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Information technology –
Fibre distributed data interface (FDDI) –

Part 4:
Single-mode fibre physical layer medium dependent (SMF-PMD)

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CONTENTS

FOREWORD

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. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75% of the national bodies casting a vote.

International Standard ISO/IEC 9314-4 was prepared by Joint technical Committee ISO/IEC JTC 1 *Information technology*, Subcommittee SC 25*, Interconnection of information technology equipment.*

ISO/IEC 9314 consists of the following parts, under the general title *Information technology – 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 Medium Dependent Layer (PMD)*
– *Part 4: Single Mode Fibre Physical Layer Medium Dependent (SMF-PMD)*
– *Part 5: Hybrid Ring Control (HRC)*
– *Part 6: Token Ring Station Management (SMT)*
– *Part 7: Physical Layer Protocol (PHY-2)*
– *Part 8: Token Ring Media Access Control-2 (MAC-2)*
– *Part 9: FDDI Low-Cost Fibre – Physical Medium Dependent (LCF-PMD)*
– *Part 10: Token Ring Twisted Pair Physical layer Medium Dependent (TP-PMD)*
– *Part 13: Conformance Test Protocol Implementation Conformance Statement proforma (CT-PICS)*
– *Part 20: Physical Medium Dependent Conformance Testing (PMD-ATS)*
– *Part 21: Physical Layer Protocol Conformance Testing (PHY-ATS)*
– *Part 25: Abstract Test Suite for FDDI – Station Management Conformance Testing (SMT-ATS)*
– *Part 26: Media Access Control Conformance Testing (MAC-ATS)*

INTRODUCTION

The Fibre Distributed Data Interface (FDDI) is intended for use in a high-performance general purpose multistation network and is designed for efficient operation with a peak data rate of 100 megabits per second. It uses a token ring architecture. This part of ISO/IEC 9314 extends the basic FDDI by allowing both multimode and single-mode fibre, (MMF and SMF respectively), as transmission media. The basic FDDI provides for hundreds of stations operating over an extent of many kilometers. The individual link lengths supported by the basic FDDI are limited to two (2) kilometers by the characteristics of the multimode fibre it specifies. This extension to the basic FDDI standard allows links to about 60 kilometers depending on cable plant characteristics, by making it possible to include single-mode fibre links in a standard FDDI network.

The Single-mode Physical Layer Medium Dependent (SMF-PMD) specifies the lower sublayer of the Physical Layer for the FDDI. As such, it presents the specifications for conforming FDDI attachment devices at the interface to the single-mode optical network. This includes power levels and characteristics of the optical transmitter and receiver, interface optical signal requirements including jitter, the connector receptacle footprint, the requirements of conforming FDDI single-mode fibre cable plants, and the permissible BER.

SMF-PMD provides for extension of the set of basic standards for FDDI that includes the following standards:

a) A Media Access Control (MAC) standard, which specifies the lower sublayer of the Data Link Layer for FDDI, including access to the medium, data framing, addressing, and data checking;

b) A Physical Medium Dependent (PMD) standard which is the alternative standard to this document, when using MMF rather than SMF;

c) A Physical Layer Protocol (PHY) standard, which specifies the upper sublayer of the Physical Layer for FDDI, including encode/decode, clocking, and data framing;

d) A Station Management (SMT) standard, which specifies the local portion of the system management application process for FDDI, including the control required for proper operation of a station in an FDDI ring;

The idea of developing a new high speed data interface for computers based on the use of optical fibre was first raised in an October 1982 meeting. An ad hoc task group was formed to examine the issues and three project proposals, for the FDDI Physical, Data Link, and Network layers were developed and subsequently approved.

Initial proposals for the Media Access Control (MAC), corresponding to the lower half of the Data Link Layer, and for the Physical (PHY), corresponding to the Physical Layer, were both submitted in June 1983. FDDI adopted the structures of the ISO/IEC 8802 Series, and early work indicated that the FDDI MAC could be developed to operate under the Logical Link Control (LLC) described in the ISO/IEC 8802 series. This decision, in effect, obviated the development of LLC or Network Layer standards unique to FDDI. MAC has been published as ISO/IEC 9314-2.

In early 1984 a need was recognized for a separate Station Management (SMT) document. This development work remains under way on ISO/IEC 9314-6.

Recognizing that fibre technology was not yet then sufficiently settled and that critical FDDI development work was dependent upon the protocol portions of the PHY document, the Physical Layer was divided into two sublayers (PHY and PMD), with the PHY document retaining only the upper sublayer of the Physical Layer. PHY was subsequently published as ISO/IEC 9314-1.

Meanwhile, issues concerning the lower sublayer of the Physical Layer for multimode FDDI were being addressed. That work led to the publication of ISO/IEC 9314-3 FDDI PMD.

In June 1987 the need was recognized for FDDI to support station-to-station distances longer than the 2 kilometers limit of the MMF design. The project objective was to stay as close as possible to the PMD standard and in particular to have the same interfaces with PHY and SMT.

With the FDDI MAC, the FDDI PHY and the multimode FDDI PMD, the FDDI SMF-PMD standard represents an alternative PMD in the set of standards that constitute FDDI.

INFORMATION TECHNOLOGY – FIBRE DISTRIBUTED DATA INTERFACE (FDDI) –

Part 4: Single-mode fibre physical layer medium dependent (SMF-PMD)

1 Scope

This part of ISO/IEC 9314 specifies the Single-mode fibre Physical Layer–Medium Dependent (SMF-PMD) requirements for the Fibre Distributed Data Interface (FDDI).

FDDI provides a high bandwidth (100 megabits per second) general purpose interconnection among computers and peripheral equipment using a fibre optic waveguide as the transmission medium. The FDDI may be configured to support a sustained transfer rate of approximately 80 megabits (10 megabytes) per second. The FDDI may not meet the response time requirements of all unbuffered high speed devices. The FDDI establishes the connection among many stations distributed over distances of several kilometers in extent. Default values for FDDI were calculated on the basis of 1000 physical connections and a total fibre path length of 200 kilometers (see the MAC Standard – ISO/IEC 9314-2 or ISO/IEC 9314-8).

The FDDI consists of:

1) The Physical Layer Medium Dependent (PMD) is specified in four alternative standards:
   a) ISO/IEC 9314-3 (FDDI PMD) corresponding to multimode fibre (MMF) which actually means "FDDI MMF-PMD".
   b) This standard ISO/IEC 9314-4 (SMF-PMD) which contains the requirements for single-mode fibre (SMF) physical connections between stations.
   c) ISO/IEC 9314-9 (FDDI LCF-PMD), an alternative lower cost multimode fibre (LCF) for shorter distances.
   d) ISO/IEC 9314-10 (FDDI TP-PMD), a copper twisted pair (TP) alternative.

   An FDDI ring can be made up of all these alternatives. (For some restrictions see 6.4). The PMD provides all services necessary to transport a suitably coded digital bit stream from station to station. The SMF-PMD specifies the point of interconnection requirements for FDDI stations and cable plants at both sides of the Media Interface Connector (MIC) for conforming stations utilizing single-mode fibre.

   SMF-PMD includes the following:
      i) The optical power budgets for two (2) categories of Active Output and Active Input Interfaces using single-mode fibre optic cables and optical bypass switches
      ii) The MIC Receptacle mechanical mating requirements including the keying features
      iii) The single-mode fibre optic cable requirements
      iv) The services provided by PMD to PHY and SMT
2) A Physical Layer Protocol (PHY), which provides connection between multimode or single-mode PMD and the Data Link Layer (DLL). 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.
3) A Data Link Layer (DLL), which controls the accessing of the medium and the generation and verification of frame check sequences to assure 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 purpose of the PHY, references to DLL are made in terms of the Media Access Control (MAC) entity, which is the lowest sublayer of DLL.

4) A Station Management (SMT), which provides the control necessary at the station level to manage the processes underway 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.

This part of ISO/IEC 9314 is a supporting document to ISO/IEC 9314-1 which should be read in conjunction with it.

The SMT document ISO/IEC 9314-6 should be consulted for information pertaining to supported FDDI station and network configurations.

The set of FDDI standards specifies the interfaces, functions and operations necessary to insure interoperability between conforming FDDI implementations. This part of ISO/IEC 9314 is a functional description. Conforming implementations may employ any design technique which does not violate interoperability.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO/IEC 9314. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO/IEC 9314 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO/IEC 9314-1:1989, Information technology – Fibre Distributed Data Interface (FDDI) – Part 1: Token Ring Physical Layer Protocol (PHY)

ISO/IEC 9314-2:1989, Information technology – Fibre Distributed Data Interface (FDDI) – Part 2: Token Ring Media Access Control (MAC)

ISO/IEC 9314-3:1990, Information technology – Fibre Distributed Data Interface (FDDI) – Part 3: Token Ring Physical Medium Dependent Layer (PMD)

ISO/IEC 9314-6:1998, Information technology – Fibre Distributed Data Interface (FDDI) – Part 6: Token Ring Station Management (SMT)

ISO/IEC 9314-7:1998, Information technology – Fibre Distributed Data Interface (FDDI) – Part 7: Physical Layer Protocol (PHY-2)

ISO/IEC 9314-8:1998, Information technology – Fibre Distributed Data Interface (FDDI) – Part 8: Token Ring Media Access Control-2 (MAC-2)

ISO/IEC 11801:1995, Information technology – Generic cabling for customer premises

IEC 60793-1-1:1999, Optical fibres – Part 1-1: Generic specification – General

IEC 60793-1-2:1995, Optical fibres – Part 1: Generic specification – Section 2: Measuring methods for dimensions

IEC 60793-1-3:1995, Optical fibres – Part 1: Generic specification – Section 3: Measuring methods for mechanical characteristics

IEC 60793-1-4:1995, Optical fibres – Part 1: Generic specification – Section 4: Measuring methods for transmission and optical characteristics

IEC 61300-3-4:1998, Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-4: Examination and measurements – Attenuation

IEC 61300-3-6:1997, Fibre optic interconnecting devices and passive components – Basic test and measurement procedures – Part 3-6: Examinations and measurements – Return loss

IEC 61300-3-9:1997, Fibre optic interconnecting devices and passive composants – Basic test and measurement procedures – Part 3-9: Examinations and measurements – Far-end crosstalk

IEC 61754-12: under development: Fibre Optic Connector Interfaces, Part-12: Type FS connector family

3 Concepts

3.1 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 method of actual physical attachment to the FDDI network may vary and is dependent on specific application requirements as described in subsequent paragraphs.

The basic building block of an FDDI network is a Physical Connection as shown in Figure 1. A Physical Connection in the FDDI network consists of the Physical Layers of two stations which are, connected over the transmission medium by a Primary Link and a Secondary Link. The two Physical Links of a Physical Connection must use the same fibre technology at the MIC: both multimode or both single-mode. A Primary Link consists of an output, called Primary Out, of a Physical Layer, communicating over a Primary Medium to the input, called Primary In, of a second Physical Layer. The Secondary Link consists of the output, called Secondary Out, of the second Physical Layer communicating over a secondary medium to the input, called Secondary In, of the first Physical Layer. Physical Connections may be subsequently logically connected within stations, via attached MACs or other means, to the network. As such, the function of each station is implementer defined and is determined by the specific application or site requirements.

Two classes of stations are defined; dual (attachment) and single (attachment). Physical FDDI rings may be composed only of dual stations which have two PHY entities to accommodate the dual (counter-rotating) rings. Concentrators provide additional PHY entities for the attachment of single stations which have only one PHY and thus cannot directly attach to the physical FDDI dual ring. A dual station, or one-half of a dual station, may be substituted for a single station in attaching to a concentrator. The logical FDDI ring consists of all attached stations.

This part of ISO/IEC 9314 specifies two categories of Active Output and Input Interfaces and allows for the four corresponding combinations. With this approach cable plant losses from 0 dB to 32 dB can be accommodated. This allows for Repeaterless Physical Link lengths up to 40 km to 60 kilometers.