**PCT**

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : **H04L 12/44**	**A1**

(11) International Publication Number: **WO 99/45677**

(43) International Publication Date: 10 September 1999 (10.09.99)

(21) International Application Number: PCT/GB98/03611

(22) International Filing Date: 3 December 1998 (03.12.98)

(30) Priority Data:
9804846.5   6 March 1998 (06.03.98)   GB
9826251.2   30 November 1998 (30.11.98)   GB

(71) Applicants: 3COM TECHNOLOGIES [–/–]; Ugland House, P.O. Box 309, Georgetown, Grand Cayman (KY). BUTCHER, Ian, James [GB/GB]; A.A. Thornton & Co., Northumberland House, 303–306 High Holbor, London WC1V 7LE (GB).

(72) Inventors: HORSPOOL, Nigel; Streekstraat 12, B–3080 Tervuren (BE). LAW, David; 12 Earls Holme, Kempston, Bedfordshire MK42 8PC (GB). TRANG, Quang, Tien; 153 Washington Avenue, Hemel Hempstead, Hertfordshire HP2 6AT (GB). OVERS, Patrick; 55 Pipers Croft, Dunstable, Bedfordshire LU5 3JZ (GB).

(74) Agents: BUTCHER, Ian, James et al.; A.A. Thornton & Co., Northumberland House, 303–306 High Holborn, London WC1V 7LE (GB).

(81) Designated States: JP, European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published
With international search report.

(54) Title: NETWORK COMMUNICATION DEVICE
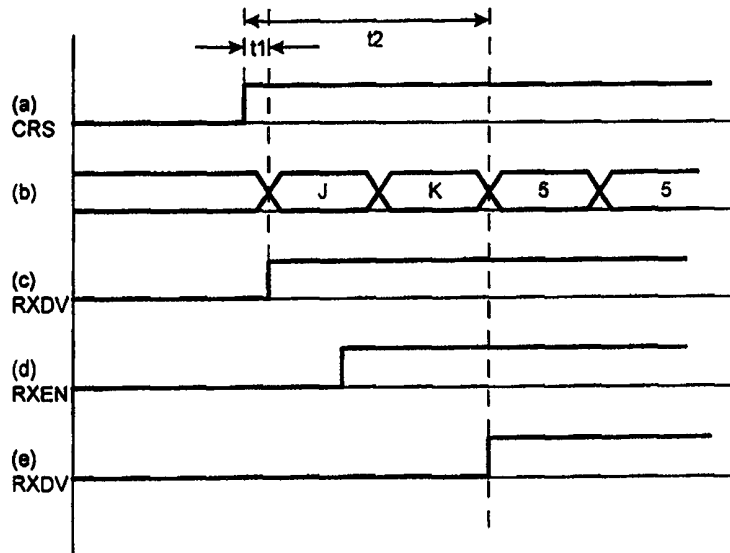
(57) Abstract

A network communications device is arranged to have a fast throughput of data packets. This is achieved by recognising that, in protocols such as Ethernet, the first symbols in a data packet do not carry any data and therefore do not necessarily require to be properly carried through a communications hub. Rather, a known number of symbols are discarded from the start of a packet on receipt and replaced on re–transmission. This discarding reduces the reception delays particularly in bussed–architecture repeaters where bus arbitration must take place for each received packet.

Network Communication Device

The present invention relates to computer networking technology and in particular to communication devices such as Repeaters for interconnecting network devices in such networks.

5   A Repeater is a very important component of computer networks such as local area networks as it provides the medium through which other devices can communicate with each other. In particular, a Repeater is provided with a number of communications ports and in the simplest configuration an end station, such as a computer is attached to each of the ports. A repeater functions such that any

10   communication which is received on one port is retransmitted on all of the other ports, so that a communication sent out by any one device attached to the network is received by all of the others. In principle, the retransmission by a Repeater of a communication should be simultaneous with its reception at the receiving port. In this ideal situation, it will therefore be understood that a common communications

15   medium is provided between all of the computers attached to the network via which communications can be sent between any of the devices. However, it is of course the case that, owing to the physical characteristics of the construction of the Repeater, the retransmission of a received communication is not instantaneous and the speed at which data can be passed through a Repeater has effects on the operation of the

20   network as will be explained in the following.

One very common type of communications protocol in such networks is a carrier sense multiple access protocol of which Ethernet is a well known example. In such a protocol communications between computers attached to the network are by way of data packets having a pre defined format. Whenever a network user wishes

25   to transmit a communications packet it simply attempts to access the communications medium provided by the Repeater or interconnected Repeaters and transmits the packet. The repeating function of the Repeater device mentioned above means that the communication packet reaches all of the other users on the network including the intended destination. In the event that another user is attempting to transmit a packet

at the same time, the two or more transmitting units sense that a collision has occurred on the network and therefore that the transmitted data packet will not have been successfully received. In order for the collision to be sensed and properly acted upon, the collision must be sensed by the transmitting station before it has completed the

5   transmission of a packet. If this occurs, the transmitting station will simply attempt, at the end of a predetermined period to retransmit the packet. If it completes transmission of the packet without receiving a collision detector signal, it will assume that the transmission was successful.

The above mentioned physical characteristics of the Repeater device

10   have an impact on the operation of such protocol for the following reasons. In order for a collision to be properly sensed by a transmitting station, the transmitted packet must be received by the Repeaters and repeated to all segments of the network quickly enough so that if a collision occurs on any one of the network segments this can be relayed back, via the Repeaters, to the transmitting station before the end of the

15   transmission of the packet in order that the collision can be properly sensed. It has been known that computer networks such as local area networks operating the Ethernet protocol can handle communications at 10 megabits per second (Mbps) for some while and it has been relatively easy to implement Repeaters for such network speeds which propagate data quickly enough so that up to approximately five

20   Repeaters could be connected together and still obtain satisfactory network performance.

More recently there have been new standards set to increase the speed of communication over local area networks. In particular standards have been set defining network communication speeds of 100Mbps. With communications

25   occurring at such increased speeds, it clearly takes less time for a transmitting station to complete the transmission of a packet. It is therefore necessary that the packet should be more quickly repeated to all of the network segments in order that any collisions can be detected and returned to the transmitting station before the completion of the transmission of the packet.

3

One standard for Repeaters which has been defined for 100Mbps networks is the Class I Repeater. With a Class I Repeater it is not permitted to connect two Repeaters together and so it is essentially necessary that each port on a Class I Repeater is directly connected to an end station or to a bridge or switch, which

5   are other well known types of communications hub.

There is also more recently defined a standard of a Class II Repeater according to which standard, two Class II Repeaters may be connected together in the configuration of a network. With such a configuration it is of course the case that a transmitted packet must be propagated through two Repeaters to enable it to reach all

10   of the network segments. To achieve this within the time constraints for detecting collisions as explained above, a Class II 100Mbps Repeater must propagate received data to its other ports significantly quicker than Class I Repeaters.

Also, for 100 Mbps Repeaters, the communication standards do not allow any alterations in the lengths of the preambles to the data packets passing

15   through the network. Therefore, as well as re-transmitting the packets quickly, a Class II Repeater must take considerable care to ensure that the whole of any received data packet, including the preamble, is accounted for and properly handled.

These constraints place considerable strain on the design of a Class II 100Mbps Repeater. The implications of this are discussed further below.

20   Within a Repeater device, there is of course a certain architecture of the various parts of the Repeater to enable the ports to be connected to the Repeater core which will be on ASIC or other chip. In particular, there is provided within a Repeater device a physical layer device (PHY) provided for each port and the PHYs are then connected to the Repeater core. In one configuration it has been known to connect all

25   of the PHYs directly to the Repeater core in a star configuration but this entails a large number of connections to the core.

A preferred Repeater architecture provides a receive data bus to which each PHY device is connected and which has a single connection to the Repeater core. Such an arrangement involving a data bus is advantageous as it reduces the

4

number of connections, and therefore physical pins, which must be made on the ASIC. This architecture is further explained, insofar as it is relevant to the present invention, with reference to Figure 2 which shows the interconnections made between ASIC 1 and PHY devices 2 in order to enable the reception of data. A Repeater

5   device would of course also include interconnections for the retransmission of the received data but the present invention is related principally to the receive side of a Repeater device and therefore the relevant portions of the receive side are shown.

As shown in Figure 2, there is provided a bus 10 to which all of the PHY devices 2 may put their received data (RXD) in order that the received data can

10   be received at ASIC 1. There is of course present some bus control arrangements such that only one PHY device at a time is accessing the bus 10 and this will be outlined in the following, also with reference to the timing diagram of Figure 3.

Figure 3b illustrates the start of a received data packet and in particular is illustrated according to the known defined 100Mbps protocol. The

15   communications packet begins with a predetermined sequence of symbols (in particular J, K followed by a plurality of 5s) which are present to enable functions such as synchronising with the packet to be done before the information bearing portion of the packet arrives, and other known functions. Shortly before the arrival of the beginning of the data packet, the imminent arrival is sensed by the PHY device

20   2 and the device asserts its carrier sense signal (CRS) as illustrated in Figure 3a. In a response to this, and if it is appropriate to do so, ASIC 1 permits access to the data bus by the PHY device in question by asserting the corresponding receive enable (RXEN) signal. The corresponding PHY device 2 then has access to data bus 10 in order to write the received data to the bus.

25   Another signal generated by PHY device 2 on reception of a data packet which is important for the proper reception of the data is the receive data valid (RXDV) signal and this signal is asserted by PHY device 2 in synchronism with the beginning of the communications packet, as illustrated in Figure 3c. In order for the data to be properly received by ASIC 1 it is therefore necessary that the PHY device

5

2 which is receiving a data packet should receive the RXEN signal to authorise its access to the bus before the beginning of the data packet and the time at which it should assert RXDV. This time interval is designated t1 is Figure 3.

At the lowest speeds at which previous Repeaters were permitted to

5   work, time interval t1 was sufficiently long to allow this to occur.

However, in the context of Class II Repeaters as mentioned above, the speed of reception of the data by the PHY device must be high in order to meet the overall timing requirements and therefore data needs to be put onto data bus 10 very quickly upon its reception. The problem with this is that there is insufficient time for

10   ASIC 1 to receive and respond to the carrier sense signal and to return the appropriate RXEN signal before the time at which the PHY device 2 is ready to put the beginning of the packet onto data bus 10 and to assert its RXDV signal. Therefore, either the PHY device 2 must delay the transmission of the data to the data bus 10, which is not acceptable in the context of a Class II Repeater, or an unknown amount of the

15   preamble of the receive data packet would be lost due to the bite assertion of RXDV, which loss is not allowed in 100Mbps networks. In particular, to avoid these problems, the RXEN signal would have to be asserted by ASIC 1 within 20ns of receiving the carrier sense signal and this is very difficult if not impossible to achieve.

The present invention provides a communication device for a computer

20   network comprising:

a plurality of ports arranged to receive and transmit communications in the form of data packets from and to the network;

communication core means arranged to receive communications received at said ports and to implement a desired functionality for re-transmission of

25   said communications via said ports;

data transfer means arranged to carry communications received at said ports to said communication core means;

receive means associated with each of said ports arranged to send received data packets to said data bus means without a predetermined portion from

the beginning of the data packets; and

transmit means associated with each said port arranged to receive data packets for transmission from said communication core means and to replace said predetermined portion at the beginning of the data packet for transmission from the respective port.

In particular, the present invention provides a Repeater for use in computer networks of the general type discussed above, in which the PHY device associated with each port, on reception of a communications packet for retransmission to the other ports, delays the assertion of its RXDV signal to a predetermined time within the preamble to the received packet and transmits all of the symbols subsequent to this predetermined time to the Repeater core.

It will be appreciated that, in the above bus-type arrangement, more time is permitted for the ASIC to provide the RXEN signal as it is necessary only to assert the RXEN signal prior to the RXDV assertion by the PHY device. The portion of the packet prior to the assertion of RXDV is therefore lost on reception of the packet by the PHY device but, as the beginning of all the communications packets would be the same, or in any event the actual bits in the beginning of the packet are not data carrying, the missing portion is replaced by other PHY devices within the overall Repeater device on retransmission of the packet to the remainder of the network. Therefore a complete packet appears to be transmitted through the Repeater device in accordance with the required standards, but a faster operation can be achieved.

In the preferred embodiment, it is the first two symbols of the communications packet preamble which are not transmitted through the Repeater.

Although particularly advantageous in Repeater devices as discussed above, this invention generally accelerates the reception and handling of data packets by network devices and therefore is also applicable to other network devices such as bridges and switches.

The invention therefore takes advantage of the fact, that in

communication protocols such as Ethernet, no important data is contained in the first portion of a communications packet, this portion of the packet being generally a non-data carrying preamble to assist in sensing and synchronising with the packet.

The removal of a predetermined number of bits from the beginning of the packet by the physical layer device on reception of the packet allows more time for the Repeater to enable access to the Repeater core and get the remainder of the communications packet to the other physical layer devices for retransmission whilst still enabling the fast transmission times necessary to meet requirements of fast operating networks, and preserving the correct length of preamble as required by the 100Mbps Ethernet standard as mentioned above. For this, it is the case that, in the invention, the preamble is completed by a physical layer device on retransmission of the packet so as to conform to network protocols.

The present invention will be better understood from the following description of a preferred embodiment with reference to the accompanying drawings in which:

Figure 1 is a schematic diagram of a communication device according to the invention in an exemplary network environment;

Figure 2 is a schematic diagram illustrating the architecture of the receive side of a Repeater according to the preferred embodiment; and

Figure 3 is a timing diagram illustrating the operation of Repeater devices.

In a preferred embodiment of this invention a network communications device is arranged to have a fast throughput of data packets. This is achieved by recognising that, in protocols such as Ethernet, the first symbols in a data packet do not carry any data and therefore do not necessarily require to be properly carried through a communications hub. Rather, a known number of symbols are discarded from the start of a packet on receipt and replaced on re-transmission. This discarding reduces the reception delays particularly in bussed-architecture repeaters where bus arbitration must take place for each received packet.

Figure 1 illustrates in schematic form a communication device 10 according to the preferred embodiment in a network context. The network includes network devices 20 which may be terminal equipment such as PCs or printers or may be other communication devices connected to other portions of the network. As

5   illustrated, communication device 10, which is, in the preferred embodiment, a repeater, has a plurality of ports 12 to which network devices 20 are connected for the transmission of communications in the form of data packets.

Associated with each of ports 12 is a physical layer device (PHY) 2 which deals with the transmission and reception of the communication as electrical

10   signals in the network. At the heart of repeater 20 is core means 1, generally implemented as an ASIC, which provides the repeater functionality. Each of PHY device 2 is in communication with ASIC 1 as will be discussed in more detail below to enable ASIC 1 ro receive and re-transmit data packets from and to the required ones of ports 12.

15   As mentioned above, Figure 2 illustrates a schematic outline of the receiver side of a Repeater device, comprising ASIC 1 performing the core functions of the Repeater and a plurality of PHY devices 2, one being provided for each port of the Repeater. Incoming communications are received at PHY devices 2 and are passed via the RXD bus 10 to ASIC 1 for retransmission from the other ports. Also

20   as outlined above, access to the bus is requested by asserting the carrier sense signal (CRS) and access to the bus is granted by the return of the RXEN signal from ASIC 1. The other signal illustrated in Figure 2 is receive data valid (RXDV) which is asserted by a PHY device 2 in synchronism with the transmission of a data packet to bus 10.

25   Also as mentioned above, Figure 3a illustrates the assertion of CRS at time interval t1 before the beginning of the communications packet illustrated in Figure 3b. In a 100Mbps per second network time interval t1 may be as small as 20ns.

Because the assertion of CRS is asynchronous with the timing which

is ongoing within ASIC 1, there is no guarantee as to the time interval between the time at which a PHY device 2 asserts CRS and the time at which the corresponding RXEN signal is returned by ASIC 1. As illustrated in Figure 3d RXEN will be asserted at some time later after the assertion of CRS and, in general, this will not be within the time interval t1.

According to this invention, on receipt of the RXEN signal the PHY device 2 does not immediately assert its RXDV signal and start sending receive data to the bus 10. Because there is no specific knowledge of the time at which RXEN will be provided, this would mean that an unknown portion of the preamble of the data packet would potentially be lost.

Rather it is the case that the PHY device 2 waits until a specific predetermined time during the preamble of the data packet before it asserts RXDV and transmits the remainder of the data packet to the data bus 10.

In the preferred embodiment, the PHY device 2 asserts RXDV at the time at the end of the second symbol (commonly known as the "K" symbol) as shown in Figure 3e. RXDV therefore usefully and properly signals the timing of the received data packet to ASIC 1 and it is known with certainty which portions of the data packet passed before the assertion of RXDV. ASIC 1 can then retransmit the received parts of the receive data to the other PHYs for retransmission, and the other PHY devices 2 are arranged so as to re-complete the preamble to the data packet by the addition of the J and K symbols so that a complete data packet is retransmitted in the form it was received.

It will be appreciated therefore that the window of opportunity available for ASIC 1 to assert RXEN is extended to the time shown as t2 in Figure 3 which typically equates to approximately 100ns. In a typical implementation of the present invention RXEN is in fact asserted within 80ns of the assertion of CRS and therefore the above described timing can be properly implemented.

The present invention therefore permits the implementation of a Class II 100Mbps per second Repeater having a bus architecture.

CLAIMS:

1.   A communication device for a computer network comprising:

            a plurality of ports arranged to receive and transmit communications in
the form of data packets from and to the network;

            communication core means arranged to receive communications
received at said ports and to implement a desired functionality for re-transmission of
said communications via said ports;

            data transfer means arranged to carry communications received at said
ports to said communication core means;

            receive means associated with each of said ports arranged to send
received data packets to said data bus means without a predetermined portion from
the beginning of the data packets; and

            transmit means associated with each said port arranged to receive data
packets for transmission from said communication core means and to replace said
predetermined portion at the beginning of the data packet for transmission from the
respective port.

2.   A communication device according to claim 1 in which said data
transfer means is a bus means common to said receive means, said receive means
being arranged to request access to said bus upon receipt of a data packet at a port,
and said communication core means being responsive to such requests to control
access to said bus means.

3.   A communication device according to claim 2 in which said
communication core asserts an enable signal to indicate to a said receive means that
it may access said data bus, said enable signal being asserted during the time said
predetermined portion of the data packet is being received at said port.

4.   A communication device according to claim 1, 2 or 3 for a network operating according to a protocol in which the beginning of each data packet comprises non-information bearing bits, and said predetermined portion of a data packet is at least some of said non-information bearing bits.

5

5.   A communication device according to claim 4 in which the bit sequence at the beginning of said data packet is known, and said transmit means is arranged to replace said known bit sequence at the beginning of each data packet for transmission.

10   6.   A communication device according to claim 4 in which said transmit means is arranged to replace said predetermined portion at the beginning of each data packet with a bit sequence in conformity with said protocol.

7.   A communication device according to claim 4, 5 or 6 in which data
15   packets in said protocol are formed of symbols, and said predetermined portion is an integral number of symbols.

8.   A communication device according to any of claims 1-7 being a repeater device, said communication core means being arranged to implement
20   repeater functionality.

9.   A communication device according to any of claims 1-7 being a bridge or switch device, said communication core means being arranged to implement a bridge or switch functionality.

25

10.   A communication device for a computer network substantially as hereinbefore described with reference to the accompanying drawings.
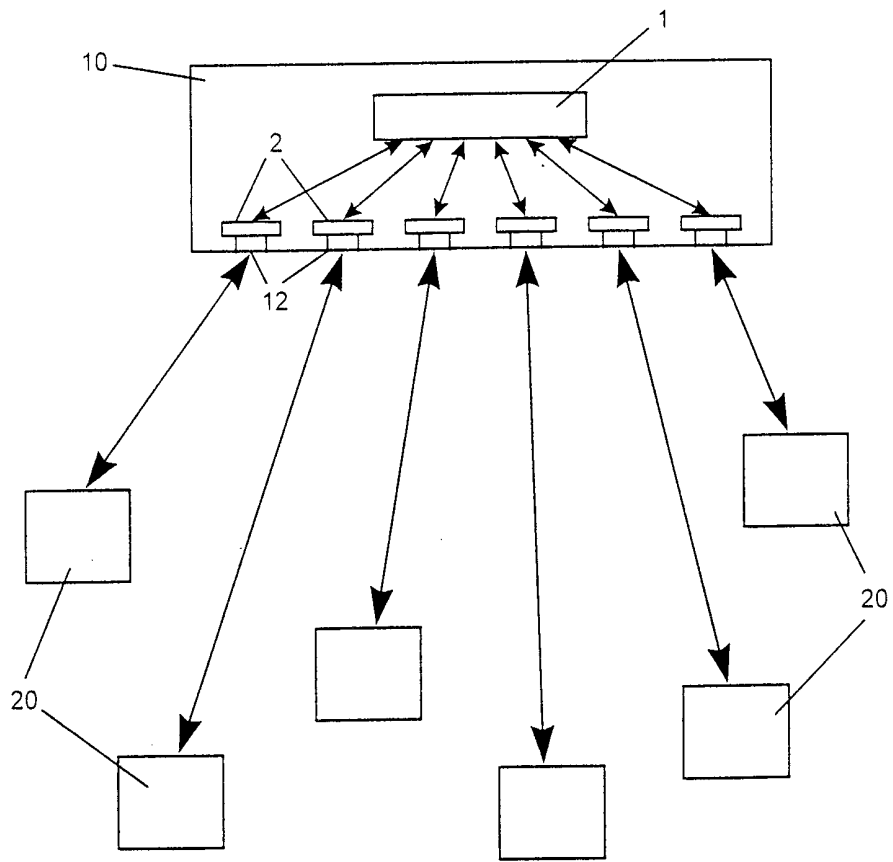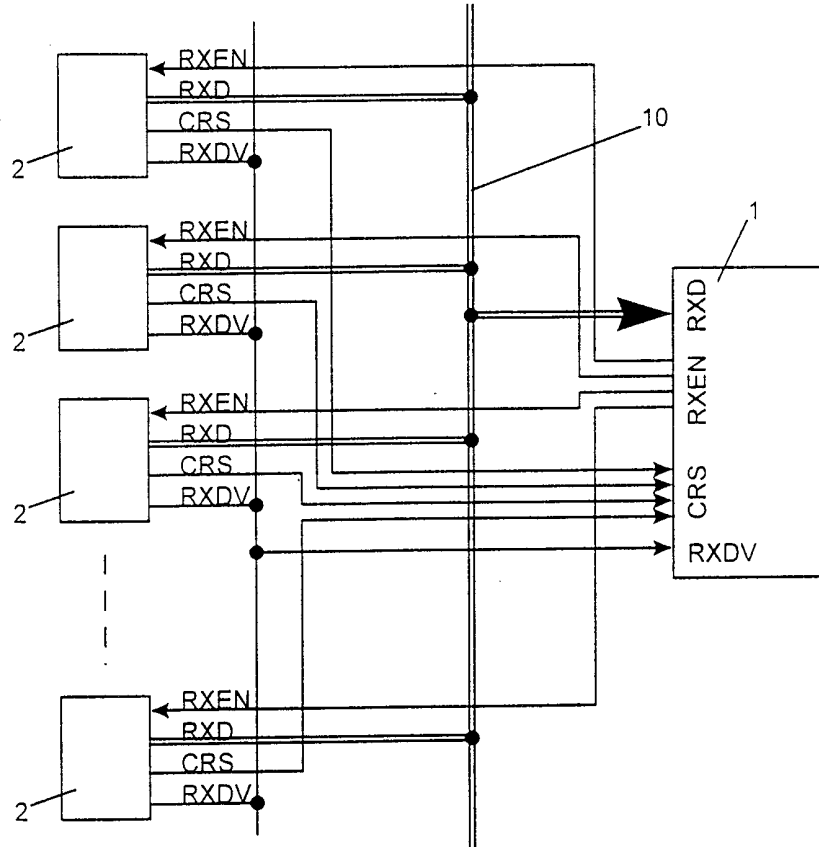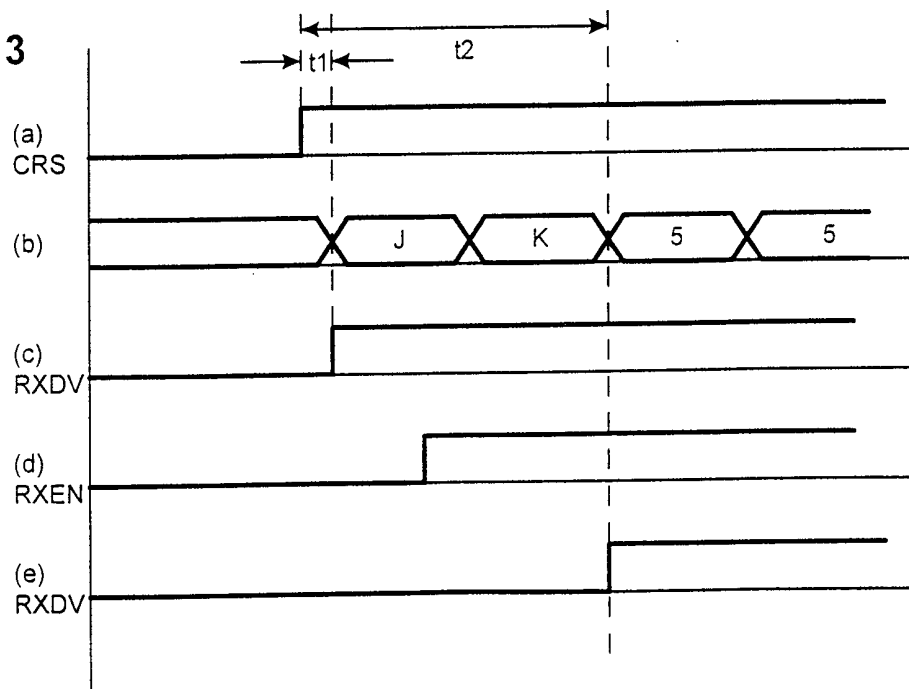
1/2

Fig. 1

Fig. 2

Fig. 3

INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6   H04L12/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6   H04L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 4 627 052 A (HOARE DAVID P ET AL) 2 December 1986 see column 2, line 65 - column 6, line 28	1,4-7,9, 10 8 2,3
X A	US 5 274 631 A (BHARDWAJ VINOD K) 28 December 1993 see column 4, line 22 - column 5, line 17 see column 14, line 8 - column 16, line 61	1,4-7,9, 10 2,3,8
Y A	US 5 550 803 A (CRAYFORD IAN S ET AL) 27 August 1996 see column 6, line 18 - line 42	8 1
A	US 5 598 581 A (DAINES BERNARD N ET AL) 28 January 1997 see column 8, line 47 - column 10, line 6	1-10

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 April 1999	26/04/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	RAMIREZ DE AREL.., F

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US 4627052	A	02-12-1986	AU	569380 B	28-01-1988
			AU	4004885 A	26-09-1985
			EP	0156542 A	02-10-1985
US 5274631	A	28-12-1993	NONE		
US 5550803	A	27-08-1996	WO	9629797 A	26-09-1996
US 5598581	A	28-01-1997	AU	680031 B	17-07-1997
			AU	7409794 A	28-02-1995
			CA	2168035 A	16-02-1995
			EP	0712515 A	22-05-1996
			JP	9509289 T	16-09-1997
			WO	9504970 A	16-02-1995
			US	5737635 A	07-04-1998