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Information technology — Local area networks —

Part 7:

Slotted ring access method and physical layer
specification

Technologies de l'information — Réseaux locaux —

*Partie 7: Spécifications pour la méthode d'accès et la couche physique
relatives à l'anneau à découpage temporel*



Reference number
ISO 8802-7:1991(E)



Documents

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Contents

	Page
1 Scope	1
2 Normative references	2
3 Definitions	2
4 Specification for the coding of bits and structure of slots and mini-packets	5
4.1 Encoding of bits	5
4.2 Slots	5
4.3 Mini-packet structure	6
5 Specification for configuration components	7
5.1 Monitor	7
5.2 Logging station	7
5.3 Nodes	8
5.4 Free-standing repeaters	8
5.5 Slave power supplies	8
5.6 Ring cables	8
5.7 Ring connector sockets	9
5.8 Continuity plugs	9
5.9 Topology	10
5.10 Total SR-LAN size	10
5.11 Ring segment length	10

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5.12	Combination of components	11
6	Specification for free-standing repeaters	11
6.1	Compliance	11
6.2	Interfaces	12
6.3	Power supply	13
6.4	Production of output	14
6.5	Output in absence of input signal	14
6.6	Output in presence of input signal	14
7	Specification for nodes	15
7.1	Compliance	15
7.2	Interfaces	16
7.3	Operator controls	19
7.4	Power supply	19
7.5	Output in absence of input signal	19
7.6	Output in presence of input signal	20
7.7	Slot structure	20
7.8	Input and output mini-packets	21
7.9	Error procedures	22
7.10	Reception of mini-packets	23
7.11	Transmission of mini-packets	27
7.12	Node/DTE interface lines	29
7.13	Reading from node	33
7.14	Writing to node	37
7.15	Enabling and disabling	39
8	Specification for monitor	41
8.1	Compliance	41
8.2	Connectors	42
8.3	Operator controls	42
8.4	Power supply	43
8.5	Modes of operation	44
8.6	Production of output	44

ISO 8802-7:1991(E)

8.7	Start/restart mode	45
8.8	Run mode	46
8.9	Resynchronization mode	48
8.10	Error reporting procedures	48
9	Specification for logging station	49
9.1	Compliance	49
9.2	Interfaces and controls	50
9.3	Power supply	50
9.4	Production of output	51
9.5	Output in absence of input signal	51
9.6	Output in presence of input signal	51
9.7	Slot structure	51
9.8	Processing of mini-packets	51
9.9	Errors detected by logging station	52
9.10	Error recording	52
9.11	Analysis of messages	53
9.12	Combination with monitor	53
9.13	Combination with node	53
10	Specification for slave power supplies	53
10.1	Compliance	53
10.2	Power rating	54
10.3	a.c. component of output	54
10.4	Control of output	54
10.5	Connection to ring	54
10.6	Combination with other devices	54
11	Specification for media access control procedures for data terminal equipment	55
11.1	Notation	55
11.2	Media access control service	55
11.3	Media Access Control Unitdata Status Reporting Service ...	59
11.4	Transmission frame format	61

11.5	Procedure for transmission of frames	62
11.6	Method of transmitting logical mini-packets	65
11.7	Determination of transmission result	66
11.8	Reception of logical mini-packets	67
11.9	Mapping of logical mini-packets on to frames	70
11.10	Processing	70
11.11	Issue of MA-UNITDATA indication	72
11.12	Functions at the node interface	73
11.13	Node interface lines	73
11.14	Read registers	75
11.15	Write registers	78
12	Specification for implementation requirements for media access control in general purpose terminal equipment	81
12.1	Compliance	81
12.2	Testing	81
12.3	MAC service access points and addresses	81
12.4	Implementation of MAC service at MAC-SAPs	82
12.5	Node class compatibility	82
12.6	Action on MA-UNITDATA request	83
12.7	Frame format	84
12.8	Frame transmission	84
12.9	Transmission of mini-packets	85
12.10	Determination of response	86
12.11	Reception of mini-packets	86
12.12	Mapping of mini-packets on to frames	86
12.13	Processing of frames	86
12.14	Issue of MA-UNITDATA indication	87
12.15	Management functions	88
12.16	Node interface connector	88
12.17	Implementation of node interface functions	88

ISO 8802-7:1991(E)

12.18	Technical documentation	88
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Annexes

A	Ring segment length test	90
A.1	Principle	90
A.2	Equipment	90
A.3	Test procedure	90
B	Sensitivity test	93
B.1	Equipment	93
B.2	Procedure	93
C	Closed loop transfer characteristics test	94
C.1	Principle	94
C.2	Apparatus	94
C.3	Procedure	94
D	Illustration of power and signal arrangements	96
E	Repeater classes	97
E.1	Distinction between classes	97
E.2	Class I: repeaters with first order phase locked loops	97
E.3	Class II: repeaters	97
E.4	Class III: repeaters with dominant second order phase locked loops	97
F	Compatibility of nodes	98
F.1	Compatibility with other nodes	98
F.2	Compatibility with monitor	98
F.3	Error message logging function	98
F.4	Compatibility with DTEs	98

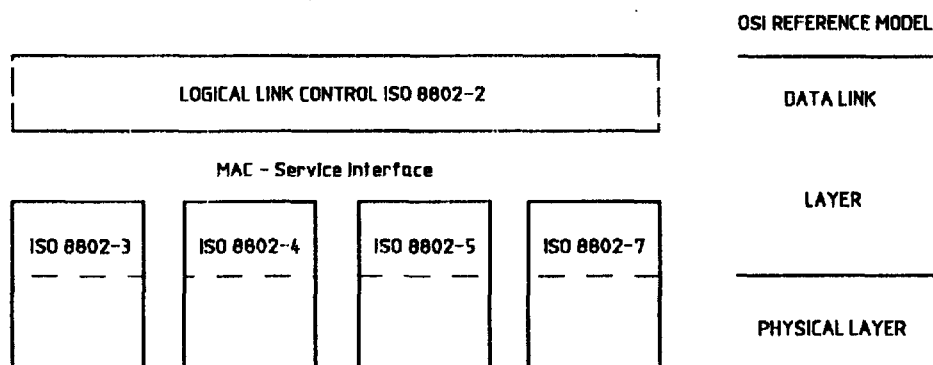
Foreword

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 voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 8802-7 was prepared by Technical Committee ISO/TC 97, *Information processing systems*.

This part of ISO 8802 is part of a series of documents that form a single standard for Local Area Networks. The standard embraces four alternative media access technologies and a common logical link control (LLC) protocol (ISO 8802-2).



The combination of the Logical Link Control (ISO 8802-2) and any one of the four media access documents form the Data-Link and Physical layers of the ISO 7498 (Open System Interconnection Basic Reference Model). The four media access technologies are

- ISO 8802-3, a bus utilizing CSMA/CD as the access method;
- ISO 8802-4, a bus utilizing token passing as the access method;
- ISO 8802-5, a ring utilizing token passing as the access method;
- ISO 8802-7, a ring utilizing slotted ring as the access method.

ISO 8802-7:1991(E)

All four media access technologies provide the Media Access Control (MAC) Sublayer Interface Service, as specified in ISO 8802-2. It is through this service interface that the LLC sublayer and higher layer entities communicate across the physical media.

It should be noted that the exact relationship of layers described in this standard to the layers defined in the OSI Reference Model is for further study.

ISO 8802 consists of the following parts, under the general title *Information technology — Local area networks*:

- *Part 1: General introduction*
- *Part 2: Logical link control*
- *Part 3: Carrier sense multiple access with collision detection (CSMA/CD) access method and physical layer specifications*
- *Part 4: Token-passing bus access method and physical layer specifications*
- *Part 5: Token ring access method and physical layer specifications*
- *Part 7: Slotted ring access method and physical layer specification*

Annexes A, B and C form an integral part of this part of ISO 8802. Annexes D, E and F are for information only.

Introduction

0.1 A slotted ring local area network

This section gives a general description of the implementation of a slotted ring local area network.

0.2 Principles

At the lowest level the communication link comprises a closed ring of cable and active repeaters. The delay in signal propagation through the cable and repeaters means that the system may be considered as a continuously circulating shift register. Each 100 m of cable causes a delay of 450 ns and so may be thought of as storage of 4,5 bits for a 10 MHz signalling frequency.

The circulating storage contains a fixed number of bits for any particular configuration of the network; in order to provide communication a regular structure is imposed on these bits by a Monitor. This consists of a small number of concatenated slots, all the same length, with a single gap of a few bits to mark a complete cycle. The start of each slot is indicated by a leader bit which is always one. The gap contains only zero bits. Very simple algorithms may be used to synchronize with this structure.

The signalling frequency is nominally 10 MHz but may vary slightly to produce an integral number of bits in circulation. To allow for adjustment of the amount of circulating storage a variable size shift register is used to provide additional "padding". The variable padding is set to permit an integral number of slots and a small gap.

The repeaters regenerate the signals on to each section of the ring, allowing rings up to several kilometres to be constructed, and providing for different cable types to suit the environment of each part of the network. The repeaters are also the points of attachment to the network for communicating devices. They demodulate signals from the ring and present them to a station which may alter them before they are modulated on to the ring again.

An active system of this kind lends itself to the implementation of a number of low level error detection and correction techniques that can be used to quickly localize faulty devices.

Since the operation of the repeaters is essential to ring integrity they are powered along the ring cable and are thus independent of the station and attached device.

0.3 Access

Communication takes place between stations which synchronize to the slot structure. The unit of transmitted data between stations is known as a mini-packet and occupies exactly one slot. Each mini-packet is in-

ISO 8802-7:1991(E)

dividually addressed, carrying eight bit destination and source addresses, 2, 4, 6, or 8 bytes of user data are carried, and in addition two "type" bits that provide for flexible user identification or framing of the data. The first bit following the slot leader bit is a full/empty marker, used to control access to the slots. Following the user data and type bits are two response bits.

A station wishing to transmit waits until an empty slot arrives; it then marks it as full, inserts the addresses and data, and initializes the response bits. The transmitter is only allowed one mini-packet in flight at the time and it counts passing slots to determine when the mini-packet it transmitted returns. The transmitter marks the returning slot empty and copies the response bits. By requiring that the returning slot be emptied, round-robin scheduling is introduced in which, however heavily loaded the ring, each slot passes around the stations giving them an opportunity to transmit within a determined time.

The response bits are used to carry back low level flow control information to the transmitter. The receiver may be physically or logically absent from the ring and in this case the transmitter will see that the mini-packet has been ignored. The receiver may also indicate that although he is present he is not listening; a "source selector" may be set to "anyone", "no-one" or " n ". When it is set to no-one or a value of n different to that of the transmitter address, the response bits indicate "not selected" to the transmitter. Thus the receiver is able to listen to all transmitters (anyone) and multiplex the incoming mini-packet individually or may concentrate on one transmitter (n = transmitter address), allowing very simple implementation of block protocols. The receiver can also generate a "busy" response when unable to process the mini-packets as fast as the transmitter tries to send them. A transmitter seeing the busy response sends the data again in a new slot. A mini-packet that has been successfully received is marked as "accepted".

Some refinements to this basic mechanism enhance its performance and reliability.

Whenever a transmitter receives a response other than accepted it is not permitted to transmit immediately but must wait for the ring structure to cycle around. Subsequent unsuccessful transmission attempts cause the transmitter to be backed off by a number of slots. This prevents the ring being swamped with useless traffic. Further, the delay is made traffic dependent by requiring that only empty slots are counted for backoff purposes. The round-robin scheduling puts an upper limit on the delay while the variable backoff produces a system in which efficiency improves under load.

When a mini-packet returns, a transmitter is able to check for consistency with the mini-packet that was sent out. If a discrepancy is found, then the response seen by the attached DTE is "transmit error", overriding the response within the mini-packet.

A repeater and station together make up a Node that is common to all DTE's communicating on the network. Logic is required to interface the Node to any particular DTE and this logic is called an Interface Unit.

0.4 Maintenance

In addition to the error detection used by the transmitter, facilities are included to continually monitor the entire system.

Every slot includes a parity bit that is checked and maintained by all nodes. A node that detects a slot with faulty parity corrects it and also sends a fault message in the next empty slot to destination zero. The

fault message contains the address of the sending node and so indicates the section of the ring where the fault occurred.

The mini-packet structure includes a bit, the Monitor Pass bit that is set by a transmitter when it fills a slot. This bit is always cleared by the Monitor on passing slots. If the Monitor detects a slot that has this bit cleared but is still marked full then it marks the slot empty. It is, therefore, impossible for a fault to cause a slot to become permanently full.

The Monitor is able to detect errors that interfere with the permanent structure and rapidly reinstates the correct structure in a non-destructive way. A burst of errors, perhaps caused by a power dip, cause the Monitor to reinitialize the network, resetting its basic frequency.

A Monitor can also fill empty slots with random address and data as they pass and check them as they return if they are still marked empty. In this way the Monitor keeps the performance of the ring under continuous surveillance and can give warning of incipient faults.

0.5 Performance

The access control rules require that a transmitter has only one mini-packet in flight at a time, and also that a slot is emptied after it is used. This specification also requires that the slot after the one emptied be allowed to pass. Thus the maximum slot utilization that a transmitter can achieve is one in every $(n + 2)$ slots. Therefore, the maximum point to point data transmission rate is

$$B_{pp} = B_s / (n + 2)$$

B_s is the total system data bandwidth, and is a function of the bit rate (clocking frequency) " f ", the number of slots on the ring " n ", the number of data bits in each slot " l " and the number of bit periods in the gap " g ":

$$B_s = \frac{f \cdot l \cdot n}{n(1 + 24) + g} \text{ [Mbps]}$$

If $m > 1$ nodes all wish to transmit simultaneously then each Node is still guaranteed access to one in every $(m + n)$ slots (provided of course it is not backed off by a slow receiver). The bandwidth is effectively shared out with each Node achieving at least $B_s / (m + n)$ unless limited by the maximum point to point bandwidth B_{pp} . If $m > n + 2$ then this maximum B_{pp} is reduced to B_t the traffic limited bandwidth.

$$B_t = \frac{B_s}{m(n + 2)}$$

Notice that $n + 2$ communicating pairs can achieve B_{pp} without traffic limiting of the bandwidth. Figure 0.1 shows a typical Slotted Ring network configuration, and the relationship between OSI Architecture, Functional blocks and the Implementation of the Slotted Ring LAN.

ISO 8802-7:1991(E)

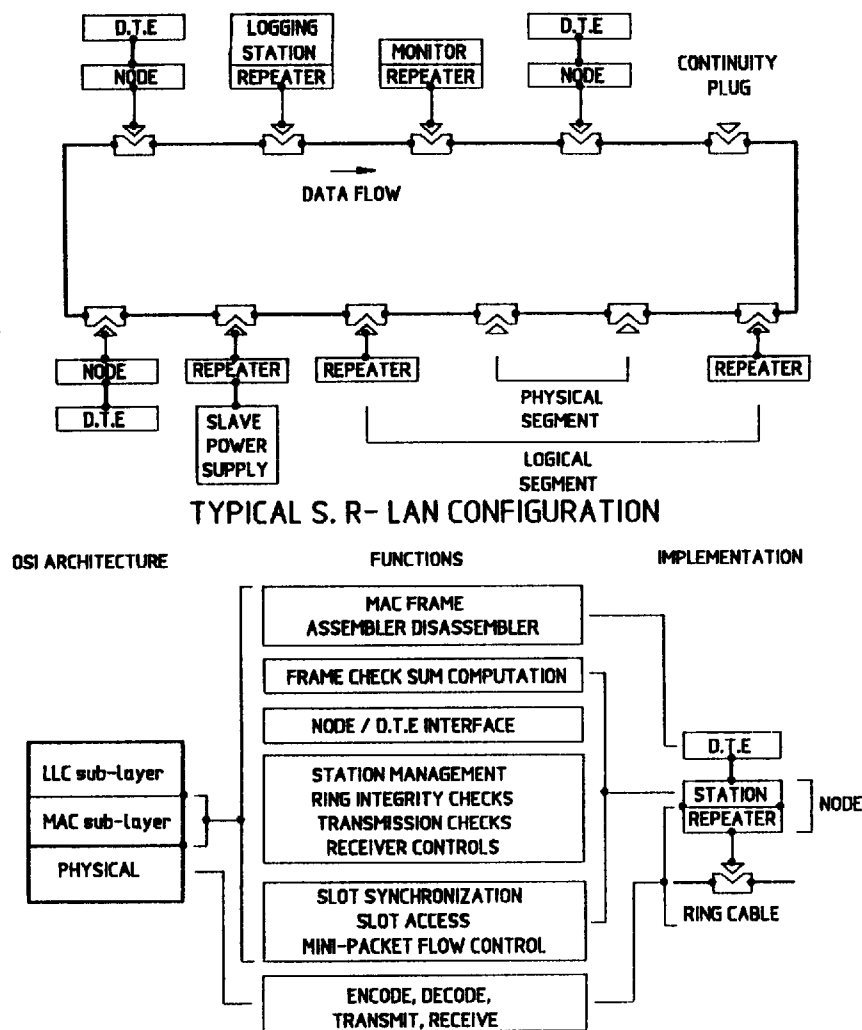


Figure 0.1 — Typical SR-LAN configuration and relationship between OSI architecture — Functions — Implementation

Information technology — Local area networks —

Part 7:

Slotted ring access method and physical layer specification

1 Scope

This part of ISO 8802 specifies the requirements for a local area network that utilizes the slotted ring access method, and that operates at 10 Mbits/second data rate.

Clause 3 defines the terms used in this part of ISO 8802.

Clause 4 specifies the coding of bits and structure of slots and mini-packets.

Clause 5 specifies, in general terms, the components of a configured slotted ring local area network (SR-LAN); in detail, the functional requirements for ring cable, ring connector sockets and ring continuity plugs; and the constraints on the size of, and the combination of components in, a configured SR-LAN.

Clauses 6, 7, 8, 9 and 10 specify in detail the functional requirements for the following components:

- free standing repeaters;
- nodes;
- monitors;
- logging stations;
- slave power supplies.

Each component is specified in terms of its functionality and measurable characteristics at the ring connector plug; and in the case of nodes (clause 7) the functions at the node/DTE interface connector and the processing of mini-packets.

Clause 11 specifies the procedures to be used by the DTE at the time of communications:

a) when transmitting

- 1) in the construction of a frame in response to a request from the user of the media access control service;
- 2) in the transfer of the frame to the local area network node for transmission as a series of mini-packets;
- 3) in determining whether the mini-packets have been successfully transmitted to the destination node;
- 4) in notifying the user of the media access control service whether the frame has been successfully transmitted.

NOTE 1 This event does not necessarily imply receipt by the remote media access control service user.

b) when receiving

- 1) in collecting from the node the contents of received mini-packets;
- 2) in assembling the contents into frames;
- 3) in transferring the contents of the frames to the user of the media access control service.

This clause specifies requirements to be met in each instance of the communication of a frame to and from a single media access control service access point (MAC-SAP), with conditions applying when multiplexing frames to and from one or more MAC-SAPs.

ISO 8802-7:1991(E)

This clause also specifies a range of additional functions from communication with the local node that are not required for the communication of frames, but which may be used for management purposes and to improve efficiency and error detection.

Clause 12 specifies the implementation requirement for the media access procedures specified in clause 11.

The functionality is described in terms of two classes: Basic class being the minimum requirement, and Enhanced Class being a defined extension to the basic functionality. Certain optional features are also specified.

Each clause includes the specification of the information that must be provided by the supplier.

Excluded from this part of ISO 8802 is

- a) internal design information used to meet these requirements;
- b) requirements relating to safety, for which the regulations and standards relevant to the environment in which the equipment is installed apply.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 8802. 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 8802 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 4903:1989, *Information technology — Data communication — 15-pole DTE/DCE interface connector and contact number assignments*.

NOTE 2 This standard uses the mechanical specification if ISO 4903, not its pin assignment specification. Further it is used not for the DTE/DCE interface but for the DCE/MEDIA.

ISO 8802-2:1989, *Information processing systems — Local area networks — Part 2: Logical link control*.

IEC 807-2:1985, *Rectangular connectors for frequencies below 3 MHz*.

3 Definitions

For the purposes of this part of ISO 8802, the following definitions apply.

3.1 slotted ring local area network (SR-LAN): A network for data communication within an area where maximum distances are in the order of 10 km; the network is in the form of a ring connecting all attached data terminal equipment, around which slots for data circulate continuously.

3.2 ring: The physical communication medium comprising ring cable, ring connector sockets and continuity plugs.

3.3 ring cable: Any cable used in the ring, comprising two twisted pairs conveying data, plus one or more conductors used for control voltage return (V_{sig}) and screening.

NOTE 3 This may be either a dedicated cable or a set of conductors from any suitable multi-conductor cable which may carry other traffic.

3.4 Pair A: The twisted pair in a ring cable, carrying the positive d.c. supply and one of the two data signalling channels.

3.5 Pair B: The twisted pair in a ring cable carrying the negative d.c. supply and the other data signalling channel.

3.6 ring connector socket: A socket at which the monitor, repeater, node, logging station or continuity plug is connected to the ring.

3.7 ring connector plug: A plug to mate with the ring connector socket, attached to a monitor, repeater, node or logging station.

3.8 continuity plug: A plug to mate with the ring connector socket, to provide ring continuity when no device is plugged in to the ring connector socket.

3.9 physical ring segment: The portion of the ring between two ring connector sockets.

3.10 logical ring segment: The portion of the ring, comprising one or more physical ring segments linked by continuity plugs, that lies between two ring connector sockets at which repeaters are attached.

3.11 repeater: A device, powered from the ring, that receives a modulated signal from one ring segment, and either regenerates it and outputs it to the next ring segment, or passes it to the attached station and output data from the attached station to the next ring segment.

NOTE 4 A repeater may be either a free standing repeater or part of a node, monitor or logging station.

3.12 free-standing repeater: A repeater that does not form part of a node, monitor or logging station, and whose function is limited to regeneration of the signal.

3.13 node: Equipment combining the functions of a repeater and a station.

NOTE 5 A node is the equipment specific to the SR-LAN of the general class of data circuit-terminating equipment (DCE).

3.14 station: The part of a node that interfaces to both the repeater section of the node and to the data terminal equipment; it performs serial to parallel and parallel to serial conversion, controls communication over the ring, and detects and reports errors.

3.15 data terminal equipment (DTE): The equipment, attached to a network, that is the source and sink of data communicated over the network; except where otherwise specified, the DTE is always the local DTE.

3.16 node/DTE interface: The interface between the node and the DTE.

3.17 node/DTE interface connector plug: The plug attached to the node for the purposes of the node interface.

3.18 node/DTE interface connector socket: The socket, attached to the DTE for the purposes of the node interface.

3.19 monitor: A device, attached to a ring connector socket, that initializes and supervises ring operation.

3.20 logging station: A device, attached to a ring connector socket, that records ring errors.

3.21 Basic Class

3.21.1 of nodes: The class of nodes supporting only 40-bit slots and having the minimum permitted functionality of the node/DTE interface.

3.21.2 of monitor and logging stations: The class designed primarily for interworking with Basic Class nodes.

3.22 Enhanced Class

3.22.1 of nodes: The class of nodes supporting alternative length slots, and having enhanced functionality at the node/DTE interface.

3.22.2 of monitors and logging stations: The class designed primarily for interworking with Enhanced Class nodes.

NOTE 6 As applied to monitors and logging stations, the terms Basic and Enhanced Class refer only to compatibility at ring level with the equivalent class of nodes; there is no necessary association between the classes and the degree of sophistication of other monitor and logging station functionality.

3.23 slave power supply: A unit supplying power at 28 V d.c. to the ring for powering repeaters.

3.24 slot: A group of 40, 56, 72 or 88 consecutive bit-positions in the bit stream circulating round the ring; each slot contains one mini-packet.

3.25 slot structure: A series of one or more consecutive adjacent slots, each of the same length, circulating round the ring, with a single gap between the end of the last slot and the beginning of the first slot when the ring is closed.

3.26 gap: A series of bits, all set to ZERO, used to close the beginning and end of the series of slots into a cycle of circulating bits, and which acts as a reference point for the identification of slots.

3.27 mini-packet: the information contained in a slot, being the data unit used to convey fragments of frames between nodes, under the control of the DTE.

3.28 leader bit: The first bit in a mini-packet, whose value is always ONE, and which thus distinguishes a slot and the mini-packet that it contains from the gap, which is composed of ZEROS.

3.29 full/empty bit: A bit in a mini-packet that distinguishes between a mini-packet that is conveying data from source to destination and back to source (FULL) and a mini-packet that is not conveying data (EMPTY).

3.30 monitor pass bit: A bit in a mini-packet that is used in conjunction with the full/empty bit by the monitor to ensure that error conditions do not allow a mini-packet to remain permanently full.

3.31 node address: An eight-bit integer used to provide unique logical identification of nodes attached to a ring.

NOTE 7 Ensuring that no duplication of node addresses occurs is the responsibility of the SR-LAN administration.

3.32 destination node address: The node address in a mini-packet that identifies the node to which a full mini-packet has been sent.

ISO 8802-7:1991(E)

NOTE 8 The destination node address 0 is reserved for the logging station. The destination node address 255 is reserved for broadcast messages.

3.33 source node address: The node address in a mini-packet that identifies the sender of full mini-packet.

NOTE 9 The source node address 0 is reserved for the monitor.

3.34 data octet: An octet in a mini-packet used for conveying data between the DTEs attached to the source and destination nodes, and for conveying data from a node or the monitor to the logging station in the case of error messages only.

3.35 type bit: One of two bits in a mini-packet used to qualify the data octets; the setting of the type bits is under the control of the DTE attached to the source node of a mini-packet.

3.36 response bits: The two bits in a mini-packet that, used together, indicate to a source node whether and how a mini-packet returning from a complete circuit of the ring has been treated by the destination node.

3.37 parity bit: A bit in a mini-packet that is used by every node, the monitor and logging station, (i.e. not specifically the source and destination nodes) to detect corruption of mini-packets in their progress round the ring.

3.38 auxiliary power supply: Power supply used to provide power at 5 V d.c. to the station section of the node when inadequate power is available from the DTE via the node/DTE interface connector.

3.39 full mini-packet: A mini-packet whose full/empty bit is set to FULL.

3.40 empty mini-packet: A mini-packet whose full/empty bit is set to EMPTY.

3.41 input mini-packet: Any mini-packet arriving at the ring connector.

3.42 received mini-packet: A full input mini-packet that is addressed to the node and is accepted by the node.

3.43 output mini-packet: Any mini-packet output to the ring by the node at the ring connector.

3.44 transmitted mini-packet: An output mini-packet whose contents are mapped by the node from data written to the node by the DTE.

3.45 returned mini-packet: An input mini-packet that is determined by counting passing slots to be a

transmitted mini-packet that has completed a circuit of the ring.

3.46 PERR mini-packet: An output mini-packet whose contents are generated by the node in response to an input mini-packet having a parity error.

3.47 BMESS mini-packet: An output mini-packet whose contents are generated by the node in response to loss of input signal from the ring due to a ring break.

3.48 IMESS mini-packet: An output mini-packet whose contents are generated by the node in response to a break in an interlock chain provided by the DTE.

3.49 local DTE: The DTE performing the procedures specified in this Part.

3.50 remote DTE: A DTE with which the local DTE communicates.

3.51 local node: The node to which the local DTE is attached.

3.52 remote node: A node through which a remote DTE is accessed (see 11.10.1.3).

3.53 media access control service (MAC service): An abstraction of the functions provided by the DTE for the transmission and reception of frames, as seen at a MAC service access point.

3.54 MAC service access point (MAC-SAP): A logical interface between the MAC service provided and MAC service user in a single DTE.

3.55 MAC address: An address identifying a single MAC-SAP.

3.56 frame: The protocol data unit used by the DTE to convey the data presented at the media access service interface.

3.57 logical mini-packet: A mini-packet as visible to the DTE.

3.58 register address: The address of a logical (and possibly real) register in the local node, to or from which the DTE transfers data and control information.

3.59 read register: A local (and possibly real) register in the local node, from which the DTE reads data.

3.60 write register: A logical (and possibly real) register in the local node, to which the DTE writes data.

3.61 register address line: A node interface line used in transferring a register address from the DTE to the node.

3.62 register data field: A part of the data written to or read from a register.

3.63 data line: A bi-directional node interface line used in transferring the data to or from a register.

3.64 local node address: The SR-LAN address assigned to the local node.

3.65 ready-to-attach DTE: Data terminal equipment that, as supplied, has the capability to transmit and receive frames via the ring.

3.66 add-on product: A product that, when installed in a DTE, makes the DTE capable of transmitting and receiving frames via the ring.

3.67 Basic Class node compatible: A DTE that has the capability of attachment to an SR-LAN via a Basic Class node.

3.68 Enhanced Class node compatible: A DTE that has the capability of attachment to an SR-LAN via an Enhanced Class node.

4 Specification for the coding of bits and structure of slots and mini-packets

4.1 Encoding of bits

4.1.1 There shall be two carrier signals, one on Pair A and one on Pair B.

4.1.2 Each carrier signal shall be phase modulated and of nominally square waveform.

NOTE 10 Physical parameters for the waveform are specified in 6.4.2.

4.1.3 Bits shall be encoded by transitions in one or both pairs at the beginning of each bit period. A bit shall be encoded in each bit period.

NOTE 11 At the nominal frequency of 10 Mbps, one bit period is 100 ns. The actual operating frequency, and hence actual bit period, is determined dynamically by the interaction between repeaters and by the total delay time of the whole ring.

4.1.4 A ONE bit shall be encoded by transitions in both pairs.

4.1.5 A ZERO bit shall be encoded by a transition in one pair.

4.1.6 Successive ZERO bits with no intermediate ONE bits or an even number of intermediate ONE bits between them shall be encoded by transitions in opposite pairs; successive ZERO bits with an odd number of intermediate ONE bits shall be encoded by a transition in the same pair.

4.1.7 Provided that the requirements in 4.1.4 to 4.1.6 are met, the transitions may occur in either pair, and in either direction in each pair.

4.2 Slots

4.2.1 Individual slots

Each slot shall comprise a sequence of consecutive bit positions, of length 40, 56, 72 or 88 bit-positions.

NOTE 12 Slot length remains fixed while a ring is operational; any changes require setting of operator controls on attached devices and re-starting the ring.

4.2.2 Slot structure

Each ring cycle shall contain one or more contiguous slots, all of the same length, followed by a single gap of two or more ZERO bits. The first bit in the first slot shall be contiguous with the last bit in the gap.

NOTES

13 Other parts of this International Standard require that the number of slots output to the ring is between 1 and 15, and that the number of gap bits is between 2 and 255. Values outside these ranges may occur in the bit stream received by a device under error conditions.

14 The number of slots and number of gap bits are set by the monitor (automatically or under operator control). Nodes adjust dynamically and continually to the values that appear at their input, even when due to faults the values are incorrect (i.e. not what the monitor set) or invalid (i.e. outside the permitted ranges). This part of ISO 8802 requires that slot structures with a gap in excess of 255 bits are interpreted as a ring break, and that other invalid structures are detected as errors by the monitor but are accepted at face value by nodes, though with reduced requirements for correct processing of slot contents.

15 The number of slots appropriate to correct operation depends on the length of the slots and the total number of bits circulating in the ring. The latter depends on the cable length and the number of repeaters. Approximately, each 22 m of cable adds 1 bit, and each repeater adds 3 bits. Dynamic interaction between repeaters ensures that there is an integral number of bits in circulation, and padding storage in the monitor adds further bits, if necessary, to ensure that at least one slot may be accommodated on the ring and, if possible, that the gap is in the range 4 to 11 bits.

ISO 8802-7:1991(E)

4.3 Mini-packet structure

4.3.2 Format

4.3.1 Length

Each mini-packet shall comprise all bits in one slot. The number of data octets in the mini-packet shall depend on the length of the slot as specified in table 1.

The format of each mini-packet shall be as specified in table 2. Bit 1 shall be the first on to the ring. Response bits shall be as specified in table 3.

Table 1 — Size of mini-packets

Number of bit-positions in slots	40	56	72	88
Number of bits in mini-packet	40	56	72	88
Number of data octets in mini-packet	2	4	6	8

Table 2 — Mini-packet format

Number of data octets in mini-packet (see note 1)				Field	
2	4	6	8		
Bit-position					
1	1	1	1	Leader: always ONE Full/empty bit: FULL: ONE; EMPTY: ZERO	
2	2	2	2		
3	3	3	3	Monitor pass: set to ZERO by monitor and by nodes transmitting error messages, set to ONE by nodes transmitting other mini-packets	
4-11	4-11	4-11	4-11	Destination node address) Source node address) see note 1	
12-19	12-19	12-19	12-19		
			20-27 28-35	Data octet 7) Data octet 6) see note 2	
		20-27 28-35	36-43 44-51	Data octet 5) Data octet 4) see note 2	
	20-27 28-35	36-43 44-51	52-59 60-67	Data octet 3) Data octet 2) see note 2	
20-27 28-35	36-43 44-51	52-59 60-67	68-75 76-83	Data octet 1) Data octet 0) see note 2	
36 37	52 53	68 69	84 85	Type bit A Type bit B	
38 39	54 55	70 71	86 87	Response bit A) Response bit B) see table 3	
40	56	72	88	Parity: computed so that the total number of ONES in the mini-packet is even	

NOTES

1 In the destination and source node addresses the bits are in ascending order, with the least significant bit of the address in the lowest numbered bit of the mini-packet field.

2 In each of the data octets the bits are in ascending order, with bit 0 of the data octet in the lowest numbered bit of the mini-packet data octet field.

Table 3 — Response bits

Response bit A	Response bit B	Response name	Meaning (see note)	
			normal mini-packets	broadcast mini-packets
ONE	ONE	IGNORED	No node has acknowledged the mini-packet	No node has acknowledged the mini-packet
ONE	ZERO	NOT SELECTED	The destination node has acknowledged the mini-packet but has not accepted it, because the node's source selector is set to a value that excludes the source node address contained in the mini-packet, or the type mask is set to exclude the type bit pattern contained in this mini-packet	NOT SELECTED is an invalid response to broadcast messages. The receiving nodes should respond IGNORE rather than NOT SELECTED
ZERO	ONE	ACCEPTED	The destination node has accepted the mini-packet	The mini-packet was accepted by one or more and was ignored by all others
ZERO	ZERO	BUSY	The destination node has acknowledged the mini-packet but has not accepted it since the DTE has not yet set the node to READY after the previous mini-packet received	The mini-packet was marked BUSY by one or more nodes
NOTE — In error message mini-packets the response bits are both set to ZERO and have no meaning.				

5 Specification for configuration components

5.1 Monitor

5.1.1 A single monitor shall be incorporated in the SR-LAN.

5.1.2 The monitor shall comply with the requirements of clause 8 of this part of ISO 8802. The monitor may implement any of the options allowed in clause 8 provided that the following constraints are observed:

- a) the monitor shall be Basic Class (i.e. supporting only 40-bit slots) or Enhanced Class (i.e. supporting 40-bit, 56-bit, 72-bit and 88-bit slots) as necessary to satisfy constraints on SR-LAN size and combination with other components (see 5.10.1.3 and 5.12.3);
- b) the monitor shall support either 7 or 15 slots as necessary to satisfy the SR-LAN size constraints (see 5.10.1.3);
- c) the class of repeater forming the repeater section of the monitor shall satisfy the constraints on mixture of classes of repeater (see 5.12.1).

5.1.3 The monitor may be connected to the ring at any ring connector socket, provided that the conditions of 5.5.2 are met.

5.1.4 The monitor shall be connected to local ground, either via the local power supply or via the ground connection terminal.

5.2 Logging station

5.2.1 Optionally, a single logging station may be incorporated in the SR-LAN. A logging station may be combined with the monitor or with a node.

5.2.2 If incorporated, the logging station shall comply with the requirements of clause 9 of this part of ISO 8802. The logging station may implement any of the options given in clause 9 provided that the following constraints are observed:

- a) the logging station shall be Basic Class (i.e. supporting only 40-bit slots) or Enhanced Class (i.e. supporting 40-bit, 56-bit, 72-bit and 88-bit slots) as necessary to satisfy constraints on SR-LAN size and combination with other components (see 5.10.1.3 and 5.12.4);
- b) the class of repeater forming the repeater section of the logging station shall satisfy the constraints on mixture of classes of repeater (see 5.12.1).

ISO 8802-7:1991(E)

5.2.3 If incorporated and not combined with the monitor, the logging station shall be connected to the ring at a ring connector socket located so that there is neither a node nor a repeater capable of generating error messages between the output of the logging station and the input of the monitor.

5.3 Nodes

5.3.1 At each point where data terminal equipment is to gain access to the SR-LAN, a node shall be connected to the ring at a ring connector socket.

5.3.2 The nodes shall comply with the requirements of clause 7 of this part of ISO 8802. The nodes may implement any of the options allowed in clause 7 provided that the following constraints are observed:

- a) the nodes shall be Basic Class (i.e. supporting only 40-bit slots) or Enhanced Class (i.e. supporting 40-bit, 56-bit, 72-bit and 88-bit slots) as necessary to satisfy constraints on SR-LAN size and combination with other components (see 5.10.1.3 and 5.12.2);
- b) the class of repeater forming the repeater section of the nodes shall satisfy the constraints on mixture of classes of repeater (see 5.12.1).

NOTE 16 It will also be necessary to ensure compatibility between the nodes and DTEs to be attached to the nodes; clause 12 and annex F contain relevant information.

5.3.3 Nodes may be connected to the ring at any ring connector socket.

5.4 Free-standing repeaters

5.4.1 A free-standing repeater shall be placed at each ring connector socket at which no node, monitor or logging station is attached, and at which the requirements of 5.11.2 preclude the attachment of a ring continuity plug.

NOTE 17 Free-standing repeaters will commonly be needed at ring connector sockets at the ends of long physical ring segments and between physical ring segments using different types of cable.

5.4.2 Each such free-standing repeater shall comply with the requirements of clause 6 of this part of ISO 8802. The repeaters may implement any of the options given in clause 6, provided that the mixture of classes of repeater in the SR-LAN complies with 5.12.1.

5.5 Slave power supplies

5.5.1 Sufficient slave power supplies, complying with clause 10 of this part of ISO 8802, shall be provided so that at each ring connector sufficient power is available for the attached repeaters or nodes.

NOTE 18 This part of ISO 8802 sets maximum power ratings for each of these components, and requires that the supplier declares the actual power rating. However, further account will need to be taken of power losses in the ring cable.

5.5.2 The slave power supplies shall be distributed so that when the SR-LAN is in operation:

- a) a d.c. voltage in the range 21 V to 28 V is present at each ring connector socket to which a repeater (whether free-standing or part of the monitor, logging station or node) is attached;
- b) the total d.c. current at any point on the ring cable does not exceed 2 A (i.e. 1 A in each conductor of a pair).

5.5.3 The slave power supplies shall be attached to the slave power supply connector on a repeater or node.

NOTE 19 The mechanical form of the slave power supply connector on a repeater or node is not standardized; hence the fitting or change of connectors may be necessary on installation.

5.6 Ring cables

5.6.1 General

The slotted ring local area network is designed to be able to use a wide range of cable types, including previously installed cable intended for other purposes, such as telephony; therefore, the physical characteristics are not specified in this part of ISO 8802.

Any specific type of cable that satisfies the requirements of this clause will be suitable, provided that the physical and logical ring segments for which it is used are sufficiently short; increasing segment lengths place increasing demands on cable performance. Accordingly, performance requirements are specified in terms of segment length in 5.11.

5.6.2 Conductors

5.6.2.1 The cable shall have the following conductors:

- a) two conductors for Pair A;
- b) two conductors for Pair B;

- c) one or more conductors jointly providing V_{sig} line; this may be a single line, a pair, or screening.

5.6.2.2 Each conductor shall be made of aluminium, copper or tin-plated copper and shall have a cross-sectional area of at least 0,22 mm².

5.6.2.3 The two conductors for a pair shall be a twisted pair.

5.6.2.4 Each of the conductors shall be insulated from each other conductor, except that multiple conductors providing the V_{sig} line shall be commoned, and each (including any screening) shall be isolated from any ground.

5.6.3 Homogeneity

5.6.3.1 Except as specified in 5.6.4, at each point along the cable the conductors forming Pair A and Pair B at that point shall be of identical type; if they are part of a multi-layer cable, they shall be from the same layer and shall be diametrically opposed within the layer.

5.6.3.2 Except as specified in 5.6.3.3, at different points within each physical ring segment the cable shall be of the same nominal impedance and of similar type. "Similar type" shall include pairs of identical construction within multi-purpose cables with different numbers and arrangements of pairs.

5.6.3.3 Where broadband cables are used in a physical segment and those cables are too large to be connected directly to a ring connector socket, the cables shall be terminated in a securely mounted terminal block and connected to the ring connector socket via a tail, less than 5 m long, of cable of a different type but the same nominal impedance.

5.6.3.4 Different physical ring segments may be of different nominal impedance and different type.

NOTE 20 A repeater will typically need to be attached at the ring connector between physical ring segments using different cable types.

5.6.4 Propagation delay matching

The differential propagation delay between Pair A and Pair B in any segment, physical or logical, shall not exceed 10 ns as measured at the ring connector socket. If necessary, the conductors for the two pairs shall be cut to different lengths, or a propagation delay matching tail shall be inserted to bring the differential within 10 ns (see annex A).

5.6.5 Impedance

The characteristic impedance between the two conductors of each pair shall be between 90 Ω and 150 Ω measured at a frequency of 5 MHz.

5.7 Ring connector sockets

5.7.1 Ring connector sockets shall be 15-way female contact shrouded and screened connectors complying with IEC 807-2.

- a) The contact number assignment shall be as specified in table 4.
- b) The locking device shall be a threaded block as specified in ISO 4903.

5.7.2 The identification of lines in each pair as "+" and "-" has no significance; an arbitrary choice may be made as to which of the two conductors in the pair is attached to which of the contacts for the pair, and the choice need not be consistent from connector to connector.

5.7.3 The V_{sig} line shall not be connected to any ground.

NOTE 21 When the monitor is plugged into a ring connector socket, it provides the sole ground connection; any other ground connection elsewhere on the ring cables, connector sockets and repeaters may cause ground loop problems.

5.8 Continuity plugs

5.8.1 A continuity plug shall be provided at each ring connector.

NOTE 22 The purpose of the plug is to complete the ring circuits when no repeater is connected to the ring connector socket.

5.8.2 The plug shall be a screened male contact plug as specified in 6.2.1.

5.8.3 Each Data In line shall be connected to the corresponding Data Out line.

5.8.4 The continuity plug shall be inserted into each ring connector socket to which no other device is attached.

5.8.5 A means of storage or attachment shall be provided, so that when not in use the continuity plug remains close to the ring connector socket.

NOTE 23 This requirement may be met by means such as female threaded fittings on the ring connector socket to which the continuity plug locking screws can be attached, or by having the continuity plug on the end of a cord attached to any convenient local fixture.

Table 4 — Ring connector contact number assignment

Contact	Line	
1	Line In A +	) Pair A, Data In and 28 V d.c. positive
9	Line In a -	
2	Reserved	
10	Line In B +	) Pair B, Data In and 28 V d.c. negative
3	Line In B -	
11	Reserved	
4	Reserved	
12	V _{sig} ; SPSU signal return/screen/drain	
5	Reserved	
13	Reserved	
6	Line Out B -	) Pair B, Data Out and 28 V d.c. negative
14	Line Out B +	
7	Reserved	
15	Line Out A -	) Pair A, Data Out and 28 V d.c. positive
8	Line Out A +	

5.9 Topology

5.9.1 Each physical ring segment shall be attached to just two ring connector sockets.

5.9.2 Each ring connector socket shall be connected to just two physical ring segments, one of which is connected to the Data In and V_{sig} contacts, and the other to the Data Out and V_{sig} contacts.

5.9.3 No connection to the ring shall be made except via a ring connector socket.

5.10 Total SR-LAN size

5.10.1 SR-LAN size related to slot structure

5.10.1.1 The ring size shall be such that the number of bits in circulation does not exceed the maximum number of bits for the largest slot structure that can be supported by the monitor, logging station if present, and nodes.

5.10.1.2 The nominal number of data bits in circulation shall be calculated as follows:

- a) 1 bit for each 22 m of ring cable;

- b) 3 bits for the monitor;

- c) 3 bits for each repeater (free-standing repeater or repeater section of node);

- d) if a logging station is present, 3 or 15 bits depending on the type.

5.10.1.3 The maximum number of bits that can be supported shall be calculated as follows:

- a) the number of slots shall be 7 if the monitor supports no more than 7 slots, or 15 otherwise;
- b) the maximum number of bit-positions in a slot shall be 88 unless any node, the monitor or logging station are Basic Class, in which case the number shall be 40;
- c) the total number of bits shall be the number of slots times the number of bit-positions in a slot, plus 11 bits for the gap.

NOTE 24 The above values are based on the nominal operating frequency of 10 Mbps; in operation the actual operating frequency will deviate to a greater or lesser extent from nominal, and so the number of bits in circulation will vary. In particular, a higher operating frequency may produce a gap longer than 11 bits. The occurrence of such conditions does not prevent effective operation, and does not imply non-compliance.

5.10.2 SR-LAN size related to repeater type

SR-LANs including Class II repeaters, but excluding Class III repeaters, shall not have a total ring cable length in excess of 4 km.

5.10.3 Maximum number of nodes in SR-LAN

The number of nodes shall not exceed 254.

NOTE 25 Other constraints may reduce this maximum (see 5.10.1).

5.11 Ring segment length

5.11.1 Physical ring segments

5.11.1.1 The physical arrangement of the installed ring cable and ring connector sockets shall be such that the maximum length requirement in 5.11.1.2 is satisfied.

5.11.1.2 No physical ring segment shall be so long that, when connected to either of the adjacent physical ring segments by a ring continuity plug, with repeaters at the other extremities of the connected physical ring segments, the resultant logical ring segment does not satisfy the test specified in annex A.

NOTES

26 The limit on length is, therefore, dependent on the length of each of the adjacent ring segments, and is set by the need to ensure that the ring can function when any one repeater (or more than one, provided they are not adjacent) is temporarily replaced by continuity plugs (e.g. in the case of repeater malfunction).

27 Practical limits depend on the type of cable employed, and are determined primarily by the amount of resistive attenuation and capacitive degradation of the transmitted waveform, but are also influenced by other factors such as crosstalk, interference, and differences between pairs caused by manufacturing and installation tolerances.

5.11.2 Logical ring segments

5.11.2.1 The disposition of repeaters attached to the ring connector sockets shall be such that the maximum length requirement in 5.11.2.2 is satisfied.

5.11.2.2 No logical ring segment shall be so long that, when connected to either of the adjacent logical ring segments by replacement of the intervening repeater by a ring continuity plug, the resultant longer logical ring segment does not satisfy the test specified in annex A.

NOTES

28 See note 26 to 5.11.1.2.

29 Practical limits are set by the length of the physical ring segments making up the logical ring segment and losses caused by any intermediate connectors, ring continuity plugs, attached slave power supply units, and differences between the electrical characteristics of adjacent physical ring segments within the logical ring segment.

30 If telephony cables are used a maximum logical segment length of 100 m generally ensures compliance with this clause.

5.12 Combination of components

5.12.1 Mixture of classes of repeater

5.12.1.1 Subject only to SR-LAN size limitations, any number of Class I repeaters, alone or mixed with repeaters of other classes, may be incorporated in the SR-LAN.

5.12.1.2 No more than 20 Class II repeaters shall be included in an SR-LAN in which there is no Class III repeater.

5.12.1.3 No more than 40 Class II repeaters shall be included in an SR-LAN in which there is one Class III repeater that has a peak transfer characteristic magnitude not exceeding 1,5 dB.

NOTE 31 If the frequency at which the Class II repeater has a transfer characteristic magnitude equal to 0 dB is

reduced below the limit specified in 6.6, then the number of Class II repeaters may be further increased.

5.12.1.4 The sum of the transfer characteristic magnitudes of all Class III repeaters in an SR-LAN shall not exceed 3 dB.

NOTES

32 Since the minimum peak magnitude for a Class III repeater is 1 dB, no more than three Class III repeaters may be included; and since the maximum peak magnitude for a Class III repeater is 3 dB, one may be included in any ring.

33 If the noise-induced error rate exceeds 1 in 10^{11} bits, repeaters of Class III may be included in the SR-LAN in an attempt to bring the error rate below this value.

5.12.2 Mixture of classes of node

5.12.2.1 Where slots of length 40 bit-positions are to be used, any mixture of Basic and Enhanced Class nodes may be included in the SR-LAN.

5.12.2.2 Where longer slots are to be used, all nodes shall be Enhanced Class nodes.

5.12.3 Monitor

5.12.3.1 Where slots of length 40 bit-positions are to be used, the monitor may be either Basic or Enhanced Class.

5.12.3.2 Where longer slots are to be used, the monitor shall be Enhanced Class.

5.12.4 Logging station

If any node is Enhanced Class, the logging station shall be Enhanced Class.

6 Specification for free-standing repeaters

6.1 Compliance

6.1.1 Product designation

In claims of compliance the product shall be designated as a free-standing repeater of Class I, Class II or Class III.

6.1.2 Condition as supplied

The product shall be supplied in such condition that when connected to an operational ring, and to a slave power supply if one is configured at that point on the ring, it complies with this part of ISO 8802.

NOTE 34 The product is not precluded from complying with specifications that differ from this part of ISO 8802, provided that it can be set to a mode of operation in which

ISO 8802-7:1991(E)

it complies and all conflicting features are rendered non-operational.

6.1.3 Limitations

The functions at the ring connector interface shall be restricted to those expressly specified or expressly permitted.

6.1.4 Implementor options

The following shall be at the option of the implementor:

- a) the class of repeater (Class I, II or III) (see 6.6.7);
- b) the form of the slave power supply unit connector (see 6.2.2.1);
- c) the presence or absence of a repeater/station interface and the nature of this interface if present (see 6.2.3);
- d) the repeater response to error conditions [see 6.5.2 a) and b), and 6.6.1 a) and b)];

NOTE 35 In both 6.5.2 and 6.6.1, option a) is the basic requirement for a repeater, namely that the repeater need have no capability to generate error messages, since the prime function of a repeater is simply the regeneration of the input signal, but b) is permitted so as to allow the use of common components for both free-standing repeaters and for the repeater section of nodes.

6.1.5 Information to be provided by the supplier

6.1.5.1 The documentation associated with the product shall include the following information on the options in 6.1.4:

- a) if the repeater is Class III, the transfer characteristic magnitude;
- b) the form of the slave power supply connector and the allocation of the required lines to pins or terminals;
- c) whether a repeater to station interface is implemented;
- d) which options in 6.1.4 d) are implemented.

6.1.5.2 The maximum continuous current consumption at an input voltage in the range 21 V to 28 V d.c. shall be declared on a plate or label attached to the repeater.

6.1.6 Tests

6.1.6.1 **Environmental conditions.** All operational requirements shall be met at all temperatures in the range 10 °C to 30 °C.

6.1.6.2 **Test point.** All input, output and measurements shall be made at the ring connector.

6.1.6.3 **Transient conditions.** For those requirements specified in terms of a steady input signal, both transient initial output and transient noise-induced output which do not satisfy the requirements shall be disregarded.

NOTE 36 Compliance with the requirements specified in 6.6.6 and 6.6.7 determines compliance with regard to response to transient conditions, including both changes in the operating frequency and noise-induced distortion of the operating frequency.

6.2 Interfaces

6.2.1 Ring connector plug

6.2.1.1 Mechanical

The repeater shall be provided with a male contact shrouded and screened connector complying with IEC 807-2.

- a) The contact number assignment shall be as specified in table 4.
- b) The locking device shall be a screw lock as specified in ISO 4903.

6.2.1.2 Electrical characteristics

6.2.1.2.1 When the repeater is powered up, for each of the two Data In pairs the impedance across the two members of the pair shall be between 90 Ω and 150 Ω measured at 5 MHz.

6.2.1.2.2 The d.c. resistance between Pair A Data In and Pair A Data Out shall be such that the power transfer requirements of 6.3 are satisfied; and likewise for Pair B Data In and Pair B Data Out.

6.2.1.2.3 The d.c. resistance between pairs A and B shall be such that the power consumption and transfer requirements of 6.3 are satisfied.

6.2.1.2.4 No d.c. connection shall be made between the V_{sig} line and local ground. The capacitance between the V_{sig} line and local ground, if any, shall exceed 10 nF (see note). The term local ground shall be taken to include parts of the repeater which may come into contact with an external local ground when installed.

NOTE 37 This capacitance is required for decoupling purposes; an appropriate means is a 47 nF decoupling capacitor.

6.2.2 Slave power supply connector

6.2.2.1 Physical form. The form of the slave power supply connector is at the option of the implementor [see 6.1.4 b)]. The connector shall not be capable of being mated with

- a) a ring connector;
- b) the connector used, if any, for an interface to a node (see 6.2.3);
- c) a connector mating with a) or b).

6.2.2.2 Lines. The following three lines shall be provided for the attachment of a slave power supply:

- a) one positive line;
- b) one negative line;
- c) one line connected to the V_{sig} line.

6.2.2.3 Electrical. The connector shall be such as to satisfy the power transfer requirements of 6.3.4.

6.2.3 Repeater to station interface

6.2.3.1 General. At the option of the implementor, the repeater may be equipped with a connector to permit the repeater to be connected to a station to form a node. If implemented, the requirements specified in 6.2.3.2 and 6.2.3.3 shall be satisfied.

6.2.3.2 Physical form. The connector shall not be capable of being mated with

- a) any other connector on the repeater;
- b) the node/DTE connector and auxiliary power supply connector specified in clause 7;
- c) any connector mating with a) or b).

6.2.3.3 Functionality. The repeater shall meet all the requirements specified in this clause when disconnected at this connector.

6.3 Power supply

6.3.1 Power source

6.3.1.1 The repeater shall draw its power supply from the ring and attached slave power supplies.

NOTE 38 annex D illustrates power arrangements.

6.3.1.2 The positive feed shall be from the four Pair A conductors (two signal input and two signal output) and the positive line from the slave power supply connector. The negative feed shall be from the four Pair B conductors and the negative line from the slave power supply connector. Means such as centre-tapped transformers shall be used to separate the d.c. power from the signal.

NOTE 39 In operation, the disposition of slave power supplies and loads in the configured ring will determine whether the source of power is the Data In pairs, the Data Out pairs or the slave power supply connector.

6.3.2 Voltage

The repeater shall be in the powered up state whenever the average of the supply voltage at the Data In pairs, the Data Out pairs and the slave power supply connector lies between 21 V and 28 V d.c.; the powered up state is the state in which the repeater meets the requirements of the remainder of this clause and of 6.4 to 6.6.

6.3.3 Current

6.3.3.1 The continuous current drawn shall not exceed 150 mA for any input voltage between 21 V and 28 V d.c., and shall not exceed 120 mA at an input voltage of 28 V d.c.

6.3.3.2 The surge current on power-up shall not exceed 500 mA.

6.3.3.3 Where current is drawn from a pair, the current shall be drawn equally to within 10 % from each member of the pair when the same voltage is present on each member of the pair.

6.3.4 Power transfer

6.3.4.1 Power supplied from the ring at the input pins shall be made available at the output pins, and vice versa, less the power consumed by the repeater.

NOTE 40 The direction of power transfer will depend on the relative disposition of slave power supplies and loads (other repeaters) in the configured ring; it can be in either the same or the reverse direction to the data flow.

6.3.4.2 Power supplied at the slave power supply connector shall be made available to the ring at both the input and output pins, less the power consumed by the repeater.

6.3.4.3 Current fed into a pair shall be divided equally between the two conductors when they present the same load.

ISO 8802-7:1991(E)

6.3.4.4 The current rating of the circuits used for power transfer shall be at least

- a) 2 A for each member of a pair (normally the members of a pair will share the peak current of 2 A, 1 A each; but each has to be able to sustain the 2 A under fault conditions without damage);
- b) 1 A for the V_{sig} line;
- c) 2 A for the positive and negative lines at the slave power supply connector.

6.4 Production of output

6.4.1 Power-up condition

The repeater shall produce continuous output on both Pair A Data Out and Pair B Data Out whenever the repeater is in the powered up condition. Output shall begin within 1 s of power being applied.

6.4.2 Waveform

The output waveform shall be a modified square wave as shown in figure A.1 that lies within the following limits when working into a balanced load whose impedance lies between 90 Ω and 150 Ω .

For a string of ONES

$$V_1 = 6,0 \text{ V} \pm 1,0 \text{ V}$$

$$V_2 = 2,3 \text{ V} \pm 0,3 \text{ V}$$

$$t = 200 \text{ ns}$$

$$t_r < 18 \text{ ns}$$

For a string of ZEROS

$$V_1 = 6,0 \text{ V} \pm 1,0 \text{ V}$$

$$V_2 = 1,75 \text{ V} \pm 0,15 \text{ V}$$

$$t = 400 \text{ ns}$$

$$t_r < 18 \text{ ns}$$

6.4.3 Balance

The algebraic sum of the signal voltages on the two lines of a Data Out pair with respect to the d.c. potential of the pair shall be constant.

6.4.4 Coding

The output shall consist of a continuous stream of bits encoded as specified in 4.1.

6.5 Output in absence of input signal

6.5.1 Free-running frequency

When no input signal is presented, the repeater shall produce an output with a frequency lying between 9,5 Mbps and 10,5 Mbps.

6.5.2 Bit stream

When no input signal is provided, the output signal shall be either

- a) the bit stream representing a continuous string of ZEROS; or
- b) the bit stream specified in 7.9.2.1 b) for ring break error procedures in a node.

NOTE 41 See note to 6.1.4 d).

6.6 Output in presence of input signal

6.6.1 Bit stream

The output shall be either

- a) a bit stream representing the same bit stream as is represented by the input; or
- b) the bit stream permitted for a node that is not powered up or is disabled, as specified in 7.6.3.1 b); in this case
 - 1) the repeater shall be equipped with a means for being configured with a single address;
 - 2) it shall be possible to configure every address in the range 1 to 254;
 - 3) this address shall be the source node address in PERR error message mini-packets.

NOTE 42 See note to 6.1.4 d).

6.6.2 Repeater delay

The bit stream output shall be delayed relative to the bit stream input by no more than 3,5 bit-periods.

NOTE 43 This delay comprises a maximum of three bit-periods for signal processing plus half a bit-period for phase shift and delay in the cable between the repeater and the ring connector. The half bit-period is an arbitrary value to draw a line between three bits plus some lag and four bits minus some lead; phase shift and cable delay will normally need to be far less than half a bit-period in order to meet other performance requirements.

6.6.3 Signal capture range

Whenever a steady encoded signal with a frequency between 8,5 MHz and 11,5 MHz and the waveform defined in 6.4.2 is presented to the input, an encoded output with the same frequency and phase-locked to the input shall be produced.

6.6.4 Low error range

Whenever a steady encoded signal with a frequency between 9,25 MHz and 10,75 MHz and the waveform defined in 6.4.2 is presented to the input, no more than 10 bit errors shall occur per 10 min averaged over a 3 h period. Outside the low error range the error rate is not specified and may be greater.

NOTE 44 This error rate is an arbitrary low rate specified simply to mark the frequency at which the onset of errors occurs due to excessive loop stress. Normal mid-band operation should yield error rates less than 1 in 10^{11} bits.

6.6.5 Sensitivity

The repeater shall have a sensitivity, V_g , such that $100 \text{ mV} \leq V_g \leq 200 \text{ mV}$ as measured by the test described in annex B.

NOTE 45 100 mV is the guaranteed noise margin while 200 mV is the minimum sensitivity.

6.6.6 Phase locked loop-closed loop stress

When the input frequency is changed within the capture range, the phase change of the output transitions with respect to the input transitions shall not exceed $2 \pi/3$ rad/MHz.

6.6.7 Phase locked loop-closed loop transfer characteristic

6.6.7.1 Class of repeater. The repeater shall comply with one of the following classes:

- a) Class I: repeaters complying with 6.6.7.3;
- b) Class II: repeaters complying with 6.6.7.4;
- c) Class III: repeaters complying with 6.6.7.5.

6.6.7.2 Parameters. The following parameters are used for specifying the phase locked loop transfer characteristics in 6.6.7.3 to 6.6.7.5; they shall be measured by the test described in annex C:

- a) closed loop gain: the magnitude of the transfer ratio of output phase modulation to input phase modulation (in decibels);
- b) the frequencies (in radians per second) at which the loop gain has given values;

- c) the control phase lag: the argument of the complex transfer ratio (in degrees) at a given frequency.

6.6.7.3 Class I. For a Class I repeater, the closed loop gain shall be less than 0 dB at all frequencies.

6.6.7.4 Class II. For a Class II repeater

- a) the closed loop gain shall not exceed 0,05 dB at any frequency;
- b) the closed loop gain shall be 0 dB at a frequency in the range $1,75 \times 10^4$ rad/s to $7,0 \times 10^4$ rad/s;
- c) at this frequency, the control phase lag shall be less than 5° .

6.6.7.5 Class III. For a Class III repeater

- a) the maximum closed loop gain shall lie in the range 1 dB to 3 dB;
- b) the frequency at which the closed loop gain is 0 dB shall be less than $3,5 \times 10^3$ rad/s.

7 Specification for nodes

7.1 Compliance

7.1.1 Product designation

In claims of compliance the product shall be designated

- a) as either a Basic Class or Enhanced Class node;
- b) in the case of a Basic Class node, as with or without the optional broadcast reception and log reception functions;
- c) in the case of an Enhanced Class node, as with or without the optional log reception function;
- d) as having a Class I, II or III repeater section.

7.1.2 Condition as supplied

The product shall be supplied in such condition that when physically installed, connected to the ring, a DTE, and if appropriate to a slave power supply and auxiliary power supply via the relevant connectors, it complies with the requirements of this part of ISO 8802.

NOTE 46 The product is not precluded from complying with specifications that differ from this part of ISO 8802, provided that it can be set to a mode of operation in which it complies with this Part of this standard.

ISO 8802-7:1991(E)

7.1.3 Limitations

The functions at the ring connector interface and the node interface shall be restricted to those expressly specified or expressly permitted.

7.1.4 Options

7.1.4.1 Class of node. The node shall be either **Basic Class** or **Enhanced Class**. An Enhanced Class node shall implement the following features in addition to those required for a Basic Class node:

- a) capability of operating with each of 40-bit, 56-bit, 72-bit and 88-bit slots (Basic Class, 40-bit slots only);
- b) implementation of SOURCE SELECT/REJECT control (a Basic Class node is required to function always as for the SELECT state of this control);
- c) implementation of TYPE SELECT/REJECT control (a Basic Class node is required to function always as for the OFF state of this control);
- d) BROADCAST RECEPTION control (optional in Basic Class, with a different means of control).

7.1.4.2 Implementor options. The following shall be at the option of the implementor:

- a) class of repeater (Class I, II or III) (see 7.6.2);
- b) ring break and parity error procedures when disabled (see 7.9.2);
- c) ring break procedures when enabled (see 7.9.2);
- d) extent of transmission comparison error checks on returned mini-packets [see 7.11.2.4 d)];
- e) implementation or non-implementation of LOG RECEPTION control (see 7.10.1.7);
- f) for Basic Class nodes, implementation or non-implementation of broadcast facility (see 7.10.1.8);
- g) IMESS mini-packet generation (see table 6).

NOTE 47 For enhanced Class nodes, implementation of broadcast facility is mandatory.

7.1.4.3 Supplier options. The following shall be at the option of the supplier:

- a) the slave power supply unit connector (see 7.2.2);

- b) the means of providing auxiliary power to replace that provided at the Node/DTE connector;
- c) the means of loading the node with its assigned ring address (see 7.3.2);
- d) the means of setting the length of slot in Enhanced Class nodes (see 7.3.1).

7.1.4.4 Undefined actions. Wherever in a requirement an action of the node is stated to be undefined, the action shall be at the option of the implementor but shall not conflict with any other requirement.

NOTE 48 In each case where an action is undefined, either

- a) the conditions under which the action is undefined will occur only if the DTE does not comply with clauses 11 and 12; or
- b) the DTE is required by clauses 11 and 12 to ignore the undefined action. The node is not required to detect or correct DTE misbehaviour.

7.1.5 Information to be provided by the supplier

The documentation associated with the product shall include the following:

- a) whether the node is Basic or Enhanced Class;
- b) which of the options in 7.1.4.2 are implemented, and if the node can be set to operate according to either alternative for an option, the means by which one alternative is selected in operation;
- c) how the options in 7.1.4.3 are implemented;
- d) if the node is capable of operating in a way differing from the requirements specified in this clause of this part of ISO 8802 (see 7.1.2), the means by which the node is set to a mode of operation in which it complies;
- e) the maximum continuous power supply current drawn by the node from the ring for powering the repeater section;
- f) the maximum continuous current drawn by the node from the DTE and/or auxiliary power supply for powering the station section.

7.2 Interfaces

7.2.1 Ring connector plug

The node shall be equipped with a ring connector plug whose characteristics shall be as specified in 6.2.1.

7.2.2 Slave power supply connector

The node shall be equipped with a connector for the attachment of a ring slave power supply unit. The characteristics shall be as specified in 6.2.2.

7.2.3 Station to repeater interface

At the option of the implementor, the station and repeater may be constructed as two separate physical units, connected by a station to repeater connector. No requirements are specified relating to this connector, other than that where the repeater section is claimed to function as a free-standing repeater, it shall comply with clause 6 of this part of ISO 8802 when the repeater section is disconnected at this interface.

7.2.4 Node/DTE interface connector plug

7.2.4.1 Mechanical

The node shall be equipped with a 50-way fixed connector with male contacts whose dimensions comply with figure 1.

This connector is the subject of standardization in IEC.

7.2.4.2 Contact number assignment

The contact number assignment shall be as specified in table 5.

7.2.4.3 Electrical

7.2.4.3.1 Lines driven by node. Each line for which the node is specified as the driver in table 5, when working into any load in the range 400 Ω to 550 Ω applied at the node connector between the line and the + 5 V line, shall have positive potential with respect to ground of between 0 V and 0,4 V in the low state and between 2,4 V and 5,25 V in the high state.

Table 5 — Node/DTE interface connector contact number assignment

Contact	Line	Driver	Contact	Line	Driver
1	Ground	--	2	TEST:N (see note 1)	
3	Ground	--	4	RDN:N	Node
5	Ground	--	6	RTPA:N	Node
7	Ground	--	8	RTPB:N	Node
9	Ground	--	10	RD:N	DTE
11	Ground	--	12	WT:N	DTE
13	Ground	--	14	A0:P	DTE
15	+ 5 V	--	16	A1:P	DTE
17	+ 5 V	--	18	D0:P	both
19	+ 5 V	--	20	D1:P	both
21	+ 5 V	--	22	D2:P	both
23	+ 5 V	--	24	D3:P	both
25	Ground	--	26	Ground	--
27	D4:P	both	28	+ 5 V	--
29	D5:P	both	30	+ 5 V	--
31	D6:P	both	32	+ 5 V	--
33	D7:P	both	34	+ 5 V	--
35	A2:P	DTE	36	+ 5 V	--
37	A3:P	DTE	38	Ground	--
39	Reserved	--	40	Ground	--
41	RINT:N (see note 2)		42	Ground	--
43	TDN:N	Node	44	Ground	--
45	TER:N	Node	46	Ground	--
47	TCLK:N	Node	48	Ground	--
49	ACK:N	Node	50	Ground	--

NOTES

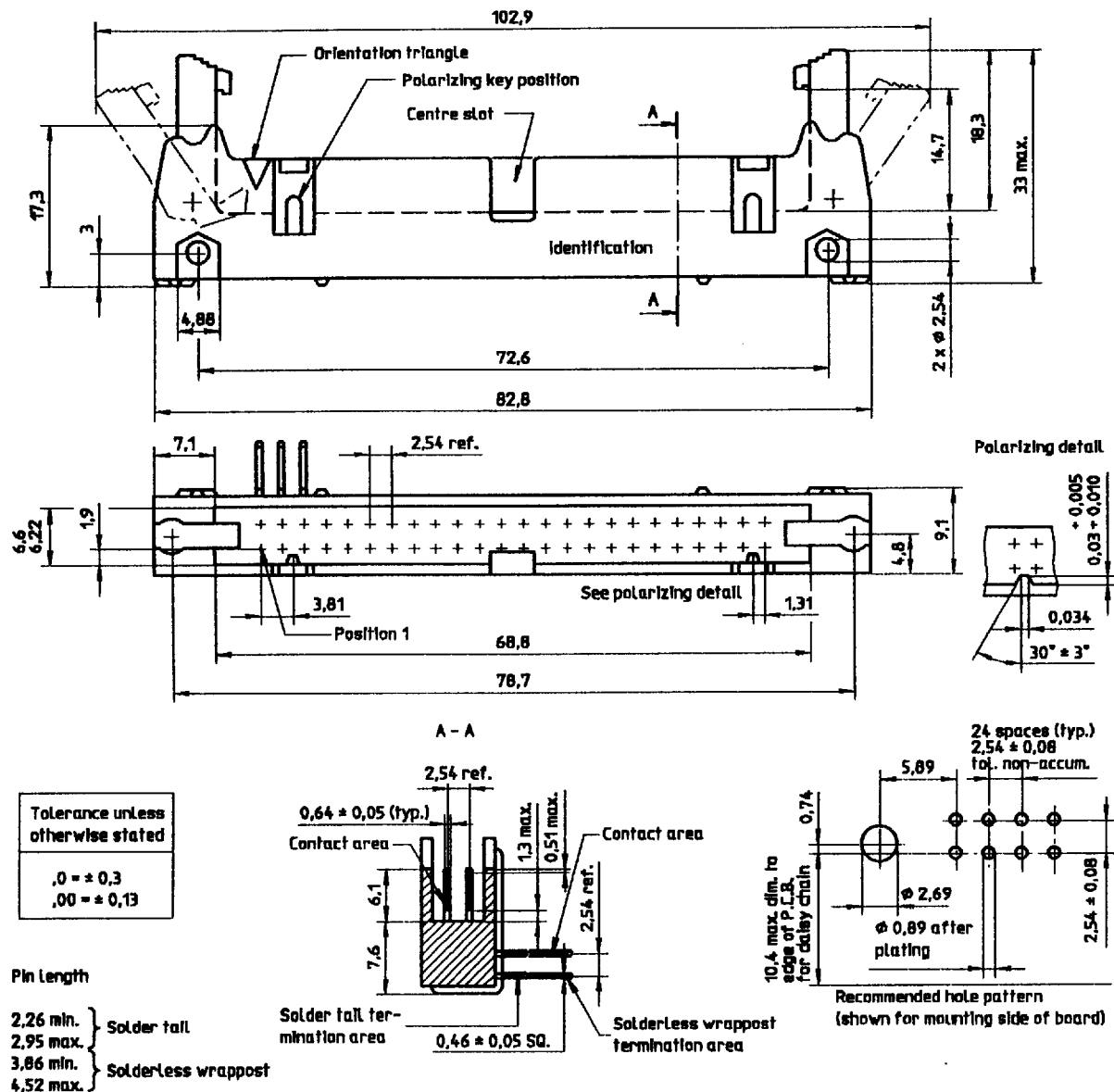
1 Contact 2 is used for TEST:N if this optional function is implemented; it is then driven by the DTE. Otherwise, it is reserved.

2 Contact 41 is used for RINT:N which is the logical NOR of BPR or LOG in Rx.SR, for Enhanced Class nodes.

If Basic Class nodes use the optional feature of broadcast reception, RINT:N = BPR:N since they cannot provide the logging message reception facility as an additional node function.

Except during transitions, the line shall always be in the low or high state while the station is powered up. Transitions shall not take longer than 25 ns between 0,4 V and 2,4 V or vice versa, and once a transition has started (i.e. the 0,4 V or 2,4 V thresholds have been crossed) it shall be completed.

Dimensions in millimetres



7.2.4.3.2 Lines driven by the DTE. Each line specified in table 5 as driven by the DTE shall present a load of between 400 Ω and 550 Ω between the line and the + 5 V lines.

A positive voltage in the range 0 V to 0.8 V with respect to ground applied at the node connector shall be recognized by the node as the low state of the line for the purposes of 7.12 to 7.15.

A positive voltage in the range 2.0 V to 5.25 V with respect to ground applied at the node connector shall be recognized by the node as the high state of the line for the purposes of 7.12 to 7.15.

7.2.4.3.3 Bi-directional lines. When the node is acting as source, the node shall comply with 7.2.4.3.1 for all loads such that the current on the signal line does not exceed 600 μ A in the high state and 12 mA in the low state.

When the node is acting as sink, it shall comply with 7.2.4.3.2.

7.2.4.3.4 + 5 V lines. These lines shall be used by the node for powering the station section if sufficient power is available from the DTE by this route (see 7.4).

7.2.4.3.5 Ground lines. These lines shall provide the 0 V reference for signals, and the power return if the station section is powered from the DTE (see 7.3). There shall be no d.c. connection within the node between these lines and the V_{sig} line at the ring connector plug.

NOTE 49 These lines may also provide protective ground, as required by the safety regulations and standards applicable to the environment in which the node will be used.

7.3 Operator controls

7.3.1 Slot and mini-packet length

Enhanced Class nodes only shall be equipped with an operator control that can select operation with each of the following, only one at a time:

- a) 40 bits (2 mini-packet data octets);
- b) 56 bits (4 mini-packet data octets);
- c) 72 bits (6 mini-packet data octets);
- d) 88 bits (8 mini-packet data octets).

7.3.2 Node address

The node shall be provided with means to allow the operator to load the node with any address in the range 1 to 254 allocated to the node by the local area network administrators. The means may be any chosen by the supplier, provided that it does not permit the address to be loaded or modified by the DTE.

NOTE 50 This does not preclude the provision of security features designed to prevent unauthorized operators from load or modifying addresses.

7.3.3 Auxiliary power supply

If as a supplier option a means for providing auxiliary power is incorporated then; the node shall be provided with means of enabling and disabling auxiliary power supply to the station section of the node; the means may be chosen by the supplier.

7.4 Power supply

7.4.1 Division of power supply

The repeater and station sections shall be separately powered, unless the total power consumed does not exceed the limit specified in 6.3. Since neither the interface between the repeater and station sections nor the division of functions between them are standardized, the separation of power arrangements is correct if

- a) when the node is attached to a powered up ring but not to a DTE or auxiliary power supply, the node satisfies the requirements of 7.4, 7.5 and 7.6.1;
- b) when the node is not attached to a ring, but is attached to a DTE (and auxiliary power supply if necessary) and is powered up and disabled, the node satisfies the requirement of 7.15 for disabled nodes.

7.4.2 Repeater section

The repeater section shall be powered from the ring and/or the slave power supply unit if one is attached at the slave power supply unit connector, as specified in 6.3.

7.4.3 Station section

7.4.3.1 Power source. The station section shall be powered from the DTE and/or an auxiliary power supply. A switch or removable link shall be fitted so that each of the following settings can be selected:

- a) auxiliary power disabled: the station section draws its power from the DTE via the node connector alone;
- b) auxiliary power enabled: the station section draws its power from the node connector and/or the auxiliary power connector; with this setting the node shall remain disabled, regardless of any enable commands, when no voltage in the range 4,75 V to 5,25 V of the correct polarity is present at the auxiliary power connector.

7.4.3.2 Voltage. The station section shall operate in accordance with this clause for all voltages in the range 4,75 V to 5,25 V d.c. When the supply voltage falls below the minimum operating voltage for the station section, which shall not exceed 4,75 V, the station section shall become powered down in such a way that any corruption to ring traffic is confined to mini-packets being transmitted or received by the node, and shall not affect other input or output mini-packets.

7.4.3.3 Current. The station section shall not draw more than 3 A.

7.5 Output in absence of input signal

7.5.1 Production of output

The node shall satisfy the requirements specified in 6.4 for power-up condition, waveform and encoding of output to the ring, and in 6.5 for free-running frequency.

ISO 8802-7:1991(E)

7.5.2 Bit stream output

The bit stream output shall either:

- a) be a continuous string of ZEROs;
- b) act as specified in 7.9.2.1.

NOTE 51 7.9.2.1 includes the option of outputting of a continuous string of ZEROs, as a).

7.6 Output in presence of input signal**7.6.1 Production of output**

The node shall satisfy the requirements specified in 6.4 for power-up condition, waveform and encoding of output to the ring.

7.6.2 Response characteristics

7.6.2.1 The node shall satisfy the requirements specified 6.6.3 to 6.6.6 for signal capture range, low error range, sensitivity and phase locked loop stress.

7.6.2.2 The node shall satisfy the phase locked loop transfer characteristic requirements specified in 6.6.7 for one of Classes I, II or III.

7.6.3 Bit stream output

7.6.3.1 Nodes with station not powered up, or powered up but disabled. At the option of the implementor, the output shall either

- a) continuously reproduce the bit stream of the input; or
- b) follow the error procedures in 7.9 when a parity error in an input mini-packet or a ring break is detected, and at all other times reproduce the bit stream of the input.

NOTE 52 This choice reflects the freedom of the implementor regarding division of functions between repeater and station sections. The minimum requirement is in effect that the node, when unpowered or disabled, acts as a free-standing repeater. However, it is not required that the error procedures of an enabled node are disabled when the normal transmission and reception functions of a node are disabled.

7.6.3.2 Enabled nodes. An enabled node shall modify the input stream as specified in 7.7 to 7.9, and output the modified stream to the ring.

7.6.4 Delay

When the bit stream is output unchanged, the maximum delay of the output relative to the input shall not exceed 3,5 bit-periods. Modification of the bit

stream in accordance with 7.6.3.1 and 7.6.3.2 shall not modify the delay through any phase shift of bit periods.

7.7 Slot structure

NOTE 53 This clause applies to enabled nodes. It applies also to nodes that are disabled or in which the station section is not powered up if the nodes perform the error procedures specified in 7.9 while in these states as an implementor option.

7.7.1 Interpretation of bit stream

The input bit stream shall be interpreted as a slot structure as specified in 4.2 according to the following rules:

- a) the following bits shall be treated as a gap bit: the first ZERO received after power-up; a ZERO immediately following a gap bit; a ZERO immediately following a slot;
- b) the following bits shall be treated as the first bit in a slot (the mini-packet leader bit): a ONE immediately following a gap bit; a ONE immediately following a slot;
- c) the following bits shall be treated as a slot:
 - 1) Basic Class nodes: the 40 consecutive bits starting with the first bit in a slot;
 - 2) Enhanced Class nodes: the number of consecutive bits, starting with the first bit in the slot, equal to the number set by the operator control for slot length (see 7.3.1).

NOTES

54 While these rules will usually lead to an incorrect identification of the slot structure on power-up, they are designed to lead to rapid correct identification, so that the node is correctly synchronized with the gap before it is enabled.

55 Where a gap bit or leader bit in the input has been corrupted a complying node can cause further corruption, both to the ring traffic and to traffic to and from the DTE; recovery from such errors is carried out by the monitor and DTEs respectively, and is not part of node function. The design of the recovery procedures relies on nodes behaving as specified in this clause.

7.7.2 Counting of slots

For the purpose of determining which slot contains a transmitted mini-packet that has returned from a circuit of the ring, the slots shall be counted, starting from the first slot to pass the node after the transmitted mini-packet, until $(n - 1)$ slots have passed, the returning mini-packet is the next input mini-

packet, where n is the total number of slots between the previous two gaps.

7.7.3 Number of slots

The node shall correctly process mini-packets for all slot structures of 1 to 15 slots with a gap of 1 to 255 bits.

NOTES

56 In normal operation, more than 15 slots will not occur. However, corruption of the ring bit stream may cause the input to the node to appear temporarily as more than 15 slots; such circumstances will usually cause resynchronization by the monitor within one ring cycle.

57 When the number of gap bits exceeds 255 bits the node is required to perform the ring break error procedure (see 7.9.2).

7.8 Input and output mini-packets

NOTE 58 This clause applies to enabled nodes only (see 7.6.3.2).

7.8.1 Identification of input mini-packets

Each arriving slot shall be treated as containing an input mini-packet formatted as specified in table 2 for the length of slot in use.

7.8.2 Output of mini-packets

Each input mini-packet shall be output to the ring in the same slot as that in which it arrived.

7.8.3 Changes to mini-packets

Each input mini-packet shall be output to the ring with all its bits unaltered, and information regarding the mini-packet (the contents of the mini-packet or the fact that any particular type of mini-packet has passed through the node) shall not be made available to the DTE, unless otherwise specified in 7.8.4 to 7.8.9.

7.8.4 Full mini-packets addressed to node

7.8.4.1 Each input mini-packet in which the full/empty bit is set to FULL and which has a destination node address equal to the node's own address shall have its response bits reset as specified in 7.10.2, and the parity reset if necessary as specified in 7.8.9.

7.8.4.2 Information regarding the mini-packet shall be processed as specified in 7.10.2 to 7.10.5.

7.8.5 Error message mini-packets

7.8.5.1 Each input mini-packet in which the full/empty bit is set to FULL and which has the destination node address 0 (error message mini-packets addressed to logging station) shall have only the parity bit reset if necessary as specified in 7.8.9.

7.8.5.2 Information regarding the mini-packet shall be processed as specified in 7.10.3 and 7.10.5.

NOTE 59 Basic Class nodes, and Enhanced Class nodes in which the LOG RECEPTION control is OFF are required to ignore such mini-packets other than for parity errors.

7.8.6 Broadcast mini-packets

7.8.6.1 Each input mini-packet in which the full/empty bit is set to FULL and which has the destination node address 255 (broadcast mini-packets) shall have the response bits reset as specified in 7.10.4 and 7.10.5, and the parity bit reset if necessary as specified in 7.8.9.

7.8.6.2 Information regarding the mini-packet shall be processed as specified in 7.10.4 and 7.10.5.

NOTE 60 Nodes in which the BROADCAST RECEPTION control is OFF or not implemented are required to ignore such mini-packets other than for parity errors.

7.8.7 Empty mini-packets

7.8.7.1 Each input mini-packet in which the full/empty bit is set to EMPTY shall have all bits other than the leader bit reset if it is required for output of a transmitted mini-packet, as specified in 7.11, or if it is required for sending PERR, BMESS or IMESS messages, as specified in 7.9.

NOTE 61 In consequence of the requirements in 7.11, 7.12 and 7.14 a node is prohibited from transmitting a mini-packet until at least $(n + 2)$ slots after the last transmitted mini-packet, where n is the number of slots in a ring cycle, and longer if the previous transmission was unsuccessful.

7.8.7.2 Information regarding empty mini-packets made available to the DTE shall be confined to the following:

- a) the implicit information that an empty mini-packet has been input implied by notification to the DTE that a transmitted mini-packet has been output (using TCLK:N, see 7.12.5.5);
- b) the implicit information regarding passage of empty mini-packets implied by the counting of empty mini-packets and the passage of the gap for the back-off after unsuccessful transmission and for determining ring status.

ISO 8802-7:1991(E)

7.8.8 Returning mini-packets

7.8.8.1 Each input mini-packet that is determined to be a returning mini-packet (i.e. a transmitted mini-packet that has completed a circuit of the ring) shall have its full/empty bit set to EMPTY as specified in 7.11.2, and the parity bit reset, if necessary, as specified in 7.8.9.

7.8.8.2 Information regarding the mini-packet shall be processed as specified in 7.11.2 and 7.11.3.

NOTE 62 When a node is transmitting to itself, the returning mini-packet will also be a mini-packet addressed to the node, as specified in 7.8.4, and so both the actions specified here and those specified in 7.8.4 apply.

7.8.9 Mini-packets with parity error

Each mini-packet shall be output to the ring with the parity bit set to even parity, regardless of the parity of the input mini-packets.

NOTE 63 If the input mini-packet has odd parity and if no other changes are required to the mini-packet for output, the parity bit will therefore be changed.

7.9 Error procedures

NOTE 64 This clause applies to enabled Basic Class nodes. It applies also to Enhanced Class nodes that are disabled or in which the station section is not powered up if the nodes perform the error procedures specified in this clause while in these states as an implementor option.

7.9.1 Parity errors

7.9.1.1 When an input mini-packet has odd parity, it shall be output with even parity.

7.9.1.2 The node shall output a PERR message in the next empty slot. The PERR message shall be as specified in table 6.

7.9.1.3 When the slot in which a PERR, BMESS or IMESS message was sent returns to the node, the mini-packet in the slot shall not be processed as a returning mini-packet, but shall be processed according to its contents as an input mini-packet, as specified in 7.8.1 to 7.8.7 and 7.8.9.

NOTE 65 These error message mini-packets will be marked empty at latest by the monitor, and so may be used for a transmitted mini-packet by any node downstream of the monitor, including the node originating the message.

Table 6 — Error message mini-packet formats

Message type Generated by	PERR Node detecting parity error	BMESS Node detecting ring break	IMESS Node detecting interlock break	MONITOR Monitor
Leader bit	ONE	ONE	ONE	ONE
Full/empty	ONE	ONE	ONE	ONE
Monitor pass	ZERO	ZERO	ZERO	ZERO
Destination node address	0	0	0	0
Source node address	Address of node detecting parity	Address of node detecting ring break	Address of originating node	0
Data octets 7 to 2 (see note 1)	0	0	0	0
Data octet 1	0	0	255	Error count
Data octet 0	0	255	0	Error flags (see note 2)
Type bits	ZERO	ZERO	ZERO	ZERO
Response bits	ZERO	ZERO	ZERO	ZERO
Parity bits	even	even	even	even

NOTES

1 The presence of data octets 2 to 7 (appearing in descending order in mini-packets) depends on the length of the mini-packet in use.

2 The error flags have no significance to the node, which simply passes the octet to the DTE if it is receiving logging messages. The values for the flags are specified in clause 8.