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Information technology –

Fibre Distributed Data Interface (FDDI) –

Part 9:

Low-cost fibre physical layer medium dependent (LCF-PMD)

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CONTENTS

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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.

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International standard ISO/IEC 9314-9 was prepared by subcommittee 25: Interconnection of information technology equipment, of ISO/IEC joint technical committee 1: Information technology.

International Standards are drafted in accordance with the ISO/IEC Directives, Part 3.

Annexes A, B, C, D, E, F and G are for information only.

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: Physical Layer Medium Dependent (PMD)*
- *Part 4: Single Mode Fibre Physical Layer Medium Dependent (SMF-PMD)*
- *Part 5: Hybrid Ring Control (HRC)*
- *Part 6: Station Management (SMT)*
- *Part 7: Physical Layer Protocol (PHY-2)*
- *Part 8: Media Access Control-2 (MAC-2)*
- *Part 13: Conformance Test Protocol Implementation – Conformance Statement (CT-PICS) Proforma*
- *Part 20: Abstract Test Suite for FDDI – Physical Medium Dependent Conformance Testing (PMD-ATS)* [1)]
- *Part 21: Abstract Test Suite for FDDI – Physical Layer Protocol Conformance Testing (PHY-ATS)* [1)]
- *Part 25: Abstract test suite for FDDI – Station Management Conformance Testing (SMT-ATS)*
- *Part 26: Abstract Test Suite for FDDI – Media Access Control Conformance Testing (MAC-ATS)* [1)]

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1) To be published.

INTRODUCTION

The Fibre Distributed Data Interface (FDDI) is intended for use in a high-performance general purpose multi-station network and is designed for efficient operation with a peak data rate of 100 Mbit/s. It uses a Token Ring architecture with optical fibre as the primary transmission medium. FDDI provides for hundreds of stations operating over an extent of tens of kilometers.

The FDDI Part: Token ring low-cost physical layer medium dependent (LCF-PMD) standard specifies the lower sublayer of the Physical Layer for FDDI. As such it specifies the power levels and characteristics of the optical transmitter and receiver, and the interface optical signal requirements including jitter. LCF-PMD also specifies the connector receptacle footprint, the requirements of conforming FDDI optical fibre cablings, and the permissible bit error rates.

LCF-PMD is one of a set of alternative international standard PMDs for FDDI. This set includes the original PMD, the Single Mode Fibre PMD (SMF-PMD), and the Twisted-Pair PMD (TP-PMD).

The set of FDDI standards includes the following standards:

a) a FDDI Part: token ring physical layer protocol (PHY), which specifies the upper sublayer of the physical layer for the FDDI, including the data encode/decode, framing and clocking, as well as the elasticity buffer, smoothing, and repeat filter functions;

b) a FDDI Part: token ring media access control (MAC), which specifies the lower sublayer of the data link layer for FDDI, including the access to the medium, addressing, data checking, and data framing;

c) a FDDI Part: token ring station management (SMT), 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.

INFORMATION TECHNOLOGY – FIBRE DISTRIBUTED DATA INTERFACE (FDDI) –

Part 9: Low-cost fibre physical layer medium dependent (LCF-PMD)

1 Scope

This part of ISO/IEC 9314 specifies the requirements for the Fibre Distributed Data Interface (FDDI); token ring low-cost fibre physical layer medium dependent (LCF-PMD).

FDDI provides a high-bandwidth (100 Mbit/s), general-purpose interconnection among computers and peripheral equipment using fibre optics as the primary transmission medium. FDDI can be configured to support a sustained data transfer rate of at least 80 Mbit/s (10 Mbyte/s). FDDI provides connectivity for many nodes distributed over distances of several kilometers in extent. Default values for FDDI are calculated on the basis of 1 000 physical links and a total fibre path length of 200 km (typically corresponding to 500 nodes and 100 km of dual fibre cable).

FDDI consists of:

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

   1) A Physical Layer, Medium Dependent (PMD) sublayer (ISO/IEC 9314-3), with several alternative medium choices, which provides the digital baseband point-to-point communication between nodes in the FDDI network. The PMD provides all services necessary to transport a suitably coded digital bit stream from node to node. The PMD defines and characterizes the medium 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.

      The original PMD standard (ISO/IEC 9314-3), called PMD, defines attachment to multi-mode fibre up to 2 km, while this LCF-PMD, optically interoperable with the original PMD, defines low-cost attachments to multi-mode fibre up to 500 m. Additional PMD sublayer standards are for attachment to single mode fibre (SMF-PMD), and twisted-pair up to 100 m (TP-PMD);

   2) A Physical Layer Protocol (PHY) sublayer (ISO/IEC 9314-1), and its enhancement, (PHY-2), 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 medium is encoded by the PHY using a group transmission code;

b) a Data Link Layer (DLL), which is divided into two or more sublayers

   1) An optional Hybrid Ring Control (HRC) (ISO/IEC 9314-5), which provides multiplexing of packet and circuit switched data on the shared FDDI medium. HRC comprises two internal components, a Hybrid Multiplexer (H-MUX) and an Isochronous MAC (I-MAC). H-MUX maintains a synchronous 125 µs cycle structure and multiplexes the packet and circuit switched data streams, and I-MAC provides access to circuit switched channels;

   2) A Media Access Control (MAC) (ISO/IEC 9314-2), and its enhancement (MAC-2), which provides fair and deterministic access to the medium, address recognition, and generation and verification of frame check sequences. Its primary function is the delivery of packet data, including frame generation, repetition, and removal;

3) An optional Logical Link Control (LLC), which provides a common protocol for any required packet data adaptation services between MAC and the Network Layer. LLC is not specified by FDDI;

4) An optional Circuit Switching Multiplexer (CS-MUX), which provides a common protocol for any required circuit data adaptation services between I-MAC and the Network Layer. CS-MUX is not specified by FDDI;

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

FDDI LCF-PMD is a supporting document to FDDI PHY and FDDI PHY-2 which should be read in conjunction with it. The FDDI SMT document should be read for information pertaining to supported FDDI node and network configurations. The original FDDI PMD should be read for issues relating to FDDI LCF-PMD to FDDI PMD optical interoperability.

ISO/IEC 9314 specifies the interfaces, functions, and operations necessary to ensure interoperability between conforming FDDI implementations. This standard provides a functional description. Conforming implementations may employ any design technique that 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 IEC and ISO maintain registers of currently valid International Standards.

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

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

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

IEC 60793-2, *Optical fibres – Part 2: Product specifications*

IEC 60874-14, *Connectors for optical fibres and cables – Part 14: Sectional specification for fibre optic connector – Type SC*

IEC 60874-19, *Connectors for optical fibres and cables – Part 19: Sectional specification for fibre optic connector – Type SC-D(uplex)*

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

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

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

ISO/IEC 9314-3:1990, *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/IEC 9314, the following definitions apply. Other parts of ISO/IEC 9314, e.g. FDDI MAC, PHY and PMD, may contain additional definitions of interest.

3.1
attenuation
level of optical power loss, expressed in decibels

3.2
average power
the optical power measured using an average reading power meter when the FDDI station is transmitting a stream of Halt symbols

3.3
bypass
the ability of a station to isolate itself optically from the FDDI network while maintaining the continuity of the cabling

3.4
centre wavelength
the average of the two wavelengths measured at the half amplitude points of the power spectrum

3.5
code bit
the smallest signalling element used by the Physical Layer for transmission on the medium

3.6
concentrator
FDDI node that has additional PHY/PMD entities beyond those required for its own attachment to an FDDI network. These additional PHY/PMD entities are for the attachment of other FDDI nodes (including other concentrators) in a tree topology

3.7
connector plug
device used to terminate a fibre optic cable

3.8
connector receptacle
fixed or stationary half of a connection that is mounted on a panel/bulkhead. Receptacles mate with plugs

3.9
counter-rotating
arrangement whereby two signal paths, one in each direction, exist in a ring topology

3.10
dual attachment concentrator
concentrator that offers two attachments to the FDDI network which are capable of accommodating a dual (counter-rotating) ring

3.11
dual attachment station
a station that offers two attachments to the FDDI network which are capable of accommodating a dual (counter-rotating) ring

3.12
dual ring (FDDI dual ring)
two FDDI rings that operate as (a pair of) counter-rotating logical rings

3.13
entity
an active service or management element within an Open Systems Interconnection (OSI) layer, or sublayer

3.14
extinction ratio
the ratio of the low, or off optical power level (PL) to the high, or on optical power level (PH) when the station is transmitting a stream of Halt symbols

$$\text{Extinction ratio (\%)} = (PL/PH) \times 100$$

3.15
fibre
dielectric material that guides light; waveguide

3.16
fibre optic cable
a cable containing one or more optical fibres

3.17
interchannel isolation
the ability to prevent undesired optical energy from appearing in one signal path as a result of coupling from another signal path; cross talk

3.18
jitter
the variation in synchronization between bits in the FDDI signalling bit stream

3.19
jitter, data dependent (DDJ)
jitter that is related to the transmitted symbol sequence

NOTE DDJ is caused by the limited bandwidth characteristics and imperfections in the optical channel components. DDJ results from non-ideal individual pulse responses and from variation in the average value of the encoded pulse sequence which may cause base-line wander and may change the sampling threshold level in the receiver.

3.20
jitter, duty cycle distortion (DCD)
distortion usually caused by propagation delay differences between low-to-high and high-to-low transitions

NOTE DCD is manifested as a pulse width distortion of the nominal baud time.

3.21
jitter, random (RJ)
RJ is caused by thermal noise

NOTE Random jitter may be modeled as a Gaussian process. The peak-to-peak value of RJ is of a probabilistic nature and thus any specific value requires an associated probability.

3.22
LCF-MIC plug
male part of the LCF-MIC which terminates a fibre optical cable

3.23
LCF-MIC receptacle
female part of the LCF-MIC which is contained in an FDDI node

3.24
logical ring
set of MACs serially connected to form a single ring

3.25
media interface connector (MIC)
a mated connector pair that provides an attachment between an FDDI node and a fibre optic cabling

NOTE When referring to the original PMD's MIC, the term MIC is used. When referring to the LCF-PMD MIC, the term LCF-MIC is used. The LCF-MIC consists of two parts; an LCF-MIC plug and an LCF-MIC receptacle.

3.26
network (FDDI network)
a collection of FDDI nodes interconnected to form a trunk, or a tree, or a trunk with multiple trees. This topology is sometimes called a dual ring of trees

3.27
node
a generic term applying to any FDDI ring attachment (station or concentrator)

3.28
numerical aperture (NA)
the sine of the radiation or acceptance half angle of an optical fibre, multiplied by the refractive index of the material in contact with the exit or entrance face

3.29
optical fall time
the time interval for the falling edge of an optical pulse to transition from 90 % to 10 % of the pulse amplitude

3.30
optical reference plane
plane that defines the optical boundary between the MIC Plug and the MIC Receptacle

3.31
optical rise time
time interval for the rising edge of an optical pulse to transition from 10 % to 90 % of the pulse amplitude

3.32
original PMD
the PMD defined in ISO/IEC 9314-3

NOTE The original PMD supports multi-mode fibre optic cable with an 11 dB loss budget.

3.33
physical connection
the full-duplex physical layer association between adjacent PHY entities (in concentrators or stations) in an FDDI network, i.e. a pair of Physical Links

3.34
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 or stations) in an FDDI network

3.35
primitive
an element of the services provided by one entity to another

3.36
receiver (optical)
opto-electronic circuit that typically converts an optical signal to an electrical logic signal

3.37
ring
a set of stations wherein information is passed sequentially between stations, each station in turn examining or copying the information, finally returning it to the originating station

3.38
services
FDDI services provided by one FDDI entity to another

NOTE Data services are provided to a higher layer entity; management services are provided to a management entity in the same or another layer.

3.39
single attachment concentrator
concentrator that offers one attachment to the FDDI network

3.40
single attachment station
a station that offers one attachment to the FDDI network

3.41
spectral width, full width half maximum (FWHM)
the absolute difference between the wavelengths at which the spectral radiant intensity is 50,0 % of the maximum power

3.42
station
an addressable node on an FDDI network capable of transmitting, repeating, and receiving information. A station has exactly one SMT and at least one MAC, one PHY, and one PMD

3.43
transmitter (optical)
an opto-electronic circuit that typically converts an electrical logic signal to an optical signal

3.44
trunk
a physical loop topology, either open or closed, employing two optical fibre signal paths, one in each direction (i.e. counter-rotating), forming a sequence of peer connections between FDDI nodes

NOTE When the trunk forms a closed loop it is sometimes called a trunk ring.

3.45
tree
a physical topology consisting of a hierarchy of master-slave connections between a concentrator and other FDDI nodes (including subordinate concentrators)

4 Conventions and abbreviations

4.1 Conventions

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

Low lines (e.g. control_action) are used as a convenience to mark the name of signals, functions, and 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. PM_UNITDATA.request) is equivalent to the use of low lines except that a period is used as an aid to distinguish modifier words appended to an antecedent expression.

The use of a colon (e.g. N:PM_UNITDATA.request) distinguishes between two or more instances of the same signal where N designates the other source/destination entity.

4.2 Abbreviations

AII	Active Input Interface
AOI	Active Output Interface
ANS_Max	Maximum acquisition time (no signal)
AS_Max	Maximum acquisition time (signal)
BER	Bit Error Rate
BERT	Bit Error Rate Tester
d.c.	direct current
DCD	Duty Cycle Distortion (jitter)
DDJ	Data Dependent Jitter
ECL	Emitter Coupled Logic
FOTP	Fibre Optic Test Procedure
FWHM	Full Width Half Maximum
LED	Light Emitting Diode
LCF-MIC	LCF-PMD MIC Connector
LS_Max	Maximum line state change time
MIC	Media Interface Connector
NA	Numerical Aperture
NRZI	Non Return to Zero, Invert on ones
RJ	Random Jitter
SAE	Static Alignment Error (clock offset error)

5 General description

5.1 Ring Overview

A ring 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 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 ring for the purpose of communicating with other devices on the ring. The method of actual physical attachment to the FDDI ring may vary and is dependent on specific application requirements as described in subsequent paragraphs.