs in a bypass state.

Figure 6 shows the general topology for the main ring path of token rings. A ring can pass through one or more telecommunications closets and may or may not contain repeaters in the trunk cabling between TCUs. In addition, there may be one or more links.

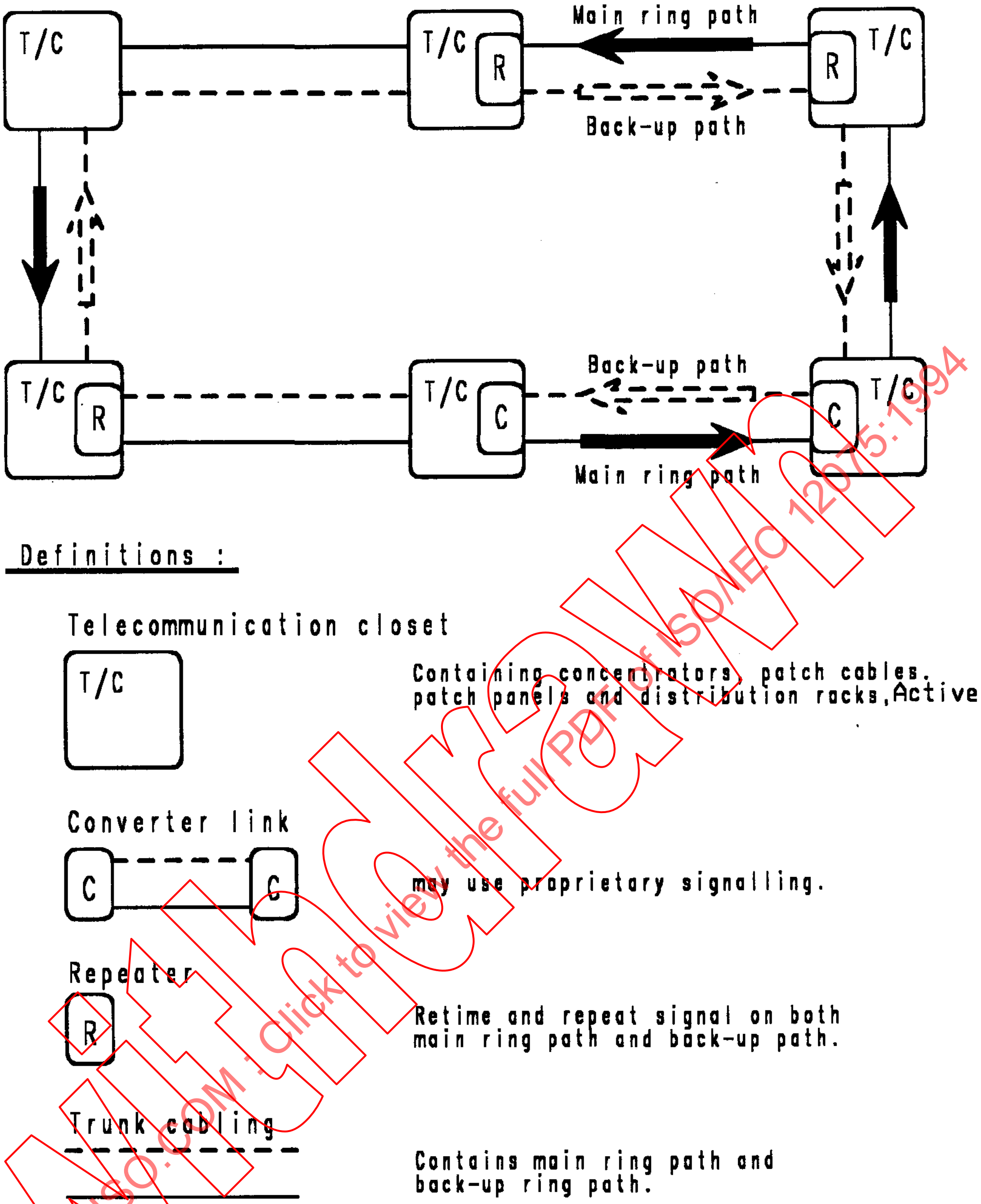


Figure 6 - General Topology of Trunk Path for token ring

3.3 Using bridges in a token ring network

Bridges can be used to extend a local area network both in station count and over larger distances by providing communications channels between rings. One bridging strategy used by relatively small networks is to daisy-chain rings together. Redundancy can be provided here by connecting the first ring and last ring together. For larger networks including campuses, a more structured approach is usually taken. Local rings, servicing a single building, portion of a building, or department, are bridged to rings covering a segment of the campus. These can be bridged to rings spanning larger segments of the campus, or even the entire campus.

At any level of interconnection, multiple bridges or multiple rings can be used to increase the availability of the network, as well as physical flexibility and the available throughput. Figure 1 on page 18 shows one configuration of creating a network by tying local rings together to a common backbone ring using bridges.

The extra bridge between local ring No. 2 and the back-bone ring, provides increased throughput between those rings, as well as a back-up path protecting the communication channel in event of a device failure in the parallel bridge. The bridge between local rings Nos. 1 and 2 provides additional channel capacity between these rings and helps off-load traffic on the back-bone ring.

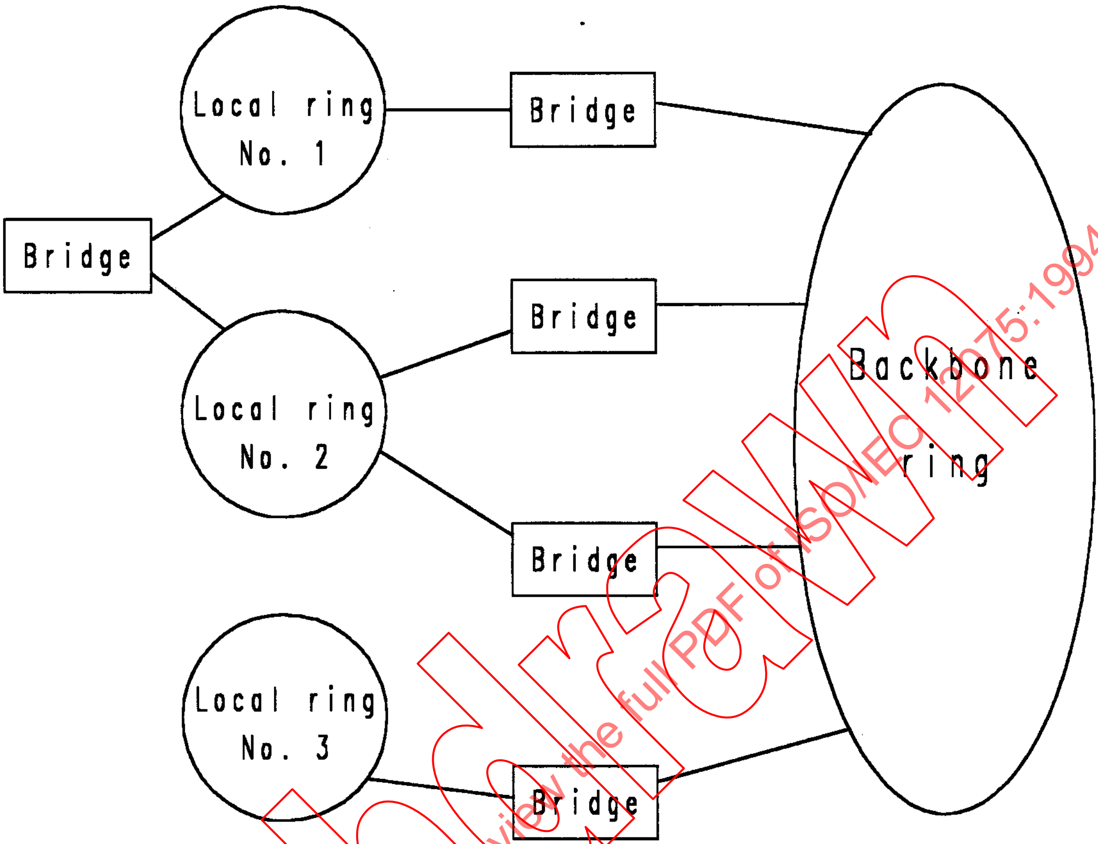


Figure 7 - Example of a Network with Bridges and a Backbone Ring

4 Guidelines for topological parameters

The topology shown in figure 8, is based on collocating token ring telecommunications closets containing the concentrators and patch panels, with the building distributor and horizontal distributors for the telecommunications wiring. This is the topology recommended. Wiring guidelines are presented to provide guidance which will allow use of the telecommunications wiring as a building utility which can support any particular LAN configuration or LAN speed. The most general cabling guidelines are shown in table 1, and serve as a basis for the cable requirements presented in table 3.

Lobe cabling (STP / UTP [1])	100 m [2])
Trunk cabling (STP)	200 m
Trunk cabling (optical fibre)	2000 m

1) See clause 11 for performance limitations using unshielded cabling.

2) Note that lobe cabling includes work area cabling and patch cables. The horizontal cabling should be limited to 90 m.

Table 1 - Cabling Limits, General Guidelines

More detailed recommendations for trunk cabling are presented in table 2. This table presents recommendations on the use of 150 Ω shielded twisted pair (STP) cable or fibre, based on the application speed (4 Mbit/s only, or both 4 and 16 Mbit/s support). "Recommended" distances are based on a cabling infrastructure which will provide maximum flexibility and support for a wide variety of attaching products from various manufacturers. "May be used" distances will allow for adequate configuration flexibility, but with a restricted set of available attachment devices to support these distances. "Not recommended" distances, either have no solutions, or only a very limited set of specializsed devices to support them.

Run length meter	Mbit/s	STP *)	Fibre *)
200 - 2.000	4 and 16	3	1
15 - 200	4 and 16	2	1
Less than 15	4 and 16	1	2
400 - 2.000	4 only	3	1
50 - 400	4 only	2	2
Less than 50	4 only	1	2
*) 1-Recommended, 2-May be used, 3-Not recommended			

Table 2 - Cabling limits, detailed trunk cabling guidelines

Maximum usable distances are dependent on token ring data rate, choice of products used and for copper cables of maximum cable temperature during token ring operation, and for optical fibre, specific optical transmission.

The recommendations in table 2 are a function of the ring speed and the products used. Actual product selection may affect the number of repeaters required for a particular token ring implementation. By following these guidelines, the cable plant should not constrain product choice.

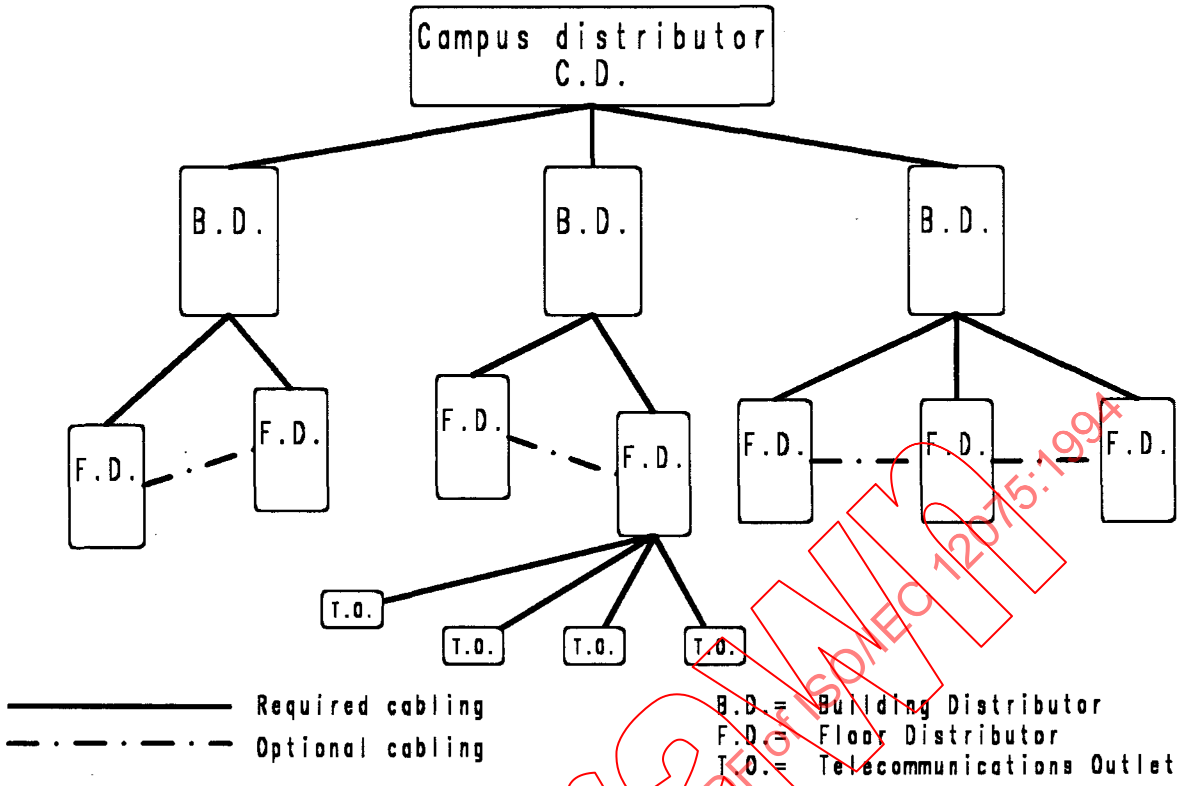


Figure 8 - Topology of Customer Premises Cabling

4.1 Building Rings Using the Recommended Topology and Distances.

The primary assumptions about the topological parameters are based on the way customer premises are wired as shown in the campus wide network configuration of figure 8. This figure gives the general guidelines for the physical cabling to support 4 or 16 Mbit/s token ring installations. The cabling distances and characteristics described here were chosen to maximise token ring configuration flexibility. Depending on the specifications of products used, active equipment may be required in some or all of the telecommunication closets. The maximum allowable attenuation in any transmission path is given in 7.1.

The media to be used to support 4 and 16 Mbit/s token ring applications are as follows:

For CD - BD, BD - BD, BD - HD, and HD - HD, use optical fibre or STP

Cable runs over 200 m (with maximum recommended run lengths of 2 km) should be implemented in multimode optical fibre. Runs between 15 and 200 m may be either STP or optical fibre depending on the specific devices planned for ring installation. Both may be installed initially for future flexibility. For runs less than 15 m, STP will provide suitable capability, although fibre may still be chosen as an alternate, or in addition to STP depending upon ring hardware plans.

For HD - Outlet, use STP

STP is the specified medium from HD to Outlet and should be limited in length to no more than 90 M. For information on other cables see clause 11.

Generally, the cabling is planned and implemented before specific token ring requirements or vendor selections have been made. Since the mid 1980s customer premises cabling trends for non-voice transmission have become more structured. A star cabling topology is employed from the office areas to a centralized telecommunications closet. In large buildings, separate telecommunications closets are maintained to serve each floor.

For token ring applications, communication between telecommunications closets in horizontal distributors is established by cabling from telecommunications closet/horizontal distributor to telecommunications closet/horizontal distributor directly or via the building distributor. Often, diverse routing is used for the ring completion path from last back to first telecommunications closet, so that physical disruption of a conduit carrying this trunk cabling will not result in splitting the ring into two separate segments. Note that a single break in the trunk cabling can be tolerated by removing the broken cable and employing the back-up path built into the cable. The ring will then be operational during the period of repair or replacement of the broken segment provided the initial ring design made allowance for the increased transmission path this configuration causes.

In a campus, there is normally one telecommunications closet per building which serves as the building's primary data entry point. Since token ring operation does not require direct connection of office equipment or data telecommunications closets to the building data entry point, there are no extra distance limitations from that point to the farthest telecommunications closet. General cabling guidelines may place limitations on this length. One proposed limit is 1.500 m.

For widely separated telecommunications closets, the cabling of choice connecting those closets is multimode optical fibre. 62,5/125 u the reference size multimode optical fibre is recommended. However, 50/125 u or other sizes can be used. Commercially available optical fibre converter/repeaters can typically span links of 2 km of 62,5/125 u optical fibre. Therefore, that is the recommended maximum spacing between adjacent telecommunications closets in an establishment or on a campus. Maximum link length can be computed based on the link's optical properties and on the allowable power budget.

The maximum recommended distance from DTE to TCU at the telecommunications closet as shown in table 1, is 100 m. When using this distance limit, the maximum cable attenuation (at 25 º C) for the lobe cable should not exceed 22 dB/km at 4 MHz nor 45 dB/km at 16 MHz. By wiring within these constraints, both 4 and 16 Mbit/s token rings can be configured as needed throughout the premises.

5 Requirements on cabling

5.1 Requirements on STP cabling

Accurate reception of token ring signals is based on received signal levels as specified in ISO/IEC 8802-5, and on the minimisation of crosstalk noise and external noise by the cabling. If cables meeting the specifications of table 3 are used for building cabling the distances presented in tables 1 and 2 are met.

Parameter, units	**Value and tolerance range 1)**
Characteristic impedance Ω	150 ± 15 from 2 MHz to 20 MHz
NEXT attenuation (dB)	≥ 58 from 2 MHz to 5 MHz ≥ 40 from 5 to 20 MHz
DC resistance (each conductor) &ohm/km	≤ 58
Maximum attenuation 2) dB/km	22 at 4 MHz, 45 at 16 MHz
Resistance unbalance 100(max R-min R)/min R (%)	≤ 4
Capacitance unbalance 3) (Pair to ground) pF/km	≤ 1500
DC Insulation Resistance 00 3) G Ω · km	≥ 16
Transfer impedance 3) m &ohm/m	< 20 measured below 10 kHz, or < 200 measured over the range of 2 MHz to 10 MHz

1) These parameters are based on experience with cable meeting these specification and with analysis based on these parameters. However these specification are not necessarily the limiting values for cable which would yield the required performance.

2) At other than 25 °C , the attenuation may increase for each 10 °C rise by 0,6 dB/km at 4 MHz and by 1,2 dB/km at 16 MHz. The use of higher attenuation cable is allowed, but may result in decreased distance limits and decreased configuration flexibility.

3) This value is measured at a test frequency that is within the range of 800 to 1000 Hz.

4) The 16 GΩ · km figure derives from the specification for a cable which has been sufficiently tested for token ring operation. This figure is believed to be non critical.

5) Transfer impedance is measured according to 7.1 of IEC 96-1.

Table 3 - 150 Ω Shielded twisted pair cable characteristics for 4 and 16 Mbit/s operation. All parameters are defined at 25 °C..

See clause 7 for application of these parameters to allowable network configurations.

5.2 Other cabling

Presently, optical fibre lobe attachment and 4 and 16 Mbit/s operation on UTP cabling are under consideration by IEEE 802.5, for incorporation within the standard ISO 8802-5. Use of UTP cabling for 4 Mbit/s token ring operation is discussed in Chapter 11.

6 Cabling topology

6.1 Content of chapter

The clause guides the user in planning network topology and cabling for an ISO 8802-5 token ring LAN.

6.2 Planning considerations

When feasible, all building work areas should be pre-wired with horizontal cabling, for later connection to DTEs. Since all work areas should be pre-wired whether or not there is an immediate need for DTEs in each, the total number of work areas is a measure of the potential number of DTEs and the cabling to be installed. The location of cabling and distributor should be chosen to minimise potential disruption cased by normal building renovation.

6.3 Cabling structure

The cabling plan should include both trunk and lobe cabling.

6.3.1 Trunk cabling

The two principle configurations for the trunk cabling are multi-layered physical star, and physical ring wiring. The wiring may employ either of these techniques or a combination of them to allow the greatest flexibility in providing for physical redundancy, connectivity, cable management, and network management. Trunk cabling typically includes the connection of building distributors to campus distributors and to each other, and the connection of horizontal distributors to building distributors and to each other.

Guidelines for trunk cabling:

A minimum of two trunk cables should be connected to each telecommunications closet with additional cabling based on projected needs.

In addition to the STP cables, multimode optical fibre cables are recommended in the trunk to support future growth.

The optical fibre cables should be the primary choice for interconnecting closets where the cabling distances exceed the recommendations presented for STP. Other applications of Optical Fibre include requirements for electrical isolation between telecommunications closets, high electro-magnetic noise, and data security.

6.3.2 Lobe cabling

Lobe cabling includes all cabling from the MIC in the workspace to the attachment at the distributor. The use of optical fibre and UTP for lobe cabling is under study. The use of UTP lobe cabling for 4 Mbit/s operation is discussed in clause 11. All cabling should be installed as physical stars from telecommunications closet to work area outlet. This highly functional wiring configuration allows for the creation of single or multiple rings to service the buildings users, based on their specific requirements.

6.3.3 Cable length

The maximum recommended length for cabling between telecommunications closets is 200 m. The maximum recommended length for cabling from the TCU or concentrator in the telecommunications closet to the MIC is 100 m.

6.3.4 Cable length for optical fibre cables

The maximum recommended length for multimode optical fibre cabling between telecommunications closets is 2.000 m.

6.4 Positioning cabling components

The first step in positioning concentrators is to review the area that the network will cover and decide whether the concentrators will be centralized or decentralized. Each option has advantages and disadvantages, but the centralized arrangement is the preferred alternative. The following two sections help in comparing a centralized concentrator arrangement to a decentralized concentrator arrangement.

6.4.1 Centralised arrangement

A centralised configuration is generally the most desirable from the standpoint of network installation, maintenance and growth. In addition, centralized configurations often require fewer repeaters because of the reduced trunk wiring. Therefore, this is the configuration which should be considered first. In the centralized

configuration shown in figure 9, the concentrators are clustered into one or more telecommunications closets that are central to the stations they service. This configuration minimises the length of the trunk path, compared to the alternative of spreading the concentrators out across the network. Since the requirement for repeaters or converters in a token ring network is based on the total length of the trunk path plus the longest lobe length, a centralised configuration minimises the need for repeaters or converters.

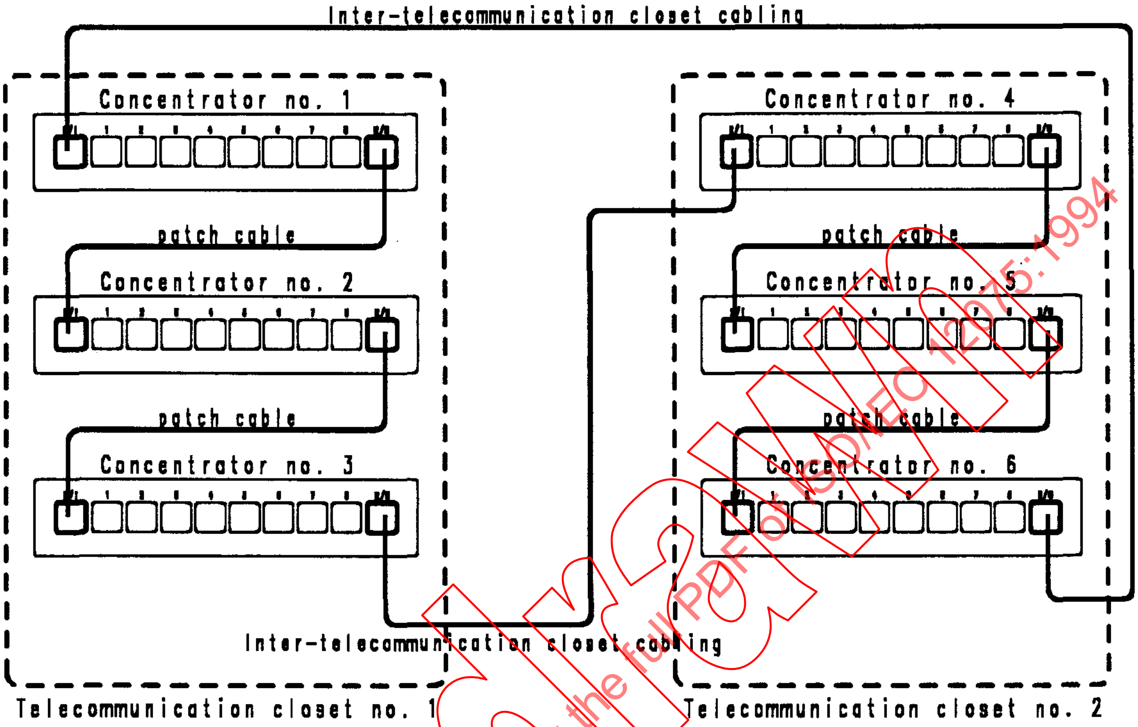


Figure 9 - Centralized concentrator arrangement

A centralized arrangement of one or more telecommunications closets is a common cabling configuration which provides the advantages associated with centralized network management while maintaining lobe lengths within maximum recommended lengths. This configuration is recommended for all large office areas which are to be pre-wired for LAN applications. A centralized arrangement makes it easier to install the main ring path. Because the concentrators are in centralized groups, interconnection is achieved using patch cables. The only long cable runs that have to be installed in the trunk path are the runs between the groups of concentrators. Troubleshooting the cable system is also made easier with a centralized arrangement. A whole group of concentrators and their cables can be tested while remaining in one location.

6.4.2 Decentralised arrangement

There are some configurations for which decentralized arrangement of concentrators is preferable. For example, if the attaching devices are widely scattered throughout the establishment, there may be no appropriate choice of telecommunications closet locations which maintain maximum lobe lengths of 100 m. In some situations, a significant savings in wiring which can be achieved by locating each concentrator near the small group of stations it services, outweighs the advantages of centralised network management.

Sites might not have any available areas where there is enough space for several concentrators. Instead of requiring that one or more large areas be set aside for concentrators, a decentralised arrangement allows the space requirement for concentrator placement to be spread throughout the establishment. Therefore, when space is limited, a decentralised arrangement may be appropriate.

Figure 10, depicts a decentralised configuration.

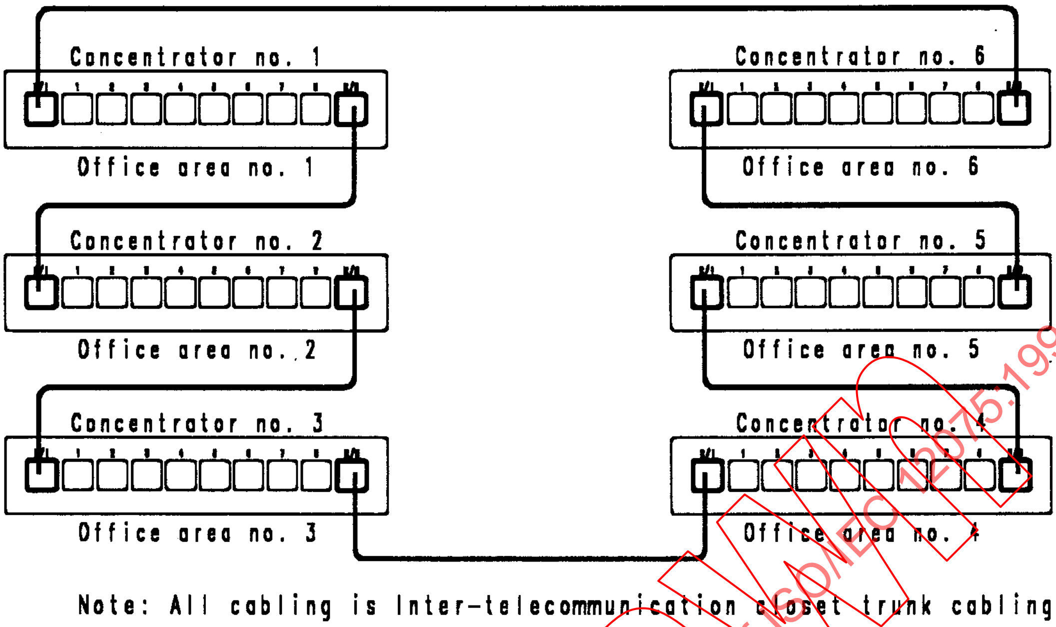


Figure 10 - Decentralised Concentrator Arrangement

6.4.3 Placement of concentrators

Once it is decided which concentrator arrangement would work best, their placement of concentrators should be determined.

If a centralized arrangement is used, open areas that have enough available space for several concentrators are required. These open areas chosen for a centralised concentrator group should be close to the stations assigned to that group, and should be chosen to ensure that maximum lobe lengths will not exceed 100 m. If a decentralized arrangement is used, each concentrator should be placed close to the group of stations it supports.

6.5 Lobe and Trunk Cable Connections

The ISO/IEC 8802-5 specifies the pin designations for transmit and receive signal at the MIC. The corresponding details for the trunk cabling and for the connection from the trunk to the lobes is not provided and cannot be inferred from Figure 7-2 in the standard (Example of station connection to the medium) since a crossover must exist at ring-in or ring-out. This subclause explicitly states the pin connections consistent with all known implementations of ISO/IEC 8802-5. For all copper trunk cabling the "Main-ring-path" twisted-pair is connected to pins R and G, while the "Back-up-path" twisted pair is connected to pins O and B. These connection assignments are maintained at all "ring-in" and "ring-out" ports of all devices which connect to the trunk cable. Therefore, the transmission path of the signal in figure 11, is from the R and G pins on the trunk, into the TCU or concentrator via the "Ring-in" port, onto the R and G pins on the lobe, through the DTE, to the O and B pins on the lobe, back to the TCU or concentrator and out the R and G pins of the "Ring-out" port. Cables meeting the requirements of this document are typically manufactured with one red/green pair and one orange/black pair. Common wiring practice is to terminate the red wire at pin R, the green wire at pin G, the orange wire at pin O and the black wire at pin B.

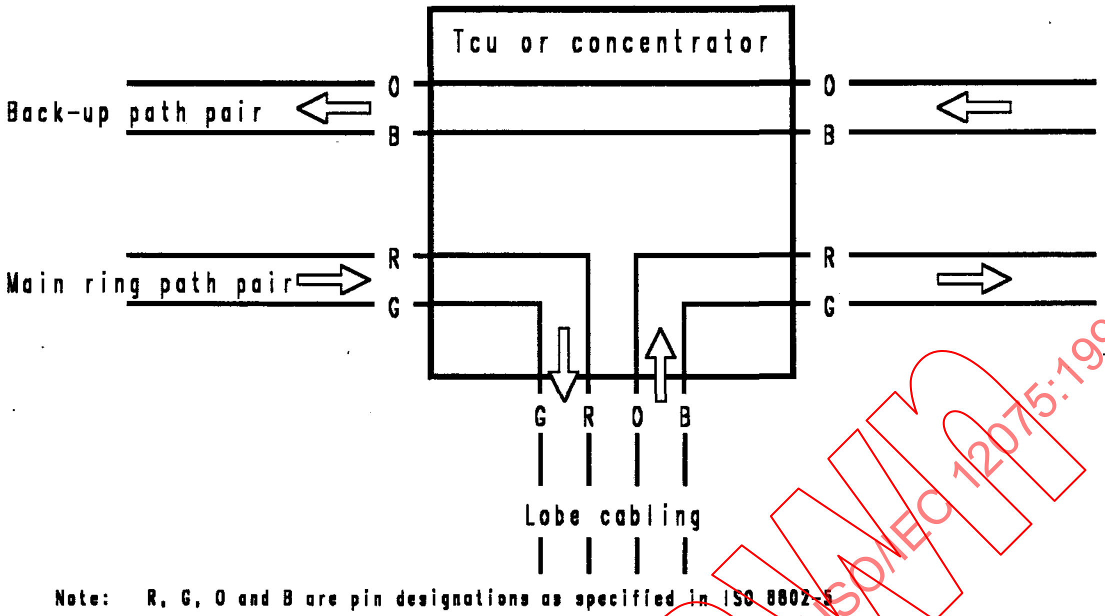


Figure 11 - Transmission path continuity at the TCU.

7 Guidelines for determining allowable network configurations

Token rings can be divided into two types, those which do and those which do not require repeaters/converters. The configuration requirement for each type is that signals generated at any station must be able to reach the MIC of a receiver station with adequate signal strength as defined in ISO/IEC 8802-5. This signal level must be attainable over the temperature range of application of the cables, using the lowest transmit voltage defined by ISO 8802-5. Where ring reconfiguration is required to accommodate restoration procedures, the receiver signal levels must still be adequate for proper operation.

A consequence of these requirements is that the longest possible transmission path must be determined, and the signal loss of that path must be computed assuming the cabling is at the maximum expected temperature for its particular installation. For single telecommunications closet configurations without repeaters, problem determination and restoration procedures normally replace suspected broken patch cables, and bypass suspected broken TCUs. Therefore, the longest transmission path will consist of the station with the longest lobe transmitting to itself and the shortest trunk cable broken. For multi-telecommunications closet rings without repeaters, the longest path is normally based on a restoration procedure where a suspected or known broken cable segment has been removed. The station with the longest lobe must still provide the drive back to itself as shown in figure 13.

When a ring has repeaters or converters as shown in figure 6, analysis of ring transmission is broken down into separate parts, one for each ring segment. The segments are bounded by repeaters or converters. Figure 1 on page 27 below illustrates an example with each segment numbered.

[1] R, G, O, and B are pin designations as specified in ISO 8802-5.

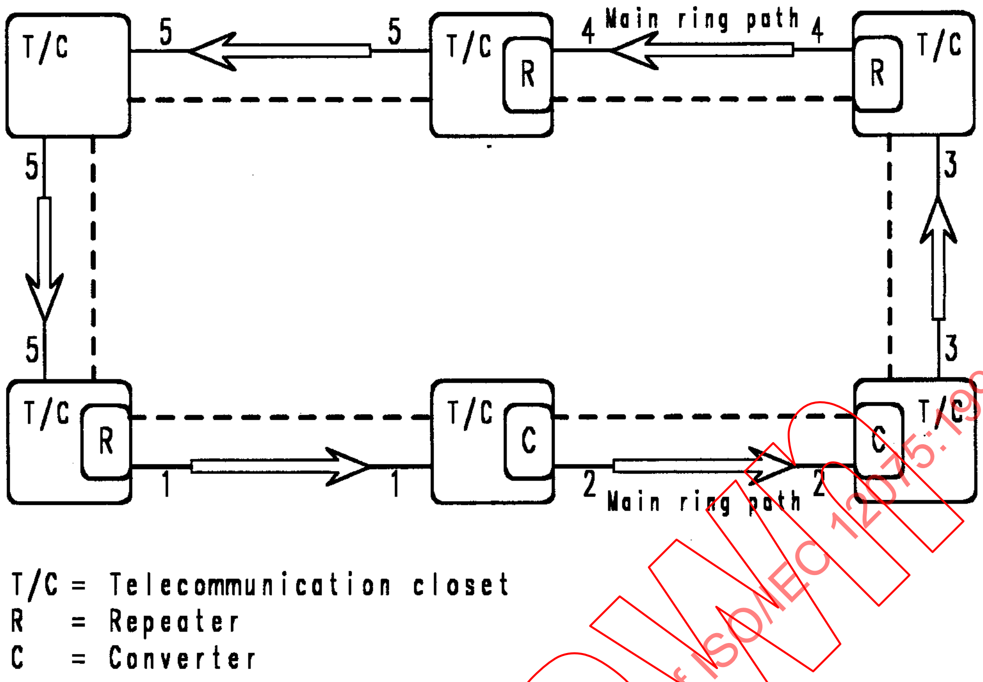


Figure 12 - Multi-Telecommunications closet configuration.

The ring in figure 12 is seen to have five separate segments.

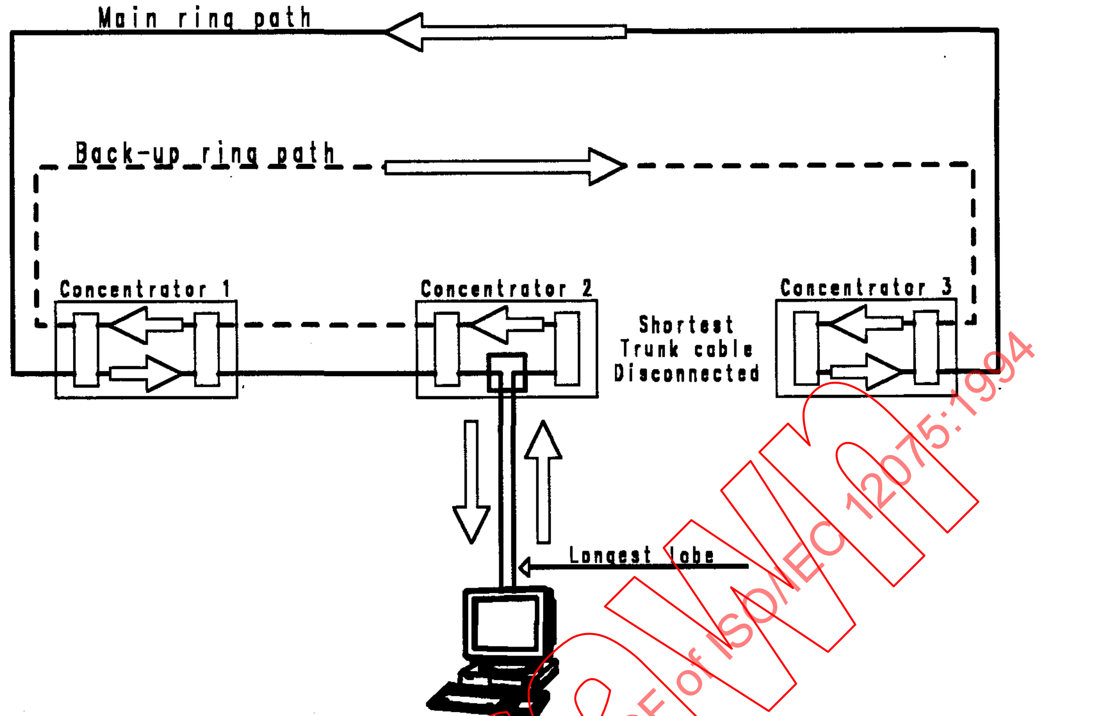
1) **Segment 1 is bounded by a repeater at its input and a converter to an alternate medium at its output.**

2) **Segment 2 is the transmission over the alternate medium.**

3) **Segment 3 is bounded by a converter at its input and a repeater at its output.**

4) **Segments 4 and 5 are both bounded by repeaters.**

Of these five segments, the second is unique. The requirements on segment 2 are that the input signal must be reproduced at the output with a waveform as defined in ISO/IEC 8802-5. The accumulated jitter must be within the limits specified for the converter by its manufacturer, in terms of the number of stations per ISO/IEC 8802-5. The delay for the segment must be specified. For the other four segments, received signal levels at any station shall always be at or greater than the minimum receive signal level as set forth in ISO/IEC 8802-5.



Note - The signal must go from any station, around the ring, to concentrator where the output wire has been disconnected. The back-up path is activated by The signal travels along the back-up path to the input of a medium unit, then the main ring path.

Figure 13 - Restored ring for worst case.

The usual assumption for system restoration, manual or automatic, is that the repeaters or converters may or may not be operational. If they are not, signals from the station with the longest lobe in each of the segments must be able to go to the input of the repeater at the segment output, wrap to the repeater at the segment input, and return back to the sending station. A second requirement is that either of the repeaters/converters at the segments input and output must be able to send a signal back to itself with the other repeater/converter wrapped and no stations in the segment active. Within this scenario is the assumption that the repeater/converter at the output of the segment has the capability to drive the back-up portion of the trunk cable under the conditions where the ring is in a wrapped state.

7.1 Attenuation limits

For 4 and 16 Mbit/s data rates, the total allowable loss in the channel between any transmitting station's MIC and the receiving station's MIC, shall be less than or equal to 19 dB. With the loss components characterised as root f attenuation and flat loss (ie. frequency independent loss), no more than 5 dB shall be attributable to flat loss *).

To use the above guidelines, add all line losses associated with the sections of permanently installed cable, and all patch cables in the transmission path between any two stations. In computing these losses, characterise all components at worst case (maximum) temperatures. If the worst case temperatures are not known, then 60 ^{o} C may be used.

*) The maximum attenuation specified for a test channel within the ISO/IEC 8802-5 is 21 dB. The difference between these values provides the margin needed for cascading token ring stations to form a ring.

8 Guidelines for documentation

8.1 General Guidelines

This clause provides guidelines for cable administration within a campus. Where national guidelines exist which are incompatible with the recommendations presented here, the national guidelines shall supersede these.

1) The cabling plant should have a numbering and labelling scheme that does not change over time and is independent of the devices that attach to it. This is essential for administering cable plant and networks since the attaching systems which will change several times in the life of the installation.

2) Cables should be labelled at each end to indicate both source and destination termination points. Termination points generally will be faceplates, distribution panels, and punchdown blocks.

3) A unique cable number, independent of source and destination information, should be assigned to each cable and recorded on each cable label.

4) Multipair cables that are terminated at several termination points should use the individual termination locations (for example, a distribution panel coordinate) to indicate the path between two termination points. The common cable number (see 3 above) will serve to indicate that the pairs are within the same cable.

5) At a minimum, appropriate labels should be applied:

- at each end of a cable run and at each termination point.

6) The following records should be maintained:

- A cable schedule for each telecommunications closet indicating the cable number, its source and destination, its type, and its current use. This schedule should be arranged both by cable number and by destination.
- A master cable schedule meeting the same requirements as listed above.
- A complete set of "as-built" cabling plans.
- A running list of work orders detailing moves and changes.

8.2 Example

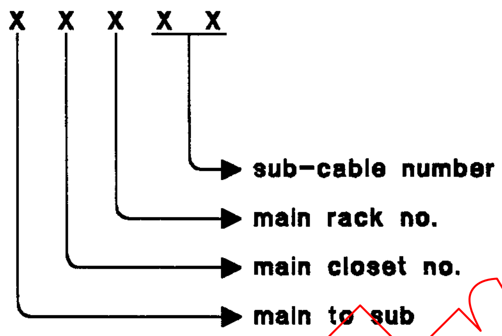
As an example of a specific implementation, figur 14, figure 15 and figure 16, can be used. Note that the number of characters used in each of the fields needs to be sufficiently large to handle all projected expansion of the cabling system for the establishment.

Label Lay-out 1/3

Label from building distributor to horizontal distributor

XXXXX – ABCDDE – FF
GHIJJK – LL – MM NN

cable number :



A = building (character)
B = floor number
C = X – coordinate (character)
DD = Y – coordinate (digit)
E = subcoordinate (digit)
FF = rack no. / panel no.
NN = coordinate in panel
coordinate from :
G = X – building (character)
H = X – floor number
I = X – coordinate (character)
JJ = Y – coordinate (digit)
K = Y – subcoordinate (digit)
LL = rack no. / panel no.
MM = coordinate in panel

Figure 14 - Building labels.

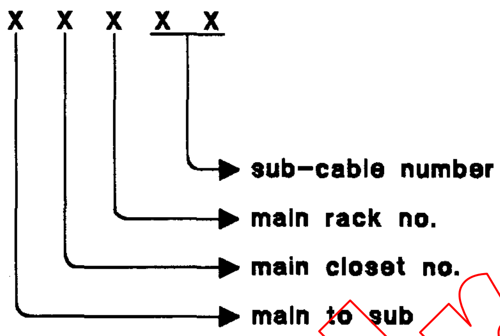
Label Lay-out 2/3

Label from horizontal distributor to horizontal distributor

XXXXX - ABCDDE - FF

GHIJJK - LL - MM NN

cable number :



A = building (character)

B = floor number

C = X - coordinate (character)

DD = Y - coordinate (digit)

E = subcoordinate (digit)

FF = rack no. / panel no.

NN = coordinate in panel

coordinate from :

G = X - building (character)

H = X - floor number

I = X - coordinate (character)

JJ = Y - coordinate (digit)

K = Y - subcoordinate (digit)

LL = rack no. / panel no.

MM = coordinate in panel

Figure 15 - Horizontal labels.

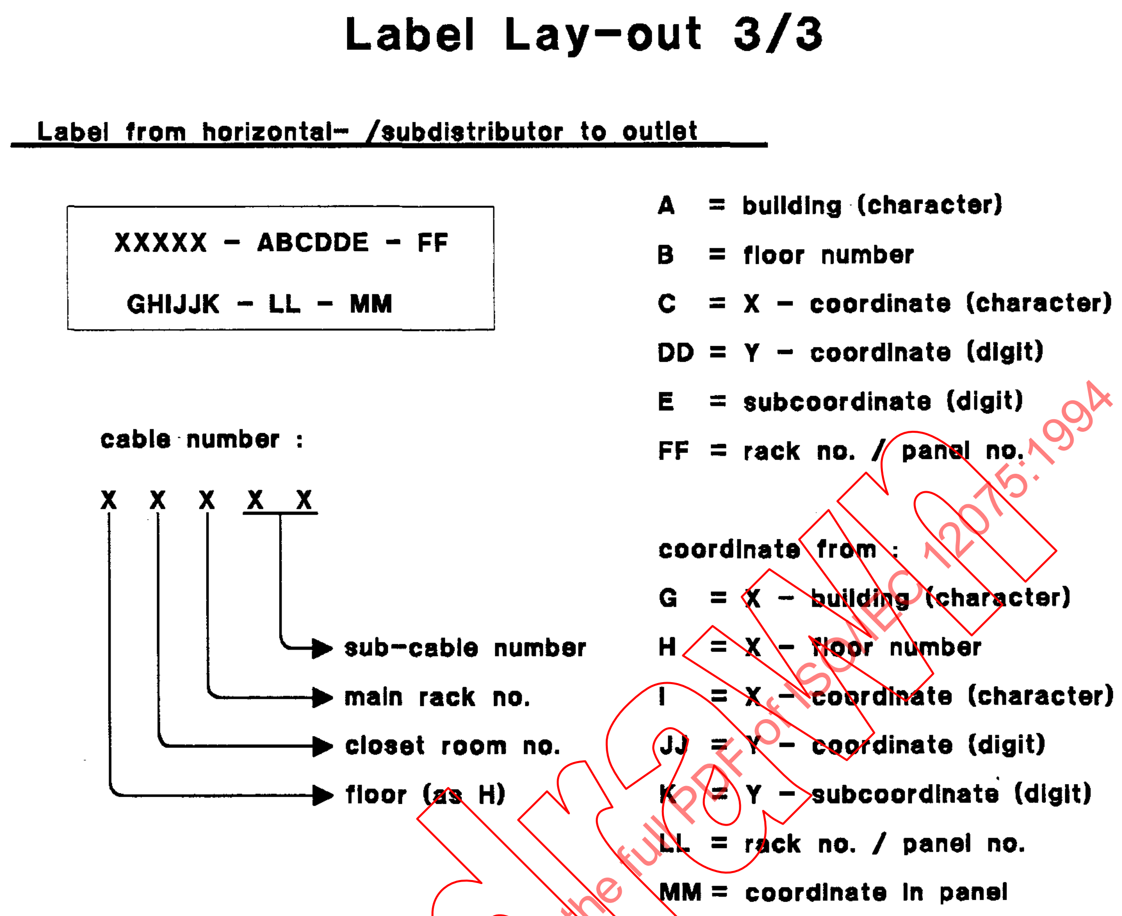


Figure 16 - Work area outlet labels.

9 Relevant safety standards

The following is an informative bibliography of standards containing provisions which should be observed. At the time of publication, the editions, where indicated, were valid. Where these referenced standards have been superseded, the latest editions should be used.

IEC 74 and IEC 153	Particular safety requirements for equipment to be connected to telecommunication networks
IEC 364	Electrical installations of buildings
IEC 479	Effects of current passing through the human body
IEC 529: 1989	Classification of degrees of protection provided by enclosure (IP Code)
IEC 536: 1976,	Classification of electrical and electronic equipment with regard to protection against electric shock.
IEC 664-1:	Insulation coordination for equipment within low voltage systems - Part 1: Principles, requirements and tests