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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*



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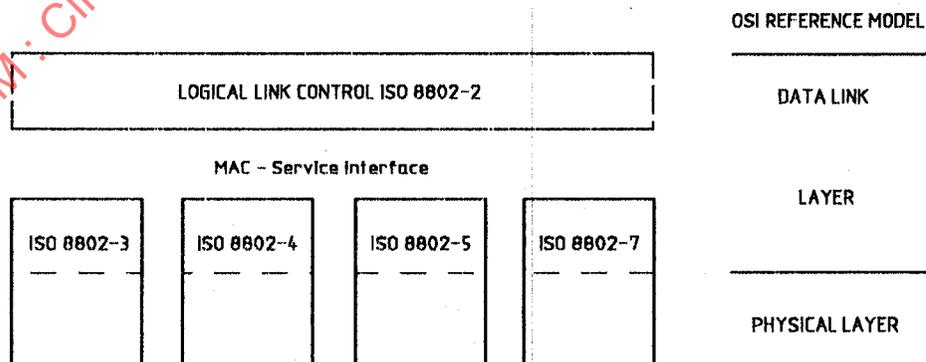
Foreword

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

Draft International Standards adopted by the technical committees are circulated to the member bodies for 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.

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.

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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-

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

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

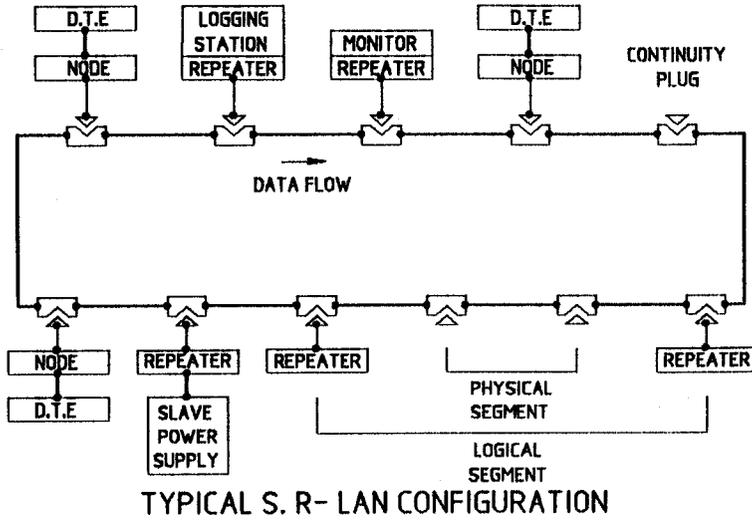
B_s is the total system data bandwidth, and is a function of the bit rate (clocking frequency) " f ", the number of slots on the ring " n ", the number of data bits in each slot " l " and the number of bit periods in the gap " g ":

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

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.



TYPICAL S-R-LAN CONFIGURATION

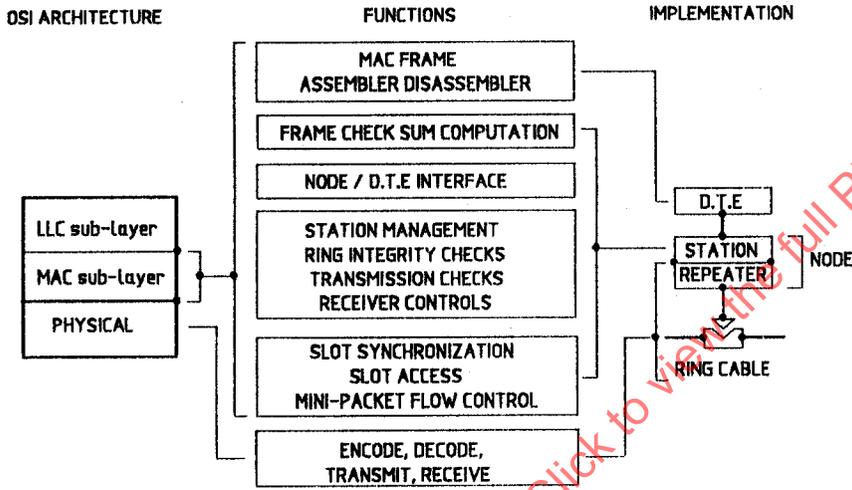


Figure 0.1 — Typical SR-LAN configuration and relationship between OSI architecture — Functions — Implementation

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.

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.

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 procedure 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.

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).

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 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

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 change 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 6.1.4b)]. 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.

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 $100 \text{ mV} \leq V_s \leq 200 \text{ mV}$ 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:

- Class I: repeaters complying with 6.6.7.3;
- Class II: repeaters complying with 6.6.7.4;
- 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:

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

- 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

- the closed loop gain shall not exceed 0,05 dB at any frequency;
- 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;
- at this frequency, the control phase lag shall be less than 5° .

6.6.7.5 Class III. For a Class III repeater

- the maximum closed loop gain shall lie in the range 1 dB to 3 dB;
- 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

- as either a Basic Class or Enhanced Class node;
- in the case of a Basic Class node, as with or without the optional broadcast reception and log reception functions;
- in the case of an Enhanced Class node, as with or without the optional log reception function;
- 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.

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)	Node
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.

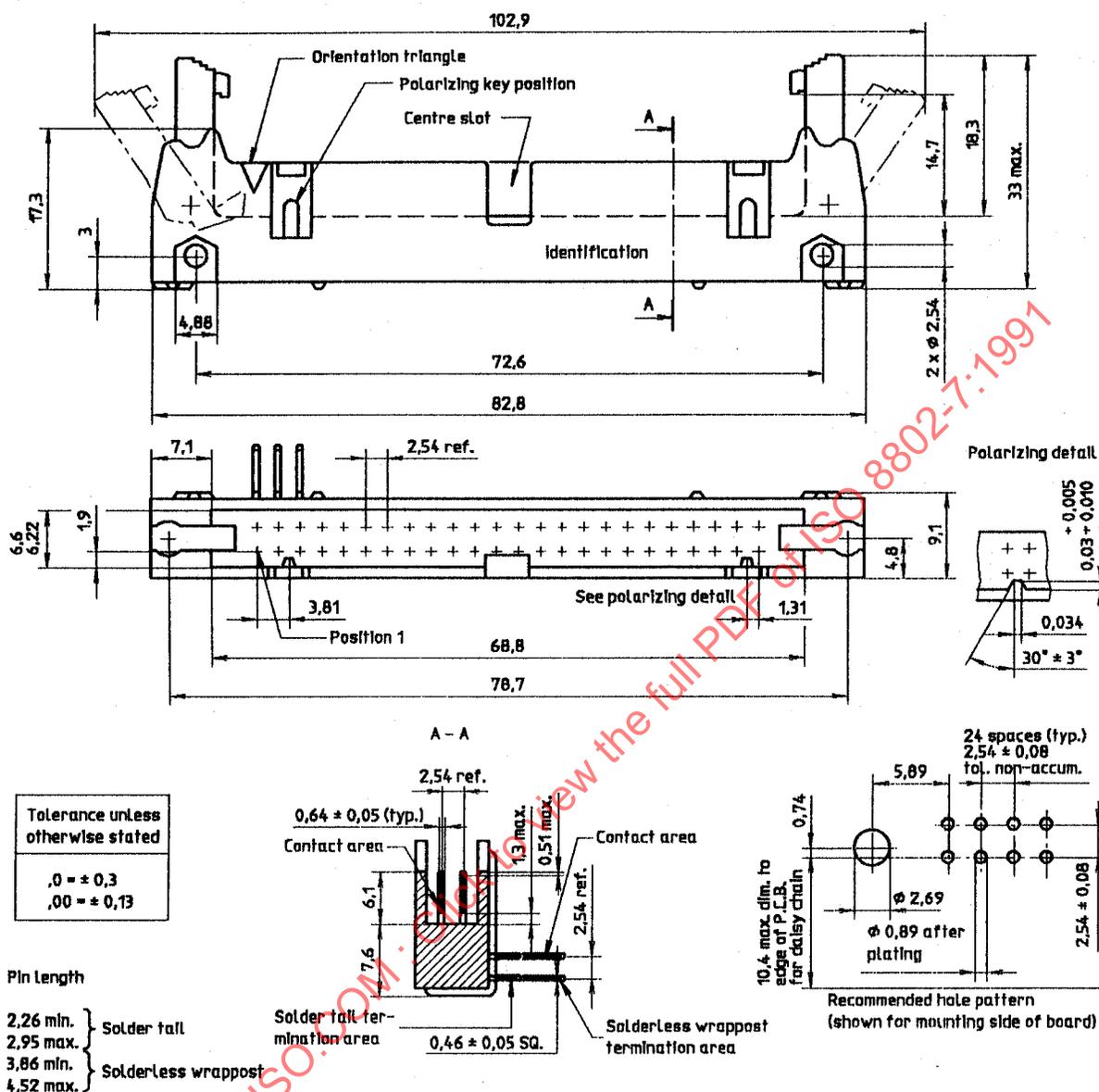


Figure 1 — Node/DTE connector plug

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.

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: 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.

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, a 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.

7.9.2 Ring break

7.9.2.1 Absence of input. When the input signal is absent (see note), the node shall either

- a) output a continuous string of ZEROs; or
- b) output a slot structure comprising one slot containing a BMESS as specified in table 5 and a gap of 255 ZERO bits repeated as long as the ring break persists.

NOTE 66 Absence of input signal will be caused by a ring break in the logical ring segment immediately preceding the node or failure of the repeater outputting to that segment.

7.9.2.2 Extended gap. When the input from the ring contains a gap of 256 or more bits, the node shall either

- a) output a slot structure comprising one slot containing a PERR message as specified in table 7 and a gap of 255 ZERO bits, repeated as long as the input consists entirely of gap bits; or
- b) act as in a), but with the slot containing a single ONE leader bit and all other bits set to ZERO.

NOTES

67 An extended gap will be produced by a node acting on a ring break as specified in 7.9.2.1 a).

68 When a node acts as specified in b), the next enabled node or disabled node in which error procedures are active will detect a parity error and put a PERR message in all but the first slot.

69 PERR and BMESS generation is completely independent of the DTE controls for Enhanced Class nodes, and dependent only on enable for Basic Class nodes. They provide a line level error reporting service.

7.10 Reception of mini-packets

7.10.1 Control of reception of mini-packets

NOTE 70 Controls are related to the state of the node (ready or busy), and to the filtering of input mini-packets on the basis of their contents (destination node address, source node address and type bits) under the control of the DTE.

7.10.1.1 Basic class nodes

7.10.1.1.1 Basic Class nodes shall have the following control functions:

- a) the READY/BUSY control, as specified in 7.10.1.3;

- b) the SOURCE SELECTOR control, as specified in 7.10.1.4;
- c) at the option of the implementor, the LOG RECEPTION control, as specified in 7.10.1.7; if this control is not implemented, then the node shall function as specified for the OFF state of this control;
- d) at the option of the implementor, the BROADCAST RECEPTION control, as specified in 7.10.1.8; if this control is not implemented, then the node shall function as specified for the OFF state of this control.

7.10.1.1.2 Basic Class nodes shall function as follows for the controls not applicable to the Basic Class:

- a) the SOURCE SELECT/REJECT control: the node shall function as specified for the SELECT state of this control in 7.10.1.5;
- b) the TYPE SELECT/REJECT control: the node shall function as specified for the OFF state of this control in 7.10.1.6.

7.10.1.2 Enhanced Class nodes

Enhanced Class nodes shall have the following control functions:

- a) the READY/BUSY control, as specified in 7.10.1.3;
- b) the SOURCE SELECTOR control, as specified in 7.10.1.4;
- c) the SOURCE SELECT/REJECT control as specified in 7.10.1.5;
- d) the TYPE SELECT/REJECT control as specified in 7.10.1.6;
- e) the BROADCAST RECEPTION control as specified in 7.10.1.8;
- f) at the option of the implementor, the LOG RECEPTION control, as specified in 7.10.1.7; if this control is not implemented, then the node shall function as specified for the OFF state of this control.

7.10.1.3 READY/BUSY control

This control shall

- a) have two states: READY, in which the node can accept mini-packets, and BUSY, in which the node cannot accept mini-packets;

- b) be set to READY by the node upon enablement, and when set by the DTE to READY (using Registers Rx.BG or Rx.G, see 7.13.4.8 and 7.13.4.9);

NOTE 71 Rx.BG sets the node to READY only when the mini-packet data octet being read is the highest numbered data octet.

- c) be set to BUSY by the node when a mini-packet is accepted (see 7.10.2).

7.10.1.4 SOURCE SELECTOR control

This control shall

- a) be capable of being set to just one value at a time, for all values in the range 0 to 255;
- b) be set to 0 by the node upon enablement, and thereafter be under the control of the DTE (using Write Register 0, SSR, see 7.14.4.2).

NOTE 72 The value 0 means "none"; the value 255 means "any"; values from 1 to 254 identify a particular source that is to be selected or rejected depending on the state of the SELECT/REJECT control. For the effect, see 7.10.1.7.

7.10.1.5 SOURCE SELECT/REJECT control

This control shall

- a) when the source selector is within the range 1 to 254, have two states, SELECT, in which a particular source identified by the source selector is selected and all others rejected, and REJECT, in which a particular source node address identified by the source selector is rejected and all others selected;
- b) when the source selector is set to address 0, have two states: SELECT, in which all source addresses are unacceptable (except monitor error logging messages when logging reception is enabled), and REJECT, in which all sources are acceptable;
- c) have no effect when
 - 1) the source selector is set to 255 ("any");
 - 2) the input mini-packet has a source node address 255 (which is an invalid source address);
 - 3) the input mini-packet destination address is 0 or 255 (messages to logging station and broadcast messages respectively);
- d) be set to SELECT by the node upon enablement, and thereafter be under the control of the DTE

(using RSS of Write Register 4, Rx.CR, see 7.14.4.4).

7.10.1.6 TYPE SELECT/REJECT control

This control shall

- a) have three states:
 - 1) OFF, in which the node rejects no mini-packets on the basis of the values of the type bits;
 - 2) SELECT, in which the only mini-packets that can be SELECTED are those having both Type Bit A and Type Bit B set to the same values as those of the TYPE BIT MASK set by the DTE;
 - 3) REJECT, in which the only mini-packets that can be SELECTED are those having one or both Type Bits set to values different from those of the TYPE BIT MASK set by the DTE;
- b) be set to OFF by the node upon enablement, and thereafter be under the control of the DTE (using CTP and ROT for setting the state and MTPA and MTPB to set the TYPE BIT MASK, all of Write Register B, SCR, see 7.14.4.8).

7.10.1.7 LOG RECEPTION control

This control shall

- a) have two stages: ON, in which mini-packets with destination node address 0 (error message mini-packets) can be received and made available to the DTE for recording, and OFF, in which they cannot be received;
- b) be set to OFF by the node upon node enablement;
- c) if set to ON by the DTE (using LGE of Write Register 4, Rx.CR, see 7.14.4.4), remain on until the node is disabled.

7.10.1.8 BROADCAST RECEPTION control

This control shall

- a) have two states: ON, in which broadcast mini-packets identified by destination node address 255 can be received, and OFF, in which they cannot be received;
- b) in Basic Class nodes, be set by an operator control;
- c) in Enhanced Class nodes, be set by the node to OFF upon node enablement, and thereafter as

set by the DTE (using BCE of Write Register 4, Rx.CR, see 7.14.4.4).

7.10.2 Action on full mini-packets addressed to the node

7.10.2.1 SELECTED and NOT SELECTED mini-packets

The mini-packet shall be SELECTED unless any one or more of the conditions a) to d) apply, in which case it shall be NOT SELECTED:

- a) the SOURCE SELECTOR is set to a value in the range 1 to 254 that is the same as the source node address in the mini-packet, while the SOURCE SELECT/REJECT control is set to REJECT (see note 73);
- b) the SOURCE SELECTOR is set to a value in the range 0 to 254 that is not the same as the source node address in the mini-packet, while the SOURCE SELECT/REJECT control is set to SELECT;
- c) Type Bits A and B do not match the TYPE BIT MASK, while the TYPE SELECT/REJECT control is set to SELECT (see note 73);
- d) Type Bits A and B match the TYPE BIT MASK, while the TYPE SELECT/REJECT control is set to REJECT (see note 73).

NOTES

73 Conditions a), c) and d) do not apply to Basic Class nodes.

Source node address 255 is an invalid address for nodes.

75 The monitor uses source address 0 for error logging messages sent only to destination 0.

76 When the SOURCE SELECTOR is set to 255, all mini-packets addressed to node will be SELECTED unless they are NOT SELECTED because of the value of the type bits.

77 When TYPE SELECT/REJECT is OFF, all mini-packets will be SELECTED unless NOT SELECTED because of the source.

7.10.2.2 Action on SELECTED mini-packets

7.10.2.2.1 When the mini-packet is SELECTED according to 7.10.2.1 and the READY/BUSY status is READY:

- a) information regarding the mini-packet shall be made available to the DTE at the node interface as specified in 7.10.5;
- b) the node status shall be set to BUSY;

- c) the mini-packet shall be output with the response bits set to ACCEPTED and the parity bit set to even parity.

7.10.2.2.2 When the mini-packet is SELECTED according to 7.10.2.1 and the READY/BUSY status is BUSY

- a) the mini-packet shall be output with the response bits set to BUSY and the parity bit set to even parity;
- b) information regarding the mini-packet shall not be made available to the DTE.

7.10.2.3 Action on NOT SELECTED mini-packets

If the mini-packet is NOT SELECTED according to 7.10.2.1

- a) the mini-packet shall be output with the response bits set to NOT SELECTED and the parity bit set to even parity;
- b) the information that a mini-packet has been marked NOT SELECTED shall be made available to the DTE as specified in 7.13.4.5 (RRJ of Read Register 4, Rx.SR);
- c) no other information regarding the mini-packet shall be made available to the DTE.

7.10.3 Action on mini-packets with destination node address 0 (error messages)

7.10.3.1 When the LOG RECEPTION control is ON and the READY/BUSY state is READY, the node shall make information regarding the mini-packet available to the DTE as specified 7.10.5.

7.10.3.2 When the LOG RECEPTION control is OFF or the READY/BUSY state is BUSY the node shall not make information regarding the mini-packet available to the DTE.

7.10.3.3 The mini-packet shall be output with the response bits unchanged and the parity bit set to even parity.

NOTES

78 Basic Class nodes function always as for the OFF state of the LOG RECEPTION control.

79 In hardware generated error messages the initial value of the response bits is BUSY (both ZERO), not IGNORED (both ONE). Only DTE generated messages to the logging station via the normal node/DTE interface of another node will carry initial values of ONES.

80 The setting of the SOURCE SELECTOR, SOURCE SELECT/REJECT, and TYPE SELECT/REJECT controls, and

the source node address and Type Bits in the mini-packet, have no effect on these requirements.

7.10.4 Action on mini-packets with destination address 255 (broadcast mini-packets)

7.10.4.1 BROADCAST RECEPTION control OFF

7.10.4.1.1 Information regarding the mini-packet shall not be made available to the DTE.

7.10.4.1.2 The node shall output the mini-packet with response bits unchanged and the parity bit set to even parity.

7.10.4.2 BROADCAST RECEPTION control ON

7.10.4.2.1 The action of the node shall depend on whether the node is READY or BUSY.

7.10.4.2.2 If the READY/BUSY state is READY

- a) information regarding the mini-packet shall be made available to the DTE as specified in 7.10.5;
- b) the node status shall be changed to BUSY;
- c) the mini-packet shall be output with the response bits set for a node response of ACCEPTED modified as specified in 7.10.4.3 and the parity bit set to even parity.

7.10.4.2.3 If the READY/BUSY status is BUSY

- a) information regarding the mini-packet shall not be made available to the DTE;

- b) the mini-packet shall be output with the response bits set for a node response of BUSY and the parity bit set to even parity.

7.10.4.3 Setting of response bits in broadcast mini-packets

The receiver section in nodes can only change response bits in input mini-packets from ONE to ZERO in the output mini-packet, but not ZERO to ONE (see table 7).

7.10.5 Making information available to DTE

When 7.10.2 to 7.10.4 require that information regarding received mini-packets be made available to the DTE, the means shall be as specified in a) to c), in accordance with the detailed specifications given in 7.12.

NOTE 81 In accordance with 7.12, when the means is a control line, the node is required to set the line without any action from the DTE (though DTE actions such as disabling the node may interrupt the node action); when the means is a read register, the node is not required to take any action unless or until the DTE reads that register

- a) arrival of mini-packet: RDN:N (see 7.12.5.4) and RDN of Rx.SR (see 7.13.4.6);
- b) destination node address: this information is not explicitly made available to the DTE, but is implied by the status of RINT:N, and BPR or LOG of Rx.SR (see 7.13.4.6) which indicate when the input mini-packet has a destination address other than this node address, and further distinguish which of the two alternatives it is, either 0 or 255;

Table 7 — Setting of response bit in broadcast mini-packets

Response in input mini-packet: Response bits A B:	IGNORED 1,1	NOT SELECTED (see note) 1,0	ACCEPTED 0,1	BUSY 0,0
Node response	Modified response put into output mini-packet			
IGNORED	IGNORED	(NOT SELECTED)	ACCEPTED	BUSY
ACCEPTED	ACCEPTED	(BUSY)	ACCEPTED	BUSY
BUSY	BUSY	(BUSY)	BUSY	BUSY

NOTE — NOT SELECTED is an invalid response to broadcast mini-packets and should only result from errors.

- c) source node address: Rx.SRC (see 7.13.4.3);
- d) data octets: Rx.B and Rx.BG (see 7.13.4.7 and 7.13.4.8);
- e) type bits: RTPA:N and RTPB:N (see 7.12.5.7 and 7.12.5.8), and RTPA and RTPB of XSR (see 7.13.4.10).

7.11 Transmission of mini-packets

7.11.1 Control of transmission

7.11.1.1 General

The node shall have the control functions specified in 7.11.1.2 to 7.11.1.5; they shall be implemented in accordance with the detailed requirements specified in section three and section five.

7.11.1.2 TRANSMISSION DONE control

This control shall

- a) have two states:

TRANSMISSION IN PROGRESS, in which the node is waiting to transmit a mini-packet, waiting for the mini-packet to return, or waiting for a specified delay before notifying the DTE of the return of the mini-packet, and cannot accept a further transmit command; and

TRANSMISSION DONE at other times;

- b) be set by the node to TRANSMISSION DONE upon enablement, and after any required back-off delay following the return of a transmitted mini-packet (see 7.11.2.3) or DTE transmitter reset command (using TRST of Rx.CR, see 7.14.4.4);
- c) be set by the DTE to TRANSMISSION IN PROGRESS by the transmit command (see 7.11.1.4).

7.11.1.3 Mini-packet contents controls

7.11.1.3.1 The contents of mini-packets to be transmitted shall be controlled by the DTE as follows:

- a) destination node address: Tx.DST (see 7.14.4.3);
- b) data octets: Tx.B and Tx.BG (see 7.14.4.5 and 7.14.4.6), and TRST of Rx.CR (see 7.14.4.4);
- c) type bits: TTPA and TTPB of XCR (see 7.14.4.8).

7.11.1.3.2 The node shall ignore these controls while in the TRANSMISSION IN PROGRESS state.

7.11.1.3.3 Other mini-packet contents shall not be under the command of the DTE.

7.11.1.4 Transmit command controls

7.11.1.4.1 The action of transmitting mini-packets shall be controlled by the DTE as follows:

- a) transmit command: Tx.G (see 7.14.4.7), and Tx.BG when the data octet being written is the highest numbered mini-packet data octet (see 7.14.4.6);
- b) retransmit on busy: AUTO-RETRY ON BUSY (see 7.11.1.5);
- c) transmitter reset: TRST of Rx.CR (see 7.14.4.4).

7.11.1.4.2 The node shall ignore transmit commands Tx.BG and Tx.G while in the TRANSMISSION IN PROGRESS state.

7.11.1.5 AUTO-RETRY ON BUSY

7.11.1.5.1 The node shall implement the AUTO-RETRY ON BUSY control, as specified in 7.11.1.5.2 and 7.11.1.5.3.

7.11.1.5.2 This control shall

- a) have two states:

ON, in which returning mini-packets with response BUSY are automatically retransmitted by the node, without a further transmit command from the DTE, until one of the events specified in 7.11.1.5.3 occurs; and

OFF, in which no automatic retransmission is made;

- b) be set by the node to OFF upon node enablement if the node is enabled by TEST:N;
- c) be set by the node according to the value of RTRY of Write Register 4, Rx.CR (see 7.14.4.4) for every occurrence of Rx.CR that causes the node to become or remain enabled.

7.11.1.5.3 When AUTO-RETRY ON BUSY is ON, automatic retransmission shall continue for a mini-packet returning with response BUSY until the first occurrence of any of the following:

- a) the mini-packet returns with a status other than BUSY;
- b) the check specified in 7.11.2.4 d) detects an error in the returned mini-packet;
- c) the DTE issues a transmitter reset (TRST), while RTRY and NEN are re-affirmed;

- d) AUTO-RETRY ON BUSY is set to OFF, while NEN is re-affirmed;
- e) the node is disabled, in which case AUTO-RETRY ON BUSY shall also be set to OFF.

NOTE 82 Items a) to c) stop retransmission of the mini-packet, but leave AUTO-RETRY ON BUSY set to ON, so that unless set to OFF by the DTE it will cause retransmission of subsequently transmitted mini-packets which return with response BUSY.

7.11.1.6 Transmission reset

See 7.11.4.

7.11.2 NORMAL TRANSMISSION

7.11.2.1 Transmit command

When the DTE has issued a transmit command (see 7.11.1.4) while the node is in the TRANSMISSION DONE state (see 7.11.1.2) the node shall process the command as specified in 7.11.2.2 to 7.11.2.5, unless the transmission process is interrupted by a transmission reset (see 7.11.4).

7.11.2.2 Transmission procedure

7.11.2.2.1 The node state shall change to TRANSMISSION IN PROGRESS (see TDN:N, 7.12.5.3).

7.11.2.2.2 The first slot that contains an empty input mini-packet, that is not required for the transmission of an error message (see 7.9), and that is not the slot immediately following a slot containing a return mini-packet, shall be used for a transmitted mini-packet.

7.11.2.2.3 When the transmitted mini-packet is output, the node shall set control line TCLK:N inactive (see 7.12.5.5).

7.11.2.3 Transmitted mini-packet contents

The mini-packet shall be transmitted with

- a) the leader bit set to ONE;
- b) the full/empty bit set to ONE;
- c) the monitor pass bit set to ONE;
- d) the destination address set to the last value set by the DTE, or undefined if the DTE has set no value since enablement;
- e) the source node address set to the node's own address;

- f) the data octets set to the values last set by the DTE, or undefined if the DTE has set no values since enablement;
- g) the type bits set to the values last set by the DTE, or undefined if the DTE has set no values since enablement;
- h) the response bits set to IGNORED;
- i) the parity bits set to even parity.

7.11.2.4 Action on returning mini-packet

When the returning mini-packet as defined by 7.7.2 is the input mini-packet it shall be processed by the node as specified in a) to j):

- a) set the full/empty bit to EMPTY;
- b) set the parity bit to even parity;
- c) output the mini-packet;
- d) check the returned packet for corruption of the full/empty bit, source node address, destination node address, data octets and type bits; at the option of the implementor, this shall be either by a parity check over all of these taken together or by a bit-by-bit comparison of each;
- e) if corruption is detected transmission comparison error shall be notified to the DTE without back-off delay;

NOTE 83 This check does not involve the parity of the mini-packet as a whole, which is ignored for the purposes of this requirement.

- f) the response shall be determined from the response bits in the returned mini-packet for all mini-packets except those which the node has transmitted to itself, in which case the response shall be that to which the node as recipient sets the response bits, not that contained in the input mini-packet;

NOTE 84 In the case of a node transmitting to itself, reception and check on returning mini-packets happen at the same time. The returning mini-packet will therefore be the input mini-packet, whose response bits will still be set to IGNORED. The receiver section of the node gives a normal response marking to both the output mini-packet and the transmit section of the node. However IGNORED is not a valid response to mini-packets addressed to self.

- g) if the response is ACCEPTED, the response shall be made available to the DTE without back-off delay;
- h) if the response is IGNORED or NOT SELECTED, the response shall be made available to the DTE

only after the back-off delay specified in 7.11.2.5.1;

- i) if the response is BUSY and AUTO-RETRY ON BUSY is OFF, the response shall be made available to the DTE only after the back-off delay specified in 7.11.2.5.1;
- j) if the response is BUSY, if AUTO-RETRY ON BUSY is ON, and if no transmission comparison error occurred, the node shall again output the transmitted mini-packet as specified in 7.11.2.2 and 7.11.2.3, after the back-off delay specified in 7.11.2.5.1 or 7.11.2.5.2.

7.11.2.5 Back off delay

7.11.2.5.1 The back-off delay referred to in 7.11.2.4 h) and i) shall be either

- a) until after the next passage of the gap immediately preceded by an empty slot; or
- b) as a) if the previous transmitted or retransmitted mini-packet had a response of ACCEPTED or a transmit comparison error was detected, and until after the fifteenth passage of the gap immediately preceded by an empty slot otherwise.

7.11.2.5.2 The back-off delay referred to in 7.11.2.4 j) shall be either

- a) as 7.11.2.5.1 b); or
- b) until one empty slot has passed for the first retransmission, until two empty slots for the second retransmission, until three empty slots for the third retransmission, until four empty slots for the fourth retransmission, and until 15 empty slots for subsequent retransmissions.

7.11.2.5.3 The node shall not return to the TRANSMISSION DONE state or transmit any further mini-packets, whether automatically for auto-retry on busy or under the command of the DTE, until the expiry of any back-off delay.

7.11.3 Making information available to the DTE

When 7.11.2 requires that information regarding transmitted mini-packets be made available to the DTE, the means shall be as specified in a) to e), in accordance with the detailed specifications given in 7.12, 7.13, 7.14 and 7.15.

NOTE 85 In accordance with 7.12, 7.13, 7.14 and 7.15, when the means is a control line, the node is required to set the line without any action from the DTE (though DTE actions such as disabling the node may interrupt the node action); when the means is a read register, the node is not

required to take any action unless or until the DTE reads that register

- a) transmission done: TDN:N (see 7.12.5.3) and TDN of Tx.SR (see 7.13.4.5);
- b) transmit comparison error: TER:N (see 7.12.5.6), TER and TCE of Tx.SR (see 7.13.4.5);
- c) response ACCEPTED: TER:N (see 7.12.5.6), TER and TAC of Tx.SR (see 7.13.4.5);
- d) response IGNORED: TER:N (see 7.12.5.6), TER and TIG of Tx.SR (see 7.13.4.5);
- e) response NOT SELECTED: TER:N (see 7.12.5.6), TER and TUS of Tx.SR (see 7.13.4.5);
- f) response BUSY, AUTO-RETRY ON BUSY OFF: TER:N (see 7.12.5.6), TER and TBY of Tx.SR (see 7.13.4.5);
- g) response BUSY, AUTO-RETRY ON BUSY ON: TCLK:N (see 7.12.5.5).

7.11.4 Interrupted transmission

If a transmission reset [see 7.14.4.4 d)] occurs after a transmit command and before the return of the mini-packet, the node shall act as follows:

- a) the node shall complete the current transmission attempt if the mini-packet is in flight, before returning to the transmission done state;
- b) on return to the transmission done state, TER:N and TER shall be inactive, even if conditions would otherwise require them to be active.

7.12 Node/DTE interface lines

7.12.1 Line logical states

7.12.1.1 Lines whose identifier has the suffix ":P" shall be logically active in the electrical high state, and shall be logically inactive in the electrical low state.

7.12.1.2 Lines whose identifier has the suffix ":N" shall be logically active in the electrical low state, and shall be logically inactive in the electrical high state.

NOTES

86 The electrical characteristics relating to the high and low states are specified in 7.2.4.

87 Where the logical states equate to binary ONE and ZERO, the active state is ONE and the inactive state is ZERO.

7.12.2 A0:P to A3:P: Register address lines

7.12.2.1 The register address lines are set by the DTE as the binary representation of a register address; the active state of the line shall represent a ONE bit, and the inactive state a ZERO bit; the bits shall be in ascending order of significance with the least significant bit an A0:P.

7.12.2.2 When control line RD:N is active and address is a read register address; while enabled, the node shall then perform the actions specified in 7.13 for the read register that is addressed; while disabled, it shall perform those specified in 7.15.

7.12.2.3 When control line WT:N is active the address is a write register address; while enabled, the node shall then perform the actions specified in 7.14 for the write register that is addressed; while disabled, it shall perform those specified in 7.15.

NOTES

88 In order to preserve consistency with the specification of requirements for the DTE and with established slotted ring terminology, the term "read" refers to the process of the DTE reading from the node, and the term "write" refers to the process of the DTE writing to the node, i.e. they are the reverse of the function as seen from the node.

89 The action of the node is undefined when both RD:N and WT:N are active at the same time.

7.12.3 D0:P to D7:P: Data lines

7.12.3.1 For read registers, the allocation of data lines shall be as specified in table 7. While enabled, the node shall set the data lines as specified for each register in 7.13; while disabled, it shall act as specified in 7.15.2.

7.12.3.2 For write registers, the allocation of data lines shall be as specified in table 9; the data lines are set by the DTE. While enabled, the node shall act on the data as specified for each register in 7.14; while disabled, it shall act as specified in 7.15.2.

7.12.3.3 For read registers 0, 1, 2, 5, 6, 9 and 10, and write registers 0, 1, 5 and 6, the setting of the data lines represents an octet; line active state of a line shall represent a ONE bit, and the inactive state a ZERO bit.

7.12.4 Control lines set by the DTE

7.12.4.1 RD:N: Node read strobe. See 7.13.2 and 7.13.3.

7.12.4.2 WT:N: Node write strobe. See 7.14.2 and 7.14.3.

7.12.4.3 TEST:N: Node enable override signal. Implementation of the functions for this line are optional. If implemented, the requirements of 7.15 shall be met. If not implemented, the node shall not use this line for any other purpose, and shall behave as though the line were inactive when the DTE sets the line active.

7.12.5 Control lines set by the node

7.12.5.1 General

When the node is disabled, the node shall set these lines as specified in 7.15.2.1. When the node becomes enabled, it shall set the lines as specified in 7.15.4; thereafter while enabled the node shall set the lines as specified in 7.12.5.2 to 7.12.5.9.

7.12.5.2 ACK:N: Node read or write acknowledge

The node shall set ACK:N as specified in 7.13.2, 7.13.3, 7.13.5, 7.14.2, 7.14.3 and 7.14.5.

Table 8 — Read registers

Register		Data lines							
No.	Code	D7:P	D6:P	D5:P	D4:P	D3:P	D2:P	D1:P	D0:P
		2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
0	SSR	binary representation of source selected							
1	Rx.SRC	binary representation of source node address in received mini-packet							
2	NODE	binary representation of node's own address							
3	Tx.SR	TDN	TER	0	TCE	TIG	TAC	TUS	TBY
4	Rx.SR	RDN	BCE*	RRJ	RSS*	LOG*	BPR*	RTRY	NEN
		bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
5	Rx.B	data octet in received mini-packet							
6	Rx.BG	data octet in received mini-packet							
7	Rx.G	undefined							
8	XSR	L2	L1	L0	AOK	RON	1	RTPB	RTPA
		2^7	2^6	2^5	2^4	2^3	2^2	2^1	2^0
9	Rx.SUM (see note 2)	Receiver checksum							
10	Tx.SUM (see note 2)	Transmitter checksum							
11) to) 15)	user defined								
NOTES									
1 Items marked with an asterisk (*) depend on the class of node and the options implemented; if not applicable or not implemented, the line is inactive.									
2 Rx.SUM and Tx.SUM apply to Enhanced Class nodes only; in Basic Class nodes they are reserved and the data line values undefined.									

Table 9 — Write registers

Register		Data lines							
No.	Code	D7:P	D6:P	D5:P	D4:P	D3:P	D2:P	D1:P	D0:P
		2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰
0	SSR	binary representation of source selected							
1	Tx.DST	binary representation of destination node address for transmitted mini-packet							
2	reserved	undefined							
3	reserved	undefined							
4	Rx.CR	0	BCE*	LGE*	RSS*	TRST	RRST	RTRY	NEN
		bit 7	bit 6	bit 5	bit 4	bit 3	bit 2	bit 1	bit 0
5	Tx.B	data octet for transmitted mini-packet							
6	Tx.BG	data octet for transmitted mini-packet							
7	Tx.G	undefined							
8	XCR	0	0	MTPB*	MTPA*	CTP*	ROT*	TTPB	TTPA
9	RSUMCLR (see note 2)	undefined							
10	TSUMCLR (see note 2)	undefined							
11) to) 15)	user defined								
NOTES									
1 Items marked with an asterisk (*) depend on the class of node and the options implemented; if not applicable or not implemented, the value is 0.									
2 RSUMCLR and TSUMCLR apply to Enhanced Class nodes only; in Basic Class nodes they are reserved.									

7.12.5.3 TDN:N: Transmission done

The node shall set this line as follows:

NOTE 90 The active state of this line corresponds to the TRANSMISSION DONE state of the node, and the inactive state the TRANSMISSION IN PROGRESS state.

- a) When a transmitted mini-packet returns with response ACCEPTED, the node shall set TDN:N active. TDN:N shall be set active within a time such that if the DTE commands the transmission of another mini-packet within 3 μs of TDN:N going active, that mini-packet will go into the next but one slot after the slot in which the first mini-packet returned, if the next but one slot is avail-

able (i.e. it is empty and no PERR message is awaiting transmission).

- b) When a transmitted mini-packet returns with response NOT SELECTED, IGNORED or a TRANSMIT COMPARISON ERROR is detected the node shall keep TDN:N inactive until any back-off delay required by 7.11.2 has expired, and then set it active within the time specified in a) counting from the empty slot that ends back-off delay instead of the returning mini-packet.
- c) When a transmitted mini-packet returns with response BUSY in the absence of TRANSMIT COMPARISON ERROR, the node shall set TDN:N as specified in b) for NOT SELECTED and IGNORED if AUTO-RETRY ON BUSY is OFF; if

AUTO-RETRY ON BUSY is ON, the node shall keep TDN:N inactive until retransmission has ceased (see 7.11.1.5.3) and then set it active within the time specified in a) counting from the empty slot that ends back-off delay instead of the returning mini-packet.

- d) The node shall set TDN:N inactive within 150 ns of WT:N going inactive when the DTE issues a transmit command using Tx.BG or Tx.G.

NOTE 91 Tx.BG is a transmit command only when the octet being written is the highest numbered octet in the mini-packet; hence for other octets written using Tx.BG the node does not set TDN:N inactive.

- e) The node shall set TDN:N active when a transmission reset occurs (see 7.11.4).

7.12.5.4 RDN:N: Receive done

7.12.5.4.1 When a mini-packet is received the node shall set RDN:N active, within a time such that if the DTE sets the node to READY using Rx.BG or Rx.G within 2,5 μ s of RDN:N becoming set active, the node can receive a mini-packet in the next but one slot after that in which this mini-packet arrived.

7.12.5.4.2 The node shall set RDN:N inactive within 150 ns after RD:N goes inactive when the DTE sets the node to READY using Rx.BG or Rx.G.

NOTE 92 Rx.BG sets the node to READY only when the octet being ready is the highest numbered octet in a mini-packet (see 7.13.4.8); hence when other octets are read, RDN:N is not set inactive.

7.12.5.5 TCLK:N: transmission clock

The node shall set TCLK:N inactive each time that a transmitted mini-packet is output to the ring, including times when a mini-packet is output as automatic retry on busy. The node shall set TCLK:N active more than 0 ns prior to setting TDN:N active after the return of a mini-packet, and shall set TCLK:N active at least one ring bit period before setting it inactive for each automatic retry.

7.12.5.6 TER:N: transmit error

7.12.5.6.1 The node shall set TER:N to active or inactive at least 20 ns before each time it sets TDN:N active. TER:N shall be set to inactive unless any of the following conditions apply, in which case it shall be set to active:

- a) the returned mini-packet fails the comparison check specified in 7.11.2.4 d);
- b) the returned mini-packet has the response IGNORED or NOT SELECTED;

- c) the returned mini-packet has the response BUSY while AUTO-RETRY ON BUSY is OFF.

7.12.5.6.2 The node shall keep TER:N set active or inactive as in 7.12.5.6.1 until after it sets TDN:N to inactive, unless the DTE resets transmission using TRST of Rx.CR, in which case TER:N shall be set to inactive until after TDN:N is set to inactive.

7.12.5.7 RTPA:N: received Type bit A

The node shall set RTPA:N active or inactive at least 10 ns before RDN:N is set active and keep it set until within 50 ns before or after RDN:N is set inactive. RTPA:N shall be set active if Type bit A in the received mini-packet was a ONE, otherwise inactive.

7.12.5.8 RTPB:N: received Type bit B

The node shall set RTPB:N active or inactive at least 10 ns before RDN:N is set active and keep it set until within 50 ns before or after RDN:N is set inactive. RTPB:N shall be set active if Type bit B in the received mini-packet was a ONE, otherwise inactive.

7.12.5.9 RINT:N: broadcast mini-packet or logging message received

The node shall set RINT:N active or inactive at least 30 ns before RDN:N is set active and keep it set until within 50 ns before or after RDN:N is set inactive. RINT:N shall be set active if the mini-packet for which RDN:N goes active is either a broadcast mini-packet or a logging message, otherwise inactive.

NOTES

93 If the BROADCAST RECEPTION control is OFF or not implemented, this line will be equivalent to a LOG:N signal.

94 If the LOG RECEPTION control is OFF or not implemented, this line will be equivalent to a BPR:N signal.

7.13 Reading from node

7.13.1 General

When the node becomes enabled, the initial conditions specified in 7.15.4 shall apply; thereafter while enabled the node shall act as specified in 7.13.2 to 7.13.5.

7.13.2 Reading conditions

When the DTE sets RD:N to active, the node shall carry out the actions specified in 7.13.3 to permit the DTE to read data from the node, provided that the following conditions apply:

- a) a register address in the range 0 to 10 has been set by the DTE on the register address lines A0:P to A3:P for at least 40 ns prior to RD:N being set active;

NOTE 95 For register addresses in the range 9 to 15 see 7.13.5.

- b) the DTE keeps RD:N set until after the node has set ACK:N active;
- c) the DTE maintains the register address set until at least 40 ns after RD:N is set inactive.

7.13.3 Read operation

The node shall

- a) set on the data lines D0:P to D7:P the data specified by the address on the register address lines;
- b) set ACK:N active not less than 15 ns after the data lines have become set and not more than 320 ns after RD:N becomes active;
- c) set ACK:N inactive not more than 250 ns after RD:N goes inactive;
- d) return the data lines to the high impedance state not less than 15 ns after ACK:N goes inactive;
- e) take all actions specified for the register.

7.13.4 Registers applicable to all nodes

7.13.4.1 General. The node shall act on these registers as specified in 7.13.4.2 to 7.13.4.10. Where a requirement contains a qualification "provided...", the action of the node is undefined when the provision is not met.

7.13.4.2 Register 0: SSR (source selector). The node shall place the currently set value of the source selector on data lines D0:P to D7:P.

7.13.4.3 Register 1: Rx.SRC (receive source node address). Provided that RDN:N is active, the node shall place the source node address of the last mini-packet received on data lines D0:P to D7:P.

7.13.4.4 Register 2: NODE (node address). The node shall place its own assigned address on data lines D0:P to D7:P.

7.13.4.5 Register 3: Tx.SR (transmit status register). The node shall perform the following actions:

- a) D7:P: TDN (transmit operation done): D7:P shall be set active if the control line TDN:N is set active, and shall be set inactive if control line

TDN:N is set inactive (see 7.12.5.3 for TDN:N); if TDN is set active, then the node shall perform the actions in b) to h) to allow the DTE to read the status of the mini-packet whose return caused TDN:N to be set active;

- b) D6:P: TER (transmit error): when AUTO-RETRY ON BUSY is ON, the node shall set TER active if any of TCE, TIG and TUS are set active; when AUTO-RETRY ON BUSY is OFF, the node shall set TER active if any of TCE, TIG, TUS and TBY are set active; after enabling (NEN) and transmit reset (TRST) the node shall set TER inactive until TDN next goes active, regardless of the current settings of TCE, TIG, TUS and TBY;

- c) D5:P: the node shall set D5:P inactive;

- d) D4:P: TCE (transmit comparison error): the node shall set D4:P active if the returned mini-packet fails the comparison check specified in 7.11.2.4 d); otherwise, inactive;

- e) D3:P: TIG (transmitted mini-packet ignored by destination node): the node shall set D3:P active if the response in the returned mini-packet is IGNORED; otherwise, inactive;

- f) D2:P: TAC (transmitted mini-packet marked ACCEPTED by destination node): the node shall set D2:P active if the response in the returned mini-packet is ACCEPTED; otherwise, inactive;

- g) D1:P: TUS (transmitted mini-packet marked NOT SELECTED by destination node): the node shall set D1:P active if the response in the returned mini-packet is NOT SELECTED; otherwise inactive;

- h) D0:P: TBY (transmitted mini-packet marked BUSY by destination node): the node shall set D0:P active if the response in the returned mini-packet is BUSY; otherwise, inactive.

7.13.4.6 Register 4: Rx.SR (receive status and node status). The node shall perform the following actions:

- a) D7:P: RDN (read done): the node shall set D7:P active if control line RDN:N is set active; otherwise, inactive;

- b) D6:P: BCE (broadcast reception on): the node shall set D6:P active if the BROADCAST RECEPTION control is ON; otherwise inactive;

- c) D5:P: RRJ (receiver reject): the node shall set D5:P active if, since the source selector was last set, the node has put the response NOT SELECTED in a mini-packet addressed to the node; otherwise, inactive;

- d) D4:P: RSS (source select/reject): the node shall set D4:P active if the SOURCE SELECT/REJECT control is set to REJECT; otherwise inactive.
- e) D3:P: LOG (error message mini-packet received): the node shall set D3:P active if the LOG RECEPTION control is ON and the received mini-packet for which RDN is active was an error message; otherwise inactive;
- f) D2:P: BPR (broadcast mini-packet received): the node shall set D2:P active if the BCE control is ON and the received mini-packet for which RDN is active was a broadcast message; otherwise inactive;
- g) D1:P: RTRY (auto-retry on busy): the node shall set D1:P active if the AUTO-RETRY ON BUSY control is ON; otherwise inactive;
- h) D0:P: NEN (node enabled): the node shall set D0:P active if the node is enabled; otherwise inactive.

NOTE 96 In items e) and f), RDN:N and RINT:N are both active when one of these bits is active.

7.13.4.7 Register 5: Rx.B (read data octet). The node shall take action on this register provided that RDN:N is set active.

The node shall set a data octet from the last received mini-packet on the data lines according to the following rules:

- a) if the data octet being read is the first data octet to be read since node enabling or receiver reset, the data octet shall be data octet 0;
- each subsequent octet being read, without an intervening node enablement or receiver reset, shall be the next in the repeating cycle 0... (n - 1), 0... (n - 1), 0... where n is the number of mini-packet data octets applicable to the slot length in use;
- c) for the purposes of a) and b) it shall make no difference whether a data octet is read using Rx.B or Rx.BG, or whether there is an intervening occurrence of Rx.G.

NOTE 97 If the DTE reads more times from this register than there are data octets in the mini-packet, without any intervening Rx.G or an Rx.BG on the highest numbered mini-packet data octet, the mini-packet data octets will be re-read cyclically.

7.13.4.8 Register 6: Rx.BG (read data octet and go). The node shall take the following actions on this register provided that RDN:N is set active:

- a) the node shall set a data octet on the data lines as specified for Rx.B in 7.13.4.7; and then

- b) if and only if the data octet set on the data lines is the highest numbered mini-packet data octet for the length of mini-packet in use, the node shall act as specified for Rx.G in 7.13.4.9 a).

7.13.4.9 Register 7: Rx.G (receive go). The node shall take the following action on this register provided that RDN:N is set active:

- a) the node shall set RDN:N to inactive within the time specified for RDN:N in 7.12.5.4.2, and set the READY/BUSY status to READY (i.e. become ready to receive another mini-packet) within such time as permits the requirement in 7.12.5.4.1 to be met;
- b) the data placed on the data lines is undefined.

7.13.4.10 Register 8: XSR (extended mode status register). The node shall take the following actions:

- a) D7:P: to D5:P: L2 to L0: (mini-packet data octet count) the node shall set these lines to represent the number of data octets in mini-packets for the slot length to which the node is currently set, as specified in table 10;

Table 10 — Representation of mini-packet data octet count

Number of octets	L2	L1	L0
2	inactive	active	inactive
4	active	inactive	inactive
6	active	active	inactive
8	inactive	inactive	inactive

NOTE — These lines represent a modulus 8 binary integer, with the most significant bit on L2.

- b) D4:P: AOK (all set up): the node shall set D4:P to active if all the following conditions apply, otherwise inactive:
 - 1) the currently loaded own address in the node is in the range 0 to 254;
 - 2) RON is active [see item c)];
 - 3) an input signal is present at the ring connector;
 - 4) the node is enabled;
- c) D3:P: RON (ring on): the node shall set D3:P active if a passage of the ring gap immediately

preceded by an empty slot has occurred within the last 6 ms; otherwise inactive;

- d) D2:P: the node shall set D2:P active;
- e) D1:P: RTPB (received Type bit B): provided that RDN:N is active, the node shall set D1:P active if Type bit B of the last received mini-packet was a ONE, and inactive if it was a ZERO;
- f) D0:P: RTPA (received Type bit A): provided that RDN:N is active, the node shall set D0:P active if Type bit A of the last received mini-packet was a ONE, and inactive if it was a ZERO.

7.13.5 Other registers

7.13.5.1 Register 9: Rx.SUM: (Receiver checksum)

7.13.5.1.1 In Basic Class nodes this register shall be reserved. If the DTE sets this register address on the address lines, the node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall set the data lines inactive.

7.13.5.1.2 In Enhanced Class nodes, this register shall represent a checksum as follows:

- a) the checksum shall be set to 0 when the DTE writes RSUMCLR;
- b) each time that an odd numbered mini-packet data octet (1, 3, 5 or 7) is read using Rx.B or Rx.BG, the value of the octet shall be added to the checksum;
- c) each time that an even numbered mini-packet data octet (0, 2, 4 or 6) is read using Rx.B or Rx.BG, the value of the data octet multiplied by 256 shall be added into the checksum;
- d) the value of the data octet set on the data lines for the first time that Rx.SUM is read following RSUMCLR shall be the high order octet, and the second time the low order octet, of a 16-bit integer that is congruent to the checksum taken modulo 65 535, and is not equal to 0 unless no data octets have been read using Rx.B or Rx.BG since the last occurrence of RSUMCLR;
- e) in Enhanced Class nodes ACK:N shall be made active (see 7.13.2).

NOTES

98 Reduction modulo 65 535 may be made after any addition without affecting the final result.

99 The algorithm is equivalent to adding odd numbered octets into the low order eight bits, and the even numbered octets into the high order eight bits, of a 16-bit register with end carry-round, with initial value being zero and final value being that to be set on the data lines. (On

overflow, 65 536 is lost at the high order end of the register, and 1 gained at the low order end through carry-round, corresponding to reduction modulo 65 535.)

7.13.5.2 Register 10: Tx.SUM: (Transmitter checksum)

7.13.5.2.1 In Basic Class nodes this register shall be reserved. If the DTE sets this register address on the address lines, the node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall set the data lines inactive.

7.13.5.2.2 In Enhanced Class nodes, this register shall represent a checksum as follows:

- a) the checksum shall be set to 0 when the DTE writes TSUMCLR;
- b) each time that an odd numbered mini-packet data octet (1, 3, 5 or 7) is written using Tx.B or Tx.BG, the value of the octet shall be added to the checksum;
- c) each time that an even numbered mini-packet data octet (0, 2, 4 or 6) is written using Tx.B or Tx.BG, the value of the data octet multiplied by 256 shall be added into the checksum;
- d) the value of the data octet set on the data lines for the first time that Tx.SUM is read following TSUMCLR shall be the high order octet, and the second time the low order octet, of a 16-bit integer that is congruent to the checksum taken modulo 65 535, and is not equal to 0 unless no data octets have been written using Tx.B or Tx.BG since the last occurrence of TSUMCLR;
- e) in Enhanced Class nodes ACK:N shall be made active (see 7.13.2).

NOTE 100 See note 98 and note 99 to 7.13.5.1.2.

7.13.5.3 Registers 11 to 15: user defined registers

These registers are not standardized. If the DTE sets these register addresses on the address lines, the node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall set the data lines inactive.

NOTES

101 In DTEs in which the register address lines are directly connected to an internal bus, register addresses 11 to 15 may be used for internal communication in the DTE, and so may appear at the node/DTE interface; the node is required to ignore these.

102 In accordance with 7.1.2, nodes are permitted to use these registers for functions other than those specified in this standard, so long as it is possible to disable such functions so that the node operates in compliance with this standard.

7.14 Writing to node

7.14.1 General

When the node becomes enabled, the initial conditions specified in 7.15.4 shall apply; thereafter while enabled the node shall act as specified in 7.14.2 to 7.14.5.

7.14.2 Writing conditions

When the DTE sets WT:N to active the node shall carry out the actions specified in 7.14.3 to permit the DTE to write data to the node, provided that the following conditions have been satisfied:

- a) a register address in the range 0 to 1 or 4 to 10 has been set by the DTE on the register address lines A0:P to A3:P for at least 40 ns prior the WT:N being set active;

NOTE 103 For register address in the range 2 to 3 and 9 to 15, see 7.14.5.

- b) data has been set by the DTE on the data lines D0:P to D7:P for at least 15 ns prior to WT:N being set active;
- c) the DTE keeps the data set until at least 30 ns after the node sets ACK:N active;
- d) the DTE keeps WT:N active until at least 30 ns after the node sets ACK:N active;
- e) the DTE keeps the register address set for at least 40 ns after WT:N is set inactive.

7.14.3 Write operation

The node shall

- a) act on the data that is on the data lines at the same time that WT:N goes active in the way specified for the register whose address is on the register address lines at that time;
- b) acknowledge reception of the data by setting ACK:N active within 320 ns of WT:N becoming active.

7.14.4 Registers applicable to all nodes

7.14.4.1 General

The node shall act on these registers as specified below. Where a requirement contains a qualification "provided...", the action of the node is undefined when the provision is not met.

7.14.4.2 Register 0: SSR (Source selector)

The node shall set the SOURCE SELECTOR control to the value on the data lines. D0:P shall be the least significant bit and D7:P shall be the most significant bit. The source selector shall become set to the new value within a time such that at most one mini-packet is received which comes from other than the selected source.

7.14.4.3 Register 1: Tx.DST (Transmit destination node address)

Provided that TDN:N is set to active, the node shall put the value on the data lines into the destination node address field of all mini-packets transmitted (other than error message mini-packets) until a new destination node address is written by the DTE.

7.14.4.4 Register 4: Rx.CR (Receive control and node control)

The node shall perform the following actions according to the values on the data lines:

- a) D0:P: NEN (node enable): the action shall depend on both the state of the control line TEST:N and whether the node implements the facility of enablement by TEST:N:
 - 1) if TEST:N is inactive or enablement by TEST:N is not implemented, then if D0:P is inactive the node shall become disabled as specified in 7.15.1, and if D0:P is active the node shall remain enabled and shall not be reset to the initial enabled state specified in 7.15.4;
 - 2) if TEST:N is active and enablement by TEST:N is implemented, the node shall remain enabled and shall not be reset to the initial enabled state specified in 7.15.4;
- b) D1:P: RTRY (auto-retry on busy): if D0:P and D1:P are active the node shall set the AUTO-RETRY ON BUSY control to ON, if inactive to OFF (see 7.11.1.5);
- c) D2:P: RRST (receiver reset): if D0:P and D2:P are active the node shall present mini-packet data octet 0 at the next occurrence of either Rx.B or Rx.BG, whichever occurs first;
- d) D3:P: TRST (transmitter reset): if D0:P and D3:P are active the node shall
 - 1) set TDN:N and TCLK:N to active, upon completion of any current transmission;
 - 2) set TER:N and TER in Tx.SR to inactive, as 1);
 - 3) cease retransmission of the last transmitted mini-packet if it returned with response BUSY

while the AUTO RETRY ON BUSY control is ON;

NOTE 104 If both TRST and RTRY are active, then any transmission or retransmission in progress ceases, but AUTO-RETRY ON BUSY is left ON (or set ON, if not ON already) so as to cause retransmission of later mini-packets returning with response BUSY.

- 4) put into mini-packet data octet 0 the data octet written by the DTE at the next occurrence of either Tx.B or Tx.BG, whichever occurs first;
- e) D4:P: RSS (source select/reject control):
 - 1) an Enhanced Class node shall set the SOURCE SELECT/REJECT control to REJECT if D0:P and D4:P are active; to SELECT if inactive;
 - 2) a Basic Class node shall take no action for either state of the D4:P;
- f) D5:P LGE (log reception control):
 - 1) an Enhanced Class node shall set the LOG RECEPTION control to ON if D0:P and D5:P are active; and take no action if inactive;

NOTE 105 Accordingly, from the time that a node is enabled each occurrence of Rx.CR with LGE inactive leaves the LOG RECEPTION control OFF if it is already OFF, and ON if it is already ON; it can only be turned OFF by disablement and re-enablement.

- 2) a Basic Class node shall take no action for either state of D5:P;
- g) D6:P BCE (broadcast reception control):
 - 1) an Enhanced Class node shall set the BROADCAST RECEPTION control to ON if D0:P and D6:P are active, to OFF if inactive;
 - 2) a Basic Class node shall take no action for either state of D6:P;

NOTE 106 In a Basic Class node, broadcast reception is set by an operator control.

h) D7:P: the node shall ignore this line.

7.14.4.5 Register 5: Tx.B (Write data octet)

The node shall take action on this register provided that TDN:N is set active.

The node shall store the data octet set on the data lines as a mini-packet data octet for the next mini-packet to be transmitted according to the following rules:

- a) if the data octet being written is the first data octet to be written since node enablement or transmitter reset, the data octet shall be mini-packet data octet 0;
- b) each subsequent octet being written, without an intervening node enablement or transmitter reset, shall be the next in the repeating cycle 0... (n-1), 0... (n-1), 0..., where n is the number of mini-packet data octets applicable to the slot length in use;
- c) each new value for a given numbered mini-packet data octet shall overwrite previous values;
- d) for the purposes of a) to c) it shall make no difference whether a data octet is written using Tx.B or Tx.BG, or whether there is an intervening occurrence of Tx.G

7.14.4.6 Register 6: Tx.BG (Write data octet and go)

The node shall take the following actions on this register provided that TDN:N is set active:

- a) the node shall store the data octet on the data lines as specified for Tx.B in 7.14.4.5; and then
- b) if, and only if the data octet set on the data lines is the highest numbered mini-packet data octet for the length of mini-packet in use, then the node shall act as specified for Tx.G in 7.14.4.7 a).

7.14.4.7 Register 7: Tx.G (Transmit go)

The node shall take the following action on this register provided that TDN:N is set active:

- a) the node shall set TDN:N to inactive within the time specified for TDN:N in 7.12.5.3 a), and act as specified for a transmit command in 7.11.2.1;
- b) the node shall ignore data placed on the data lines.

7.14.4.8 Register 8: XCR (Extended mode control register)

Provided that TDN:N is active, the node shall perform the following actions:

- a) D0:P: TTPA (mini-packet Type bit A): the value on D0:P shall be put into Type bit A of all mini-packets transmitted until the next occurrence of XCR;
- b) D1:P: TTPB (mini-packet Type bit B): the value on D1:P shall be put into Type bit B of all mini-packets transmitted until the next occurrence of XCR;

c) D2:P: ROT (reject on type) and D3:P: CTP (control type reception):

- 1) an Enhanced Class node shall set the TYPE SELECT/REJECT control to OFF if CTP is inactive, to SELECT if CTP is active and ROT is inactive, and to REJECT if both CTP and ROT are active;
- 2) a Basic Class node shall not take any action for any state of these lines;

NOTE 107 A Basic Class node always functions as for the OFF state.

d) D4:P: MTPA (type bit A mask):

- 1) an Enhanced Class node shall set the value of Type bit A in the TYPE BIT MASK used by the TYPE SELECT/ REJECT control to ONE if D4:P is active, to ZERO if inactive;
- 2) a Basic Class node shall take no action for either state of this line;

e) D5:P: MTPB (type bit B mask):

- 1) an Enhanced Class node shall set the value of Type bit B in the TYPE BIT MASK used by the TYPE SELECT/REJECT control to ONE if D5:P is active, to ZERO if inactive;
- 2) a Basic Class node shall take no action for either state of this line.

f) D6:P and D7:P: the node shall ignore these lines.

7.14.5 Other registers

7.14.5.1 Registers 2 and 3: reserved registers

These registers are reserved. If the DTE sets one of these register addresses on the register address lines, the node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall ignore the data on the data lines.

7.14.5.2 Register 9: RSUMCLR

7.14.5.2.1 In Basic Class nodes, this register shall be reserved. If the DTE sets this register address on the register address lines, the node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall ignore the data on the data lines.

7.14.5.2.2 An Enhanced Class node shall set the receiver checksum to 0 as specified in 7.13.5.1.2 a) and ignore the data on the data lines, and set ACK:N active (see 7.14.2).

7.14.5.3 Register 10: TSUMCLR

7.14.5.3.1 In Basic Class nodes, this register shall be reserved. If the DTE sets this register address on the register address lines, the node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall ignore the data on the data lines.

7.14.5.3.2 An Enhanced Class node shall set the transmitter checksum to 0 as specified in 7.13.5.2.2 a) and ignore the data on the data lines, and set ACK:N active (see 7.14.2).

7.14.5.4 Registers 11 to 15: user defined registers

These registers are not standardized. The node shall keep ACK:N inactive (i.e. not acknowledge the register address) and shall ignore the data on the data lines.

NOTE 108 See notes 101 and 102 to 7.13.5.3.

7.15 Enabling and disabling

7.15.1 Disabling

7.15.1.1 The node shall be in the disabled state:

- a) immediately on power-up;
- b) after a disable command (NEN of Rx.CR) from the DTE if TEST:N is inactive or not implemented;
- c) when TEST:N is inactive, if the last enable/disable command was disable, or no enable/disable command has been issued by the DTE since power-up;
- d) when PFD:N becomes active while auxiliary power is enabled.

7.15.1.2 For the conditions in 7.15.1.1 b) to d), the node shall enter the disabled state not later than the passage of the ring gap through the node.

7.15.1.3 Disabling shall not cause corruption of the ring traffic at the ring connector.

NOTE 109 With some designs it is necessary to synchronize disablement with the ring gap in order to meet this requirement.

7.15.2 Disabled state

7.15.2.1 Control lines

In the disabled state those control lines which are controlled by the node shall be set as follows:

- a) RDN:N: inactive;

- b) TDN:N: active;
- c) TCLK:N: active;
- d) TER:N: inactive;
- e) RTPA:N: undefined;
- f) RTPB:N: undefined;
- g) RINT:N: inactive.

NOTE 110 ACK:N responds only to RD:N and WT:N while the conditions specified in 7.13.2 and 7.14.2 are met; ACK:N is not dependent upon the enable or disable states.

7.15.2.2 Read registers

7.15.2.2.1 In the disabled state, the node shall take action on the read registers 2, 4 and 8 (NODE, Rx.SR and XSR) as specified in 7.15.2.3, 7.15.2.4 and 7.15.2.5.

7.15.2.2.2 The read conditions and read operation shall be as specified in 7.13.2 and 7.13.3 for enabled nodes.

7.15.2.2.3 Action on other registers is undefined.

7.15.2.3 Register 2: NODE (node own address)

The node shall place its own assigned address on data lines D0:P to D7:P.

7.15.2.4 Register 4: Rx.SR (read status and node status)

The node shall perform the following actions:

- a) D0:P NEN: the node shall set D0:P inactive;
- b) other data lines: all inactive.

NOTE 111 NEN overrides all other controls.

7.15.2.5 Register 8: XSR (extended mode status register)

The node shall perform the following actions:

- a) D7:P L2 to D5:P: L0 (mini-packet data octet count): the node shall set these as specified in 7.13.4.10;
- b) D4:P AOK (all set up): the node shall set D4:P inactive;
- c) D3:P RON (ring on): the node shall set D3:P active if a passage of the ring gap immediately preceded by an empty slot has occurred within the last 120 μ s: otherwise, inactive;

- d) other data lines: undefined.

7.15.2.6 Write registers

7.15.2.6.1 In the disabled state, the node shall take action on the write register 4 (Rx.CR) as specified in 7.15.2.7.

7.15.2.6.2 The write conditions and the write operation shall be as specified in 7.14.2 and 7.14.3.

7.15.2.6.3 Writing to registers 6 and 7 (Tx.BG and Tx.G) shall not cause the node to transmit mini-packets.

7.15.2.6.4 Action on other registers is undefined.

7.15.2.7 Register 4: Rx.CR (receive control and node control)

If the DTE sets D0:P (NEN) active, the node shall become enabled as specified in 7.15.3; if the DTE sets D0:P inactive, the node shall remain disabled. The action for the settings of other lines is undefined.

7.15.3 Enabling

7.15.3.1 Subject to the requirement of 7.15.3.2, the node shall enter the initial enabled state not later than the first passage of the ring gap through the node after

- a) TEST:N goes active if TEST:N is implemented;
- b) an enable command (NEN of Rx.CR) from the DTE.

7.15.3.2 The node shall not become enabled unless PFD:N is inactive when auxiliary power is enabled in the node.

7.15.3.3 Enabling shall not cause corruption of ring traffic at the ring connector.

NOTE 112 With some designs it is necessary for the node to synchronize enabling with the ring gap in order to meet this requirement.

7.15.4 Initial enabled state

7.15.4.1 Control lines

In the initial enabled state each control line that is controlled by the node shall be set as follows, and shall remain so set until any requirement in 7.12, 7.13 and 7.14 changes its status (to active, inactive, or undefined):

- a) RDN:N: inactive;
- b) TDN:N: active;

- c) TCLK:N: active;
- d) TER:N: inactive;
- e) RTPA:N: undefined;
- f) RTPB:N: undefined;
- g) RINT:N: inactive.

NOTE 113 ACK:N responds only to RD:N and WT:N while the conditions specified in 7.13.2 and 7.14.2 are met; ACK:N is not dependent upon the enable or disable states.

7.15.4.2 Read registers

The node shall act on read registers as specified in 7.13 except as follows:

- a) Register 0: SSR: the source selected shall be 0 (NONE) until the DTE has written a source using SSR;
- b) Register 1: Rx.SRC: the mini-packet source shall be undefined until RDN:N goes from inactive to active;
- c) Register 3: Tx.SR: until TDN:N goes inactive, the data lines shall be set as follows:
 - 1) D7:P: TDN: active;
 - 2) D6:P: TER: inactive;
 - 3) D5:P: inactive;
 - 4) D4:P: TCE: inactive;
 - 5) D3:P: TIG: inactive;
 - 6) D2:P: TAC: active;
 - 7) D1:P: TUS: inactive;
 - 8) D0:P: TBY: inactive;
- d) Register 4: Rx.SR: the data lines shall be set as follows:
 - 1) D7:P: RDN: inactive;
 - 2) D6:P: BCE: if the node was enabled by Rx.CR, as set then; if the node was enabled by TEST:N, inactive; in both cases, until the next occurrence of Rx.CR;
 - 3) D5:P: RRJ: inactive until a mini-packet has been rejected;

- 4) D4:P: RSS: if the node was enabled by Rx.CR, as set then; if the node was enabled by TEST:N, inactive; in both cases, until the next occurrence of Rx.CR;
 - 5) D3:P: LOG: inactive until a mini-packet has been received;
 - 6) D2:P: BPR: inactive until a mini-packet has been received;
 - 7) D1:P: RTRY: if the node was enabled by Rx.CR, as set then; if the node was enabled by TEST:N, inactive; in both cases, until the next occurrence of Rx.CR;
 - 8) D0:P: NEN: active until disabled;
- e) Register 8: XSR: D4:P: RTPB and D0:P: RTPA shall be undefined until a mini-packet has been received; other data lines shall be as specified in 7.13.4.10.

7.15.4.3 Write registers

The node shall act on write registers 6 and 7 as specified in 7.14 except as follows:

The value of the transmitted mini-packet destination, data octets and type bits shall be undefined until the DTE has written values using Tx.DST, Tx.BG or TX.G, and XCR respectively.

8 Specification for monitor

8.1 Compliance

8.1.1 Product designation

In claims of compliance the product shall be designated as

- a) Basic Class or Enhanced Class;
- b) supporting 7 or 15 slots;
- c) having a Class I, II or III repeater section.

8.1.2 Condition as supplied

The product shall be supplied in such condition that when physically installed, and connected to the ring and mains power supply, it complies with the requirements of this part of ISO 8802.

NOTE 114 The product is not precluded from complying with specifications that differ from this clause, provided that it can be set to a mode of operation in which it complies with this clause and in which all conflicting features are rendered non-operational.

8.1.3 Limitations

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

8.1.4 Options

8.1.4.1 Implementor options

The following shall be at the option of the implementor:

- a) class of repeater (Class I, II or III) (see 8.6.8);
- b) capability of operating with each of 40-bit, 56-bit, 72-bit and 88-bit slots (Basic Class 40-bit slots only);
- c) capability of operating with 1 to 7 slots, or 1 to 15 slots;
- d) manual or automatic ring sizing;
- e) generation of error messages to logging station;
- f) error overflow at 128 or 256 errors (see 8.10.1.3);
- g) inclusion of a slave power supply unit (see 8.4.5).

8.1.4.2 Supplier options

The following shall be at the option of the supplier:

- a) the means of setting the length of slot, if the monitor is Enhanced Class (see item c) of 8.3);
- b) the means of setting the number of slots, if the monitor uses manual ring sizing (see item d) of 8.3);
- c) the form of display of information to the operator.

8.1.4.3 Undefined actions

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

8.1.5 Information to be provided by the supplier

The documentation associated with the product shall include the following:

- a) which of the options in 8.1.4.1 are implemented, and if the monitor can be set to operate according to either alternative for an option, the means by which one alternative is selected in operation;

- b) how the options in 8.1.4.2 are implemented;
- c) if the monitor is capable of operating in a way in conflict with the requirements specified in this clause (see 8.1.2), the means by which the monitor is set to a mode of operation in which it complies;
- d) the maximum continuous power supply current drawn by the monitor from the ring for powering the repeater section.

8.2 Connectors

8.2.1 Ring connector plug

8.2.1.1 Mechanical

The monitor shall be provided with a shrouded and screened 15-way male contact connector complying with the specification in 6.2.1.

8.2.1.2 Electrical characteristics

8.2.1.2.1 For both Data In Pairs the impedance across the two conductors of the pair shall be between 90 Ω and 150 Ω measured at 5 MHz when the monitor is powered up.

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

NOTE 115 Means such as centre-tapped transformers will be needed to separate the high-frequency signals from the d.c. power and provide the above impedance and resistance characteristics.

8.2.1.2.3 The V_{sig} line shall be connected to local ground (see 8.2.2).

8.2.2 Ground terminal

The monitor shall be provided with an external terminal for connection to local ground, for use where the mains power supply does not provide a good ground connection.

8.2.3 Slave power supply connector

Only if the monitor does not incorporate a slave power supply (see 8.4.5), then the monitor shall be fitted with a slave power supply connector as specified in 6.2.2.

8.3 Operator controls

The monitor shall have the following operator controls:

- a) a mains power switch ON/OFF;

- b) a start/restart control;
- c) a slot length control, for Enhanced Class monitors only; the control shall be capable of being set to each of 40-bits, 56-bits, 72-bits, and 88-bits, and to no other value;
- d) a slot number control, if the monitor implements manual ring sizing; in this case, the control shall be capable of being set to every value in the range 1 to 7 or 1 to 15, for monitors supporting maxima of 7 and 15 slots respectively, and to no greater number;
- e) a control to clear all error indications and error counts;
- f) if the monitor implements the error message transmission function, a control to enable or disable this function;
- g) a control to select random or zero data check packet modes;
- h) a control to inhibit automatic restart (for test purposes only).

NOTE 116 Controls g) and h) may be mounted inside the monitor housing since they are only required during test conditions.

8.4 Power supply

8.4.1 Power source for logic functions

The monitor shall draw power for logic functions from the ring and attached slave supplies, or from local mains supply, or both. Where power is drawn from the ring and attached slave power supplies, the requirement of 8.4.2 shall be satisfied.

8.4.2 Power drawn from ring and attached slave power supplies

8.4.2.1 The positive feed shall be from the four Pair A conductors (two signal input and two signal output) and the positive line connector for a slave power supply. The negative feed shall be from the four Pair B conductors and the negative line connector for a slave power supply.

8.4.2.2 The logic functions shall comply with this clause of this standard when both the voltage at the ring connector lies between 21 V and 28 V d.c. and the monitor is switched on.

NOTE 117 Apart from a brief delay when the monitor is switched on and off, and apart from fault conditions on the ring, the ring d.c. voltage will be present while the monitor

is switched on, since it is controlled by the monitor master power supply.

8.4.2.3 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.

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

8.4.2.5 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.

8.4.3 Power transfer

8.4.3.1 Power supplied from the ring at the Data In pins shall be made available at the Data Out pins, and vice versa, less the power consumed by the monitor.

8.4.3.2 Power supplied at the slave power supply connector or from a slave power supply incorporated in the monitor shall be made available to the ring at both the Data In and Data Out pins, less the power consumed by the monitor.

8.4.3.3 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, the voltage being measured with respect to the mean of the voltages on the members of the corresponding pair (Data In or Data Out) carrying the opposite polarity d.c. supply.

8.4.3.4 Current fed into a pair shall be divided equally to within 10 % between the two conductors when they present the same load.

8.4.3.5 The monitor shall accept a current at any of the power supply points of 2A without damage or overheating.

8.4.4 Master power supply

8.4.4.1 The monitor shall be equipped with a master power supply unit.

NOTE 118 The function of the master power supply unit is to generate a control voltage on the ring, that causes the slave power supply units to supply operating power to the ring.

8.4.4.2 The positive feed from the master power supply shall be to the four Pair A lines (two Data In and two Data Out), and the negative feed shall be to the V_{sig} line.

8.4.4.3 The master power supply shall be capable of delivering up to a maximum chosen by the implementor in the range 0,2 A to 0,5 A d.c. at the ring connector.

8.4.4.4 The voltage at the ring connector shall not exceed 28 V d.c., and shall not be less than 27 V while the current drawn by the load does not exceed the maximum current capability of the master supply.

8.4.4.5 When all pins at the ring interface are short-circuited, the current from the master power supply shall not exceed 1 A and neither the master power supply nor any other part of the monitor shall be damaged.

NOTE 119 This may be achieved either by current-limiting techniques or by causing the master power supply to power down under such conditions.

8.4.4.6 The conditions governing whether the master power supply is on or off shall be as specified in 8.6.1.

8.4.5 Slave power supply unit

8.4.5.1 At the option of the implementor, the monitor may incorporate a slave power supply unit, in which case the following requirements shall be satisfied:

- a) the power rating and a.c. components of the power output shall be as specified in 10.2 and 10.3;
- b) the slave power supply shall be switched on and off when the master power supply is switched on and off; if this is achieved by detection of the master power supply voltage, as for separate slave power supplies, then the requirements of 10.4 shall be satisfied.

8.5 Modes of operation

8.5.1 The monitor shall have the following modes of operation:

- a) start/restart mode, as specified in 8.7;
- b) run mode, as specified in 8.8;
- c) resynchronization mode, as specified in 8.9.

8.5.2 In all modes, the requirements of 8.6 shall be satisfied.

8.6 Production of output

8.6.1 Power-up condition

The monitor shall produce continuous output on both Pair A and B whenever the d.c. power supply at the ring connector lies between 21 V and 28 V; the output shall begin within 1 s of the power being applied.

8.6.2 Waveform

The output waveform shall be as specified in 6.4.2.

8.6.3 Modulation

The output shall be continuously modulated to represent an uninterrupted stream of bits. The encoding method shall be as specified in 4.1. The bits making up the bit stream shall be as specified for each mode of operation.

8.6.4 Free-standing frequency

When no input signal is present at the ring connector Data In lines, and when any requirement specifies that the monitor output frequency be unaffected by the frequency of input, if any, the output frequency at the Data Out lines shall lie between 9,85 Mbps and 10,15 Mbps.

8.6.5 Signal capture range

When the monitor enters the synchronization phase of the start/restart mode (see 8.7.4) it shall output a signal with the same frequency as the input signal whenever the input signal has a steady frequency in the range 8,5 Mbps to 11,5 Mbps.

8.6.6 Low error range

Whenever a steady signal, encoded as a slot structure with mini-packets such that the only action required by the monitor is to change the monitor pass bit to ZERO, with a frequency between 9,25 Mbps and 10,75 Mbps and with the waveform specified in 8.6.2 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.

8.6.7 Sensitivity

The monitor shall satisfy the sensitivity specified in 6.6.5.

8.6.8 Phase locked loop characteristics

The monitor shall satisfy the requirements specified in 6.6.6 and 6.6.7 for a Class I, II or III repeater.

8.6.9 Delay

When there is present at the ring connector Data In lines an input signal comprising bits that the monitor is required to output (modified or unmodified), the delay between input and output shall be as follows:

- a) there shall be fixed delay not exceeding 4,5 bit-periods; this delay shall not vary under steady operating frequency and temperature and shall be unaffected by the content of the bit stream;

NOTE 120 The fixed delay comprises a maximum of 4 bit-periods for processing by the monitor plus an allowance for PLL phase error and delay in the cable between the monitor and the ring connector. The half bit-period is an arbitrary value to distinguish between four plus some lag and five minus some lead; far smaller values of phase error than 1/2 bit are normally needed to meet other performance requirements.

- b) There shall be an additional variable delay provided by padding storage of from 0 to 40 bit-periods for Basic Class monitors, and from 0 to 88 bit-periods for Enhanced Class monitors;
- c) The variable delay shall be capable of being set manually in the case of monitors with manual ring sizing, and automatically in the case of monitors with automatic sizing, in each case to 0, to the maximum value specified in b), and to intermediate values in steps not exceeding 8 bit-periods.

NOTE 121 The variable delay is required to adjust the total number of circulating bits for ring sizing.

8.7 Start/restart mode

8.7.1 Initiation of start/restart mode

8.7.1.1 The start/restart mode shall be initiated by

- a) an operator turning the monitor on;
- b) an operator causing a manual restart using the manual restart control;
- c) overflow of error counters (see 8.10.1.3).

8.7.1.2 Upon initiation of the start/restart mode, the monitor shall act as specified in 8.7.2 to 8.7.7, in the sequence specified.

8.7.2 Master power supply

The monitor shall immediately turn the master power supply on if it is not on already. Providing that no electrical failure, such as loss of mains power or a short-circuit on the ring causes automatic shut off of the master power supply, the monitor shall keep

the master power supply on until the monitor is turned off.

8.7.3 Start phase

8.7.3.1 The monitor shall then output to the ring a continuous series of slot structures complying with 4.2. Each slot shall be of 40 bits long for Basic Class monitors and the length to which the slot length control is set for Enhanced Class monitors, and shall contain one start mini-packet of the same length, in which the first two bits are set to ONE and the remainder to ZERO.

8.7.3.2 The signal frequency shall be the free-running frequency of the monitor and shall be unaffected by the frequency of any input from the ring.

8.7.3.3 Input from the ring, if any, shall cause neither any change to the output bit stream nor the logging of errors.

8.7.3.4 The start transmission phase shall continue until the synchronization phase begins.

8.7.4 Synchronization phase

8.7.4.1 The synchronization phase shall

- a) begin not less than 1,25 s after the start transmission phase begins;
- b) last not less than 1,25 s and not more than 5 s;
- c) be completed not later than 10 s after the start transmission phase begins.

8.7.4.2 The monitor shall phase-lock the output to the ring to the input from the ring. The output frequency shall then be determined dynamically through the interaction of ring components, and shall no longer be set by the monitor free-running frequency.

8.7.4.3 The monitor shall continue to output a slot structure as specified in 8.7.3.1.

8.7.4.4 The input bit stream shall not cause any change in the output bit stream other than a change in the number of slots and gap bits. Errors in the input bit stream shall not cause any error reporting procedures to be performed.

8.7.4.5 By the end of the synchronization phase, provided that the bit stream input from the ring exactly reproduces the bit stream output to the ring, the monitor shall have established a stable slot structure as specified in 8.7.5 if ring sizing is manual, and as specified in 8.7.6 if the ring sizing is automatic.

8.7.4.6 All slots shall be of the same length as established in the start phase (see 8.7.3.1).

8.7.5 Manual ring sizing

Provided that the operator has set a number of slots and an amount of padding storage that produce a gap of between 2 and 255 bits, the monitor shall output that number of slots per ring cycle, shall count the resultant number of gap bits, and shall make the count available for display. If the number of slots and amount of padding set by the operator does not produce a gap of between 2 and 255 bits, the action of the monitor is undefined.

NOTE 122 On entering run mode, an insufficient number of gap bits will cause a "one in gap" error, and an excessive number of gap bits will cause a "ring break" error.

8.7.6 Automatic ring sizing

8.7.6.1 Subject to the qualifications in 8.7.6.4, a monitor incorporating automatic ring sizing shall establish a slot structure that has a number of slots in the range 1 to 15 inclusive and a number of gap bits in the range 4 to 11 inclusive.

8.7.6.2 This slot structure shall be produced by selection of the number of slots and the insertion of padding storage not exceeding the number of bits in a slot.

8.7.6.3 While seeking a slot structure satisfying these requirements, the monitor is permitted to output any slot structure which has 1 to 7 or 1 to 15 slots, according to the maximum number of slots supported, and a gap of 2 to 255, and shall not output any slot structure outside this range.

8.7.6.4 The requirement of 8.7.6.1 shall be met whenever the number of circulating bits, with no padding storage in use, does not exceed the number equivalent to 7 slots and 11 gap bits; when this number is exceeded, the following qualifications shall apply:

- a) at the option of the implementor the monitor may be able to establish slot structures as specified in 8.7.6.1 when the number of circulating bits does not exceed the number equivalent to 15 slots and 11 gap bits; in this case, the monitor shall be capable of establishing a correct slot structure for every number of bits up to this value;
- b) where the number of circulating bits is equivalent to the maximum number of slots that the monitor can support (7 or 15) plus a number of gap bits in the range 12 to 255, the monitor shall establish a slot structure in which the number of slots is the monitor's maximum, with a gap in the range 12 to 255 bits;

- c) where the number of circulating bits is equivalent to the maximum number of slots that the monitor can support (7 or 15) plus a number of gap bits in excess of 255, the action of the monitor is undefined.

8.7.7 Completion of start/restart mode

On completion of the synchronization phase, the monitor shall enter run mode as the gap is output by the monitor.

8.8 Run mode

8.8.1 Duration of run mode

Once the monitor has entered run mode it shall remain in run mode until the first of the following occurs:

- a) loss of slot structure (see 8.8.3);
- b) count of all errors exceeds set limit (see 8.10.1.3);
- c) the monitor is turned off.

8.8.2 Interpretation of input bit stream

NOTE 123 This clause does not specify a unique interpretation of all possible combinations of error conditions. Accordingly, in the event of multiple errors, more than one interpretation is possible.

The monitor shall continuously examine the input bit stream and act on it as follows:

- a) when a single error occurs, the monitor shall act correctly for that error;
- b) when multiple errors occur, the monitor shall act correctly for at least one of the errors;
- c) then, when multiple errors occur and one of the errors is a loss of slot structure, the monitor shall act as specified for the loss of slot structure, unless the errors cause an overflow of the error counter, in which case the restart required for an error overflow shall have precedence over the resynchronization required for loss of slot structure.

8.8.3 Slot structure

8.8.3.1 The monitor shall continuously check that the slot structure is maintained. The correct slot structure shall comprise the number of slots set during the synchronization phase, each slot having the first bit set to ONE, plus the number of gap bits set during the synchronization phase, each gap bit being a ZERO. While the slot structure input to the

monitor from the ring remains correct, the monitor shall output the same slot structure to the ring.

8.8.3.2 The following errors shall constitute a loss of slot structure:

- a) a ZERO bit in the input from the ring where, as determined by comparison of the input with the slot structure established by the monitor, there should be the ONE bit that is the first bit in a slot (LOST LEADER error);
- b) a ONE bit in the input from the ring where, as determined by comparison of the input with the slot structure established by the monitor, there should be a gap bit (ONE IN GAP error);
- c) the absence of input from the ring (RING BREAK error).

8.8.3.3 When loss of slot structure occurs, the monitor shall exit from run mode and enter resynchronization mode (see clause 9) and shall perform the error reporting procedures specified in clause 10.

8.8.4 Mini-packets

8.8.4.1 Processing of mini-packets

Mini-packets input from the ring shall be output to the ring in the same slot in which they arrived. No changes to the mini-packet other than those specified in 8.8.4.2 to 8.8.4.7 shall be made. Where the mini-packet satisfies the conditions applying to one or more changes, each change shall be made.

8.8.4.2 Parity

Each mini-packet shall be output to the ring with the parity bit so that the number of ONE bits in the slot is even. If an input mini-packet has an odd number of ONE bits, the monitor shall

- a) change the parity bit if no other bits in the mini-packet are changed;
- b) if other bits are changed, set the parity bit to provide even parity;
- c) perform the error reporting procedure specified in clause 10.

8.8.4.3 Monitor pass

8.8.4.3.1 Each mini-packet shall be output with the monitor pass bit set to ZERO.

8.8.4.3.2 When an input mini-packet has the full/empty bit set to ONE (i.e. full), and the monitor pass bit set to ZERO, the monitor shall

- a) output the mini-packet with the full/empty bit changed to ZERO;
- b) if the destination node address is other than 0, perform the error reporting procedures specified in clause 10 for SECOND PASS FULL errors.

NOTE 124 If the destination node address is 0, then the mini-packet is either a start mini-packet or an error message, see 8.8.4.6.

8.8.4.3.3 When an input mini-packet has the full/empty bit set to ZERO and the monitor pass bit set to ONE, the monitor shall output the mini-packet with the monitor pass bit set to ZERO. No error reporting procedure is required.

8.8.4.4 Sending check mini-packets

When an input mini-packet has both full/empty and monitor pass bits set to ZERO, and when the monitor does not need the empty slot for a fault message, the monitor shall output the mini-packet with its destination address, source address, and data octets changed to either all ZEROs or to pseudo-random numbers, according to the setting of the check mini-packet control (see item g) of 8.3).

NOTE 125 The full/empty bit thus remains unchanged at ZERO.

8.8.4.5 Receiving check mini-packets

8.8.4.5.1 When input mini-packet is

- a) in a slot that is the n th slot after the one in which a check mini-packet was output, where n is the number of slots in the slot structure set by the monitor (i.e. the slot is the same slot having returned from its journey round the ring); and
- b) with the full/empty bit set to ZERO (i.e. has not been used by any node to transmit a mini-packet);

the monitor shall compare the value of each bit in the address and data octets with the value set when the check mini-packet was transmitted.

8.8.4.5.2 If any ONE bit in these octets has been changed to ZERO, or any ZERO bit to a ONE, the monitor shall perform the error reporting procedures specified in clause 10 for ONE TO ZERO and ZERO TO ONE errors respectively.

8.8.4.5.3 If the monitor pass bit in the returning check mini-packet is ONE, it shall be changed as specified in 8.8.4.3.3; if it is ZERO, either a fault message or another check mini-packet shall be output, as specified in 8.8.4.4 and 8.8.4.6.

8.8.4.6 Sending fault messages

If the monitor implements the capability of transmitting error messages, when any of the errors specified in this clause occurs while the error message transmission control is on (see item f) of 8.3) the monitor shall send a fault message as specified in 8.10.2.3.

NOTE 126 In the absence of a logging station on the ring, if fault messages are sent they will return to the monitor unchanged.

8.8.4.7 Receiving start mini-packets and error messages

When an input mini-packet has the full/empty bit set to ONE, the monitor pass bit set to ZERO, and the destination address set to ZERO, the monitor shall

- a) output the mini-packet with the full/empty bit changed to ZERO;
- b) perform no error reporting procedures until the gap has returned once to the monitor at the beginning of the run mode;

NOTE 127 Until the first return of the gap, the mini-packets will be the returning start mini-packets transmitted at the end of the synchronization or resynchronization phases, not error messages.

- c) after the gap has returned once to the monitor at the beginning of the run mode:
 - 1) the monitor incorporates the logging station function, log the error message;
 - 2) if the monitor does not incorporate the logging station function, record a SECOND PASS FULL error, but not output a monitor fault message for a SECOND PASS FULL error, regardless of the setting of the monitor fault message control.

8.9 Resynchronization mode

8.9.1 Duration of resynchronization mode

The resynchronization mode shall

- a) be entered when a loss of slot structure occurs (see 8.9.2);

- b) last until two ring cycles in which slot structures with the same number of slots and same number of gap bits have been output;
- c) be completed not later than 5 s after starting re-synchronization.

8.9.2 Output frequency

The monitor shall maintain the output frequency the same as, and phase-locked to, the input.

8.9.3 Procedure

The procedure shall be the same as that specified for the synchronization phase of the start/restart mode in 8.7.3.1, 8.7.4.5 and 8.7.4.6.

8.10 Error reporting procedures

8.10.1 Basic procedures

8.10.1.1 The monitor shall incorporate an error counter and an error counter overflow indicator. A display shall allow the operator to observe the values in the counter (number of errors recorded) and overflow indicator (overflow or no overflow).

8.10.1.2 Each time that an error occurs for which 8.8 specifies that the error reporting procedure be performed, the value in the counter shall be incremented. The counter shall be incremented by one where the error is such that it can only be interpreted as a single error, and by at least one where the error is such that it can be interpreted as several errors (see 8.8.2).

8.10.1.3 The error counter shall overflow on a count of either 128 or 256 errors, as selected by the implementor. When overflow occurs

- a) the count shall continue, starting again from zero;
- b) the overflow indicator shall be set;
- c) the monitor shall enter restart mode.

8.10.1.4 The error count shall be reset to zero only on overflow and when reset by the manual reset control. The error overflow indicator shall be reset only by the manual reset control.

8.10.2 Additional procedures

8.10.2.1 General

It is recommended that the monitor should implement the error reporting procedures specified in 8.10.2.1 to 8.10.2.3. If implemented, the procedures shall be as follows.

8.10.2.2 Error type display

8.10.2.2.1 The error display shall indicate one of the following:

- a) whether or not any errors of a type have been detected since the monitor was switched on or the error display has been reset manually;
- b) the count of errors of a type that have been detected since the monitor was switched on or the error display has been reset manually.

8.10.2.2.2 The error display shall discriminate at least between the following groups of errors, and may discriminate between each error type in each group:

- a) "lost leader" and "one in gap" (loss of slot structure);
- b) parity error;
- c) "one to zero" and "zero to one" (corruption of check mini-packets);
- d) second time full.

8.10.2.3 Transmission of fault messages

8.10.2.3.1 The monitor shall transmit a fault message in the first empty mini-packet input after the fault is detected. The format of the fault message shall be as follows:

- a) the full/empty bit shall be set to ONE;
- b) the monitor pass bit shall be set to ZERO;
- c) the destination node address shall be ZERO;
- d) the source node address shall be ZERO;
- e) mini-packet data octet 0 shall be

bit 0: ONE for a ONE IN GAP error, otherwise ZERO;

bit 1: ONE for a LOST LEADER error, otherwise ZERO;

bit 2: ONE for a SECOND TIME FULL error, otherwise ZERO;

bit 3: ONE for a ONE TO ZERO error, otherwise ZERO;

bit 4: ONE for a ZERO TO ONE error, otherwise ZERO;

bit 5: ONE for a PARITY error, otherwise ZERO;

bit 6: ONE if the error counter overflow indicator is set, otherwise ZERO;

bit 7: ZERO (reserved);

- f) mini-packet data octet 1 shall contain the value currently held in the error counter;
- g) if the slot length in use is such that the mini-packet has more than two data octets, data octets 2 upwards shall be filled with ZERO bits;
- h) the Type bits shall both be ZERO;
- i) the response bits shall both be ZERO;
- j) the parity bit shall be set to even parity.

8.10.2.3.2 An operator control shall be provided that allows the operator to enable or disable the sending of fault messages.

8.10.2.4 Logging of first PERR message

The monitor shall record and make available for display the source address of the first PERR message received since the last of a manual start or a manual error reset.

8.10.3 Implementation of logging station functions

The monitor may implement the error reporting functions of a logging station specified in clause 9. In such cases, the error reporting functions shall be additional to the monitor functions specified in this clause, and shall not cause any requirement of this clause to be contravened.

9 Specification for logging station

9.1 Compliance

9.1.1 Condition as supplied

The product shall be supplied in such condition that when physically installed, and connected to the ring, it complies with the requirements of this clause of this part of ISO 8802.

NOTE 128 The product is not precluded from complying with specifications that differ from this clause, provided that it can be set to a mode of operation in which it complies with this clause.

9.1.2 Limitations

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

9.1.3 Options

9.1.3.1 Implementor options

The following shall be at the option of the implementor:

- a) whether the logging station is combined with a monitor or node (see clause 5);
- b) whether the logging station is Basic Class, supporting only 40-bit slots, or Enhanced Class, supporting 40-bit, 56-bit, 72-bit or 88-bit slots;
- c) whether the repeater section is Class I, II or III;
- d) whether the logging station can set the full/empty bit to EMPTY on re-output of input mini-packets addressed to the logging station;
- e) the extent and manner in which any recording of errors is carried out beyond the minimum required.

9.1.3.2 Supplier options

The following shall be at the option of the supplier:

- a) the physical form of the slave power supply unit connector (see 9.2.2);
- b) the means by which the logging station is set to the length of mini-packet in use (see 9.2.3);
- c) the means by which logged errors are presented.

9.1.3.3 Undefined actions

Wherever in a requirement an action of the logging station is stated to be undefined, the action may be any chosen by the implementor that does not conflict with any other requirement.

9.1.4 Information to be provided by the supplier

The documentation associated with the logging station shall include the following information:

- a) the maximum continuous power supply current drawn from the ring for powering the repeater section;
- b) which of the options in 9.1.3.1 are implemented, and if more than one alternative for an option is implemented, the means by which one alternative is selected in operation;
- c) how the options in 9.1.3.2 are implemented;
- d) what error recording and analysis beyond the minimum required is implemented;

- e) if the logging station is capable of operating in a way that differs from the requirements specified in this clause (see note to 9.1.1), the means by which it is set to a mode of operation in which it complies.

9.2 Interfaces and controls

9.2.1 Ring connector plug

The logging station shall be equipped with a ring connector plug whose characteristics shall be as specified in 6.2.1, i.e. the same as a repeater.

9.2.2 Slave power supply unit connector

The logging station shall be provided with a connector for the attachment of a slave power supply unit as specified in 6.2.2, i.e. the same as a repeater.

9.2.3 Mini-packet length selector

The logging station shall be provided with a control to select the mini-packet length as specified in 7.2.

9.2.4 Error count reset controls

The logging station shall be provided with controls to permit the resetting of all error counts.

9.3 Power supply

9.3.1 Division of power supply

The repeater and station sections shall be separately powered, as specified in 9.3.2 and 9.3.3 respectively. Since neither the interface between the repeater and station sections nor the division of functions between them are standardized, the separation of power arrangements shall be correct if

- a) when the logging station is attached to a powered up ring but is itself not powered up, it satisfies the requirements of 9.4, 9.5 and 9.6.1.1;
- b) when the logging station is powered up and connected to the ring, the power from the ring consumed by the logging station does not exceed that specified in 6.3.

9.3.2 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.

9.3.3 Station section

The power arrangements for the station section of a logging station are not standardized.

9.4 Production of output

The logging station shall satisfy the requirements in 6.4 for power-up condition, waveform and coding of output to the ring.

9.5 Output in absence of input signal

When no input signal is presented at the ring connector, the logging station shall satisfy the requirements in 6.5 for free-running frequency and coding of output to the ring.

9.6 Output in presence of input signal

9.6.1 Coding

9.6.1.1 When station section is not powered up

The output shall reproduce the bit stream of the input.

9.6.1.2 When station section is powered up

The logging station shall modify the input stream as specified in 9.8 and 9.9.

9.6.2 Delay

9.6.2.1 General

The delay to the bit stream shall be as specified in either 9.6.2.2 or 9.6.2.3. Changes made by the logging station to values of bits in the bit stream shall change the delay.

9.6.2.2 Logging stations not setting the full/empty bit

For logging stations that do not set the full/empty bit to EMPTY on a mini-packet addressed to the logging station, the maximum delay of the output relative to the input shall not exceed 3,5 bit-periods.

9.6.2.3 Logging stations setting the full/empty bit

For logging stations that set the full/empty bit to EMPTY in a mini-packet addressed to the logging station, the maximum delay of the output relative to the input shall not exceed 15,5 bit-periods.

9.6.3 Other aspects

The logging station shall satisfy the requirements of 6.6.3 to 6.6.7 for signal capture range, low error range, sensitivity and phase locked loop characteristic.

9.7 Slot structure

9.7.1 The input bit stream shall be interpreted as a slot structure as specified in 7.7.

NOTE 129 This is the same as a node, but not the same as a monitor; a node is required to accept the slot structure as correct, a monitor to see whether it is correct. See 9.12 and 9.13 for requirements when a logging station is combined with a node or monitor.

9.7.2 The logging station shall process input mini-packets as specified in 9.8 for all slot structures with a number of slots in the range 1 to 15 and a gap of 2 to 255 bits.

9.7.3 When the number of slots exceeds 15, the requirements are reduced; the logging station may at the option of the implementer do any of the following:

- output all input mini-packets unchanged and not log any errors;
- as a), but correct parity errors (see clause 11);
- behave as specified in clause 8 (i.e. as for 15 or fewer slots).

9.7.4 When the number of gap bits exceeds 255 bits the logging station shall perform the ring break error procedure specified in clause 11.

9.7.5 Basic Class logging stations shall be capable of handling slots with 40 bit-positions (corresponding to mini-packets with two data octets). Enhanced Class logging stations shall be capable of handling slots with 40, 56, 72, and 88 bit-positions (corresponding to 2 to 8 data octets).

9.8 Processing of mini-packets

NOTE 130 This clause applies only when the logging station is powered-up (see 9.6.1).

9.8.1 Slot contents

9.8.1.1 Each slot shall be treated as containing a mini-packet formatted as specified in table 2.

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

9.8.2 Error message input mini-packets

9.8.2.1 Each input mini-packet which satisfies the following conditions shall be treated as an error message mini-packet:

- the full/empty bit is set to FULL;

- b) the destination node address is ZERO;
- c) at least one of the source node address, data octet 0 or data octet 1 is other than ZERO.

NOTE 131 Input mini-packets in which both destination and source node addresses and both data octets 0 and 1 are ZERO are, in the absence of corruption, start mini-packets, not error messages.

9.8.2.2 The contents of the source node address field and data octets 0 and 1 shall be processed as specified in clause 4.

9.8.2.3 The mini-packet shall be output as follows:

- a) the full/empty bit shall be unchanged (i.e. FULL) if the logging station fixed delay is 4 bit-periods or less;
- b) the full/empty bit shall be changed to EMPTY if the logging station fixed delay exceeds 4 bit-periods;
- c) the response bits shall be output changed in accordance with 9.10.3;
- d) the parity bit shall be set to even parity;
- e) all other bits shall be unchanged.

9.8.3 Other input mini-packets

9.8.3.1 All other input mini-packets shall be output to the ring with all bits unaltered, unless an error occurs for which clause 9 requires changes to the mini-packet.

9.8.3.2 The information contained in the address fields and data octets in mini-packets other than error message mini-packets shall not be stored or made available at any output from the logging station.

9.8.3.3 In so far as there is no conflict with the other requirements of clause 8, the logging station may, at the option of the implementor, make available to the error recording and analysis functions information regarding ring traffic.

9.9 Errors detected by logging station

9.9.1 Parity errors

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

9.9.1.2 The logging station shall record the parity error as specified in 9.10.1.

9.9.2 Extended gap

When the input from the ring contains a gap of 256 or more bits, the logging station shall send a single leader bit, at intervals of not less than 256 bits and not more than 344 bits, depending upon the current setting of the slot length.

NOTES

132 When the ring break is immediately upstream of the logging station, then there will be no input, in which case clause 5 applies.

133 When the ring break is more than two nodes upstream, the input to the logging station will appear as any combination of ring breaks, and full or empty mini-packets, with or without parity errors; additional corruption may occur due to operating frequency instability. Processing these as specified elsewhere in this section is sufficient to cause proper recovery.

9.10 Error recording

9.10.1 Error message types

9.10.1.1 The error message types shall be as specified in table 5 in clause 7.

9.10.1.2 The logging station shall record every message of type MONITOR ERROR MESSAGE and PERR MESSAGE, except as permitted in 9.11 and 9.13.

9.10.1.3 An Enhanced Class logging station shall also record messages of type BMESS and IMESS.

9.10.2 Monitor error messages

The logging station shall record the time of a monitor error message and the error count and error type flags contained in the message.

9.10.3 PERR messages

The logging station shall record the time and source address of every PERR message, except as permitted in 9.11 and 9.13.

9.10.4 BMESS messages

An Enhanced Class logging station shall record the time and source of every BMESS message, except as permitted in 9.11 and 9.13.

9.10.5 IMESS messages

An Enhanced Class logging station shall record the time and source of every IMESS message, except as permitted in 9.11 and 9.13.

9.11 Analysis of messages

9.11.1 The logging station shall record cumulative totals of monitor error messages by type of error.

9.11.2 The logging station shall record cumulative totals of PERR messages.

9.11.3 At the option of the implementor, the logging station may discard the individual records of a series of PERR messages coming from a single source at intervals of less than 400 bits, and record instead a ring break, with the time and the source node address of the node sending the PERR messages.

9.11.4 The logging station may discard all error messages of any type occurring during a ring start, restart or resynchronization, and record only the time of the start, restart or resynchronization; the start, restart or resynchronization shall be determined as starting with the first start mini-packet and ending with the first empty mini-packet.

9.11.5 The logging station may provide any further analysis chosen by the implementor, providing that the requirement of 9.8.3.2 is met.

9.12 Combination with monitor

The combined logging station and monitor shall comply with clause 8 and with the following sub-clauses

- a) 9.1, except for 9.1.3.1 c);
- b) 9.2;
- c) 9.8 except for 9.8.2.3 and 9.8.3 which shall apply only when the monitor is not required to output a different mini-packets from those input;
- d) 9.9;
- e) 9.10 and 9.11.

9.13 Combination with node

The logging station functions may be provided by a node implementing error message reception functions plus error message analysis and logging functions in the DTE attached to a node. In this case

- a) the logging station shall satisfy all the requirements of clause 7 for nodes with error message reception functions;

NOTE 134 Accordingly, the logging station can have only a 3,5 bit delay and cannot set the full/empty bit to EMPTY in error messages.

- b) the logging station shall satisfy the requirements of clause 10 and clause 11, except that where it specifies that every error of a type is recorded, error messages arriving at the node while in the BUSY state shall not be recorded, and error messages arriving while the DTE is in the process of receiving a frame need not be recorded.

10 Specification for slave power supplies

10.1 Compliance

10.1.1 Complying products

10.1.1.1 Any product that meets the requirements in this clause may be claimed to comply, whether or not it is designed specifically as an SR-LAN slave power supply unit.

10.1.1.2 Any claims to compliance made other than in the context of SR-LAN shall make it clear that the requirements met are those for powering an SR-LAN.

NOTE 135 This is to avoid confusion with other standards which cover more general aspects excluded from this part of ISO 8802.

10.1.2 Implementor options

The following shall be at the option of the implementor:

- a) the maximum rated current;
- b) combination of the slave power supply unit with another SR-LAN device (see 10.6).

10.1.3 Information to be provided by the supplier

10.1.3.1 Marking

The supplier shall provide the following information on a plate or label attached to the slave power supply unit:

- a) the type of external power supply from which the slave supply unit is designed to draw its input power;
- b) the voltage or range of voltages over which the unit can work;
- c) the maximum power consumption for the worst-case combination of input voltage and output load;
- d) the maximum output current.

10.1.3.2 Information in associated documentation

The following information shall be included in the documentation associated with the product:

- a) the information specified in 10.1.3.1;
- b) the means of connection to the ring, if the slave power supply unit is not combined with another device attached to the ring.

10.2 Power rating

10.2.1 The slave supply shall provide a voltage of between 27 V and 28 V d.c. for any current drawn by the load up to the rated maximum specified by the supplier. That rated maximum shall be at least 0,8 A and at most 1,5 A.

10.2.2 When the output from the slave power supply is short-circuited, the current shall not exceed 2 A and the unit shall not suffer damage.

NOTE 136 This may be achieved by current-limiting techniques or by automatic removal of power when a fault is detected.

10.2.3 The slave power supply unit shall not suffer damage if when connected in parallel with other power supplies the voltage at the output exceeds that of the slave supply unit, provided that the voltage is less than 35 V d.c.

10.3 a.c. component of output

The a.c. component of the output shall not exceed the following values for any d.c. output in the range 27 V to 28 V and 0 A to 1,5 A:

- a) 0,1 V r.m.s. at 50, 60, 100 or 120 Hz;
- b) 0,01 V r.m.s. at any higher frequency.

10.4 Control of output

The power output to the ring shall be automatically controlled by the voltage between the ring positive lines and the control voltage return line (V_{sig}).

Power shall be switched on when the control voltage exceeds 21 V d.c., and switched off when the control voltage falls below 21 V d.c., in each case within a tolerance of 10 %.

The voltage detector shall not put a back e.m.f. in excess of 1 V between the ring positive and control return lines.

10.5 Connection to ring

10.5.1 General

The slave power supply shall be equipped with a cable for connection to a repeater, as specified in 10.5.2.

10.5.2 Connection to repeater

10.5.2.1 The following circuits shall be provided:

- a) ring positive power supply;
- b) ring negative power supply;
- c) ring control voltage return.

None of these circuits shall be connected to local ground.

10.5.2.2 The form of the connector shall be such that it cannot be mated with any of the following:

- a) the 15-way ring connector pin contact plug or socket;
- b) the 50-way node interface plug or socket.

10.5.2.3 The lines at the free end of the cable shall be clearly marked, so as to enable easy fitting or replacement of the connector.

10.6 Combination with other devices

10.6.1 A slave power supply unit may be combined with any of the following devices:

- a) a free-standing repeater;
- b) a node;
- c) a monitor;
- d) a logging station.

10.6.2 In such cases the combined device shall

- a) satisfy all the requirements in this clause, except 10.5;
- b) satisfy all the requirements in the clauses specifying the device with which the slave power supply is combined, except that a connector for attachment of an external slave power supply is not required, and the power transfer requirements from that connector to the ring shall apply to power transfer from the internal slave power supply unit to the ring.

11 Specification for media access control procedures for data terminal equipment

11.1 Notation

Table 11 to table 15 specify the notation used for node interface lines, registers, register data fields, times and lengths respectively.

11.2 Media access control service

The media access control service is an unconfirmed service.

NOTE 137 This section is the subject of a new work item. When a MAC Service Definition common to all of the ISO 8802 documents is published, this clause will be replaced by a reference to that document.

Table 11 — Notation for node interface lines

Notation	Type	Name
A0:P to A3:P	register address lines	ADDRESS LINE 0 to 3
ACK:N	control line	READ OR WRITE ACKNOWLEDGE
●:P to D7:P	register data lines	DATA LINE 0 to 7
RD:N	control line	READ STROBE
RDN:N	control line	RECEIVE DONE
RINT:N	control line	BROADCAST OR ERROR MINI-PACKET RECEIVED
RTPA:N	control line	RECEIVED TYPE BIT A
RTPB:N	control line	RECEIVED TYPE BIT B
TCLK:N	control line	TRANSMISSION CLOCK
TDN:N	control line	TRANSMISSION DONE
TER:N	control line	TRANSMISSION ERROR
TEST:N	control line	ENABLE OVERRIDE
WT:N	control line	WRITE STROBE

Table 12 — Notation for read and write registers

Notation	Type	Name
NODE	read register	LOCAL NODE ADDRESS
RSUMCLR	write register	RECEIVER CHECKSUM CLEAR
Rx.B	read register	READ OCTET
Rx.BG	read register	READ OCTET AND CLEAR BUSY
Rx.CR	write register	RECEIVER AND NODE CONTROL
Rx.G	read register	CLEAR BUSY
Rx.SR	read register	RECEIVE STATUS REGISTER
Rx.SRC	read register	SOURCE NODE
Rx.SUM	read register	RECEIVER CHECKSUM
SSR	read/write register	SOURCE SELECTOR
TSUMCLR	write register	TRANSMITTER CHECKSUM CLEAR
Tx.B	write register	TRANSMIT DATA OCTET
Tx.BG	write register	TRANSMIT DATA OCTET AND GO
Tx.DST	write register	DESTINATION NODE
Tx.G	write register	TRANSMIT GO
Tx.SR	read register	TRANSMISSION STATUS REGISTER
Tx.SUM	read register	TRANSMITTER CHECKSUM
XCR	write register	EXTENDED CONTROL REGISTER
XSR	read register	EXTENDED STATUS REGISTER

Table 13 — Notation for register data fields

Notation	Name	Used in
AOK	ALL SET UP	XSR
BCE	BROADCAST RECEPTION ENABLE	Rx.SR/CR
BPR	BROADCAST MINI-PACKET RECEIVED	Rx.SR
CTP	CONTROL TYPE RECEPTION	XCR
L0 to L3	MINI-PACKET LENGTH	XSR
LGE	LOG RECEPTION CONTROL	Rx.CR
LOG	ERROR MESSAGE MINI-PACKET RECEIVED	Rx.SR
MTPA	TYPE BIT A MASK	XCR
TPB	TYPE BIT B MASK	XCR
NEN	NODE ENABLE	Rx.SR/CR
RDN	RECEIVE DONE	Rx.SR
RON	RING ON	XSR
ROT	REJECT ON TYPE	XCR
RRJ	RECEIVE REJECT	Rx.SR
RRST	RECEIVER RESET	Rx.CR
RSS	REJECT SELECTED SOURCE	Rx.SR/CR
RTPA	RECEIVED TYPE BIT A	XSR
RTPB	RECEIVED TYPE BIT B	XSR
RTRY	AUTO-RETRY ENABLE	Rx.SR/CR
TAC	TRANSMISSION RESPONSE - ACCEPTED	Tx.SR
TBY	TRANSMISSION RESPONSE - BUSY	Tx.SR
TCE	TRANSMISSION COMPARISON ERROR	Tx.SR
TDN	TRANSMISSION DONE	Tx.SR
TER	TRANSMISSION ERROR	Tx.SR
TIG	TRANSMISSION RESPONSE - IGNORED	Tx.SR
TRST	TRANSMITTER RESET	Rx.CR
TTPA	TRANSMIT TYPE BIT A	XCR
TTPB	TRANSMIT TYPE BIT B	XCR
TUS	TRANSMISSION RESPONSE - NOT SELECTED	Tx.SR

Table 14 — Notation for times

Notation	Name
T(1)	Transmit next mini-packet maximum delay
T(2)	First mini-packet retry persistence
T(3)	Frame control mini-packet retry persistence
T(4)	Subsequent mini-packets retry persistence
T(5)	Whole frame transmit time
T(6)	Set READY: maximum delay on control part of frame
T(7)	Minimum mini-packet waiting time
T(8)	Whole frame minimum waiting time
T(9)	Clear busy maximum delay on subsequent mini-packets

Table 15 — Notation for lengths

Notation	Name
S	Data field length indicator
M	Number of data octets in mini-packet

11.2.1 Media access control service access points (MAC-SAPs)

11.2.1.1 Function

The media access control service access points shall be the one or more abstract access points through which the MAC service is provided to the MAC service user or users.

11.2.1.2 MAC addresses

11.2.1.2.1 Just one MAC address shall be associated with each MAC-SAP.

11.2.1.2.2 Each MAC address shall be either 16 or 48 bits long.

NOTE 138 Where there is more than one MAC-SAP in a DTE, it is not necessary that the same length of MAC address is in each, though this will normally be the case and may be enforced by the DTE or required by the higher layer protocols.

11.2.2 Media Access Control Service Unitdata (MA-UNITDATA)

11.2.2.1 Primitives

NOTE 139 Figure 2 shows the sequence of primitives.

11.2.2.1.1 MA-UNITDATA request

11.2.2.1.1.1 An MA-UNITDATA request shall be the primitive, generated by the MAC service user at a MAC-SAP that:

- a) if the destination MAC-SAP is in a remote DTE, requests the transmission of a single frame;
- b) if the destination MAC-SAP is in the local DTE, requests either the transmission of a frame via the SR-LAN back to the local DTE or the direct production of a MA-UNITDATA indication without frame transmission.

11.2.2.1.1.2 The parameters of the MA-UNITDATA request shall be

- a) the destination MAC address;
- b) the source MAC address;
- c) data field comprising 1 to 65 536 octets of transparently conveyed data;
- d) requested service class (see 11.3.2.4).

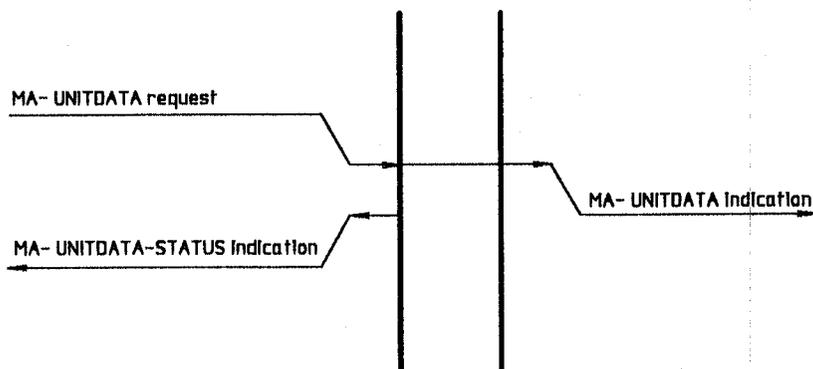


Figure 2 — MAC Service Primitive exchange sequence

11.2.2.1.2 MA-UNITDATA indication

11.2.2.1.2.1 An MA-UNITDATA indication shall be the primitive that notifies the MAC service user at the destination MAC-SAP of the reception of a frame or an MA-UNITDATA request from another MAC-SAP in the local DTE.

11.2.2.1.2.2 The parameters of the MA-UNITDATA indication shall be

- a) the destination MAC address;
- b) the source MAC address;
- c) data field comprising 1 to 65 536 octets of transparently conveyed data;
- d) requested service class (see 11.3.2.4).

11.2.2.2 Parameters

11.2.2.2.1 Destination MAC address parameter

The destination MAC address shall be the MAC address that identifies the MAC-SAP to which delivery of the data in the data field is requested by the MAC service user.

NOTE 140 This MAC protocol requires that the length of the destination MAC address (16 or 48 bits) is the same as the MAC address assigned to the MAC-SAP that is the source of the MA-UNITDATA request [see 11.3.2.3.1 g)], unless both source and destination MAC-SAPs are in the local DTE, in which case they may differ.

11.2.2.2.2 Source MAC address parameter

The source MAC address shall be the source MAC address contained in the same frame as that in which the data field was received.

NOTE 141 Since this protocol requires that the destination and source MAC addresses in a frame be delivered to the local MAC-SAP which has an address equal in

length to the destination MAC address in the frame, the source MAC address will have the same length as the local MAC-SAP, unless both source and destination MAC-SAPs are in the local DTE, in which case it is possible that the lengths differ.

11.2.2.2.3 Data field parameter

The data field shall be the string of octets, of length 1 to 65 536 octets, that represents the higher level protocol data unit (or multiples or fragments thereof) sent in a frame, unless both source and destination MAC-SAPs are in the local DTE, in which case the data field parameter in an MA-UNITDATA indication may be derived directly from that in the MA-UNITDATA request without frame transmission.

11.3 Media Access Control Unitdata Status Reporting Service

NOTE 142 The MAC unitdata status reporting service is not an essential part of the unconfirmed MAC service. It is a service offered by the MAC provider. The MAC service user is not obliged to use it. Furthermore it is not specified how the MAC service user, uses the status information.

11.3.1 Primitive

11.3.1.1 MA-UNITDATA-STATUS indication

11.3.1.1.1 An MA-UNITDATA-STATUS indication shall be the primitive that

- a) if the destination MAC-SAP is in a remote DTE, notifies the MAC service user issuing the MA-UNITDATA request the result of frame transmission as seen by the local node;
- b) if the destination MAC-SAP is in the local DTE and the means of actioning the MA-UNITDATA request is transmission of a frame via the SR-LAN, the result of frame transmission as seen by the local node acting as transmitter;

c) if the destination MAC-SAP is in the local DTE and the means of actioning the MA-UNITDATA request is direct issue of an MA-UNITDATA indication, whether or not the MA-UNITDATA indication could be produced.

11.3.1.1.2 The parameters of the MA-UNIT-DATA-STATUS indication shall be

- a) transmission status (see 11.3.2.1);
- b) provided service class (see 11.3.2.4).

11.3.2 Parameters

11.3.2.1 Transmission status parameter

In the case of a slotted ring local area network, the transmission status parameter shall consist of two sub-parameters, the local response sub-parameter and the ring status sub-parameter. These are specified in 11.3.2.2 and 11.3.2.3 respectively.

11.3.2.2 Local response parameter

The local response parameter shall be NOT TRANSMITTED if the frame has been discarded by the local DTE, or no MA-UNITDATA indication has been produced when the destination MAC-SAP is in the local DTE; otherwise it shall be TRANSMITTED.

NOTE 143 The rules for frame transmission and reception are such that if the local response is NOT TRANSMITTED the complete frame in uncorrupted form cannot have been received by the destination DTE; there is a very small probability that a truncated and corrupted version has been accepted by the destination DTE as correct. However, the local response TRANSMITTED can occur when the destination DTE has discarded the frame, and will always occur where transmission failure occurs on the last mini-packet in the frame. Accordingly, loss of a frame with local response TRANSMITTED may occur, but retransmission of a frame with local response NOT TRANSMITTED will not cause duplication of the frame.

11.3.2.3 Ring status parameter

11.3.2.3.1 The value of the ring status parameter shall depend on the conditions under which the transmission ceased, as follows:

- a) if the last mini-packet for which a transmit command was issued was the last in the series representing a frame, the response was ACCEPTED, and no transmission comparison error was detected, the parameter value shall be ACCEPTED;
- b) if the last mini-packet for which a transmit command was issued was any other than the first in the series representing a frame, the response

was NOT SELECTED, and no transmission comparison error was detected, the parameter value shall be NOT SELECTED;

- c) if the last mini-packet for which a transmit command was issued was any in the series representing a frame, the response was IGNORED, and no transmission comparison error was detected, the parameter value shall be IGNORED;
- d) if the last mini-packet for which a transmit command was issued was any in the series representing a frame and the response was either TRANSMIT COMPARISON ERROR or could not be determined, the parameter value shall be ERROR;
- e) if transmission ceased because of expiry of a timer in the local DTE, the parameter value shall be TOO LONG;
- f) if transmission ceased, or did not start, because the node or ring was not operable, the parameter value shall be RING INOPERABLE;
- g) if the destination MAC address is unknown or not equal in length to the MAC address of the local MAC-SAP through which the MA-UNITDATA request was received, the parameter value shall be BAD ADDRESS.

11.3.2.3.2 Where more than one value is applicable, the value shall be any one of the applicable values.

NOTE 144 In particular, more than one value is applicable when any of the conditions a) to d) of 11.3.2.3.1 occur within the tolerance of the times specified for TOO LONG.

11.3.2.3.3 If both source and destination MAC-SAPs are in the local DTE and no frame is transmitted via the SR-LAN, the response shall be as follows:

- a) ACCEPTED if a MA-UNITDATA indication is produced;
- b) BAD ADDRESS if the source and destination MAC addresses differ in length and the destination MAC-SAP cannot support differing lengths;
- c) NOT SELECTED otherwise.

11.3.2.4 Provided service class parameter

The provided service class specifies the class that was provided for the frame transfer.

NOTE 145 The SR-LAN MAC protocol provides a single quality of service.

11.3.3 Means of associating indication with request

There shall be a means of associating a MA-UNITDATA-STATUS indication with the MA-UNITDATA request to which it applies.

NOTES

146 Where only one MA-UNITDATA request can be awaiting a status report at one time, the association may be adequately provided by sequence; otherwise some form of identification will be required.

147 The MAC service user is not obliged to wait for the MA-UNITDATA-STATUS indication (see figure 2).

11.4 Transmission frame format

11.4.1 Syntax

11.4.1.1 Relationship of syntax to MAC address length

Each frame transmitted shall have one of the following syntaxes:

- a) the syntax specified in 11.4.1.2 for frames which contain 16-bit MAC addresses and which are transmitted in response to a MA-UNITDATA request from a MAC-SAP with a 16-bit MAC address;
- b) the syntax specified in 11.4.1.3 for frames which contain 48-bit MAC addresses and which are transmitted in response to a MA-UNITDATA request from a MAC-SAP with a 48-bit MAC address.

NOTE 148 The syntax differs only in the number of bits assigned to the destination and source MAC addresses and in the value of the second header octet that distinguishes between the two versions.

11.4.1.2 Syntax for frames with 16-bit MAC addresses

The frame shall comprise the following octets in the sequence given:

- a) a 2-octet **header**, of which the earlier octet shall be 1001 1100 and the later shall be 1001 1100;
- b) a 2-octet **length indicator** representing an integer (see 11.4.2) in the range 0 to 65 535 whose value S is one less than the number of octets represented by the data field of the MA-UNITDATA request;
- c) a 2-octet **destination MAC address** represented by the destination MAC address parameter of the MA-UNITDATA request, with the high-order 8 bits of the represented address forming the earlier octet in the frame;

- d) a 2-octet **source MAC address** that is the MAC address associated with the MAC-SAP through which the MA-UNITDATA request was received, with the high-order 8 bits of that address forming the earlier octet in the frame;
- e) the 1 to 65 536 **data octet** represented by the data field parameter of the MA-UNITDATA request, in the same sequence, with first octet of the represented data field coming earliest in the frame;
- f) if and only if the number of data octets is odd, a single **padding octet** of arbitrary value;
- g) a 2-octet **checksum** representing an integer (see 11.4.2) in the range 1 to 65 535 whose value is congruent to the sum, taken modulo 65 535, of all the preceding octet pairs in the frame, each taken as a 2-octet integer.

NOTES

149 Although the value of the padding octet is arbitrarily chosen, the definition in g) requires that the chosen value is used in the calculation of the checksum.

150 The formula for the checksum is equivalent to adding each octet pair prior to the checksum into a 16-bit register with end-around carry, where the initial value is zero and the final value forms the checksum. (With end-around carry, each overflow causes a loss of 65 536 at the high-order end and a gain of 1 at the low-order end, corresponding to reduction modulo 65 535.)

151 With Enhanced Class nodes, registers TSUMCLR and Tx.SUM provide a means of obtaining the checksum value from the node.

11.4.1.3 Syntax for frames with 48-bit MAC addresses

The frame shall comprise the following octets in the sequence given:

- a) a 2-octet **header**, of which the earlier octet shall be 1001 1100 and the later shall be 1001 1101;
- b) a 2-octet **length indicator** as specified in 11.4.1.2 b);
- c) a 6-octet **destination MAC address** represented by the destination MAC address parameter of the MA-UNITDATA request, with the high-order 8 bits of the address forming the earliest of the address octets in the frame, and with each subsequent 8 bits forming the next octet in sequence;
- d) the 6-octet **source MAC address** that is the MAC address associated with the MAC-SAP through which the MA-UNITDATA request was received, with the high-order 8 bits of the address forming the earliest of the address octets in the frame,

and with each subsequent 8 bits forming the next octet in sequence;

- e) the 1 to 65 536 **data octets** as specified in 11.4.1.2 e);
- f) if and only if the number of data octets is odd, a **single padding** octet of arbitrary value;
- g) a 2-octet **checksum** as specified in 11.4.1.2 g).

11.4.2 Representation of integers

In each octet pair that represents an integer, and in every octet pair when taken as an integer for the purposes of the checksum, the earlier octet shall be the high-order octet and the later octet the low order octet. The two octets together shall represent an unsigned positive binary integer, whose value lies in the range 0 to 65 535.

NOTE 152 The value of any given octet pair may be further restricted.

11.4.3 Bit sequence

11.4.3.1 In the header octets, the bits shall be in sequence with the leftmost bit of the value as specified in 11.4.1.2 a) and 11.4.1.3 a) as bit 7 of the frame octet and the rightmost bit as bit 0.

11.4.3.2 In octets that represent part of an integer, and in other octets taken as representing part of an integer for the purposes of the checksum, the bits shall be in sequence with the most significant bit in the octet as bit 7 and the least significant bit as bit 0.

11.4.3.3 In octets representing 8 bits of a MAC address, bits shall be in the same sequence with the most significant of the 8 address bits as bit 7 of the frame octet.

11.4.3.4 In the octets representing a data field octet, the bits shall be in the same sequence with the most significant bit of the data field octet as bit 7 of the frame octet.

11.5 Procedure for transmission of frames

11.5.1 General

For each MA-UNITDATA request received for which the destination MAC-SAP is in a remote DTE, one frame shall be transmitted, unless discarding is specified by any requirement in this clause. If the destination MAC-SAP is in the local DTE and the means of actioning the MA-UNITDATA request is transmission of a frame via the SR-LAN back to the local DTE, the requirements shall be as for transmission to a remote DTE.

11.5.2 Determination of destination node address

11.5.2.1 The destination node address shall be an integer in the range 1 to 254, determined from the destination MAC address.

11.5.2.2 The frame shall be discarded if either of the following apply:

a) if the destination MAC address is not the same length as the MAC address associated with the MAC-SAP at which the MA-UNITDATA request was received, unless the destination MAC address is that of a MAC-SAP in the local DTE, in which case either the frame shall be discarded or a MA-UNITDATA indication shall be issued at the destination MAC-SAP without transmission of the frame via the SR-LAN;

b) if the means of determining the destination node address yields either no value or a value not in the range 1 to 254.

11.5.2.3 If the frame is discarded for any of the above reasons, the MA-UNITDATA-STATUS indication local response parameter shall be NOT TRANSMITTED and the ring status parameter BAD ADDRESS.

11.5.3 Mapping of frame on to logical mini-packets

11.5.3.1 Logical mini-packet contents

Each frame shall be mapped on to a series of logical mini-packets each of which comprises a destination node address, two to eight mini-packet data octets, and two type bits.

NOTE 153 The physical mini-packets as transmitted round the ring contain further elements that are generated by the SR-LAN components; neither these nor the format of the physical mini-packet as a whole are visible to the DTE. Returning physical mini-packets contain a response which taken together with node error detection determine the transmission result visible to the DTE.

11.5.3.2 Destination node address

Each logical mini-packet in the series shall have the same destination node address. This node address shall be that corresponding to the destination MAC address in the MA-UNITDATA request (see 11.5.2).

11.5.3.3 Data octets

11.5.3.3.1 The number of data octets, M, in each logical mini-packet shall be the same. This number shall be 2, 4, 6 or 8, whichever is the currently set value for the DTE.

NOTES

154 The number of data octets in both logical and physical mini-packets is a static parameter of an SR-LAN; where it can be changed, it can only be changed while the ring is non-operational.

155 A DTE may be permanently set to a single length or may be capable of being set to any length; in the latter case, the length may be statically set through DTE configuration or dynamically through DTE examination of the mini-packet length field of the node/DTE interface register XSR (see 11.14.2.9).

156 The data octets in a logical mini-packet are numbered from 0 to $(M - 1)$.

11.5.3.3.2 Where M is the number of data octets in a logical mini-packet, the first M octets of the frame shall be the data octets in the first logical mini-packet of the series representing the frame, the next M octets in the second logical mini-packet, and so on until the frame is complete; if the number of octets in a frame is not an exact multiple of m , only the last logical mini-packet in the series shall have less than M frame octets.

11.5.3.3.3 In each logical mini-packet, the octets shall be in the same sequence as in the frame, with the earliest of the frame octets as logical mini-packet data octet 0.

11.5.3.3.4 If the number of octets in the frame is not an exact multiple of the number of data octets in the mini-packets, the value of the data octets following the end of the frame in the last mini-packet shall be arbitrary.

11.5.3.4 Type bits

The first logical mini-packet of the series, containing the frame header octets, shall have the type bits set with type bit A as ZERO, and type bit B as ONE. All other logical mini-packets shall have both type bits set to ZERO.

11.5.4 Procedure

11.5.4.1 The series of logical mini-packets shall be transmitted sequentially from first to last, with or without retransmission of each logical mini-packet, until either all logical mini-packets in the series have been transmitted or the frame is discarded.

11.5.4.2 The decision to retransmit the same logical mini-packet, transmit the next logical mini-packet in the frame, or to cease transmission of the frame (either by regarding the transmission of the frame as completed or by discarding an incomplete frame) shall be made on the basis of the result of the previous transmission, as specified in 11.5.5.

11.5.4.3 Between the transmission of one logical mini-packet and the next, or between retransmissions of the same logical mini-packet, logical mini-packets which are not part of the series may be transmitted, provided that they have different destination node addresses, and provided that the timings specified in this clause are satisfied.

NOTE 157 In particular, when the DTE is waiting to send more than one frame to different destination nodes, it is recommended that while responses of BUSY or NOT SELECTED are received for the first logical mini-packet in one frame attempts to send other frames should be interleaved.

11.5.4.4 Once the frame has been transmitted completely or has been discarded, no further transmission of the whole or any part of the frame shall be made in response to the MA-UNITDATA request that initiated transmission.

NOTE 158 As part of the higher level protocols, further MA-UNITDATA requests may be made that cause retransmission of data that is not acknowledged by the recipient.

11.5.4.5 Once the frame has been transmitted completely or has been discarded, a MA-UNITDATA-STATUS indication primitive shall be issued as specified in 11.3.1.

11.5.5 Progression through frame

11.5.5.1 The DTE shall begin the progression through the frame by transferring to the node the contents for the first logical mini-packet in the series representing the frame and commanding its transmission. Subsequent actions shall be as specified in 11.5.5.2 to 11.5.5.5, so long as the ring is operational and a response is received from the local node. If at any stage the ring becomes inoperable or no response is received from the node, the frame shall be discarded.

11.5.5.2 The actions following the transmission of the first logical mini-packet shall be as follows:

- a) on a response of ACCEPTED the DTE shall transmit the next logical mini-packet within time $T(1)$;
- b) on a response of IGNORED or TRANSMIT COMPARISON ERROR the DTE shall discard the frame;
- c) on a response of BUSY or NOT SELECTED, the DTE shall retransmit the logical mini-packet;
- d) retransmission shall continue until a) or b) occur, or until at least 19 retransmissions have occurred, the last of which was at least time $T(2)$ after the first transmission; thereafter the frame

shall be discarded unless continued retransmission is enabled as specified in 11.5.7;

NOTE 159 If the DTE uses auto-retry on busy and does not use TCLK:N, the DTE will not know how many times retransmission has occurred when a response of BUSY is received; however, the timings are such that in the worst possible case (with maximum size ring and maximum congestion) more than 20 transmissions will have occurred before time-out.

- e) when discarding occurs, the local response parameter of the MA-UNITDATA-STATUS indication shall be NOT TRANSMITTED.

11.5.5.3 The actions following the transmission of the logical mini-packets, if any, that satisfy each of the conditions a) to c) shall be as specified in a) to d):

Conditions

- a) The logical mini-packet is not the first in the frame.
- b) The logical mini-packet contains any frame octet prior to the first octet of the data field or is the logical mini-packet immediately following one containing such octets.
- c) The logical mini-packet does not contain the frame checksum octets (i.e. is not the last logical mini-packet in the series representing a complete frame).

Actions

- a) On a response of ACCEPTED the DTE shall transmit the next logical mini-packet within time T(1).
- b) On a response of BUSY the DTE shall retransmit the logical mini-packet. For a continued response of BUSY, the DTE shall continue retransmission during time T(3); thereafter the frame shall be discarded unless continued retransmission is enabled as specified in 11.5.7.
- c) For any other response the frame shall be discarded.
- d) When discarding occurs, the local response parameter of the MA-UNITDATA-STATUS indication shall be NOT TRANSMITTED.

11.5.5.4 The actions following the transmission of the logical mini-packets, if any, that satisfy both of the conditions a) and b) shall be as specified in a) to e):

Conditions

- a) The logical mini-packet contains only octets from the frame data field.
- b) The logical mini-packet is not one immediately following a logical mini-packet containing any frame octets prior to the beginning of the frame data field [see 11.5.5.3 b)].

Actions

- a) On a response of ACCEPTED the DTE shall transmit the next logical mini-packet within time T(1).
- b) On a response of BUSY the DTE shall retransmit the logical mini-packet. For a continued response of BUSY, the DTE shall continue retransmission during time T(4); thereafter the frame shall be discarded unless continued retransmission is enabled as specified in 11.5.7.
- c) For any other response the frame shall be discarded.
- d) If from the time of the last transmission of the first mini-packet the elapsed time exceeds T(5), the frame shall be discarded unless continued transmission is enabled as specified in 11.5.7.
- e) When discarding occurs, the local response parameter of the MA-UNITDATA-STATUS indication shall be NOT TRANSMITTED.

11.5.5.5 The action following the transmission of the logical mini-packet that contains the frame checksum shall be as follows:

- a) Unless b) applies, on a response of BUSY the DTE shall retransmit the mini-packet. For a continued response of BUSY, the DTE shall continue retransmission during time T(4); thereafter transmission of the frame shall cease unless continued retransmission is enabled as specified in 11.5.7.
- b) For any response other than BUSY transmission shall cease.
- c) When transmission ceases, the local response parameter of the MA-UNITDATA-STATUS indication shall be TRANSMITTED.

11.5.6 Times

11.5.6.1 General

The values of the times given in 11.5.5 shall be as specified in 11.5.6.2 to 11.5.6.6. The times given in 11.5.6.2 to 11.5.6.6 are, in several cases, specified as a range rather than a specific value. In such

cases, the time being specified shall have a nominal value set at the midpoint of the range, with the range specified allowing for a tolerance of $\pm 30\%$ from this nominal value. The arithmetic has been done and a range specified to avoid potential ambiguities on the application of the tolerances.

NOTE 160 The times are those required to determine communication failure and to prevent the remote DTE from determining communication failure; they are not those necessary to provide any given level of throughput.

11.5.6.2 T(1): Transmit next mini-packet maximum delay

T(1) shall be a maximum of 13 ms, measured from the time that the node sets TDN:N active.

11.5.6.3 T(2): First mini-packet retry persistence

The default value of T(2) shall be between 840 ms and 1560 ms, measured from the time that the DTE issues the first transmit command for the first mini-packet; in environments where frames with data fields longer than 4096 octets are common, proportionately greater times may be set by the user.

11.5.6.4 T(3): Frame control mini-packet retry persistence

T(3) shall be between 42 ms and 78 ms, measured from the time that the DTE issues the first transmit command for each mini-packet that meets the conditions in 11.5.5.3.

11.5.6.5 T(4): Subsequent mini-packets retry persistence

T(4) shall be between 14 ms and 26 ms, measured from the time that the DTE issues the first transmit command for each mini-packet that meets the conditions in 11.5.5.4.

11.5.6.6 T(5): Whole frame transmit time

T(5) shall be between 280 ms and 520 ms, measured from the time that the DTE receives an ACCEPTED response for the first mini-packet, for frames with less than 4096 data octets; and proportionately longer for longer frames.

11.5.7 Extended transmission

Optionally, transmission may continue after the expiry of times T(2) to T(5), as follows:

- a) transmission may be extended automatically if no further frame is awaiting transmission; in this case, extended transmission shall cease not later than the time when such extended transmission would cause delay to the awaiting frame;

- b) extended transmission may be a facility under the control of site management; in this case, the conditions under which it is terminated are not specified.

11.5.8 Interleaving

11.5.8.1 Frame multiplexing

More than one frame may be transmitted at one time by interleaving the logical mini-packets representing the different frames, providing that the destination node address for each frame is different.

NOTE 161 In particular, the interleaving of transmission of the first mini-packet of different frames to different destination nodes is recommended when more than one frame is awaiting transmission and initial attempts to send the first frame are unsuccessful.

11.5.8.2 Other protocols

11.5.8.2.1 During the transmission of a MAC frame, from the time that the response to the first logical mini-packet is ACCEPTED until transmission of the frame ceases (whether complete or discarded), mini-packets forming part of other protocols (including broadcast mini-packets) may be transmitted, provided that one or both of a) or b) apply:

- a) the destination node address is not the same as that in the logical mini-packets representing the frame;
- b) type bit A is ONE.

11.5.8.2.2 While no MAC frame is being transmitted or while no response of ACCEPTED has been received for the first logical mini-packet in a frame, logical mini-packets forming part of other protocols may be transmitted, provided that the first or only logical mini-packet in a protocol data unit does not have Type bit A set to ZERO, Type bit B set to ONE, and data octets 0 and 1 set to the values for a MAC frame header.

11.6 Method of transmitting logical mini-packets

11.6.1 Actions

11.6.1.1 General

When required to transmit a mini-packet as specified in 11.5, the DTE shall perform the actions in 11.6.1.2 to 11.6.1.5.

NOTES

162 In order to perform these actions, node management operations such as enablement may be necessary. These do not form part of the procedures specified here.

163 Clause 7 provides a detailed specification of the node/DTE interface functions used in these actions.

11.6.1.2 Write destination address

11.6.1.2.1 The DTE shall write the destination address by using write register 1 (Tx.DST).

11.6.1.2.2 If the destination is the same as that last set since enablement, this action may be omitted.

11.6.1.3 Write type bits

11.6.1.3.1 The DTE shall write the type bits by using write register 8 (XSR), fields TTPA and TTPB.

11.6.1.3.2 If the setting of the type bits is the same as that last set since enablement, this action may be omitted.

11.6.1.4 Write mini-packet data octet

11.6.1.4.1 The DTE shall write the mini-packet data octets by using write register 5 or 6 (Tx.B or Tx.BG respectively). The sequence in which the octets are written to the node shall be any that according to the specification of Tx.B and Tx.BG produces the correct assignment.

NOTE 164 Tx.BG also acts as a transmit command when used to write the highest numbered data octet of a mini-packet, see 11.6.1.5.

11.6.1.4.2 This action may be omitted for any octet that has a value that is either the same as the previously written value for that numbered mini-packet data octet or is one of the arbitrary valued octets following the end of a frame.

NOTE 165 Where the checksum calculating facility of an Enhanced Class node is being used, it is essential that each of the frame octets is written once and once only, i.e. it is essential that the octets are not rewritten when a mini-packet is retransmitted, and that each octet of a string of repeated values in a frame is written, the only exception being octet pairs comprising all ONE bits or all ZERO bits, since these do not affect the final checksum value.

11.6.1.5 Transmit mini-packet

The DTE shall cause the node to transmit the mini-packet either by using write register 7 (Tx.G) or by using Tx.BG to write the highest numbered data octet of a mini-packet (see 11.6.1.4).

11.6.2 Interrelationship between actions

11.6.2.1 Sequence

The actions may be performed in any order, and writing destination node address and type bits, as well as any other actions to determine the response to a previous mini-packet, receive a mini-packet or set node management functions, may be interleaved between writing successive data octets, providing that the following constraints are observed:

- a) transmit mini-packet shall be the last of the actions in 11.6.1.2 to 11.6.1.4;
- b) the actions to transmit or retransmit one mini-packet shall not be interleaved with any actions to transmit or retransmit another mini-packet, or a node disable command.

11.6.2.2 Repetition of actions

Any action other than TRANSMIT MINI-PACKET may be repeated; in each case, the last occurrence of the action shall write the values required for the transmitted mini-packet. See note to 11.6.1.4.2.

11.6.3 Retransmission

Where retransmission of a mini-packet is required by 11.5, the DTE shall act as follows:

- a) retransmission on NOT SELECTED: the mini-packet shall again be transmitted as specified in 11.6;

NOTE 166 Only the first mini-packet in a frame is retransmitted on NOT SELECTED.

- b) retransmission on BUSY: if the AUTO-RETRY ON BUSY control is currently set to ON by the DTE (RTRY of Rx.SR and Rx. CR, see 11.14.2.5 and 11.15.2.3) retransmission will be automatic; otherwise, the DTE shall again retransmit the mini-packet as specified in 11.6.1.

11.7 Determination of transmission result

11.7.1 The DTE shall determine the results of transmission in accordance with 11.7.2, before the TRANSMIT MINI-PACKET action for the next mini-packet.

NOTE 167 While the conditions for each result are as specified in 11.7.2, this does not necessarily mean that the DTE needs to examine the lines and register fields specified, since redundancy in the node/DTE interface allows more than one means of determining a particular condition. Accordingly, any means may be used provided that when the conditions are as specified in 11.7.2 the response used for subsequent actions is that specified for the condition.

11.7.2 The result shall be

- a) ACCEPTED if, when TDN:N is active after transmission, TAC is active and TCE is inactive;
- b) IGNORED if, when TDN:N is active after transmission, TIG is active and TCE is inactive;
- c) NOT SELECTED if, when TDN:N is active after transmission, TUS is active and TCE is inactive;
- d) TRANSMIT COMPARISON ERROR if, when TDN:N is active after transmission, TCE is active;
- e) BUSY if, when TDN:N is active after transmission and AUTO-RETRY ON BUSY is OFF, TBY is active and TCE is inactive;

● BUSY so long as TDN:N remains inactive while AUTO-RETRY ON BUSY is ON;

g) BUSY if AUTO-RETRY ON BUSY is ON, and TDN:N has been set active by the node in response to a transmitter reset (TRST);

h) RING INOPERABLE if any of the following apply:

- 1) TDN:N remains inactive for more than 2 ms while auto-retry on busy is not enabled;
- 2) TCLK:N remains inactive for more than 2 ms;
- 3) AOK or RON of XSR are inactive.

11.8 Reception of logical mini-packets

11.8.1 Reception control functions

11.8.1.1 General

The reception of logical mini-packets shall be subject to the reception control functions specified in 11.8.1.2 to 11.8.1.5.

11.8.1.2 READY/BUSY control

This control shall

- a) have two states:
 - 1) READY, in which mini-packets can be received by the node, but in which the DTE cannot determine the contents of the last mini-packet received; and
 - 2) BUSY, in which mini-packets cannot be received by the node, but in which the DTE can determine the contents of the last received mini-packet;

- b) be set to READY by the DTE by the action of enabling the node using NEN of write register Rx.CR or TEST:N (see 11.15.2.3 and 11.13.4.3), and while the node is enabled, when set by the DTE to READY using read registers Rx.BG or Rx.G (see 11.14.2.7 and 11.14.2.8);

NOTE 168 Rx.BG sets the control to READY only when the mini-packet data octet being read is the highest numbered octet.

- c) be set to BUSY when the node sets RDN:N active (denoting the receipt of a mini-packet by the node).

11.8.1.3 SOURCE SELECTOR control

This control shall

- a) be set to just one value at a time for all values in the range 0 to 255 as follows:

- 1) 0, "none", when the node can accept mini-packets from no source, but returns them with response NOT SELECTED;
- 2) 255, "any", when the DTE can accept mini-packets from any source;
- 3) a value in the range 1 to 254, in which mini-packets with a source node address equal to the value set will be accepted and others returned with response NOT SELECTED, or vice versa, depending on the value of the SOURCE SELECT/REJECT control (see 11.8.1.4).

- b) be set to 0 by the DTE by the action of enabling the node using NEN of write register Rx.CR or TEST:N (see 11.15.2.3 and 11.13.4.3), and while the node is enabled by the DTE to the value written using write register SSR (see 11.15.2.1).

NOTES

169 Both Basic and Enhanced Class nodes support this control.

170 Since the value is set to 0 upon node enablement, thus preventing the node from accepting mini-packets from any source, the DTE will need to use this control before frames can be received, normally by setting it to 255. Its use may be further required to cause mini-packets to be returned with response NOT SELECTED when a frame is discarded (see 11.10.1.5). Otherwise, the use of this control is optional, as a means of causing the node to filter out mini-packets coming from sources other than that of a frame being received.

11.8.1.4 SOURCE SELECT/REJECT control

This control shall

- a) have two states:

- 1) SELECT, in which only mini-packets with the source node address **equal** to that in the range 1 to 254 set by the SOURCE SELECTOR can be received by the node and made available to the DTE, mini-packets with other source node address being returned with response NOT SELECTED;
 - 2) REJECT, in which only mini-packets with the source node address **not equal** to that in the range 1 to 254 set by the SOURCE SELECTOR can be received by the node and made available to the DTE, mini-packets with source node address equal to that set by the SOURCE SELECTOR being returned with response NOT SELECTED;
- b) have two states while the SOURCE SELECTOR is set to 0:
- 1) SELECT, in which any mini-packet can be accepted by the node;
 - 2) REJECT, in which no mini-packet can be accepted by the node;
- c) have no effect while the SOURCE SELECTOR is set to 255;
- d) if the node is an Enhanced Class node, be set to SELECT by the DTE action of enabling the node using TEST:N and to SELECT or REJECT according to the value of RSS in every occurrence of Rx.CR that enables the node or keeps the node enabled (see 11.15.2.3).
- e) if the node is a Basic Class node, be set to SELECT at all times.

NOTES

171 Basic Class nodes do not support this control, and always function as for SELECT.

172 The use of this control is not necessary for the MAC procedures. It may be used as a means of causing mini-packets of a discarded frame to be returned with response NOT SELECTED, by setting this control to REJECT and the SOURCE SELECTOR to the source of the mini-packets; this permits frames to be received from other sources.

11.8.1.5 TYPE SELECT/REJECT control

This control shall

- a) have three states:
 - 1) OFF, in which the node marks no mini-packets NOT SELECTED on the basis of the value of the type bits;
 - 2) SELECT, in which the node can receive and make available to the DTE only mini-packets

having both Type bit A and Type bit B set to the same values as those of the TYPE BIT MASK set by the DTE, all others being returned with response NOT SELECTED by the node;

- 3) REJECT, in which the node can receive and make available to the DTE only mini-packets having one or both Type bit A and Type bit B set to the different values from those of the TYPE BIT MASK set by the DTE, those in which both type bits are the same as the TYPE BIT MASK values being returned with response NOT SELECTED by the node;

b) if the node is an Enhanced Class node, be set to OFF by the DTE action of enabling the node using NEN of Rx.CR or TEST:N (see 11.15.2.3 and 11.13.4.3); and while the node is enabled, be set according to the values of CTP, ROT, MTPA and MTPB, all of write register XCR;

c) if the node is a Basic Class node, be set to OFF at all times.

NOTES

173 Basic Class nodes do not support this control, and function always as for the OFF state.

174 Since XCR is used also for writing the type bits for transmitted mini-packets, care needs to be taken that there are no incorrect interactions between the transmission and reception functions.

175 The use of this control is not necessary for the MAC procedures. It may be used for causing the node to return with response NOT SELECTED mini-packets of a discarded frame, by selecting the type bits for a new frame or rejecting the type bits for the later mini-packets in the discarded frame, provided that no other frame is being received at the same time.

176 After the receipt of a mini-packet starting a new frame, this control cannot be used to select only mini-packets with the type bits for the remainder of a frame, since the DTE is required to detect a mini-packet with the type bits set as for a start of frame from the same source [see 11.9.1.2 b)].

11.8.2 Procedure

11.8.2.1 General

When required to receive a mini-packet, the DTE shall perform the actions specified in 11.8.2.2 to 11.8.2.6.

NOTE 177 In order to perform this procedure the DTE will need to take actions to set both itself and the node into a state in which this procedure can be performed correctly. Such actions do not form part of these procedures.

11.8.2.2 Detect reception of mini-packet by node

The DTE shall monitor either control line RDN:N or field RDN of read register 3 Rx.SR; when these go active, the DTE shall perform the actions in 11.8.2.3 to 11.8.2.6.

NOTE 178 When RDN:N goes active the READY/BUSY control state becomes BUSY.

11.8.2.3 Read source node address

11.8.2.3.1 The DTE shall read the source node address by using read register 1 (Rx.SRC).

11.8.2.3.2 This action may be omitted and the source node address taken as equal to the selected source if a single source has been selected using the SOURCE SELECTOR and the SOURCE SELECT/REJECT control state is SELECT, and either of the following conditions apply:

- a) at least one mini-packet has been received since the last change to either of these controls;
- b) at least 12 μ s have elapsed between the last change to either of these controls and RDN:N going active.

11.8.2.4 Read type bits

11.8.2.4.1 The DTE shall read the type bits by using read register 8 (XSR), fields RTPA and RTPB.

11.8.2.4.2 If the source is one from which the mini-packets are being discarded, this action may be omitted.

11.8.2.4.3 If the TYPE SELECT/REJECT control is on SELECT and more than 12 μ s have elapsed between the last change to this control and RDN:N going active, action may be omitted and the value of the type bits be taken as equal to the setting of the TYPE BIT MASK.

NOTE 179 The TYPE SELECT/REJECT control state can only be OFF for a Basic Class node.

11.8.2.5 Read mini-packet data octets

11.8.2.5.1 The DTE shall read the mini-packet data octets by using read register 5 or 6 (Rx.B or Rx.BG respectively). Within the constraints set by the specification of Rx.B and Rx.BG, the sequence in which the octets are read is undefined.

11.8.2.5.2 This action may be omitted for the whole mini-packet if the mini-packet is one that is established on the basis of the source destination address or type bits to be part of a discarded frame or not part of a frame.

NOTE 180 Where the checksum calculating facility of an Enhanced Class node is being used, it is essential to omit this action for mini-packets extraneous to the frame being processed, in order to avoid the octets values being included in the checksum.

11.8.2.5.3 This action may be omitted for some octets in a mini-packet if the value of previously read octets in the mini-packet requires the discarding of the frame to which the mini-packet belongs.

11.8.2.5.4 This action may be omitted for any octets following the end of a frame in the last mini-packet of a frame.

NOTE 181 This action may not, however, be omitted for the arbitrary valued padding octet in frames with an odd number of octets in the data field, since the value, though arbitrary, is required for calculation of the checksum.

11.8.2.6 Set READY/BUSY control to READY

The DTE shall cause the node to clear busy and be ready to receive the next mini-packet, by using read register Rx.G or by using Rx.BG to read the highest numbered data octet.

11.8.3 Interrelationship between actions

11.8.3.1 Sequence

The following constraints on the sequence of action shall be observed; within these constraints, any sequence may be used:

- a) detection of reception of a mini-packet shall be the first action;
- b) setting the READY/BUSY control shall be the last action;
- c) reading of source node address and type bits may be interleaved between reading of mini-packet data octets;
- d) The actions to read the contents of one mini-packet shall not be interleaved with any actions for the reading of the contents of another mini-packet or a node disable command.

NOTE 182 Except as specified in d), the sequence of actions to receive a mini-packet may be interleaved with any actions for transmitting a mini-packet, determining the response to a transmitted mini-packet, or for node management functions.

11.8.3.2 Repetition of actions

Within the constraints on sequence specified in 11.8.3.1, any action may be repeated.

NOTE 183 Where the checksum calculating facility of an Enhanced Class node is being used, it is essential that each frame octet other than the checksum is read once and once only.

11.9 Mapping of logical mini-packets on to frames

11.9.1 Series of logical mini-packets representing a frame

11.9.1.1 Every logical mini-packet which satisfies conditions a) and b) shall be processed as the first logical mini-packet of a series representing a frame:

- a) Type bit A is ZERO and Type bit B is ONE;
- b) data octet 0 is 1001 1100, and data octet 1 is either 1001 1100 or 1001 1101 (i.e. the header octets for frames with 16-bit or 48-bit MAC addresses respectively).

11.9.1.2 All subsequent logical mini-packets that satisfy each of the following conditions 1) to 3) shall be processed as subsequent logical mini-packets in the series representing the frame, until any of the events a) to c) occurs:

- a) the source node address is the same as in the first logical mini-packet;
- b) both type bits set are to ZERO;
- c) the logical mini-packet is not an error message addressed to the SR-LAN logging station.

NOTE 184 The reception of error messages addressed to the SR-LAN logging station does not form part of these MAC procedures. They will not be received unless the node supports the optional facility and the DTE has enabled the facility, where the logging station function is implemented in the same DTE as the MAC procedures.

When the facility is enabled, the error messages can be reliably distinguished from frame logical mini-packets only by the setting of LOG of Rx.SR, since they always have both type bits set to ZERO and may be generated by the remote node through which a frame is being transmitted (and will consequently have the same source node address). See 11.9.1.4:

- a) the last logical mini-packet in the series is received, as specified in 11.9.1.3;
- b) another logical mini-packet containing the same source node address and with the Type bit A set to ZERO and Type bit B to ONE is received; in this case the incomplete frame shall be discarded;

NOTE 185 If this logical mini-packet also satisfies condition b) in 11.9.1.1 it is the beginning of a new frame and is to be processed as such.

- c) the frame is required by 11.10 to be discarded while incomplete.

11.9.1.3 The last logical mini-packet in the series shall be that which contains the last octet of the frame, determined on the basis of the values of the first four frame octets (header and S) as follows:

- a) if the header octets have the value 1001 1100 (indicating 16-bit MAC addresses), the last frame octet shall be the n th, where $n = S + 11$ if S is odd and $n = S + 12$ if S is even;
- b) if the header octets have the value 1001 1101 (indicating 48-bit MAC addresses), the last frame octet shall be the n th, where $n = S + 19$ if S is odd and $n = S + 20$ if S is even.

11.9.1.4 Every logical mini-packet that does not form part of the series representing a complete or incomplete frame shall be disregarded for the purposes of the processing of MAC frames, except that a logical mini-packet as specified in 11.9.1.2 b) shall cause a frame to be discarded as specified there, the contents of the logical mini-packet being disregarded unless it is the start of a new frame.

11.9.2 Mapping of logical mini-packet data octets to frame octets

11.9.2.1 The mapping shall be as specified in 11.5.3.3.2 to 11.5.3.3.4 for transmitted frames.

11.9.2.2 Where the number of octets in a frame is not an exact multiple of M, the octets following the end of the frame in the last mini-packet shall be disregarded; they shall have no effect on the frame protocol, regardless of their value.

11.10 Processing

11.10.1 Procedure

11.10.1.1 Beginning of frame

Each time that a logical mini-packet that is the beginning of a frame is received (see 11.9.1.1), the DTE shall begin processing the new frame and shall continue to process it as specified in this clause, until the frame is either complete or discarded.

11.10.1.2 Setting of reception controls

So long as the frame is neither complete nor discarded, the DTE shall maintain the setting of the SOURCE SELECTOR, and if the local node is an Enhanced Class node, SOURCE SELECT/REJECT and

TYPE SELECT/REJECT controls, in such a state that no mini-packet in the series representing the frame is marked NOT SELECTED.

11.10.1.3 Issue of READY commands

So long as the frame is neither complete nor discarded, the DTE shall always issue a ready command within time T(6) after the receipt of a logical mini-packet containing any of the frame octets prior to the frame data field, and within time T(9) for later logical mini-packets.

11.10.1.4 Discarding conditions

The frame shall be discarded if and only if any of the following conditions apply:

- a) **congestion:** the DTE is in the process of receiving frames from other sources up to the maximum capacity of the DTE for frame reception;
- b) **MAC address length:** the value of the first two octets corresponds to that of a header identifying a frame with MAC address length other than that supported at that time by the DTE;
- c) **length:** the value in the third and fourth octets yields a value of S [see 11.4.1.2 b)] that corresponds to a frame length that is greater than that supported by the DTE or a data field length greater than that supported by the DTE for the MAC-SAP identified by the destination MAC address.
- d) **unassigned destination MAC address:** the destination MAC address contained in the fifth and sixth or fifth to tenth octets (for 16-bit and 48-bit MAC addressed respectively) is not assigned to any MAC-SAP in the DTE;
- e) **source MAC address validation:** optionally, if the source MAC address in the seventh and eighth octets or eleventh to sixteenth octets (for 16-bit and 48-bit MAC addresses respectively) is not one known by the DTE to be valid for the source node address contained in the mini-packets, the frame may be discarded;

NOTE 186 It is not required that the DTE should validate source MAC addresses against source node addresses, and no means for such validation is specified; however, discarding of frames that have failed MAC address validation does not constitute a violation of the protocol.

- f) **checksum:** the value of the last two octets in the frame does not satisfy the checksum formula specified in 11.4.1.2 g);

NOTE 187 With Enhanced Class nodes, registers RSUMCLR and Rx.SUM provide a means of obtaining the checksum value from the node.

- g) **next mini-packet waiting time:** the RECEIVE DONE signal is not received from the node for the next logical mini-packet in the series within T(7) of the READY command issued by the DTE for the previous mini-packet, unless, extended reception is enabled (see 11.10.3);
- h) **whole frame waiting time:** time T(8) elapses before reception of the frame is complete unless extended reception is enabled (see 11.10.3);
- i) **new frame starts:** reception of the frame is interrupted by the start of a new frame from the same source node address, as specified in 11.9.1.2 b);
- j) **ring non-operational:** the ring is detected to be non-operational (see 11.14.2.9, read register XSR).

11.10.1.5 Action on discarding

When a frame is discarded

- a) no MA-DATA indication shall be produced;
- b) if discarding occurs on any other than the last logical mini-packet, the DTE shall set the SOURCE SELECTOR, SOURCE SELECT/REJECT or TYPE SELECT/REJECT controls in such a way that the node returns the next mini-packet in the series with response NOT SELECTED, for a period equal to time T(7), unless the DTE is in the process of receiving other frames at the same time and no such setting is possible without causing mini-packets belonging to such other frames to be returned with response NOT SELECTED;
- c) the DTE shall set the node READY/BUSY control and SOURCE SELECTOR controls, and in the case of Enhanced Class nodes, the SOURCE SELECT/REJECT and TYPE SELECT/REJECT controls so that a new frame can be received, subject to any delay imposed by the means used to achieve b).

11.10.1.6 Action on frame completion

When a complete frame is received without discarding

- a) a MA-DATA indication shall be produced as specified in 11.11;
- b) the DTE shall set the node READY/BUSY control and SOURCE SELECTOR controls, and in the case of Enhanced Class nodes, the SOURCE SELECT/REJECT and TYPE SELECT/REJECT controls so that a new frame can be received.

11.10.2 Times

11.10.2.1 General

The values of the times given in 11.10.1 shall be as specified in 11.10.2.2 to 11.10.2.5 (see also the remarks on ranges in 11.5.6.1).

11.10.2.2 T(6) Set READY: maximum delay on control part of frame

T(6) shall be measured from when the node sets RDN:N active until the DTE clears busy using Rx.BG or Tx.G. T(6) shall not exceed 39 ms.

11.10.2.3 T(7) Minimum mini-packet waiting time

T(7) shall be measured from when the DTE clears busy using Tx.BG or Tx.G until the node sets RDN:N active for the next mini-packet that is part of the frame. T(7) shall be between 14 ms and 26 ms.

11.10.2.4 T(8) Whole frame minimum waiting time

T(8) shall be measured from when the node sets RDN:N active for the first mini-packet. T(8) shall be between 560 ms and 1040 ms for frames with 4096 or less data octets; for longer frames the time may be proportionately increased.

11.10.2.5 T(9) Clear busy maximum delay on subsequent mini-packets

T(9) shall be measured as for T(6). T(9) shall not exceed 13 ms.

11.10.3 Extended reception

Optionally, reception of a frame may continue after the expiry of times T(7) and T(8), provided that this does not prevent the reception of other frames. Otherwise, when this facility is used, the conditions which terminate reception of incomplete frames are not standardized.

11.11 Issue of MA-UNITDATA indication

11.11.1 Production of MA-UNITDATA indication in response to frame

11.11.1.1 When a complete frame has been received and has not been discarded, a MA-UNITDATA indication shall be produced at the MAC-SAP identified by the destination MAC address as follows:

a) the **source MAC address** parameter shall represent the value of the source MAC address contained in the received frame; the mapping of

octets shall be as specified in 11.4.1.2 c) for 16-bit source MAC addresses and 11.4.1.3 c) for 48-bit source MAC addresses, and the mapping of bits shall be as specified in 11.4.3.3;

b) the **destination MAC address** parameter shall represent the value of the destination MAC address contained in the received frame; the mapping of octets shall be as specified in 11.4.1.2 d) for 16-bit destination MAC addresses and 11.4.1.3 d) for 48-bit destination MAC addresses, and the mapping of bits shall be as specified in 11.4.3.3;

c) the **data field** parameter shall represent the octets in the data octets field of the frame; the mapping of octets shall be as specified in 11.4.1.2 e) and the mapping of bits shall be as specified in 11.4.3.4.

11.11.1.2 No MA-UNITDATA indication shall be produced for a discarded frame.

11.11.2 Production of MA-UNITDATA indication in response to MA-UNITDATA request

11.11.2.1 Where the source and destination MAC-SAPs are both in the local DTE and the means of actioning the MA-UNITDATA request is not the transmission of a frame, a MA-UNITDATA indication shall be produced unless

a) the source and destination MAC addresses are of different length and the DTE does not support different lengths;

b) the data field parameter is too long for the destination MAC-SAP;

c) the DTE is in the process of receiving frames up to its maximum capacity.

11.11.2.2 The MA-UNITDATA indication parameters shall be as specified in 11.2.2.2.

11.11.2.3 MA-UNITDATA-STATUS indication shall be produced as specified in 11.3.2.

11.11.3 Discarding of the MA-UNITDATA indication

If internal flow control at the MAC-SAP prevents immediate transfer of the MA-UNITDATA indication, the MA-UNITDATA indication shall either

a) be discarded immediately; or

b) be retained until transferred or until retention would prevent reception of other frames, in which case it shall be discarded.

11.12 Functions at the node interface

11.12.1 Use of node interface

The DTE shall use the node interface as the sole means of interaction with the node.

11.12.2 Use of node interface functions

11.12.2.1 The use or non-use by the DTE of each function provided by the node interface, and the mapping between these functions and the procedures specified in 11.4 to 11.11 shall be any that

- a) allow the requirements specified in 11.4 to 11.11 to be met;
- b) do not conflict with any requirement specified in 11.13 to 11.15;
- c) do not utilize the state of any line when it is specified in 11.13 to 11.15 that the state is not significant or undefined.

11.12.2.2 Usage and mapping shall be either statically determined for the DTE, or dynamically varied.

11.13 Node interface lines

11.13.1 Line logical states

11.13.1.1 Lines whose identifier has the suffix “:P” shall be logically active in the electrical high state, and shall be logically inactive in the electrical low state.

11.13.1.2 Lines whose identifier has the suffix “:N” shall be logically active in the electrical low state, and shall be logically inactive in the electrical high state.

NOTE 188 For the specification of the electrical characteristics, including the voltages corresponding to the high and low states, see 7.2.4.

11.13.2 A0:P to A3:P: Register address lines

11.13.2.1 The register address lines shall be set by the DTE as the binary representation of a register address; the active state of the line shall represent a ONE bit, and the inactive state a ZERO bit; the bits shall be in ascending order of significance with the least significant bit on A0:P.

11.13.2.2 The DTE shall set control line RD:N active to make the register a read register and shall set control line WT:N active to make the register a write register.

11.13.3 D0:P to D7:P: Data lines

11.13.3.1 For read registers, the allocation of data lines shall be as specified in table 8, for write registers as specified in table 9.

11.13.3.2 For read registers 0, 1, 2, 5, 6, 9 and 10, and write registers 0, 1, 5 and 6, the setting of the data lines shall represent an octet; the active state of the line shall represent a ONE bit and the inactive state a ZERO bit.

11.13.4 Control lines set by the DTE

11.13.4.1 RD:N: Node read strobe

See 11.14.1.

11.13.4.2 WT:N: Node write strobe

See 11.15.1.

11.13.4.3 TEST:N: Node enable override signal

11.13.4.3.1 This line is optional on nodes.

11.13.4.3.2 If the DTE uses TEST:N, the DTE shall set TEST:N active and keep it active to enable the node, regardless of the value last written to NEN of Rx.CR; and shall set and keep TEST:N inactive to return control over enablement to NEN of Rx.CR.

NOTE 189 The use of this line for node enablement for other than test purposes is deprecated.

11.13.5 Control lines set by the node

11.13.5.1 ACK:N: Node read or write acknowledge

The read and write operations of the DTE shall be subjected to the state of ACK:N as specified in 11.14.1 and 11.15.1.

11.13.5.2 TDN:N: Transmission done

11.13.5.2.1 While the node is enabled, the active state of the line permits the DTE to write the destination node address, type bits and data octets for the next mini-packet and command its transmission; and if a previous mini-packet has been sent since enablement, permits the DTE to determine the response to its transmission.

11.13.5.2.2 The active state of the line during the first 150 ns after the DTE sets WT:N inactive at the end of a transmit command shall be treated by the DTE as the inactive state (see note 189).

11.13.5.2.3 The inactive state indicates to the DTE that transmission of a mini-packet is in progress (see note 190) and prohibits the DTE performing the actions in 11.13.5.2.1.

NOTES

190 The 150 ns is the maximum delay permitted for the node in setting TDN:N inactive after a transmit command.

191 The transmission time includes actual transmission time, a node-imposed delay designed to protect the ring from too frequent retransmissions if the response was other than accepted, and, while auto-retry on busy is enabled, the time for any retransmissions.

192 TDN:N is active while the node is disabled, and upon enablement until a mini-packet is transmitted.

11.13.5.3 RDN:N: Receive done

11.13.5.3.1 The active state of the line indicates to the DTE that a mini-packet has been received, and permits the DTE to read the contents of the mini-packet; it further indicates that the node is in the BUSY state and cannot accept further mini-packets until the DTE has issued a READY command (Rx.BTG or Rx.G).

11.13.5.3.2 The active state of the line for the first 150 ns after the DTE sets RD:N inactive at the end of a READY command shall be treated by the DTE as the inactive state (see note 193).

11.13.5.3.3 The inactive state of the line indicates to the DTE that no mini-packet has been received since the last of either enablement or a READY command, and prohibits the DTE from reading the contents of any previously received mini-packet.

NOTES

193 The 150 ns is the maximum permitted delay for the node in setting RDN:N inactive after a clear busy command.

194 RDN:N is inactive while the node is disabled.

11.13.5.4 TCLK:N: transmission clock

11.13.5.4.1 From the time when the DTE issues a transmit command, the active state of the line indicates to the DTE that the mini-packet has not yet been transferred to the ring; thereafter, the inactive state indicates that the mini-packet has been transferred to the ring and the response is not yet available.

11.13.5.4.2 If auto-retry on busy is enabled, each subsequent time that TCLK:N goes active without TDN:N going active, followed by TCLK:N again going inactive (see note 195), indicates to the DTE that a response of busy has been received and that the

mini-packet has been retransmitted; when TCLK:N goes active with TDN:N going active within 20 ns, this indicates a response other than busy (see note 196).

11.13.5.4.3 If auto-retry is not enabled, TCLK:N going active indicates that TDN:N will go active within 20 ns (see note 196).

NOTES

195 In this case, TCLK:N will be active for a minimum of 90 ns.

196 In these cases, TCLK:N will remain active until after the next transmit command.

11.13.5.5 TER:N: transmit error

11.13.5.5.1 TER:N has significance only while TDN:N is active and transmit reset (TRST of Rx.CR) has not occurred since TDN:N became active (see note 197).

11.13.5.5.2 When auto-retry on busy is enabled, the active state of the line indicates to the DTE that the last completed transmission had a result of IGNORED, NOT SELECTED, or TRANSMIT COMPARISON ERROR.

11.13.5.5.3 When auto-retry on busy is enabled, the inactive state of TER:N indicates to the DTE that the last completed transmission had a result of ACCEPTED or BUSY, if TDN:N is active; or that no response other than BUSY has yet been received, if TDN:N remains inactive for more than 20 ns after TCLK:N goes active.

11.13.5.5.4 When auto-retry on busy is disabled, the active state of TER:N indicates to the DTE that the last completed transmission has a result of IGNORED, NOT SELECTED, TRANSMIT COMPARISON ERROR or BUSY, and the inactive state indicates that the result was ACCEPTED.

NOTES

197 TER:N is set inactive during disablement, upon enablement, and upon transmit reset.

198 TER:N is set to a new state (active or inactive) not later than 20 ns before TCLK:N goes active, and stays in that state until after TCLK:N goes inactive.

11.13.5.6 RTPA:N and RTPB:N: received Type bits A and B

11.13.5.6.1 These lines are significant only while RDN:N is active.

11.13.5.6.2 The active state of RTPA:N indicates to the DTE that the last received mini-packet had Type bit A set to ONE, the inactive state, ZERO; and similarly for RTPB and Type bit B.

NOTE 199 The node sets these lines to the appropriate state at least 10 ns before setting RDN:N active, and keeps them in that state until after RDN:N goes inactive.

11.13.5.7 RINT:N: broadcast or error message mini-packet received

11.13.5.7.1 This line is only significant while RDN:N is active.

11.13.5.7.2 The active state of RINT:N indicates to the DTE that the mini-packet for which RDN:N became active was a broadcast or error message mini-packet, and that the BPR or LOG field of register Rx.SR is set accordingly (see 11.14.2.5); the inactive state indicates that it was not.

NOTE 200 The transmission and reception of broadcast or error message mini-packets does not form part of the MAC procedures. However, if the node is enabled to receive broadcast mini-packets (under DTE control in Enhanced Class nodes, optional and under operator control in Basic Class nodes) or enabled to receive error message mini-packets (under DTE control in Enhanced Class nodes only), the requirements specified in 11.9.1.4 apply to any broadcast or error message mini-packet received while a frame is being processed.

11.14 Read registers

11.14.1 Read operation

11.14.1.1 This operation applies to registers supported by all nodes; for other registers, see 11.14.3.

11.14.1.2 The DTE shall set a read register address in the range 0 to 8 on the register address lines A0:P to A3:P, and keep it set until at least 40 ns after RD:N has become inactive.

11.14.1.3 Not less than 40 ns after the register address lines have become set, and not before ACK:N has become inactive after the last read or write operation, the DTE shall set RD:N active and keep it active until after ACK:N has become active.

11.14.1.4 When ACK:N becomes active, the DTE shall read the values on the data lines D0:P to D7:P.

11.14.1.5 After an undefined time after ACK:N going active (see note) the DTE shall set RD:N inactive.

NOTE 201 Completion of the handshake after reading the data may take place immediately, or not until necessary in preparation for the next read or write operation, or at any time between.

11.14.2 Standardized registers

11.14.2.1 Register 0: SSR (source selector)

11.14.2.1.1 The DTE shall read from this register only while the node is enabled.

11.14.2.1.2 The octet on the data lines D0:P to D7:P indicates to the DTE the source to which the node source selector is currently set.

NOTE 202 Until the source selector has been set by the node following enablement, the value will be 0 (i.e. the node will not accept mini-packets from any source).

11.14.2.2 Register 1: Rx.SRC (receive source node address)

11.14.2.2.1 The DTE shall read from this register only while the node is enabled and RDN:N is active.

11.14.2.2.2 The octet on the data lines D0:P to D7:P indicates to the DTE the source node address in the last received mini-packet.

11.14.2.3 Register 2: NODE (local node ring address)

11.14.2.3.1 The DTE shall read from this register only while the node is enabled.

11.14.2.3.2 The octet on the data lines D0:P to D7:P indicates to the DTE the address currently loaded in the node as its own ring address.

11.14.2.4 Register 3: Tx.SR (transmit status register)

11.14.2.4.1 The DTE shall read from this register only while the node is enabled.

11.14.2.4.2 The settings on the data lines D0:P to D7:P shall have the significance specified in a) to h) once a mini-packet has been transmitted since the node was enabled; until then only TDN shall be significant.

NOTE 203 Until a mini-packet has been transmitted since enablement, TDN and TAC will be active and all other lines inactive.

a) **D7:P: TDN (transmit operation done):** the active state indicates to the DTE that control line TDN:N is active and will remain active until the DTE issues a transmit command using Tx.BG or Tx.G, and, if a mini-packet has been transmitted since node enablement, that the settings of TER, TCE, TIG, TAC, TUS and TBY are significant. The inactive state indicates that TDN:N was inactive at the beginning of the read operation, and that the settings of TER, TCE, TIG, TAC, TUS and TBY are not significant;

- b) **D6:P: TER (transmit error):** while auto-retry on busy is disabled, the active state of TER indicates to the DTE that TCE, TIG, TUS or TBY is active; while enabled, TCE, TIG, or TUS only. The inactive state of TER indicates to the DTE that TAC is active, unless a transmitter reset has occurred since the last transmit command, in which case the inactive state of TER has no significance;
 - c) **D5:P: D5:P** is inactive and has no significance;
 - d) **D4:P: TCE (transmit comparison error):** the active state indicates to the DTE that the result of transmission was TRANSMIT COMPARISON ERROR; the inactive state, that no TRANSMIT COMPARISON ERROR occurred;
 - e) **D3:P: TIG (transmitted mini-packet ignored):** only if TCE is inactive, the active state of TIG indicates to the DTE that the result of transmission was IGNORED; the inactive state, any other result;
 - f) **D2:P: TAC (transmitted mini-packet accepted):** only if TCE is inactive, the active state of TAC indicates to the DTE that the result of transmission was ACCEPTED; the inactive state, any other result;
 - g) **D1:P: TUS (transmitted mini-packet not selected):** only if TCE is inactive, the active state of TUS indicates to the DTE that the result of transmission was NOT SELECTED; the inactive state, any other result;
 - h) **D0:P: TBY (destination node busy):** only if TCE is inactive and auto-retry on busy is not enabled, the active state of TBY indicates to the DTE that the result of transmission was BUSY; the inactive state, any other result.
- ception is enabled; the inactive state, that it is not (see note to 11.13.5.7.2);
- c) **D5:P: RRJ (receive reject):** the active state indicates to the DTE that since the source selector was last set the node has rejected a mini-packet addresses to the node and returned it with response NOT SELECTED, on the basis of the settings of the SOURCE SELECTOR, SOURCE SELECT/REJECT, TYPE SELECT/REJECT and BROADCAST RECEPTION (see note to 11.13.5.7.2) controls; the inactive state, that no such rejection has occurred;
 - d) **D4:P: RSS (source select/reject):** the active state of RSS indicates to the DTE that the SOURCE SELECT/REJECT control is set to REJECT, the inactive state, SELECT;
 - e) **D3:P: LOG (error message mini-packet received):** while RDN:N is active, the active state of D3:P indicates to the DTE that the last mini-packet received was an error message, the inactive state that it was not; while RDN:N is inactive, this line has no significance (see note to 11.9.1.2 3) and note to 11.13.5.7.2);
 - f) **D2:P: BPR (broadcast mini-packet received):** while RDN:N is active, the active state of D2:P indicates to the DTE that the last received mini-packet was a broadcast mini-packet, the inactive state that it was not (see note to 11.13.5.7.2);
 - g) **D1:P: RTRY (auto-retry on busy):** the active state indicates to the DTE that auto-retry on busy is enabled; the inactive state, disabled;
 - h) **D0:P: NEN (node enabled):** the active state indicates to the DTE that the node is enabled; the inactive state, disabled.

NOTE 204 The active states of TIG, TAC, TUS and TBY are mutually exclusive.

11.14.2.5 Register 4: Rx.SR (receive status and node status)

The DTE may read from this register at all times. When the node is enabled (i.e. NEN is active) the significance shall be as specified in a) to h). When the node is disabled (i.e. NEN is inactive), only the setting of NEN shall be significant:

- a) **D7:P: RDN (read done):** the active state indicates to the DTE that control line RDN:N is active and will remain active until the DTE issues a READY command using Rx.BG or Rx.G. The inactive state indicates that RDN:N was inactive at the beginning of the read operation;
- b) **D6:P: BCE (broadcast reception enabled):** the active state indicates to the DTE that broadcast re-

11.14.2.6 Register 5: Rx.B (read data octet)

11.14.2.6.1 The DTE shall not read from this register unless RDN:N is active.

11.14.2.6.2 The value of the octet on the data lines D0:P to D7:P indicates to the DTE the value of one of the data octets in the last received mini-packet according to the following rules:

- a) if the data octet being read is the first data octet to be read since node enabling or receiver reset, regardless of whether a data octet is read using Rx.B or Rx.BG, the data octet shall be data octet 0;
- b) each subsequent data octet being read, without an intervening node enablement or receiver reset, shall be the next in the repeating cycle 0...(M-1), 0... where M is the number of data octets in a mini-packet, regardless of whether

previous octets have been read using Rx.B or Rx.BG.

NOTE 205 If the DTE reads more than M times from this register after RDN:N is set active, without any intervening Rx.G or Rx.BG, the mini-packet data octets will be re-read cyclically. If any mixture of Rx.B and Rx.BG are used to read the data octets, they will be re-read cyclically so long as Rx.BG is not used to read data octet M-1.

11.14.2.7 Register 6: Rx.BG (read data octet and go)

11.14.2.7.1 The DTE shall not read from this register unless RDN:N is active.

11.14.2.7.2 The significance of the data on the data lines D0:P to D7:P shall be as specified in 11.14.2.6.2.

11.14.2.7.3 If and only if mini-packet data octet M is set on the data lines, the reading of this register shall set the READY/BUSY control to READY.

11.14.2.8 Register 7: Rx.G (receive go)

11.14.2.8.1 The DTE shall read from this register only while RDN:N is active.

11.14.2.8.2 The data on the data lines is undefined and shall be ignored by the DTE.

11.14.2.8.3 The reading of this register shall set the READY/BUSY control to READY.

11.14.2.9 Register 8: XSR (extended mode status register)

11.14.2.9.1 The DTE may read from this register at any time.

11.14.2.9.2 The significance shall be as follows:

- a) **D7:P, D6:P and D5:P: L (mini-packet data field length):** the value set on these lines indicates to the DTE the number M of data octets in a mini-packet to which the node is currently set, as specified in table 10;
- b) **D4:P: AOK (all set up):** the active state indicates to the DTE that the node is correctly set up, the inactive state that it is not.

NOTE 206 The condition for being all set up are

- 1) the node is enabled;
- 2) the currently loaded own address in the node is in the range 0 to 254;
- 3) RON is active [see c)];
- 4) an input signal is present at the ring connector;

- c) **D3:P: RON (ring on):** the active state indicates to the DTE that ring operation as seen by the node is correct; the inactive state, that incorrect behaviour has been detected by the node;

NOTE 207 Normal operation is defined as the passage of the ring gap immediately preceded by an empty slot within the last 500 µs.

- d) **D2:P:** this line is active, and has no significance;

- e) **D1:P and D0:P: RTPB and RTPA (received Type bit B):** while the node is enabled and RDN:N is active, then the active state of RTPB indicates to the DTE that Type bit B of the last received mini-packet was ONE; the inactive state, ZERO; and similarly for RTPA and Type bit A. If the node is disabled or RDN:N is inactive, these lines have no significance.

11.14.3 Other registers

11.14.3.1 Register 9: Rx.SUM (receiver checksum)

11.14.3.1.1 With Basic Class nodes, this register is reserved, and the DTE shall not read from it.

NOTE 208 If an attempt is made to read from this register, the node will not acknowledge the read command with ACK:N, leaving the read handshake suspended.

11.14.3.1.2 With Enhanced Class nodes, the read procedure shall be as specified for other read registers in 11.14.1.

11.14.3.1.3 The values on the data lines represent the frame checksum, if the DTE acts as follows:

- a) before reading any data octets for the first logical mini-packet in a frame, the DTE writes to register RSUMCLR, and does not again write to RSUMCLR until the checksum has been read;
- b) every octet in the frame prior to the checksum (including the padding octet if present) is read, using Rx.B or Rx.BG, once and once only;
- c) no octet of a logical mini-packet not belonging to the frame is read between writing to RSUMCLR and reading Rx.SUM;
- d) Rx.SUM is read twice after reading the last frame octet prior to the frame checksum and before reading the mini-packet octets representing the checksum.

Then the value placed on the data lines for the first time that Rx.SUM is read will be the high order octet of the 16-bit checksum, and the value the second time will be the low order octet.

11.14.3.2 Register 10: Tx.SUM (transmitter checksum)

11.14.3.2.1 With Basic Class nodes, this register is reserved, and the DTE shall not read from it.

NOTE 209 If an attempt is made to read from this register, the node will not acknowledge the read command with ACK:N, leaving the read handshake suspended.

11.14.3.2.2 With Enhanced Class nodes, the read operation shall be as specified for other read registers in 11.14.1.

11.14.3.2.3 The values on the data lines represent the frame checksum, if the DTE acts as follows:

- a) before writing any data octets for the first logical mini-packet in a frame, the DTE writes to register TSUMCLR, and does not again write to TSUMCLR until the checksum has been read;
- b) every octet in the frame prior to the checksum (including the padding octet if present) is written, using Tx.B or Tx.BG, once and once only;
- c) no octet of a logical mini-packet not belonging to the frame is written between writing to TSUMCLR and reading Tx.SUM;
- d) Tx.SUM is read twice after writing the last frame octet prior to the frame checksum and before writing the mini-packet octets representing the checksum.

Then the value placed on the data lines for the first time that Tx.SUM is read will be the high order octet of the 16-bit checksum, and the value the second time will be the low order octet.

11.14.3.3 Registers 11 to 15: user defined registers

Reading from these registers does not form part of the procedure specified in this part of ISO 8802, and is neither required nor prohibited.

NOTES

210 If these registers are read, the node will not acknowledge the read command by ACK:N.

211 In DTEs in which the register address lines are directly connected to an internal bus, register addresses 11 to 15 may be used for internal communication in the DTE, and so may appear at the node interface.

11.15 Write registers

11.15.1 Write operation

11.15.1.1 This operation applies only to registers applicable to all nodes; for other registers, see 11.15.3.

11.15.1.2 The DTE shall set the register address lines A0:P to A3:P to a register address in the range 0 to 1 or 4 to 8, and keep them set until at least 40 ns after WT:N becomes inactive.

11.15.1.3 The DTE shall set the data lines D0:P to D7:P to the values specified for the register being written to, and keep them set until at least 15 ns after ACK:N becomes active.

11.15.1.4 The DTE shall set WT:N active

- a) not before ACK:N has become inactive at the end of the previous read or write operation;
- b) not less than 40 ns after the register address lines have become set;
- c) not less than 15 ns after the data lines have become set; and keep it active so long as the data lines remain set.

11.15.2 Registers applicable to all nodes

11.15.2.1 Register 0: SSR (Source selector)

11.15.2.1.1 The DTE shall write to this register only while the node is enabled.

11.15.2.1.2 The DTE shall set on the data lines the value required for the SOURCE SELECTOR control.

11.15.2.2 Register 1: Tx.DST (Transmit destination node address)

11.15.2.2.1 The DTE shall write to this register only while the node is enabled and only while TDN:N is active.

11.15.2.2.2 The DTE shall set the data lines D0:P to D7:P to the destination node address to which all mini-packets are to be sent until the next occurrence of Tx.DST.

11.15.2.3 Register 4: Rx.CR (receive control and node control)

11.15.2.3.1 The DTE may write to this register at any time.

11.15.2.3.2 Subject to the restrictions in 11.15.2.3.3, the DTE shall write to this register as follows:

- a) **D0:P: NEN (node enable):** the DTE shall set NEN
 - 1) active to cause node enablement, or to leave the node enabled if enablement has already occurred;

- 2) inactive to cause the node to become disabled immediately if TEST:N is not active, or when TEST:N becomes inactive if TEST:N is currently active; or to cause the node to remain disabled if it is already disabled.
- b) **D1:P: RTRY (enable auto-retries):** the DTE shall set RTRY active to cause the node to retransmit repeatedly the next mini-packet for which a transmit command is given if it returns with response BUSY, until the first occurrence of any of the following:
- 1) the DTE disables the node, which also disables auto-retry;
 - 2) the DTE sets RTRY inactive, which also disables auto-retry;
 - 3) the DTE sets TRST active [see note to 11.15.2.3.2 d) 5)];
 - 4) a mini-packet returns with response ACCEPTED, IGNORED or NOT SELECTED;
 - 5) the node detects TRANSMIT COMPARISON ERROR for a returned mini-packet;
- otherwise the DTE shall set RTRY inactive;
- c) **D2:P: RRST (receiver reset):** the DTE shall set RRST active to cause the node to put mini-packet data octet 0 on the data lines the next time that the DTE reads from either of Rx.B or Rx.BG; otherwise it shall set RRST inactive.
- d) **D3:P: TRST (transmitter reset):** the DTE shall set TRST active to effect all of the following:
- 1) interrupt any current mini-packet transmission;
 - 2) make the next octet written using Tx.B or Tx.BG mini-packet data octet 0;
 - 3) cause the node to set TER:N inactive;
 - 4) cause the node to set TER inactive when Tx.SR is read before the next transmit command;
 - 5) stop automatic retries on busy for the last mini-packet transmitted;
- NOTE 212 If RTRY is active in the same occurrence of Rx.CR, auto-retry will be enabled for future mini-packets.
- e) **D4:P: RSS (source select/reject):** the DTE shall set RSS active for the REJECT state of the

SOURCE SELECT/REJECT control, and inactive for the SELECT state;

- f) **D5:P: LGE (log reception enable):** the DTE shall set D5:P active to enable the reception of error messages until the node is next disabled; inactive to leave error reception disabled; and either active or inactive if error reception is already enabled;

NOTE 213 This line can therefore not be used to disable error message reception, which can only be achieved by disabling the node. See note to 11.9.1.2 3) for use of error message reception.

- g) **D6:P: BCE (broadcast reception):** the DTE shall set D6:P active to enable or leave enabled broadcast message reception, inactive to disable it or leave it disabled;
- h) **D7:P:** the DTE shall set this line inactive.

11.15.2.3.3 The following restrictions shall be observed:

- a) if NEN is set inactive, all other lines shall be set inactive;
- b) the DTE shall not set RTRY active while TDN:N is inactive, unless auto-retry is already enabled at the time of writing to Rx.CR.

11.15.2.4 Register 5: Tx.B (Write data octet)

11.15.2.4.1 The DTE shall not write to this register unless TDN:N is active.

11.15.2.4.2 The DTE shall set on the data lines D0:P: to D7:P a mini-packet data octet according to the following rules.

- a) the octet shall be mini-packet data octet 0 if it is the first data octet written since enabling or transmission reset;
- b) each subsequent octet being written, without an intervening node enablement or transmission reset, shall be the next in the repeating cycle 0... (M-1), 0..., where M is the number of data octets applicable to the length of mini-packets in use;
- c) Each new value for a given numbered mini-packet data octet shall overwrite previous values;
- d) for the purposes of a) to c) it shall make no difference whether a data octet is written using Tx.B or Tx.BG, or whether there is an intervening occurrence of Tx.G.