TECHNICAL REPORT

ISO/IEC TR 10738

ANSI/IEEE Std 802.5b

First edition
1993-03-05

Information technology — Local and metropolitan area networks — Token ring access method and physical layer specifications — Recommended practice for use of unshielded twisted pair cable (UTP) for token ring data transmission at 4 Mbit/s

Technologies de l'information — Réseaux locaux et urbains — Méthode d'accès par anneau à jeton et spécifications pour la couche physique — Pratique recommandée pour l'utilisation de paire de câbles torsadés sans protection pour transmission de données par anneau à jeton à 4 Mbits/s

Reference number
ISO/IEC TR 10738:1993 (E)
ANSI/IEEE
Std 802.5b, 1993 Edition

The Institute of Electrical and Electronics Engineers, Inc.
345 East 47th Street, New York, NY 10017-2394, USA

ISBN 1-55937-273-7

March 5, 1993 *SH15792*

ISO/IEC TR 10738 : 1993
ANSI/IEEE Std 802.5b, 1993 Edition
(Supplement to ISO/IEC 8802-5 : 1992)

Information technology—Local and metropolitan area networks—Token ring access method and physical layer specifications—Recommended practice for use of unshielded twisted pair cable (UTP) for token ring data transmission at 4 Mbit/s

Sponsor

Technical Committee on Computer Communications of the IEEE Computer Society

Approved June 26, 1991

IEEE Standards Board

Approved December 12, 1991

American National Standards Institute

Abstract: The recommended practice for using unshielded twisted pair cables (UTP) for transmitting data at 4 Mb/s is described. Signal characteristics, unshielded twisted pair transmission characteristics, medium interface connection, cable routing, bit error rate, safety, and reliability are covered.
Keywords: token ring access method, token ring data transmission, token ring networks, unshielded twisted pair cable

Published by
The Institute of Electrical and Electronics Engineers, Inc.

ISO/IEC TR 10738 : 1993

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) 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 committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison 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 JTC 1.

The main task of technical committees is to prepare International Standards, but 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 under technical development or where for any other reason there is the future but not immediate possibility of an agreement on an International Standard;
- type 3, when a technical committee has collected data of a different kind from that which is normally published as an International Standard ("state of the art," for example).

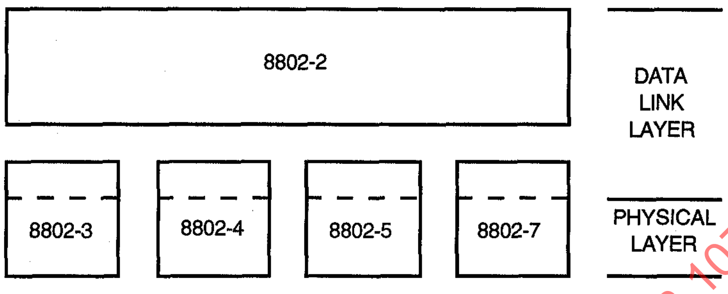
Technical Reports of types 1 and 2 are subject to review within three years of publication, to decide whether they can be transformed into International Standards. Technical Reports of type 3 do not necessarily have to be reviewed until the data they provide are considered to be no longer valid or useful.

ISO/IEC TR 10738, which is a Technical Report of type 3, was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology.*

International Organization for Standardization/International Electrotechnical Commission
Case postale 56 • CH-1211 Genève 20 • Switzerland

Foreword to Technical Report ISO/IEC TR 10738 : 1993

This technical report is part of a family of standards for Local and Metropolitan Area Networks. The relationship of the members of the family to each other is shown below. (The numbers in the figure refer to ISO standard numbers.)



This family of standards deals with the physical and data link layers as defined by the ISO Open Systems Interconnection Basic Reference Model (ISO 7498 : 1984). The access standards define four types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining these technologies are as follows:

a) ISO/IEC 8802-3 [ANSI/IEEE Std 802.3, 1992 Edition], a bus utilizing CSMA/CD as the access method,
b) ISO/IEC 8802-4 [ANSI/IEEE Std 802.4-1990], a bus utilizing token passing as the access method,
c) ISO/IEC 8802-5 [ANSI/IEEE Std 802.5-1992], a ring utilizing token passing as the access method,
d) ISO 8802-7, a ring utilizing slotted ring as the access method.

ISO 8802-2 [ANSI/IEEE Std 802.2-1989], Logical Link Control protocol, is used in conjunction with the medium access standards.

The reader of this document is urged to become familiar with the complete family of standards.

IEEE Standards documents are developed within the Technical Committees of the IEEE Societies and the Standards Coordinating Committees of the IEEE Standards Board. Members of the committees serve voluntarily and without compensation. They are not necessarily members of the Institute. The standards developed within IEEE represent a consensus of the broad expertise on the subject within the Institute as well as those activities outside of IEEE which have expressed an interest in participating in the development of the standard.

Use of an IEEE Standard is wholly voluntary. The existence of an IEEE Standard does not imply that there are no other ways to produce, test, measure, purchase, market, or provide other goods and services related to the scope of the IEEE Standard. Furthermore, the viewpoint expressed at the time a standard is approved and issued is subject to change brought about through developments in the state of the art and comments received from users of the standard. Every IEEE Standard is subjected to review at least once every five years for revision or reaffirmation. When a document is more than five years old, and has not been reaffirmed, it is reasonable to conclude that its contents, although still of some value, do not wholly reflect the present state of the art. Users are cautioned to check to determine that they have the latest edition of any IEEE Standard.

Comments for revision of IEEE Standards are welcome from any interested party, regardless of membership affiliation with IEEE. Suggestions for changes in documents should be in the form of a proposed change of text, together with appropriate supporting comments.

Interpretations: Occasionally questions may arise regarding the meaning of portions of standards as they relate to specific applications. When the need for interpretations is brought to the attention of IEEE, the Institute will initiate action to prepare appropriate responses. Since IEEE Standards represent a consensus of all concerned interests, it is important to ensure that any interpretation has also received the concurrence of a balance of interests. For this reason IEEE and the members of its technical committees are not able to provide an instant response to interpretation requests except in those cases where the matter has previously received formal consideration.

Comments on standards and requests for interpretations should be addressed to:

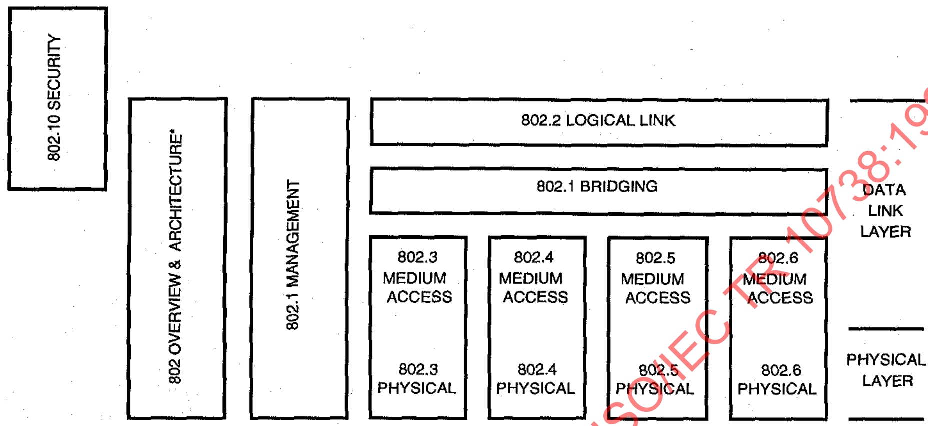
Secretary, IEEE Standards Board
345 East 47th Street
New York, NY 10017
USA

IEEE Standards documents are adopted by the Institute of Electrical and Electronics Engineers without regard to whether their adoption may involve patents on articles, materials, or processes. Such adoptions does not assume any liability to any patent owner, nor does it assume any obligation whatever to parties adopting the standards documents.

Foreword to ANSI/IEEE Std 802.5b, 1993 Edition

(This foreword is not a part of ANSI/IEEE Std 802.5b, 1993 Edition, IEEE Recommended Practice for Use of Unshielded Twisted Pair Cable (UTP) for Token Ring Data Transmission at 4 Mb/s.)

This recommended practice is part of a family of standards for local and metropolitan area networks. The relationship of the members of the family to each other is shown below. (The numbers in the figure refer to IEEE standard numbers.)



* Formerly IEEE Std 802.1A.

This family of standards deals with the Physical and Data Link Layers as defined by the ISO Open Systems Interconnection Basic Reference Model (ISO 7498 : 1984). The access standards define several types of medium access technologies and associated physical media, each appropriate for particular applications or system objectives. Other types are under investigation.

The standards defining these technologies are as follows:

• IEEE Std 802[1]:	Overview and Architecture. This standard provides an overview to the family of IEEE 802 Standards. This document forms part of the 802.1 scope of work.
• IEEE Std 802.1D:	MAC Bridging. Specifies an architecture and protocol for the interconnection of IEEE 802 LANs below the MAC service boundary.
• IEEE Std 802.1E:	System Load Protocol. Specifies a set of services and protocol for those aspects of management concerned with the loading of systems on IEEE 802 LANs.
• ISO 8802-2 [ANSI/IEEE Std 802.2]:	Logical Link Control
• ISO/IEC 8802-3 [ANSI/IEEE Std 802.3]:	CSMA/CD Access Method and Physical Layer Specifications
• ISO/IEC 8802-4 [ANSI/IEEE Std 802.4]:	Token Bus Access Method and Physical Layer Specifications
• ISO/IEC 8802-5 [ANSI/IEEE Std 802.5]:	Token Ring Access Method and Physical Layer Specifications

[1]The 802 Architecture and Overview Specification, originally known as IEEE Std 802.1A, has been renumbered as IEEE Std 802. This has been done to accommodate recognition of the base standard in a family of standards. References to IEEE Std 802.1A should be considered as references to IEEE Std 802.

- IEEE Std 802.6: Metropolitan Area Network Access Method and Physical Layer Specifications

- IEEE Std 802.10: Interoperable LAN/MAN Security (SILS)—Secure Data Exchange (SDE) [*Currently contains* Secure Data Exchange (Clause 2)]

In addition to the family of standards, the following is a recommended practice for a common technology:

- IEEE Std 802.7: IEEE Recommended Practice for Broadband Local Area Networks

Conformance test methodology

An additional standards series, identified by the number 1802, has been established to identify the conformance test methodology documents for the 802 family of standards. This makes the correspondence between the various 802 standards and their applicable conformance test requirements readily apparent. Thus the conformance test documents for 802.3 are numbered 1802.3, the conformance test documents for 802.5 will be 1802.5, etc. Similarly, ISO will use 18802 to number conformance test standards for 8802 standards.

This standard contains state-of-the-art material. The area covered by this standard is undergoing evolution. Revisions are anticipated to this standard within the next few years to clarify existing material, to correct possible errors, and to incorporate new related material. Information on the current revision status of this standard may be obtained by contacting

Secretary, IEEE Standards Board
Institute of Electrical and Electronics Engineers, Inc.
PO Box 1331, 445 Hoes Lane
Piscataway, NJ 08855-1331
USA

Participants

When the IEEE 802.5 Working Group approved ANSI/IEEE Std 802.5b-1991, it had the following membership:

Robert A. Donnan, *Chair*

Don Aelmore
Charles Amann
Rey Bautista
Alan Beardsley
Steve Belisle
Philip Brownlee
Patrik Bulteel
Robert R Campbell
Hsin-Hwai Chen
Thomas Coradetti
Rick Downs
Hanoch Eldar
Farzin Firoozmand
Gunnar Forsberg
Nathan Fritts
Harry Gold
Tom Gulick
Sharam Hakimi
James Harrer
Carl G. Hayssen
Tricia Hill
Paul Hittel
Tom Hogan
Clarence C. Joh
Arthur D. Jopling
Dave Juhre
Lisa Kelley
Bryan B. Kim
David M. Kollm
William F. Kous
Katie D. Lee
Robert D. Love
Carl Madison
Alan C. Marshall
Kelly P. McClellan
Colin Mick
Arthur Miller
John E. Montague
Steven Moustakas
Bilal Murtaza
Andrew Norton
Brian O'Connell
Dave Pearce
Thanh Pham
Richard Podgalsky
Kirk Preiss
Ivan Reede
Everett O. Rigsbee III
Andrew L. Ringwald
Bob Ross
Jacques A. Roth
Mike Rubera
Howard Rubin
Haig A. Sarkissian

David Sheehy
Marc Shoquist
Somsubhra Sikdar
Raymond Sit
Bob Smith
Robert Snyder
Bob Southard
Louis Stankaitas
Leo Staschover
Ed Sterling
Richard Sweatt
Andre Szczepanek
Hidenori Takahashi
Peter Williams
Lars Thernsjo
Scott Thomas
Jeff Tong
Akihisa Toyooka
John Trites
Chang-Jung Wang

The following persons were on the balloting committee that approved this document for submission to the IEEE Standards Board:

William B. Adams
Don Aelmore
Kit Athul
William E. Ayen
George S. Carson
Chih-Tsai Chen
Michael H. Coden
Robert Crowder
Richard Denton
R. A. Donnan
Mitchell Duncan
John E. Emrich
Philip H. Enslow
John W. Fendrich
Hal Folts
Harvey Freeman
Patrick Gonia
Ambuj Goyal
Joseph L. Hammond
J. Scott Haugdahl
Richard Iliff
Raj Jain
Samuel Kho
David M. Kollm
Thomas Kurihara
Anthony B. Lake
Mike Lawler
Lee Jaiyong
F. C. Lim
Randolph Little
William D. Livingston
Donald C. Loughry
Joseph F. P. Luhukay
Darrell B. McIndoe
David S. Millman
Aditya N. Mishra
John E. Montague
Kinji Mori
David J. Morris
Arne A. Nilsson
Charles Oestereicher
Young Oh
Thomas L. Phinney
Rafat Pirzada
Udo W. Pooch
Marya S. Repko
John P. Riganati
Gary S. Robinson
Julio Sanz
Ambatipudi R. Sastry
Norman Schneidewind
Adarshpal S. Sethi
D. A. Sheppard
Leo Sintonen
Ind. Alex. Soceanu
Robert K. Southard
John Spragins
Carel M. Stillebroer
Fred Strauss
Efstathios D. Sykas
Daniel Sze
Ahmed Tantawi
Nathan Tobol
David L. Umbaugh
Thomas A. Varetoni
James Vorhies
Don Weir
Michael Willett
George B. Wright
Oren Yuen

The final conditions for approval of this recommended practice were met on June 26, 1991. This recommended practice was conditionally approved by the IEEE Standards Board on March 21, 1991, with the following membership:

Marco W. Migliaro, *Chair* **Donald C. Loughry,** *Vice Chair*
Andrew G. Salem, *Secretary*

Dennis Bodson
Paul L. Borrill
Clyde Camp
James M. Daly
Donald C. Fleckenstein
Jay Forster*
David F. Franklin
Ingrid Fromm
Thomas L. Hannan
Donald N. Heirman
Kenneth D. Hendrix
John W. Horch
Ben C. Johnson
Ivor N. Knight
Joseph L. Koepfinger*
Irving Kolodny
Michael A. Lawler
John E. May, Jr.
Lawrence V. McCall
Donald T. Michael*
Stig L. Nilsson
John L. Rankine
Ronald H. Reimer
Gary S. Robinson
Terrance R. Whittemore

*Member Emeritus

Paula M. Kelty
Kristin M. Dittmann
IEEE Standards Project Editors

Contents

Information technology— Local and metropolitan area networks—Token ring access method and physical layer specifications— Recommended practice for use of unshielded twisted pair cable (UTP) for token ring data transmission at 4 Mbit/s

1. Introduction to the recommended practice

This supplement to ISO/IEC 8802-5 : 1992 (ANSI/IEEE Std 802.5-1992) describes the recommended practice for using unshielded twisted pair cables (UTP) for transmitting data at 4 Mb/s. A standard to support token ring over unshielded twisted pair is a subject for future study.

1.1 Scope

There are many applications where UTP can be successfully used if noise sources are controlled as recommended in this document. The need to use existing wiring, or to minimize short-term installation costs, makes the decision to use UTP for 4 Mb/s token ring operation an appropriate business decision for many installations.

When UTP is used in the channel, the resulting token ring operation will be limited. The limitations include a maximum attach capability of 72 stations instead of 250. In addition, the error rate performance is highly dependent upon noise sources that may interfere with ring operation. Guidance is provided to help minimize ring error rate.

The transmit and receive waveforms are different from those described in 7.5 of ISO/IEC 8802-5 due to the need for media filters to prevent excessive electromagnetic radiation from the UTP and to control common-mode noise. The characteristics at the media filter are defined in clause 3. It is an element in the transmission signal path and is matched to the token ring transmitter and receiver. Since a media filter may be designed for a particular transmitter/receiver, it may not be suitable for use with other stations due to electromagnetic radiation compliance. Therefore, interchangeability of stand-alone UTP media filters across attaching stations is not assured by this practice.

1.2 Overview

Within this document, UTP will be used to mean 100 Ω unshielded twisted pair cable. This type of cable has previously been called telephone wire. Token ring operation using UTP media, while not conforming to ISO/IEC 8802-5, will provide satisfactory operation in many applications when used according to these recommendations. In many applications, the use of UTP as the lobe media (the wire used for transmission from the user areas to the trunk coupling unit) is viable and will lead to satisfactory ring operation using stations that conform to ISO/IEC 8802-5. However, this operation is not part of that standard.

A consequence of using UTP for token-ring application is the modification of the transmitted waveforms to limit electromagnetic radiation and NEXT (near-end crosstalk) noise. Many countries have regulations limiting high-frequency energy radiated from telephone cables as well as electronic equipment. Since UTP cables do not limit this radiation as well as shielded cables, the high frequency content of the Manchester signals that are transmitted on the UTP must be limited by the media filter. In addition, the filtering also limits the amount of high-frequency components that can be coupled by crosstalk into adjacent pairs in a cable sheath. Limitation of the high-frequency crosstalk reduces the incident noise into the receiver from the station's transmitter. That transmitted signal, which may be at maximum signal strength, propagates along the wires adjacent to the twisted pair connected to the receiver.

This recommended practice specifies the data transmission performance characteristics of the filter/station combination for station interoperability. Radiation-limiting characteristics of the media filter are not specified. Equipment should comply with local and national codes for limiting electromagnetic interference.

1.3 References

ANSI/ICEA S-80-576-1988, Telecommunications Wire and Cable for Wiring of Premises.[1]

EIA/TIA-568 (1991), Commercial Building Wiring Standard.[2]

IEC 189-2 (1981), Low-frequency cables and wires with p.v.c. insulation and p.v.c. sheath. Part 2: Cables in pairs, triples, quads and quintuplets for inside installations.[3]

ISO 8877:1987, Information processing systems—Interface connector and contact assignments for ISDN basic access interface located at reference points S and T.[4]

2. Signal characteristics

Except for those specifications addressed below, the media specified in clause 3 and the safety considerations addressed in clause 7, all sections of the Physical Layer remain unchanged. This includes symbol encoding and decoding, symbol timing, buffering, ring-access control, and electromagnetic radiation.

---

[1]This ICEA publication is available from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA. (For information about a future revision, contact ICEA, P.O. Box 411, South Yarmouth, MA 02664, USA.)

[2]EIA publications are available from Global Engineering, 1990 M Street NW, Suite 400, Washington, DC 20036, USA.

[3]IEC publications are available from IEC Sales Department, Case Postale 131, 3 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse. IEC publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10035, USA.

[4]ISO publications are available from ISO, Case Postale 56, 1 rue de Varembé, CH-1211, Genève 20, Switzerland/Suisse. ISO publications are also available in the United States from the Sales Department, American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036, USA.

The signal characteristics for transmission on a UTP system listed below can be met by a conformant station combined with a media filter as part of the transmitter and receiver interface to the UTP media. The relevant characteristics of the filter are not specified alone, but combined with the function of the transmitter and receiver. The methodology was selected to allow each manufacturer maximum flexibility in filter design while maintaining interoperability requirements. The required filtering of the Manchester signals will be performed by the media filter, which may perform any of the following:

a) Differential-mode filtering;
b) Common-mode filtering;
c) Impedance matching.

2.1 Overview

The Physical Layer is divided into three segments: the transmitter, including all components in the transmission path up to the first medium interface connection; the channel, including the installed cabling, connectors, and coupling units; and the receiver, including all components following the last medium interface connection. Each segment is specified independently to assure compatibility among different suppliers. The specifications in this subclause do not address ring-access control.

The interfaces between the three segments are defined at the medium interface connections, which are the UTP interfaces nearest the attaching stations, usually a wall-mounted jack mated to a modular plug. The media filter is included in the transmitter and receiver segments. The connectors are defined in clause 4. The interfaces are defined for 100 Ω loads and therefore will have a voltage transformation with respect to the shielded 150 Ω system.

The physical and logical size of a network of token rings using UTP can be extended with bridges, repeaters, etc. Lobe lengths, attachment limits, and required number of repeaters may be different for UTP networks incorporating these choices than for rings using strictly 150 Ω shielded twisted pair media (STP).

2.2 Transmitter

The transmitter includes all the components in the transmission path up to the first medium interface connection. Phantom drive signaling requirements, measured in the UTP case at the first medium interface connection on the TCU side of the media filter, are unchanged from those specified for shielded twisted pair. The transmitter interface to the UTP media will be at the output of the media filter specified below. The transmit asymmetry, TA, is defined in 7.5.1 of ISO/IEC 8802-5.

2.2.1 Differential output voltage

The transmitter output is specified at the medium interface connection with a 100 Ω resistive termination. The transmitted signal should be a differential signal centered around ground with a peak-to-peak (p-p) amplitude between 2.5 and 3.7 V. (These levels are equivalent to 3.0–4.5 V p-p into a 150 Ω load.) The transmitter waveform should have the characteristics of a signal that is the result of passing a square wave signal through a bandpass filter with a high-pass 3 dB point below 30 kHz, and one or two low-pass poles having a combined 3 dB point above 4.6 MHz. The 3 dB points are measured with respect to the passband loss, which should be less than 0.5 dB over the range 100 kHz to 1 MHz. The amplitude of the positive and negative transmitted levels should be balanced within 5%.

2.2.2 Media filter

The transmitter should contain a media filter that is used to interface with the UTP media. (The receiver is not required to have a media filter.) When a conformant station is used, a media filter is required. This filter, when combined with any output filter that is provided by the conformant station, should provide the transmitter waveform specified above. The filter should match the media as described below.

2.2.3 Differential output impedance

The differential output impedance should be such that any reflection, due to differential signals incident upon the transmitter from the UTP channel, which has a characteristic as specified in clause 3, should be at least 12 dB below the incident signal over the frequency range of 1–8 MHz. This return loss is defined as follows:

$$RL = 20\log(|Z_t + Z_c| / |Z_t - Z_c|)$$

where

Z_t is the impedance looking into the transmitter

Z_c is the characteristic impedance of the UTP

2.2.4 Common-mode rejection

The transmitter should have a balanced output to minimize the conversion of common-mode noise to differential noise. For common-mode input noise in the frequency range 1 kHz to 8 MHz, the reflected differential-mode noise should be at least 40 dB below the input common-mode noise. The differential output voltage and output jitter characteristics should be met in the presence of a common-mode ac voltage of 20 V p-p at all frequencies from 60 Hz to 8 MHz.

2.3 Channel

The channel is treated as a two-port device, the ports being at the UTP interface connectors for the transmitting and receiving stations. As described in 7.5.3 of ISO/IEC 8802-5, the channel characteristics are specified in order to verify transmitter and receiver interoperability. The channel is characterized as a network with a square-root-frequency attenuation (SQA), plus a flat attenuation (ATT), plus rational poles. The flat attenuation should not exceed 6 dB. There should be no rational poles between 50 kHz and 16 MHz. The maximum channel attenuation is defined by the minimum eye size required by the receiver.

When the channel is driven by a transmitter described in 2.2, and any valid data pattern, the signal at the output of the passive equalizer attached to the receiver end of the channel should have an eye height greater than 82 mV p-p over the center 1/3 of the half-bit time as shown in Fig 7-3 of ISO/IEC 8802-5. (This voltage level is equivalent to a 100 mV eye after the 100–150 Ω transformation.)

The eye trigger should be provided by the transmitter clock. The eye should be measured at the output of the passive equalizer described in 7.5.3 of ISO/IEC 8802-5, which has poles at 2.7 MHz and 16 MHz, a zero at 0.54 MHz, and an input impedance of 100 Ω.

NOTE—The voltage of 100 mV compared to the minimum eye opening of the 50 mV p-p in 7.5.3 of ISO/IEC 8802-5 provides additional noise margin for UTP operation.

2.4 Receiver

Definitions of the following elements can be found in 7.5.4 of ISO/IEC 8802-5. Specifications for uncorrelated jitter, jitter bandwidth, and jitter tolerance are not altered by UTP transmission.

2.4.1 Differential input voltage

Referring to 7.5.2, figure 7.3, of ISO/IEC 8802-5, the receiver should operate properly whenever the received eye as measured through the reference equalizer is greater than 82 mV p-p over the center third of the half-bit time. The eye is based on the reception of a pseudo-random signal and is triggered from the transmitter clock.

2.4.2 Differential input impedance

The receiver should be matched to the transmission media. The differential input impedance should be such that any reflection, due to differential signals incident upon the receiver from the UTP channel, which has a characteristic as specified in clause 3, should be at least 12 dB below the incident signal over the frequency range of 1–8 MHz. This return loss is defined as follows:

$$RL = 20\log(|Z_r + Z_c|/|Z_r - Z_c|)$$

where

Z_r is the input impedance of the receiver
Z_c is the characteristic impedance of the UTP

2.4.3 Common-mode rejection

The receiver should operate in the presence of an ac common-mode voltage of 20 V p-p at all frequencies between 60 Hz and 8 MHz.

2.4.4 Correlated jitter

The correlated jitter output, as defined in 7.5.3.1 of ISO/IEC 8802-5, should be less than 0.063 UI. (A unit interval [UI] is equal to 125 ns.) This specification corresponds to unfiltered correlated jitter (UCJ) being less than 0.063 UI, and no specification on filtered correlated jitter.

2.4.5 Uncorrelated jitter

Uncorrelated jitter specified in 7.5.3.2 of ISO/IEC 8802-5, is not altered by the UTP media.

2.4.6 Jitter bandwidth

The jitter bandwidth specified in 7.5.3.3 of ISO/IEC 8802-5 is not altered by the UTP media.

2.4.7 Jitter tolerance

Jitter tolerance specified in 7.5.3.4 of ISO/IEC 8802-5 is not altered by the UTP media.

3. Unshielded twisted pair cable (UTP) transmission characteristics

This clause recommends the transmission parameters for the UTP. Two transmission parameters that affect token ring performance are attenuation and crosstalk. Since a significant number of UTP token ring network applications will use existing in-place cable, these recommended transmission parameters have taken into account the characteristics of this cable to ensure that it may be utilized. The following specifications can generally be met by 0.4–0.5 mm (24 to 22 AWG) UTP.

3.1 Attenuation

The following attenuation characteristics are recommended maximum limits and permit cables with better characteristics to be used.

Frequency (MHz)	Maximum attenuation (dB/km @ 20 °C)
1.0	26
4.0	52
10.0	98

3.2 Near-end crosstalk (NEXT) attenuation

The recommended minimum near-end differential crosstalk attenuation between the two twisted pairs used in a token ring network application is shown below.

Frequency (MHz)	Minimum attenuation (dB @ 20 °C)
1.0	41.0
4.0	32.0
10.0	26.0

3.3 Cable physical configuration

The cable should have a minimum of six twists per meter. In addition, to avoid periodic repetitions of the twist lengths of pairs within the cable, the twist length of individual pairs should be unique and not integral multiples of a common length.

3.4 Differential characteristic impedance

The magnitude of the differential characteristic impedance at 4 MHz of each twisted pair should be 100 ± 15 Ω.

3.5 Supporting media standards

For new installations, UTP with attenuation and crosstalk characteristics no worse than those specified in EIA/TIA-568,[5] should be used. This referenced publication provides telecommunication cabling guidelines for commercial building and specifications for a variety of media, including 100 Ω UTP. Existing cable should conform to ANSI/ICEA S-80-576, IEC 189-2, or EIA/TIA-568.

[5]Information on references can be found in 1.3.

4. Medium interface connection

Since the primary connector used with UTP is the modular connector, it is recommended for medium interface connection. Both the 6-pin and 8-pin wall connectors are recommended for all UTP token ring applications. (When a UTP cable is used for both voice and token ring signals, the voice is normally connected to a separate jack.) For the 6-pin and 8-pin connectors, the convention at the wall outlet is as follows:

	←6-PIN JACK→						←8-PIN JACK→							
Terminal No.	1	2	3	4	5	6	1	2	3	4	5	6	7	8
Designator	U	Tx	Rx	Rx	Tx	U	U	U	Tx	Rx	Rx	Tx	U	U

NOTES

1—Designators U are unassigned and not used by token ring.

2—The physical dimensions of the 8-pin jack are specified in ISO 8877.

Careful attention must be paid to the wiring, insuring that both transmit "Tx" terminals and the receive "Rx" terminals are each assigned to separate UTP pairs. Continuity of the pairs must be maintained from the wall outlet to the telephone connecting blocks in the telephone closet. Testing the continuity of the UTP link before attaching the station is recommended. The following signal wiring continuity should be observed in wiring stations to the ring using UTP media and modular connectors:

Station signal assignment	6-pin jack (pin no.)	8-pin jack (pin no.)	Data connector code	TCU pin function
Tx	2	3	B	Rx
Rx	3	4	R	Tx
Rx	4	5	G	Tx
Tx	5	6	O	Rx

NOTE—The station transmit and receive circuits are connected to the TCU receive and transmit circuits, respectively.

5. Cable routing

Telephone wiring practices have a significant effect on the capability of a UTP wiring system to accommodate token ring signals. For satisfactory transmission, in addition to conforming with the specifications in the previous clauses, the following conditions should be met:

a) The UTP cable should be free of splices, stubs, and bridge taps.
b) The wiring run from the TCU to the wall outlet should pass through no more than two connecting blocks (sometimes referred to as "punchdown blocks").
c) When token-ring signals are carried in cables that are routed through floor ducts, the ducts should be properly grounded.
d) Cables should be routed away from all sources of interference. These include power lines, motors, radio interference, fluorescent lights, and heavy machinery.
e) For transmission between TCUs, UTP should not be used.
f) Where there are both UTP and STP lobes on the same ring, attach limits are based on a maximum ring count of 72 stations.

g) Token-ring signals should not be routed through UTP cables that exit a building or which are adjacent to cables either exiting a building or exposed to direct lightning strikes and power surges.

h) UTP cables that contain token-ring signals should contain no more than one wire pair carrying analog voice signals and one wire pair carrying digital data signals.

i) For single wiring closet rings, lobe lengths should not exceed 100 meters of 0.4 mm or 0.5 mm wire from attaching device to the TCU.

Where possible, it is recommended that a dedicated UTP cable be used for token ring signals. If this practice is followed, the crosstalk noise due to other signals in the cable is minimized and a lower error rate is realizable.

NOTE—The transmission distances supported by UTP for token ring operation are 1/3 to 1/2 those supported by STP. In addition, simultaneous use of multi-pair UTP for token ring and other high-speed data with telephone service may further limit the token ring drive distance and increase the system error rate.

6. Bit error rate

The error rate of the token ring is a function of both the environmental electrical noises and the noise generated by signals on the wire pairs in the same cable sheath as the lobe pairs carrying the token ring signals. This includes the self-crosstalk noise from the node transmit signal. Since the UTP is not shielded, the error rate of the UTP lobe system is not guaranteed in the presence of the noise generated outside the token ring. When environmental electrical noise is encountered that may cause excessive errors, it is recommended to use STP in those locations. UTP should not be used for interconnecting TCUs in separate wiring closets.

Although the error rate of 10^{-9} cannot be guaranteed, with careful planning an acceptable error rate can be achieved in most office environments.

7. Safety

7.1 Precautionary notes

Token ring equipment attached to UTP media may be subject to voltages that are not present with the use of STP, and should be designed assuming these voltages may be present. Implementors are urged to consult the relevant local, national, and international safety regulations to ensure compliance with the appropriate standards regarding the attachment of DTEs to UTP telephone media.

7.2 Telephony voltages

During installation and maintenance of the UTP cable plant, care should be taken to ensure that the UTP media cable conductors do not make electrical contact with non-network conductors or ground. Use of unshielded twisted pair will often bring the token ring wiring into close proximity with other wiring through the sharing of conduit, cable trays, wiring closets, etc. Due to the lack of shielding, this may expose the token ring and attached equipment to potentially damaging voltages through inductive coupling of impulses, electrostatic discharge, and high-voltage breakdown events (lightning). Equipment vendors are urged to provide installation guidelines that will do the following:

a) Alert installers and users to this exposure.

b) Suggest means to minimize the exposure to risks of this type.

c) Suggest techniques that will minimize damage should such an event occur.

The use of building wiring brings with it the possibility of wiring errors that may connect telephony voltages to token ring equipment. Other than voice signals, the primary voltages that may be encountered are the "battery" and ringing voltages. Although there is no universal standard, the following maximums apply:

— Battery voltage to an on-hook telephone line is about 56 Vdc applied to the line through a balanced 400 Ω source impedance.
— Battery voltage to the off-hook telephone line is about 56 Vdc applied through a balanced 400 Ω source impedance. Most of this voltage is dropped across this impedance due to the relatively low impedance of an off-hook telephone.
— Ringing voltage is a composite signal consisting of an ac component and a dc component.The ac component can be up to 175 V p-p at 20–60 Hz, with a 100 Ω source impedance. The dc component is 56 Vdc with a 300 Ω to 600 Ω source impedance. Large spikes can occur at the start and end of each ring cycle as well as when the telephone instrument goes off-hook.

8. Reliability

The reliability of the UTP cabling system and connectors are a function of the individual components and associated cabling practices and are not covered by this practice. (See 7.6 of ISO/IEC 8802-5 and clause 5 of this document for reliability using STP.)