# INTERNATIONAL STANDARD

# ISO 9314-1

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## Information processing systems — Fibre Distributed Data Interface (FDDI) —

## Part 1 :
Token Ring Physical Layer Protocol (PHY)



*Systèmes de traitement de l'information — Interface de données distribuées sur fibre (FDDI) —*

*Partie 1 : Protocole de la couche physique de l'anneau à jeton*



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## Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.



International Standard ISO 9314-1 was prepared by Technical Committee ISO/TC 97, *Information processing systems.*



ISO 9314 consists of the following parts, under the general title *Information processing systems — Fibre Distributed Data Interface (FDDI)*:

— *Part 1: Token Ring Physical Layer Protocol (PHY)*

— *Part 2: Token Ring Media Access Control (MAC)*

— *Part 3: Token Ring Physical Layer, Medium Dependent (PMD)*

## Introduction

This part of ISO 9314 on the FDDI physical layer protocol is intended for use in a high-performance multistation network. This protocol is designed to be effective at 100 Mbit/s using a Token ring architecture and fibre optics as the transmission medium over distances of several kilometers in extent.

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# Information processing systems — Fibre Distributed Data Interface (FDDI) —

# Part 1 :
# Token Ring Physical Layer Protocol (PHY)

## 1 Scope

This part of ISO 9314 specifies the Physical Layer Protocol (PHY), the upper sublayer of the Physical Layer, for Fibre Distributed Data Interface (FDDI).

FDDI provides a high-bandwidth (100 Mbit/s), general-purpose interconnection among computers and peripheral equipment using fibre optics as the transmission medium. FDDI can be configured to support a sustained transfer rate of approximately 80 Mbit/s (10 Mbyte/s). It may not meet the response time requirements of all unbuffered high-speed devices. FDDI establishes connections among many stations distributed over distances of several kilometers in extent. Default values for FDDI were calculated on the basis of 1 000 physical links and a total fibre path length of 200 km (typically corresponding to 500 stations and 100 km of dual fibre cable).



FDDI consists of:



(a) A Physical Layer (PL), which is divided into two sublayers:

(1) A Physical Medium Dependent (PMD), which provides the digital baseband point-to-point communication between stations in the FDDI network. The PMD provides all services necessary to transport a suitably coded digital bit stream from station to station. The PMD defines and characterizes the fibre-optic drivers and receivers, medium-dependent code requirements, cables, connectors, power budgets, optical bypass provisions, and physical-hardware-related characteristics. It specifies the point of interconnectability for conforming FDDI attachments.

(2) A Physical Layer Protocol (PHY), which provides connection between the PMD and the Data Link Layer. PHY establishes clock synchronization with the upstream code-bit data stream and decodes this incoming code-bit stream into an equivalent symbol stream for use by the higher layers. PHY provides encoding and decoding between data and control indicator symbols and code bits, medium conditioning and initializing, the synchronization of incoming and outgoing code-bit clocks, and the delineation of octet boundaries as required for the transmission of information to or from higher layers. Information to be transmitted on the interface medium is encoded by the PHY into a grouped transmission code. The definition of PHY is contained in this part of ISO 9314.

(b) A Data Link Layer (DLL), which controls the accessing of the medium and the generation and verification of frame check sequences to ensure the proper delivery of valid data to the higher layers. DLL also concerns itself with the generation and recognition of device addresses and the peer-to-peer associations within the FDDI network. For the purpose of the PHY definition contained in this part of ISO 9314,

references to DLL are made in terms of the Media Access Control (MAC) entity, which is the lowest sublayer of DLL.

(c) A Station Management (SMT)[1], which provides the control necessary at the station level to manage the processes under way in the various FDDI layers such that a station may work cooperatively on a ring. SMT provides services such as control of configuration management, fault isolation and recovery, and scheduling procedures.

The definition of PHY as contained in this part of ISO 9314 is designed to be as independent as possible from the actual physical medium.

ISO 9314 specifies the interfaces, functions, and operations necessary to ensure interoperability between conforming FDDI implementations. This part of ISO 9314 is a functional description. Conforming implementations may employ any design technique that does not violate interoperability.

## 2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 9314. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 9314 are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.



ISO 9314-2: 1989, *Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 2: Token Ring Media Access Control (MAC).*



ISO 9314-3: ----[2], *Information processing systems - Fibre Distributed Data Interface (FDDI) - Part 3: Token Ring Physical Layer, Medium Dependent (PMD).*

## 3 Definitions

For the purposes of this part of ISO 9314, the following definitions apply:

**3.1 code bit:** The smallest signalling element used by the Physical Layer for transmission on the medium.

**3.2 code group:** The specific sequence of five code bits representing a DLL symbol.

**3.3 concentrator:** A node on the FDDI ring, which in turn provides connections for additional conforming FDDI stations so that they may communicate with other attachments to the FDDI ring. A concentrator has two Physical Layer entities and may or may not have one or more Data Link Layer entities.

**3.4 Connection Management (CMT):** That portion of the Station Management (SMT) function that controls network insertion, removal, and connection of PHY and MAC entities within a station.

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[1] SMT will form the subject of a future part of ISO 9314.

[2] To be published.

**3.5 entity:** An active element within an Open System Interconnection (OSI) layer, or sublayer; or SMT, in a specific station.

**3.6 fibre optics:** A technology whereby signals are transmitted over an optical waveguide medium through the use of light-generating transmitters and light-detecting receivers.

**3.7 frame:** A Protocol Data Unit transmitted between cooperating MAC entities on a ring, consisting of a variable number of octets.

**3.8 nonreturn to zero (NRZ):** A technique in which a polarity level high, or low, represents a logical "1" (one), or "0" (zero).

**3.9 nonreturn to zero invert on ones (NRZI):** A technique in which a polarity transition represents a logical "1" (one). The absence of a polarity transition denotes a logical "0" (zero).

**3.10 physical connection:** The full-duplex physical layer association between adjacent PHY entities (in concentrators, repeaters, or stations) in an FDDI ring, i.e., a pair of Physical Links.

**3.11 physical link:** The simplex path (via PMD and attached medium) from the transmit function of one PHY entity to the receive function of an adjacent PHY entity (in concentrators, repeaters, or stations) in an FDDI ring.

**3.12 primitive:** An element of the services provided by one entity to another.



**3.13 Protocol Data Unit (PDU):** Information delivered as a unit between peer entities that may contain control information, address information and data (e.g., an Service Data Unit from a higher layer).



**3.14 receive:** The action of a station of accepting a frame, token, or control sequence from the medium.



**3.15 repeat:** The act of a station in receiving a code-bit stream (e.g., frame or token) from an upstream station and placing it on the medium to the next station. The station repeating the code-bit stream examines it and may copy it into a buffer and modify control indicators as appropriate.

**3.16 ring:** Two or more stations in which information is passed sequentially between active stations, each station in turn examining or copying the information, finally returning it to the originating station.

**3.17 Service Data Unit (SDU):** The unit of data transfer between a service user and a service provider.

**3.18 services:** The services provided by one entity to a higher entity or to SMT.

**3.19 station:** An addressable logical and physical node on a ring capable of transmitting, repeating, and receiving information.

**3.20 Station Management (SMT):** The entity within a station on the ring that monitors station activity and exercises overall appropriate control of station activity.

**3.21 symbol:** The smallest signalling element used by the Data Link Layer (DLL). The symbol set consists of 16 data symbols and 8 control symbols. Each symbol corresponds to a specific sequence of code bits (code group) to be transmitted by the Physical Layer.

**3.22 transmit:** The action of a station that consists of generating a frame, token, or control sequence, and placing it on the medium to the next station.

# 4 Conventions and abbreviations

## 4.1 Conventions

The terms SMT, MAC, PMD and PHY, when used without modifiers, refer specifically to the local entities.

Low lines (e.g., control_action) are used as a convenience to mark the name of signals, functions, or the like, which might otherwise be misinterpreted as independent individual words if they were to appear in text.

The use of a period (e.g., PH_UNITDATA.request) is equivalent to the use of a low line except that a period is used as an aid to distinguish modifier words appended to an antecedent expression.

## 4.2 Abbreviations

| | |
|---|---|
| ALS | Active_Line-state |
| HLS | Halt_Line-state |
| ILS | Idle_Line-state |
| MLS | Master_Line-state |
| NLS | Noise_Line-state |
| QLS | Quiet_Line-state |
| NRZ | Non Return to Zero |
| NRZI | Non Return to Zero, Invert on Ones |
| PI | Primary Input |
| PO | Primary Output |
| RCRCLK | Receiver Recovery Clock |
| SI | Secondary Input |
| SO | Secondary Output |
| Hi_Ct | Current Smoother extension (in symbols) at 14-symbol threshold |
| Lo_Ct | Current Smoother extension (in symbols) at 12-symbol threshold |
| Out_Ct | Number of symbols output in current Smoother state |
| T_Flag | Indicates current frame can not be stripped |
| D_Max | Maximum ring latency |
| Hi_Max | Maximum smoothing capacity (in symbols) at 14-symbol threshold |
| Lo_Max | Maximum smoothing capacity (in symbols) at 12-symbol threshold |
| P_Max | Maximum number of Physical Layer entities |
| SD_Max | Maximum starting delimiter delay contribution |
| SD_Min | Minimum starting delimiter delay |



# 5 General description

A ring network consists of a set of stations logically connected as a serial string of stations and transmission media to form a closed loop. Information is transmitted sequentially, as a stream of suitably encoded symbols, from one active station to the next. Each station generally regenerates and repeats each symbol and serves as the means for attaching one or more devices to the network for the purpose of communicating with other devices on the network.

The basic building block of an FDDI network is a Physical Connection as shown in figure 1. A Physical Connection in the FDDI ring consists of the Physical Layers of two stations that are connected over the transmission medium by a Primary Link and a Secondary Link. A Primary link consists of an output, called Primary Out (PO), of a Physical layer, communicating over a Primary medium to the input, called Primary In (PI), of a second Physical Layer. The Secondary link consists of the output, called Secondary Out (SO), of the second Physical Layer communicating over a Secondary medium to the input, called Secondary In (SI), of the first Physical Layer. Physical Connections may be subsequently logically connected within nodes, via attached MACs or other means, to create the network.

An FDDI network consists of a theoretically unlimited number of connected stations. SMT establishes the physical connections between stations, and the correct internal station configuration, to create an FDDI network of logical rings. The method of actual physical attachment of stations to the FDDI network will vary and is dependent on specific application requirements. The function of each station is implementer defined and is determined by the specific application or site requirements.

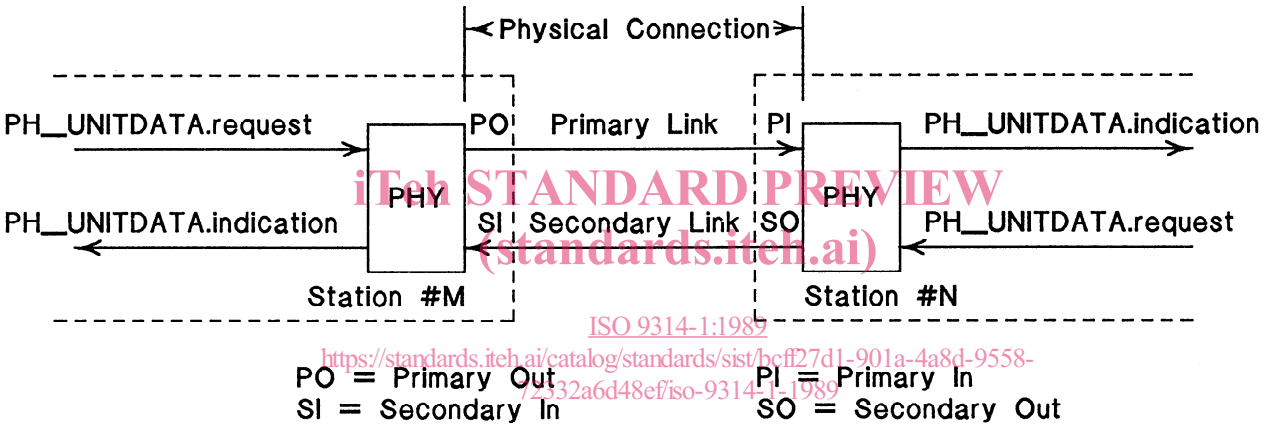




**Figure 1 - FDDI physical connection example**

## 6 Services

This clause specifies the services provided by PHY. The services as defined in this clause do not imply any particular implementation or any interface. Services described are:

(a) PHY services provided to the local MAC entity (indicated by PH__ prefix)

(b) Services required from the local PMD entity by PHY (indicated by PM__ prefix)

(c) PHY services provided to the local SMT entity (indicated by SM__PH__ prefix)

Figure 2 shows the block diagram organization of the FDDI Physical layer including the separate functions, related signals and interfaces that it contains. The interfaces and signals between the Physical Layer, the data link layer and Station Management are intended to be logical rather than physical. Any other set of signals that causes the same physical behaviour of the protocol is equally valid.

### 6.1 PHY-to-MAC services

This subclause specifies the services supplied by PHY to allow the local MAC entity to exchange PDUs with peer entities. Additional detail is provided in ISO 9314-2 on FDDI MAC concerning conditions that generate these primitives and MAC actions upon receipt of PHY-generated primitives. The following primitives are defined:

PH_UNITDATA.request
PH_UNITDATA.indication
PH_UNITDATA_STATUS.indication
PH_INVALID.indication

All primitives described in this clause are mandatory.

The description of each primitive includes a description of the information that shall be passed between MAC and PHY.

These services shall be "synchronous", e.g., each PH_UNITDATA.indication causes exactly one PH_UNITDATA.request. Depending upon the current internal configuration of the station, the PH_UNITDATA.request may be returned to the same PHY, or to a different PHY. Although these services are primarily intended as a PHY-to-MAC interface, they also serve as a PHY-to-PHY interface when repeating on a logical ring with no intervening MAC. In this case the function of the Repeat Filter (see 8.4) is required somewhere in the repeat path within the physical layer.

#### 6.1.1 PH_UNITDATA.request



This primitive defines the transfer of data from MAC to PHY.



##### 6.1.1.1 Semantics of the primitive

```
PH_UNITDATA.request        (
                           PH_Request (symbol)
                           )
```

The symbol specified by PH_Request (symbol) shall be one of the following:

J, K, T, R, S, I, n, H and optionally Q or V, where n is any of the sixteen data symbols specified in Table 1.

##### 6.1.1.2 When generated

MAC sends PHY one PH_UNITDATA.request for each PH_UNITDATA.Indication received from PHY.

##### 6.1.1.3 Effect of receipt

Upon receipt of this primitive the PHY entity shall encode and transmit the symbol. When the PHY entity is ready to accept another PH_UNITDATA.request, it shall return to MAC a PH_UNITDATA_STATUS.indication.

NOTE - The transmission of Q, H, or V does not occur on a PH_UNITDATA.request from MAC. However, when repeating in the physical layer, a PH_UNITDATA.request of H is possible (and Q or V in implementations in which the Repeat Filter function is located after the PH_UNITDATA.request interface).

## Table 1 - Symbol coding

| Decimal | Code Group | Symbol | Assignment | |
|---|---|---|---|---|
| *Line State Symbols* | | | | |
| 00 | 00000 | Q | QUIET | |
| 31 | 11111 | I | IDLE | |
| 04 | 00100 | H | HALT | |
| *Starting Delimiter* | | | | |
| 24 | 11000 | J | 1st. of Sequential SD Pair | |
| 17 | 10001 | K | 2nd. of Sequential SD Pair | |
| *Data Symbols* | | | | |
| | | | Hex | Binary |
| 30 | 11110 | 0 | 0 | 0000 |
| 09 | 01001 | 1 | 1 | 0001 |
| 20 | 10100 | 2 | 2 | 0010 |
| 21 | 10101 | 3 | 3 | 0011 |
| 10 | 01010 | 4 | 4 | 0100 |
| 11 | 01011 | 5 | 5 | 0101 |
| 14 | 01110 | 6 | 6 | 0110 |
| 15 | 01111 | 7 | 7 | 0111 |
| 18 | 10010 | 8 | 8 | 1000 |
| 19 | 10011 | 9 | 9 | 1001 |
| 22 | 10110 | A | A | 1010 |
| 23 | 10111 | B | B | 1011 |
| 26 | 11010 | C | C | 1100 |
| 27 | 11011 | D | D | 1101 |
| 28 | 11100 | E | E | 1110 |
| 29 | 11101 | F | F | 1111 |
| *Ending Delimiter* | | | | |
| 13 | 01101 | T | Used to Terminate the Data Stream | |
| *Control Indicators* | | | | |
| 07 | 00111 | R | Denoting Logical ZERO (Reset) | |
| 25 | 11001 | S | Denoting Logical ONE (Set) | |
| *Invalid Code Assignments* | | | | |
| 01 | 00001 | V or H | These code patterns shall not be transmitted because they violate consecutive code-bit zeros or duty cycle requirements. Codes 01, 02, 08 and 16 shall however be interpreted as Halt when received. | |
| 02 | 00010 | V or H | | |
| 03 | 00011 | V | | |
| 05 | 00101 | V | | |
| 06 | 00110 | V | | |
| 08 | 01000 | V or H | | |
| 12 | 01100 | V | | |
| 16 | 10000 | V or H | | |

(12345) = sequential order of code-bit transmission.