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Online : EPODOC

(54) Abstract Title

Coping with momentary line interruption in data transmission apparatus eg a modem

(57) This apparatus comprises a 2.5-second counter (142) for counting 2.5 seconds from the restoration of a carrier, and a 15-second counter (143) for counting 15 seconds from the interruption of the carrier. A hold signal (2) being a logical sum (144) of the output of the 2.5-second counter and the output of the 15-second counter instructs the cancellation of a holding of parameters related to a data receiving operation, when either of the counters finishes counting. While a hold signal (4), not using the output of the 2.5-second counter (142), instructs the cancellation of the holding immediately after the restoration of the carrier, a hold signal (2) using the output of the 2.5-second counter (142) instructs the cancellation of the holding a prescribed time after the restoration of the carrier. By changing the hold conditions of parameters according to a time after the interruption of the carrier or control targets, under these instructions, a data transmission apparatus can be restored rapidly when a short line interruption occurs.

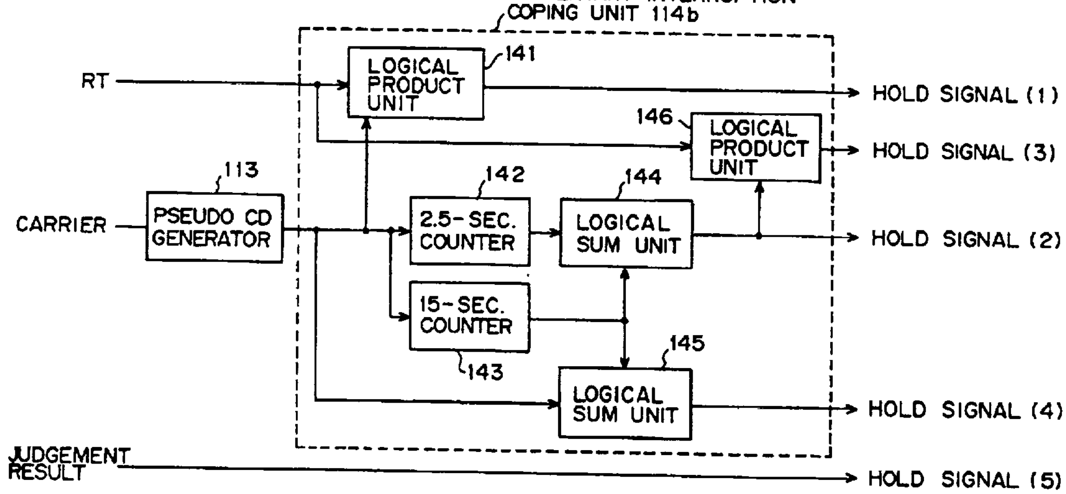


FIG. 8

GB 2 341 060 A

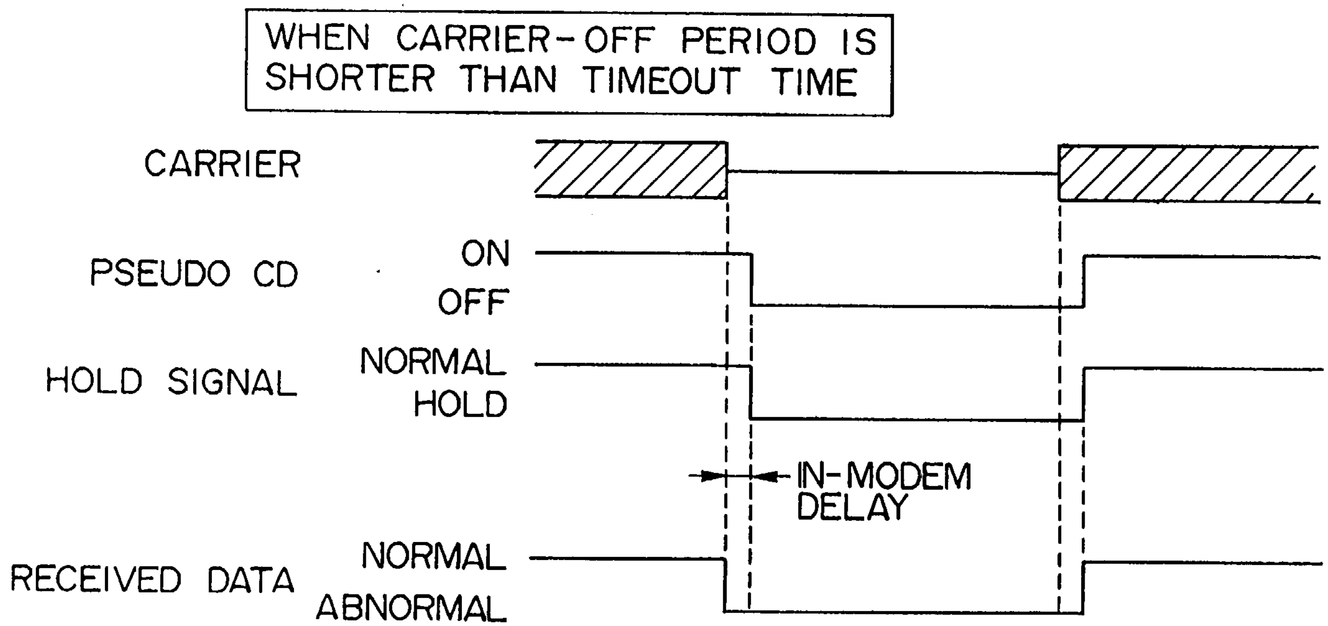


FIG. 1 PRIOR ART

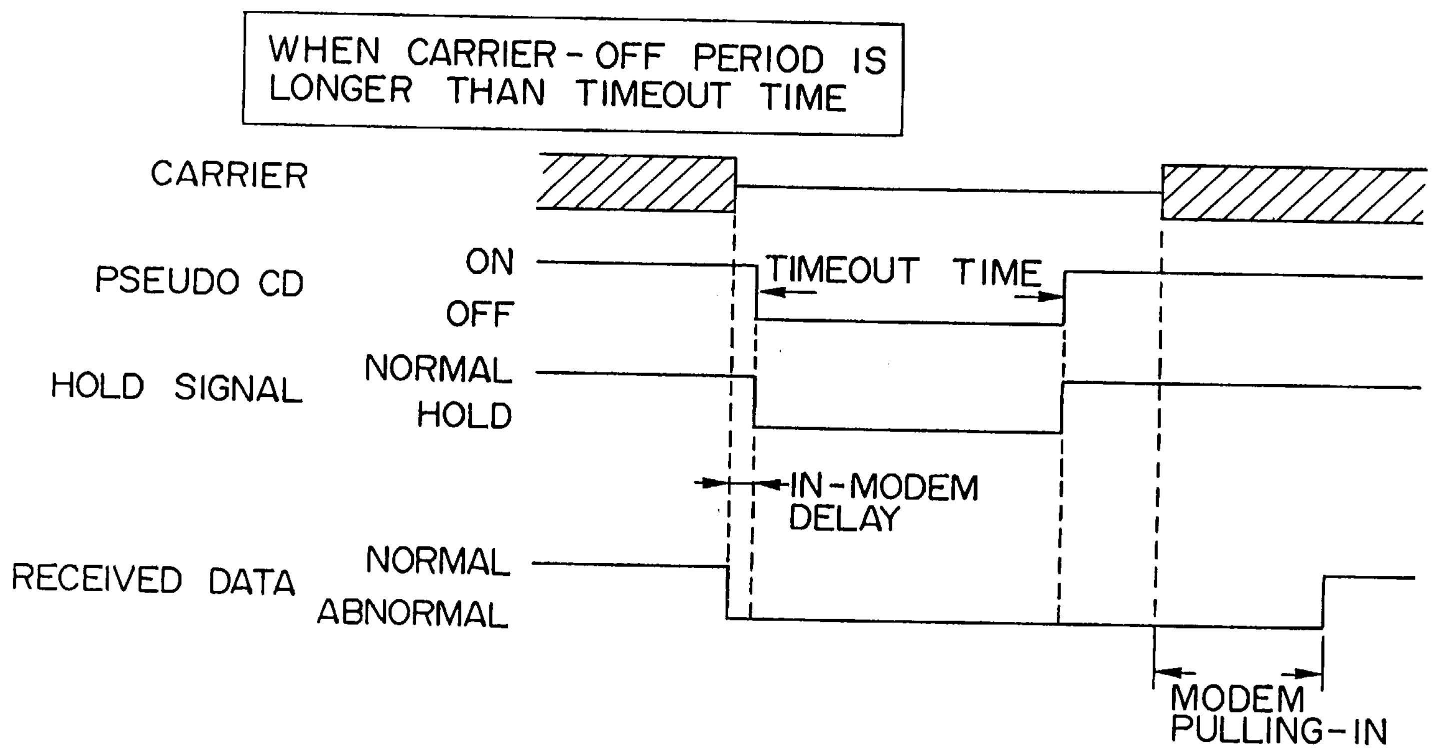


FIG. 2 PRIOR ART

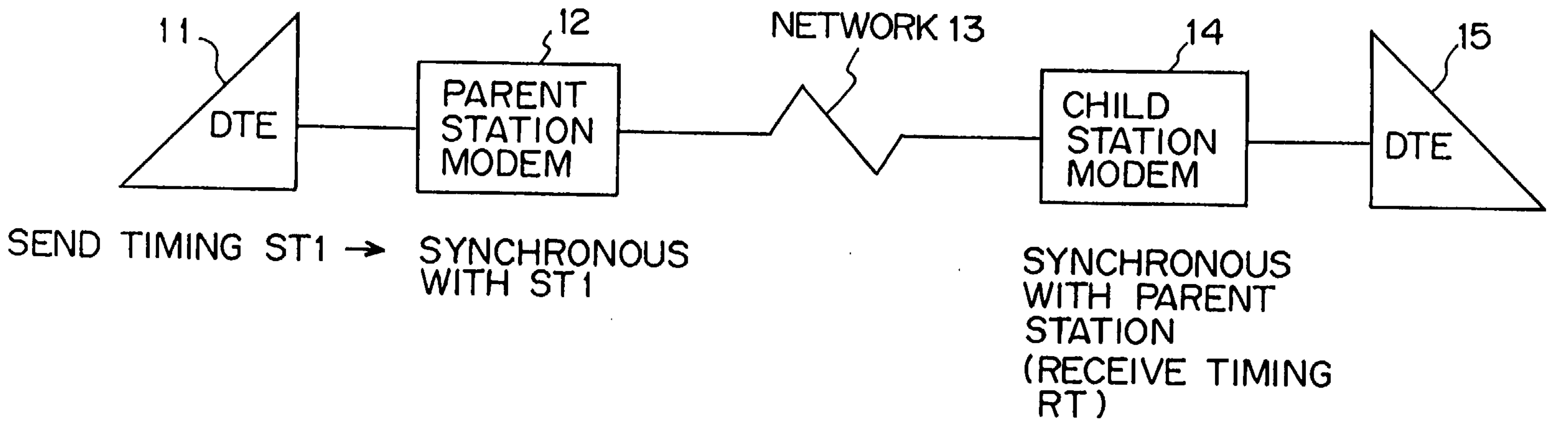
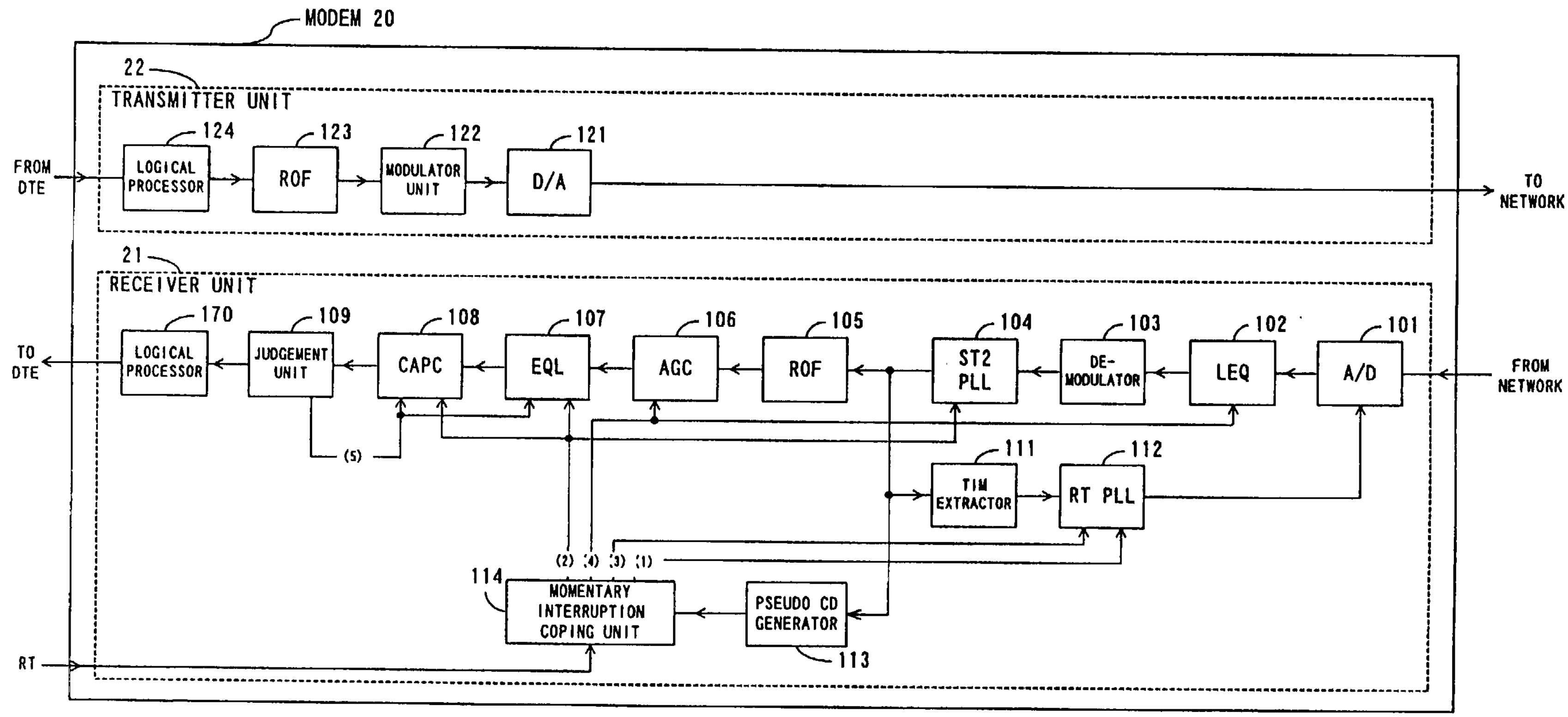
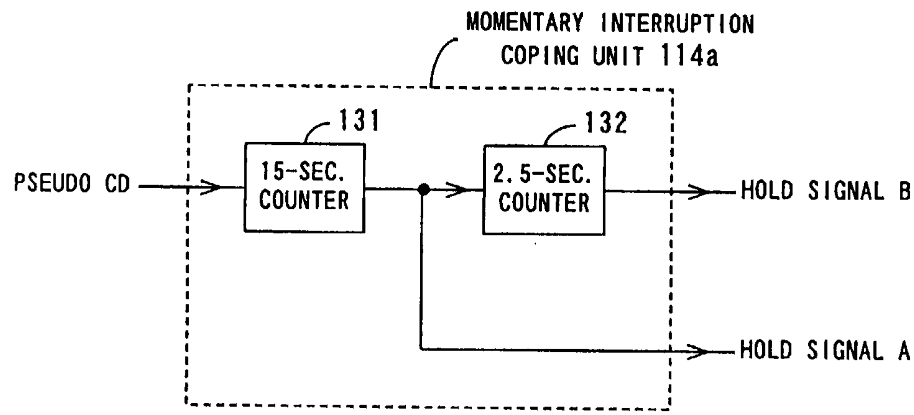

11
DTE
12
PARENT STATION MODEM
NETWORK 13
14
CHILD STATION MODEM
15
DTE
SEND TIMING ST1 →
SYNCHRONOUS WITH ST1
SYNCHRONOUS WITH PARENT STATION (RECEIVE TIMING RT)

FIG. 3


MODEM 20
22
TRANSMITTER UNIT
FROM DTE
LOGICAL PROCESSOR
124
ROF
123
MODULATOR UNIT
122
D/A
121
TO NETWORK
21
RECEIVER UNIT
TO DTE
LOGICAL PROCESSOR
170
JUDGEMENT UNIT
109
CAPC
108
EQL
107
AGC
106
ROF
105
ST2 PLL
104
DE-MODULATOR
103
LEQ
102
A/D
101
FROM NETWORK
(5)
TIM EXTRACTOR
111
RT PLL
112
(2) (4) (3) (1)
114
MOMENTARY INTERRUPTION COPING UNIT
PSEUDO CD GENERATOR
113
RT

F I G. 4


MOMENTARY INTERRUPTION
COPING UNIT 114a
131
132
PSEUDO CD
15-SEC.
COUNTER
2.5-SEC.
COUNTER
HOLD SIGNAL B
HOLD SIGNAL A

F I G. 5

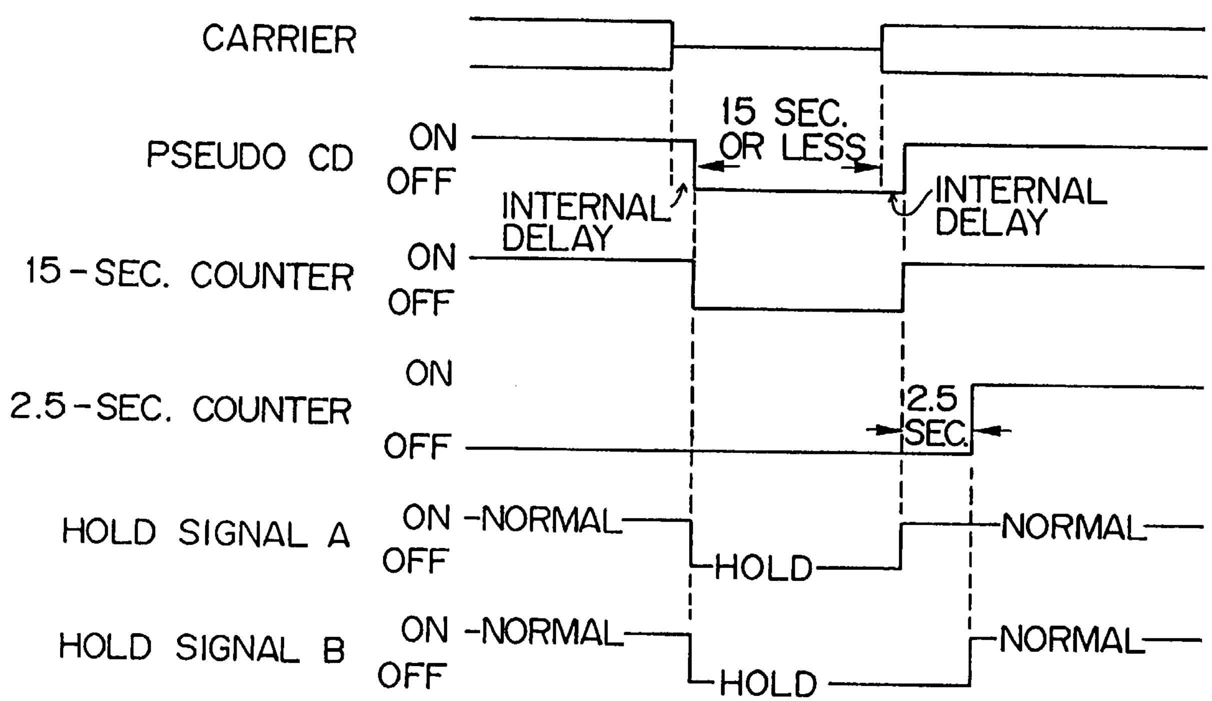

CARRIER
PSEUDO CD
ON
OFF
15-SEC. COUNTER
ON
OFF
2.5-SEC. COUNTER
ON
OFF
HOLD SIGNAL A
ON
OFF
HOLD SIGNAL B
ON
OFF
15 SEC. OR LESS
INTERNAL DELAY
INTERNAL DELAY
2.5 SEC.
NORMAL
HOLD
NORMAL
NORMAL
HOLD
NORMAL

FIG. 6

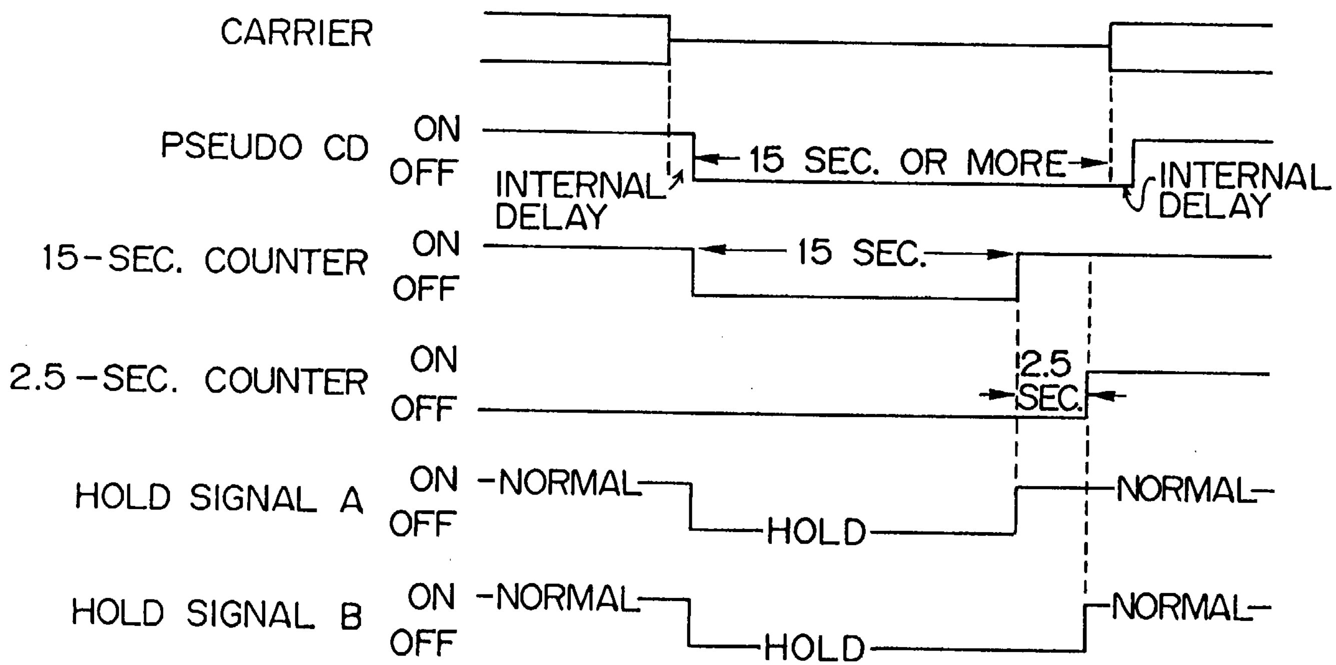

CARRIER
PSEUDO CD
ON
OFF
INTERNAL DELAY
15 SEC. OR MORE
INTERNAL DELAY
15-SEC. COUNTER
ON
OFF
15 SEC.
2.5-SEC. COUNTER
ON
OFF
2.5 SEC.
HOLD SIGNAL A
ON
OFF
NORMAL
HOLD
NORMAL
HOLD SIGNAL B
ON
OFF
NORMAL
HOLD
NORMAL

FIG. 7

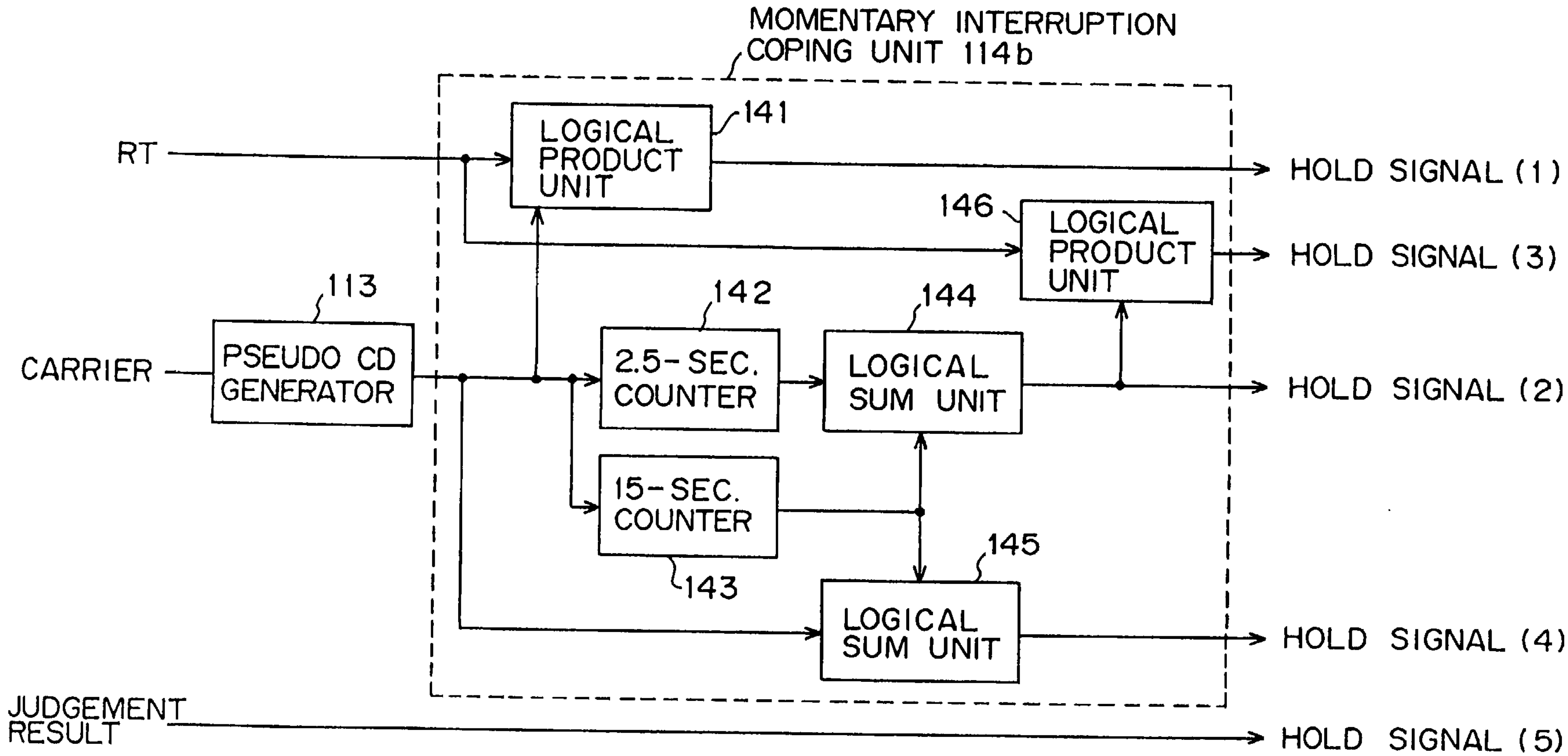

MOMENTARY INTERRUPTION
COPING UNIT 114b
RT
CARRIER
JUDGEMENT
RESULT
113
PSEUDO CD
GENERATOR
141
LOGICAL
PRODUCT
UNIT
142
2.5-SEC.
COUNTER
15-SEC.
COUNTER
143
144
LOGICAL
SUM UNIT
145
LOGICAL
SUM UNIT
146
LOGICAL
PRODUCT
UNIT
HOLD SIGNAL (1)
HOLD SIGNAL (3)
HOLD SIGNAL (2)
HOLD SIGNAL (4)
HOLD SIGNAL (5)

FIG. 8

SIGNAL	CONTROL TARGET FOR HOLDING PARAMETERS
HOLD SIGNAL (1)	· RT PLL (PHASE INFORMATION)
HOLD SIGNAL (2)	· ST2 PLL · EQL · CAPC
HOLD SIGNAL (3)	· RT PLL (FREQUENCY INFORMATION)
HOLD SIGNAL (4)	· AGC · LEQ
HOLD SIGNAL (5)	· EQL · CAPC

F I G. 9

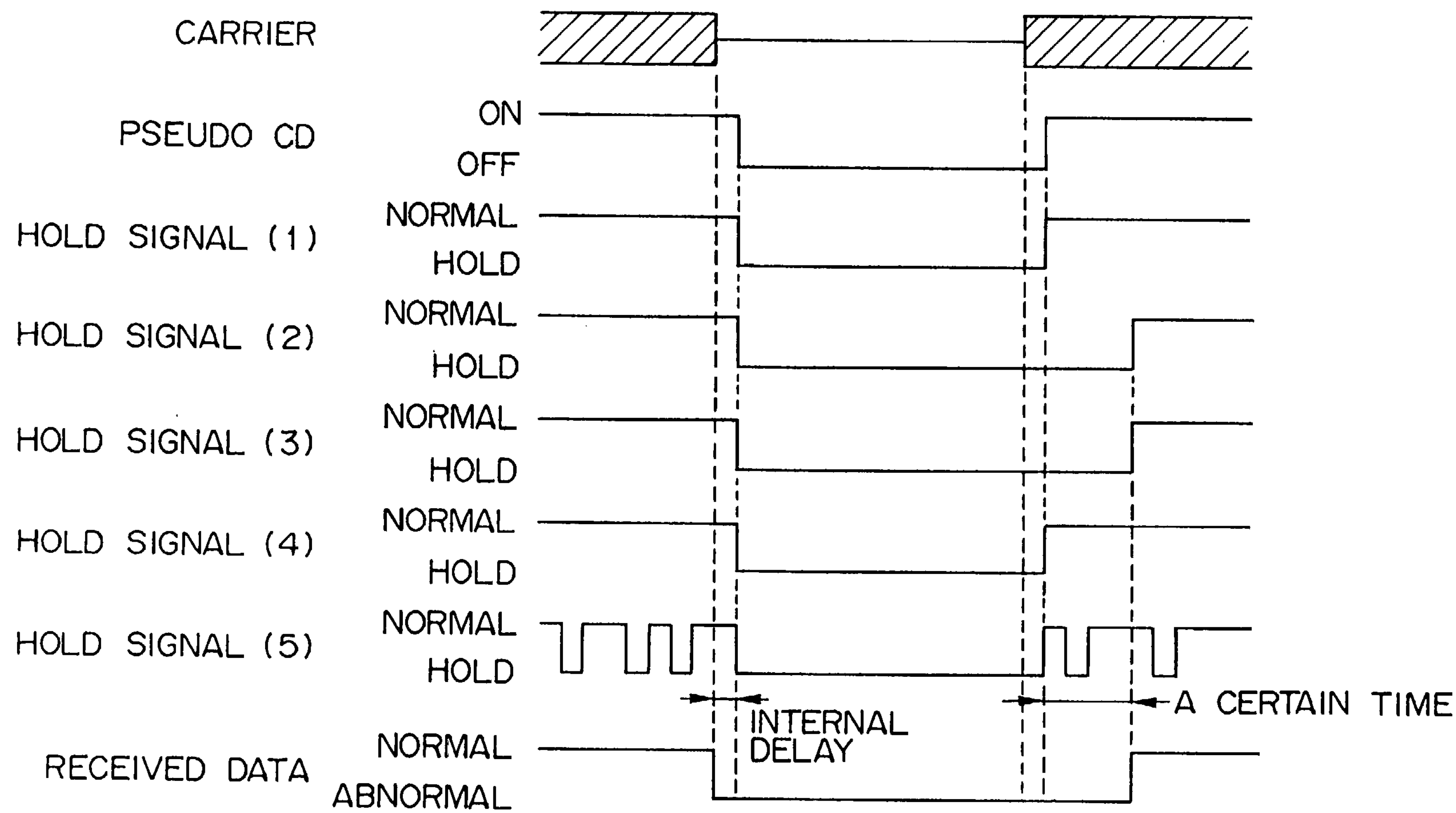

CARRIER
PSEUDO CD
ON
OFF
HOLD SIGNAL (1)
NORMAL
HOLD
HOLD SIGNAL (2)
NORMAL
HOLD
HOLD SIGNAL (3)
NORMAL
HOLD
HOLD SIGNAL (4)
NORMAL
HOLD
HOLD SIGNAL (5)
NORMAL
HOLD
INTERNAL DELAY
A CERTAIN TIME
RECEIVED DATA
NORMAL
ABNORMAL

FIG. 10

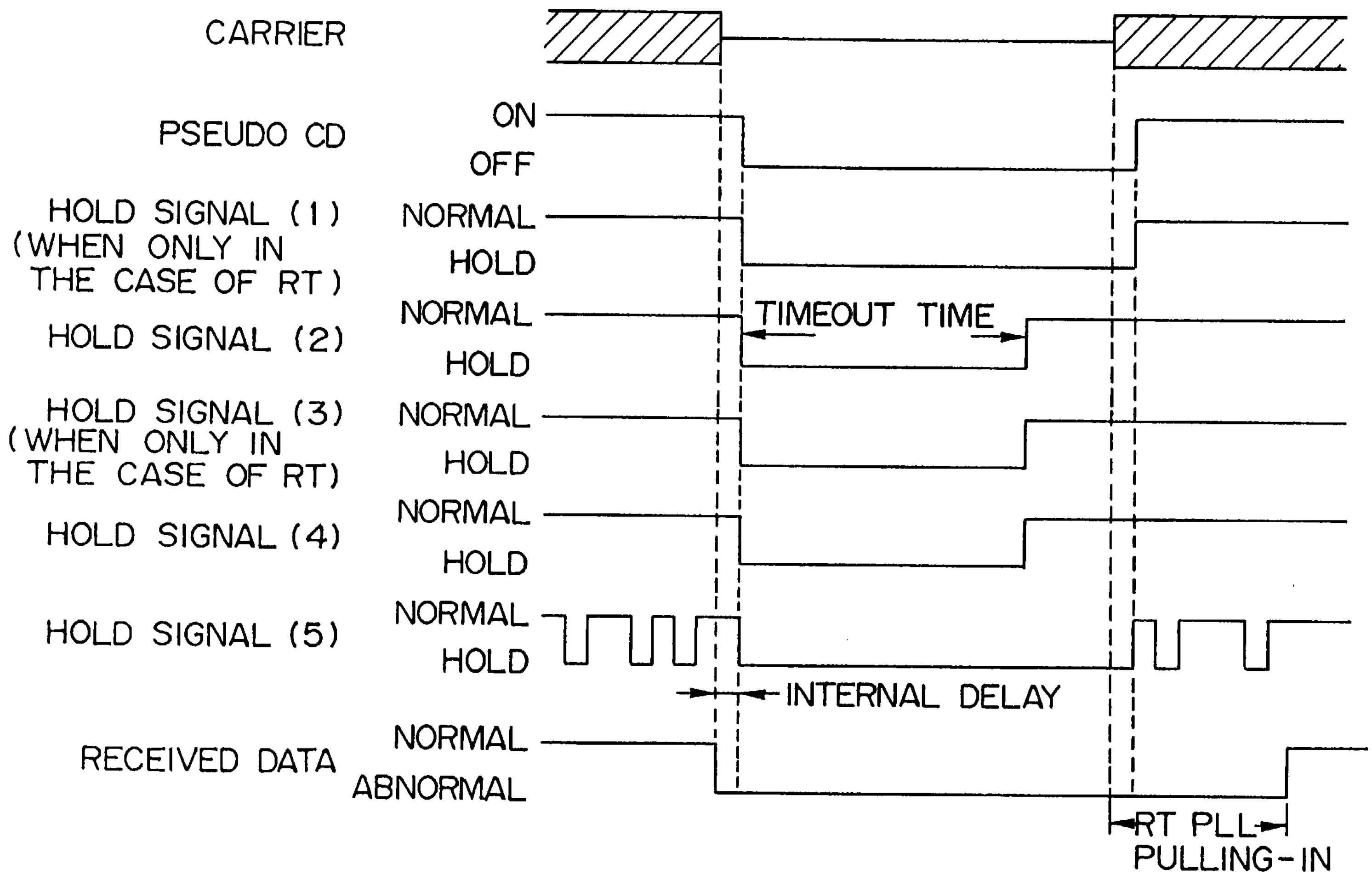

CARRIER
PSEUDO CD
ON
OFF
HOLD SIGNAL (1) (WHEN ONLY IN THE CASE OF RT)
NORMAL
HOLD
HOLD SIGNAL (2)
NORMAL
HOLD
TIMEOUT TIME
HOLD SIGNAL (3) (WHEN ONLY IN THE CASE OF RT)
NORMAL
HOLD
HOLD SIGNAL (4)
NORMAL
HOLD
HOLD SIGNAL (5)
NORMAL
HOLD
INTERNAL DELAY
RECEIVED DATA
NORMAL
ABNORMAL
RT PLL PULLING-IN

FIG. 11

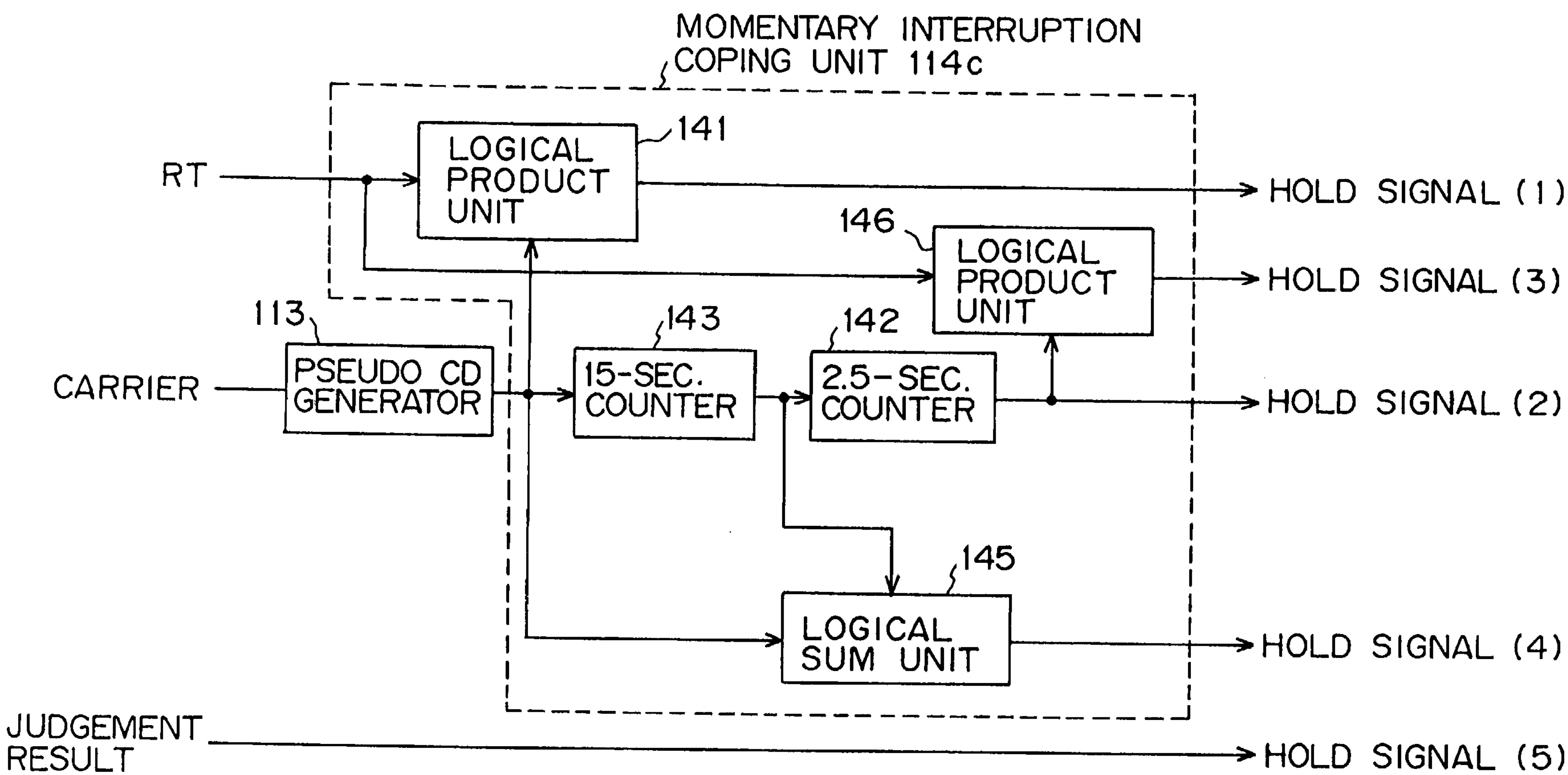

MOMENTARY INTERRUPTION
COPING UNIT 114c
RT
LOGICAL PRODUCT UNIT
141
HOLD SIGNAL (1)
146
LOGICAL PRODUCT UNIT
HOLD SIGNAL (3)
113
PSEUDO CD GENERATOR
CARRIER
143
15-SEC. COUNTER
142
2.5-SEC. COUNTER
HOLD SIGNAL (2)
145
LOGICAL SUM UNIT
HOLD SIGNAL (4)
JUDGEMENT RESULT
HOLD SIGNAL (5)

FIG. 12

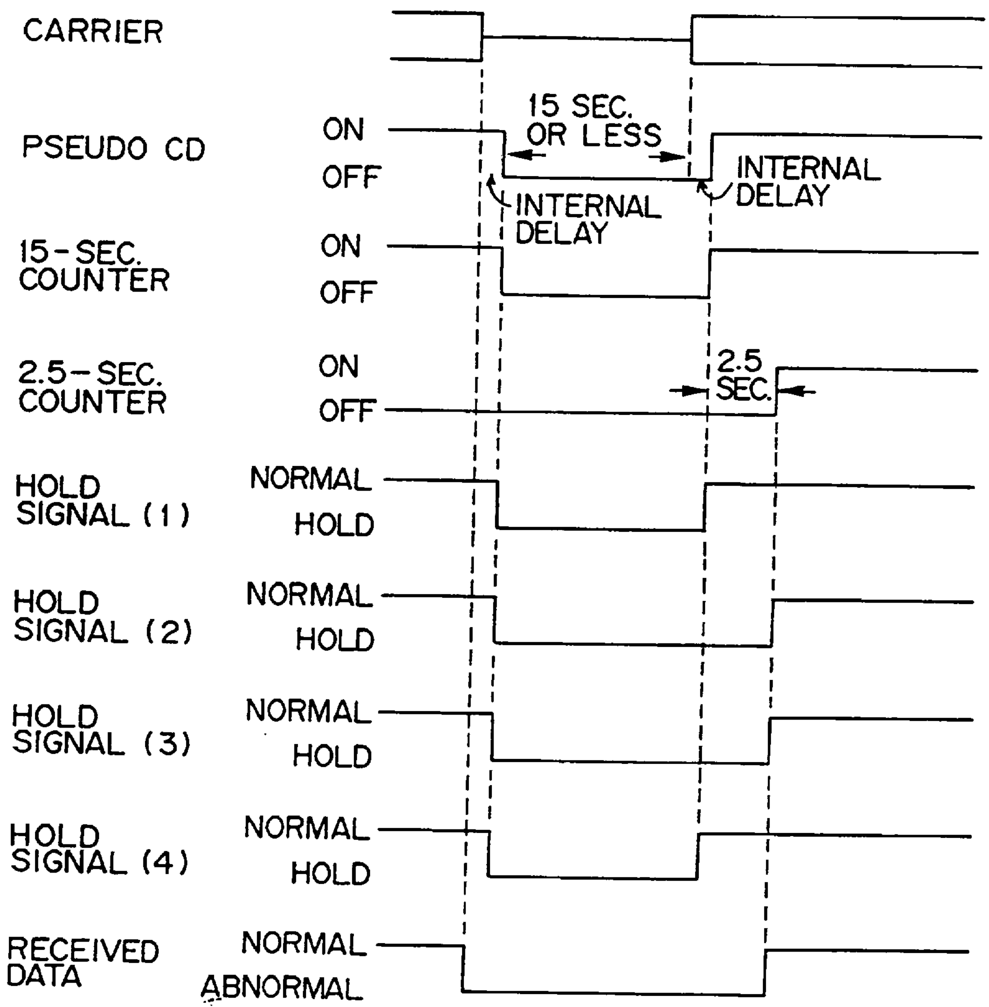

CARRIER
PSEUDO CD
ON
OFF
15 SEC.
OR LESS
INTERNAL
DELAY
INTERNAL
DELAY
15-SEC.
COUNTER
ON
OFF
2.5-SEC.
COUNTER
ON
OFF
2.5
SEC.
HOLD
SIGNAL (1)
NORMAL
HOLD
HOLD
SIGNAL (2)
NORMAL
HOLD
HOLD
SIGNAL (3)
NORMAL
HOLD
HOLD
SIGNAL (4)
NORMAL
HOLD
RECEIVED
DATA
NORMAL
ABNORMAL

FIG. 13

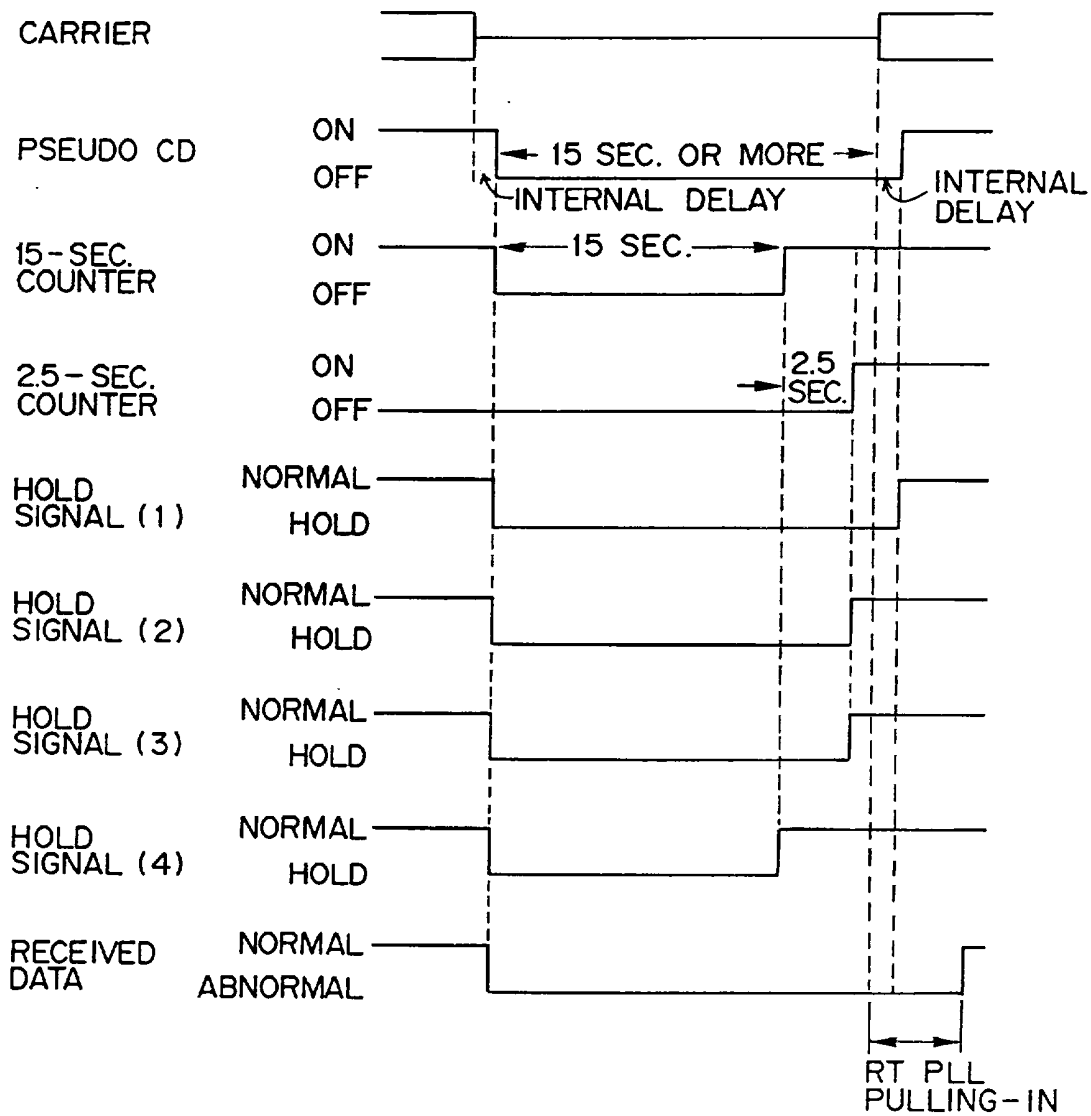

CARRIER
PSEUDO CD
ON
OFF
15 SEC. OR MORE
INTERNAL DELAY
INTERNAL DELAY
15-SEC. COUNTER
ON
OFF
15 SEC.
2.5-SEC. COUNTER
ON
OFF
2.5 SEC.
HOLD SIGNAL (1)
NORMAL
HOLD
HOLD SIGNAL (2)
NORMAL
HOLD
HOLD SIGNAL (3)
NORMAL
HOLD
HOLD SIGNAL (4)
NORMAL
HOLD
RECEIVED DATA
NORMAL
ABNORMAL
RT PLL PULLING-IN

FIG. 14

2341060

METHOD OF COPING WITH MOMENTARY LINE INTERRUPTION IN DATA TRANSMISSION APPARATUS AND DATA TRANSMISSION APPARATUS FOR COPING WITH MOMENTARY LINE INTERRUPTION

The present invention relates to a method for rapid restoration after a momentary line interruption when one occurs in data transmission apparatuses, such as a modem, etc. It also relates to an apparatus for coping with such a momentary line interruption.

A momentary interruption of data transmission signals due to the failure of a communication network, etc. occurs, and a variety of counter-measures have been examined.

Conventionally, a modem has always monitored whether or not a carrier for data transmission signals transmitted in a communication network is interrupted, that is, whether or not the carrier is received. When the carrier is interrupted (becomes off), a variety of the set parameters of the modem have been held, whereas when the carrier becomes on, that is, when the carrier is normally received, the holding of the variety of parameters has been cancelled.

Figs. 1 and 2 are timing charts showing this method in further detail. Fig. 1 shows a process in a case where a carrier-off period is shorter than a predetermined timeout time. Fig. 2 shows a process in a case where the time for the carrier-off period is longer than the timeout time. A timeout time is a time after which a rapid restoration process is abandoned and the holding of the variety of parameters is cancelled when the interruption of the carrier continues for a time longer than an arbitrary predetermined time.

First, Fig. 1 is described.

The modem is configured such that while a carrier signal is received, a pseudo CD (carrier detect) signal becomes on, whereas while it is not received, the pseudo CD signal becomes off. In the case of Fig. 1, too, when the carrier signal becomes off, that is, the carrier signal stops being received, the pseudo CD signal changes from on to off. Since from when the carrier-off is detected until the pseudo CD signal becomes off, a delay in time due to the process inside the modem occurs, there is an in-modem delay from when the carrier signal becomes off until the pseudo CD signal becomes off as shown in Fig. 1.

Since when the carrier signal becomes off, signals cannot be received normally, received data changes from a normal state to an abnormal state. When the pseudo CD signal becomes off, simultaneously a hold signal for instructing the cancellation of the holding of the variety of parameters of the modem changes from a normal state to an abnormal state.

When the carrier becomes on before the timeout time elapses, the pseudo CD signal becomes on after the in-modem delay time elapses. Then, the hold signal changes from a hold state to a normal state, and the received data is restored from an abnormal state to a normal state. In this way, after the carrier is restored to on, the normal reception of data can be re-started rapidly.

On the other hand, the case shown in Fig. 2 is as follows.

The process in the case where the carrier becomes off, is the same as that in Fig. 1. When the carrier does not become on after the timeout time elapses, the pseudo CD signal is forced to become on. Here, a timer is used to judge whether or not the timeout time has elapsed. When the counting by the timer exceeds the timeout time, the pseudo CD signal becomes on. Then, the hold signal changes from a hold state to a normal state. When the hold signal changes to a normai state, the variety of held parameters are cleared.

In this case, after the carrier becomes on, the modem is "pulled in" again (synchronized with a signal from the opposite station), and after parameters in each part of the modem are reset, the reception of data is re-started.

In conventional counter-measures against a momentary line interruption, a variety of parameters in the modem are held based on the pseudo CD signal. Namely, when the pseudo CD signal becomes off, the variety of parameters are held simultaneously, and when the pseudo CD signal becomes on, the holding of the variety of held parameters are cancelled simultaneously.

In this case, there is a high possibility that the following problems may occur.

The modem often extracts a timing signal from signals received from an opposite station, and controls its own operation so as to synchronize with the extracted timing signal. In this case, however, since the modem cannot receive signals from the opposite station while data transmission signals are interrupted, it cannot extract the timing signal. For this reason, the modem free-runs using its own clock running based on the timing signal extracted before the interruption. In this way, during the interruption, since the modem cannot receive a timing signal from the opposite station and operates based on its own clock, the synchronization with the opposite station cannot be maintained. Since after the finish of the interruption (restoration of signals) the modem can receive signals from the opposite station, the modem can extract a timing signal from the opposite station and the restoration of the synchronization with the opposite station becomes possible.

Since the operation timing at the time of free-running of the modem during the interruption is based on its own clock, a slight deviation occurs between the operation timing and that of the opposite station. For this reason, there is a possibility of the timing signal newly extracted after the finish of the interruption and the operation timing at the time of the free-running of the modem deviating. Although the modem tries to execute a variety of its processes using this deviated timing as it is, it cannot execute them because of the deviated timing, and it takes a long time for synchronization to be restored, which is a problem. During this period the modem cannot receive data normally, and errors occur.

From when the carrier is interrupted and the modem judges that a short interruption occurs until the variety of parameters are held, an in-modem delay occurs. For this reason, strictly speaking, a deviation is generated between the held parameters and those at the moment when the carrier becomes off, too. If the holding is cancelled at the time of the finish of the interruption under such conditions, it takes a long time for a synchronization to be restored due to the existence of a deviation between the parameters, and there will be a possibility that data errors occur for a while after the interruption finishes.

An embodiment of the present invention may provide a method and data transmission apparatus for rapid restoration after a momentary line interruption when one occurs in a data transmission apparatus.

An apparatus for transmitting and receiving data through a communication network being one of the preferred embodiments of the present invention provides a plurality of hold signals for instructing the holding/cancellation of the holding of a plurality of parameters related to the receiving operation of data transmitted through the network, and comprises a detector unit for detecting the existence/non-existence of signals transmitted through the communication network, a hold setting unit for setting the holding of the parameters according to the instructions of the hold signals when the detector unit detects the non-existence of the signals, and a hold cancel setting unit for setting the cancellation of the holding of the parameters in order according to the instructions of the plurality of hold signals when the detector unit newly detects the existence of the signals after it detects the non-existence of the signals.

Among parameters related to the receiving operation there are parameters which should cancel the holding immediately after the carrier is restored following the line interruption and those whose fluctuations can be reduced in a shorter time if the holding is cancelled after the fluctuations of other parameters settle down. The configuration described above makes it possible to cancel the holding in an appropriate order according to the characteristics of each parameter without cancelling the holding of a plurality of parameters simultaneously, and as a result, the time needed for the fluctuations of each parameter to settle down and a normal data reception to be restored, can be reduced.

In the configuration described above, the hold cancel setting unit can also be configured so as to set the cancellation of the holding of the parameters in an order different from that which is set when the detector unit newly detects the existence of the signals before a prescribed time elapses, according to the instructions of the plurality of hold signals, when the detector unit continues to detect the non-existence of the signals after the prescribed time elapses.

The fluctuations of the parameters related to the receiving operation often settle down more rapidly if an order of the cancellation of the holding of the parameters is changed according to the length of the line interruption period. In the configuration described above, the holding of parameter groups with such characteristics can be cancelled in an appropriate order according to the length of the interrupted period, and as a result, a time needed for the fluctuations of each parameter to settle down and a normal data reception to be restored can be reduced.

A detailed description of the present invention will now be given by way of example with reference to the accompanying drawings, in which;

Fig. 1 is a timing chart showing conventional counter-measures against a momentary line interruption (No.1).

Fig. 2 is a timing chart showing conventional counter-measures against a momentary line interruption (No.2).

Fig. 3 shows two connected modems.

Fig. 4 shows the configuration of a modem as a preferred embodiment of the present invention.

Fig. 5 shows the configuration of a momentary interruption coping unit in a first preferred embodiment of the present invention.

Fig. 6 is a timing chart showing the operation of the momentary interruption coping unit shown in Fig. 5 (No.1).

Fig. 7 is a timing chart showing the operation of the momentary interruption coping unit shown in Fig. 5 (No.2).

Fig. 8 shows the configuration of a momentary interruption coping unit in a second preferred embodiment of the present invention.

Fig. 9 shows the control target of each hold signal.

Fig. 10 is a timing chart showing the operation of the momentary interruption coping unit shown in Fig. 8 (No.1).

Fig. 11 is a timing chart showing the operation of the momentary interruption coping unit shown in Fig. 8 (No.2).

Fig. 12 shows the configuration of a momentary interruption coping unit in a third preferred embodiment of the present invention.

Fig. 13 is a timing chart showing the operation of the momentary interruption coping unit shown in Fig. 12 (No.1).

Fig. 14 is a timing chart showing the operation of the momentary interruption coping unit shown in Fig. 12 (No.2).

Fig. 3 shows a connection arrangement of modems in which a parent station modem 12 and a child station modem 14 are connected at opposite ends of a network 13, and data terminal equipment (DTE) 11 and 15 are connected to the parent and child station modems 12 and 14, respectively. In the example shown in Fig. 3, the parent station modem 12 operates synchronous with a send timing signal ST1 transmitted from the DTE 11. The child station modem 14 extracts a timing element from signals received from the parent station modem 12, and operates based on the extracted received timing signal (RT).

Fig. 4 shows the configuration of a modem as a preferred embodiment of the present invention. A modem 20 shown in Fig. 4 transmits and receives data using a quadrature amplitude modulation (QAM) of 768 values and has a general modem configuration, except for a pseudo CD generator unit 113 and a momentary interruption coping unit 114 related to the present invention. In the operation of each unit, digital signal processing is performed. The modem 20 is largely divided into a receiver unit 21 and a transmitter unit 22. When the modem shown in Fig. 4 is used for the parent station modem 12 shown in Fig. 3, the left and right sides of Fig. 4 are connected to the DTE 11 and the network 13, respectively

First, the receiver unit 21 of the modem 20 shown in Fig. 4 is described.

Analog signals received from the network 14 are converted to digital signals by an A/D converter unit 101. Then, these digital signals pass through a line equalizer unit (LEQ) 102 for mainly adaptively correcting the attenuation of the high-pass frequency due to the network of transmission signals, and are demodulated to base-band signals by a demodulator unit 103.

The demodulated signals are transferred to an ST2 PLL 104. The ST2 PLL 104 acts so as to maintain a phase relation between the modulated signals and the current operation timing of the modem constant.

A roll-off filter (ROF) 105 is called a decimation filter, which lowers the sampling frequency of the modulated signals which have passed through the ST2 PLL 104.

The signals which have passed through the ROF 105 are controlled so as to be at a constant signal level by an automatic gain control unit (AGC) 106. Then, the influence of a transmission system, such as a network, etc. is eliminated by the adaptive-control of the equalizer unit (EQL) 107, and the signals are led to a carrier automatic phase control unit (CAPC) 108.

The signals inputted to the CAPC 108 are quadrature-amplitude-modulated multi-valued data and are controlled by the CAPC 108 so as to maintain the phase of quadrature-amplitude-modulated carrier waves at a constant.

The modulated multi-valued digital data of the signals outputted from the CAPC 108 are judged and extracted by a judgement unit 109, and the original digital data are supplied to the DTE through a logical processor unit 110.

A signal for holding/cancelling the holding of each parameter is transmitted from the judgement unit 109 to both the EQL 107 and the CAPC 108 (shown as (5) in Fig. 4). The hold signal (5) is described later in detail.

The modulated signals which have passed through the ST2 PLL 104 are led to both a timing extractor unit (TIM) 111 and a pseudo CD generator unit 113.

The timing extractor unit (TIM) 111 extracts a timing signal from the modulated signals.

An RT PLL 112 is a digital PLL for generating an operation clock for the entire modem 20, and establishes synchronization with the extracted timing signal. A part of the clock generated by the RT PLL 112 is used as a sampling timing signal for the A/D converter unit 101.

The pseudo CD generator unit 113 detects the existence/non-existence of a carrier for the modulated signals. If there is a carrier, the output becomes on (the "H" level), whereas if not, the output becomes off (the "L" level).

The short interruption coping unit 114 related to the present invention is described later.

Next, the transmitter unit 22 of the modem 20 shown in Fig. 4 is described. The digital data received from the DTE are converted to multi-valued QAM signals by the logical processor unit 124, and the band of the signals is limited by the roll-off filter (ROF) 123. The signals are modulated to transmission-band signals by a modulator unit 122, are converted to analog signals by a D/A converter 121, and are transmitted to the network 13.

Fig. 5 shows the configuration of a momentary interruption coping unit 114a in the modem being a first preferred embodiment of the present invention. The configuration is one example of the short interruption coping unit 114 shown in Fig. 4.

In Fig. 5, a pseudo CD signal is inputted to a 15-second counter 131.

The 15-second counter 131 starts counting when the pseudo CD signal becomes off, and the output becomes on when a period in which the pseudo CD signal is off continues for 15 seconds after the start of counting, though the output is off during the counting. During a period when the pseudo CD signal is on, the on state is maintained regardless of the existence/non-existence of the counting. The 15 seconds correspond to the timeout time described earlier.

A 2.5-second counter 132 starts counting when the output of the 15-second counter 131 becomes on and becomes on again when 2.5 seconds elapse after the start of counting, though the output is off during the counting. The output of the 2.5-second counter 132 is always off, while the 15-second counter 131 is off.

The output of the 15-second counter 131 is used as a hold signal A. The output of the 2.5-second counter 132 is used as a hold signal B.

The operation of the momentary interruption coping unit 114a shown in Fig. 5 is described using timing charts.

Figs. 6 and 7 are timing charts showing the operation of the short interruption coping unit 114a shown in Fig. 5.

Fig. 6 shows a case where a period when the carrier is off (the pseudo CD signal is off) is less than the timeout time (15 seconds).

When the carrier is interrupted and an internal delay time elapses (since the delay is due to the process of the pseudo CD generator unit 113, etc. and the delay is only slight compared with the in-modem delay described above, it can be considered to be substantially simultaneous with the interruption of the carrier), the pseudo CD signal becomes off. When the pseudo CD signal becomes off, the 15-second counter 131 and the hold signals A and B become off. Simultaneously, the 15-second counter 131 starts counting.

If the carrier is restored before 15 seconds elapse, the pseudo CD signal becomes on after the internal delay time elapses. Then, the output of the 15-second counter 131 becomes on, and simultaneously the hold signal A changes from a hold state to a hold cancel state (shown as normal in Fig. 6). If the output of the 15-second counter 131 becomes on, the 2.5-second counter 132 starts counting, and the output of the 2.5-second counter 132 becomes on after 2.5 seconds elapse. Then, the hold signal B changes to a hold cancel state (shown as normal in Fig. 6).

Fig. 7 is different from the case in Fig. 6 and shows a case where a carrier-off period exceeds the timeout time (15 seconds).

The operation at the time of a carrier

interruption is the same as that shown in Fig. 6. When the carrier is interrupted, the pseudo CD signal becomes off after the internal delay time elapses, both the 15-second counter 131 and 2.5-second counter 132 become off, and the hold signals A and B change to a hold state. Then, the 15-second counter 131 starts counting.

If 15 seconds elapse before the carrier is restored, the 15-second counter 131 finishes the 15-second counting, and the output becomes on, then, the hold signal A changes to a normal state.

When the 15-second counter 131 finishes the 15-second counting, the 2.5-second counter 132 starts counting. Then, if 2.5 seconds elapse, the 2.5-second counter 132, that is the hold signal B, changes to a normal state.

In this way, the hold signal B always changes to a normal state 2.5 seconds later than the hold signal A regardless of the length of the carrier restoration time. For example, the hold signal A is suited for controlling the rapid cancellation of the holding of the targets after a carrier restoration, and the hold signal B is used to control the cancellation of the holding of targets a prescribed time later after the carrier restoration, since it is accompanied by a "pulling-in" operation, etc. In the configuration shown in Fig. 4, a hold signal A is used to hold/cancel the holding of a parameter for the phase information of the RT PLL 112, a gain control parameter for the AGC 106 and a correction parameter for the LEQ 102, and a hold signal B is used to hold/cancel the holding of a parameter of frequency information for the PT PLL 112 and each of the control parameters for the ST2 PLL 104, EQL 107 and CAPC 108.

Fig. 8 shows the configuration of a momentary interruption coping unit 114b in a second preferred embodiment of the present invention.

In this preferred embodiment, five kinds of hold signals, hold signals (1) through (5) are set as shown in Fig. 4.

Fig. 9 shows the control targets of each hold signal.

As shown in Fig. 9, control targets of each of the hold signals are different. The hold signal (1) is for the RT PLL 112 and particularly controls the phase information. The hold signal (3) is also for the RT PLL 112, but controls the frequency information. In the RT PLL 112, when synchronization with signals from the opposite station cannot be obtained due to a momentary interruption, the deviation of the synchronization is considered to be slight, if the interrupted period is short. In this case, frequency synchronization is almost maintained, and it is sufficient to perform only a phase synchronization after the carrier restoration following the interruption. If the interrupted period is long, after the carrier restoration following the interruption, first frequency synchronization is performed.

The hold signal (2) controls the ST2 PLL 104, EQL 107 and CAPC 108.

The hold signal (4) controls the AGC 106 and LEQ 102.

In both the AGC 106 and LEQ 102, there is a possibility that a great deviation occurs between held parameters due to an in-modem delay from when the carrier is interrupted until a parameter is held. For this reason, both the AGC 106 and LEQ 102 are also designed in such a way that a "pulling-in" starts after the interruption finishes.

The hold signal (5) controls both the EQL 107 and CAPC 108. When a signal level inputted to the judgement unit 111 is less than a prescribed value, in this preferred embodiment, and when the judgement result is one of four points in the vicinity of an origin in a QAM signal of 768 values, the hold signal (5) holds the parameter to be controlled.

Next, the conditions of each hold signal output are described using Fig. 8.

When a carrier is inputted to the pseudo CD generator unit 113, a pseudo CD signal is outputted based on specific conditions. Assuming that a difference between the amplitude of the carrier and a threshold is A, the pseudo CD signal becomes on ("H" level), if the value of A is 0 or more (0 or positive). If A is negative, the pseudo CD signal becomes off ("L" level).

The pseudo CD signal outputted from the pseudo CD signal generator unit 113 is inputted to a logical product unit 141, 2.5-second counter 142, 15-second counter 143 and logical sum (OR) unit 145.

To the logical product unit 141 a signal RT is inputted together with the pseudo CD signal. The RT signal indicates the operation mode of a modem. If the modem is set in RT mode, that is, a mode where it operates based on signals received from the opposite station, RT becomes on ("H" level), and if not, it becomes off ("L" level). The logical product unit 141 comprises, for example, an AND circuit and a NOT circuit, and the output is used as a hold signal (1).

The logical product unit 141 is configured in such a way that this hold signal (1) changes to a hold state ("L" level) when RT is on and the pseudo CD signal is off, and it changes to a normal state ("H" level) in conditions other than this.

The 2.5-second counter 142 counts the period when the pseudo CD signal is on. The output of the 2.5-second counter 142 becomes on ("H" level) when the on period of the pseudo CD signal continues for more than 2.5 seconds, and it becomes off ("L" level) either when the off period of the pseudo CD signal or the on period of the pseudo CD signal is less than 2.5 seconds.

The 15-second counter 143 counts the off period of the pseudo CD signal. The output of the 15-second counter 143 shown in Fig. 8 becomes on either when the off period of the pseudo CD signal continues for more than 15 seconds or while the pseudo CD signal is on, and it becomes off when the off period of the pseudo CD signal is less than 15 seconds.

Each of the outputs of the 2.5-second counter 142 and 15-second counter 143 is inputted to a logical sum unit 144. The logical sum unit 144 comprises, for example, an OR circuit, and the output is used as a hold signal (2). The OR unit 144 is configured in such a way that the hold signal (2) changes to a normal state ("H" level) when either the output of the 2.5-second counter 142 or that of 15-second counter 143 is on, and it changes to a hold state ("L" level) in the other case (when the outputs of the counters 142 and 143 are both off).

Both the output of the logical sum unit 144 and the receive timing RT are inputted to a logical product unit 146. The logical product unit 146 comprises, for example, an AND circuit and a NOT circuit, and the output is used as a hold signal (3). This hold signal (3) changes to a hold state when RT is on and the output of the logical sum unit 144, that is, the hold signal (2) changes to a hold state, and it changes to a normal state in a case other than this.

Both the pseudo CD signal and the output of the 15-second counter 143 are inputted to the logical sum unit 145. The output of the logical sum unit 145 is used as a hold signal (4). The logical sum unit 145 comprises, for example, an OR circuit, and the hold signal (4) changes to a hold state when the pseudo CD signal and the output of the 15-second counter 143 are both off, and it changes to a normal state in a state other than this.

The judgement result is the result of a signal point judgement by the judgement unit 109. If the level of received signal is one of four points located in the vicinity of an origin, the judgement result signal changes to a hold state, and if not, it changes to a normal state. This judgement result signal is used as a hold signal (5) as it is.

These hold signals instruct each unit to hold/ cancel the holding of a variety of control parameters.

Both the detailed hold conditions and hold cancel conditions of each hold signal are as follows.

Hold signal (1)

Hold conditions: When signal RT is on and a pseudo CD signal is off

Hold cancel conditions: When a pseudo CD signal is on or RT is off

Hold signal (2)

Hold conditions: When a pseudo CD signal is off

Hold cancel conditions: When either 2.5-second counter 142 or 15-second counter 143 is on

Hold signal (3)

Hold conditions: When RT is on and a pseudo CD signal is off

Hold cancel conditions: When either 2.5-second counter 142 or 15-second counter 143 is on, or RT is off

Hold signal (4)

Hold conditions: When a pseudo CD signal is off

Hold cancel conditions: When a pseudo CD signal is on, or 15-second counter 143 is on

Hold signal (5)

Hold conditions: When the judgement result is one of four points in the vicinity of an origin

Hold cancel conditions: When the judgement result is not one of four points in the vicinity of an origin where the state of only the hold signal (5) changes regardless of the state of the carrier (pseudo CD signal).

Next, the timing, etc. of the status change of each hold signal shown in Fig. 8 is described using timing charts. In the following charts, RT is assumed to be always on.

Fig. 10 is the timing chart showing a case where the carrier-off period is shorter than the timeout time.

In this case, when the carrier is interrupted, received data become abnormal, and the pseudo CD signal becomes off after the internal delay time in the modem elapses. When the pseudo CD signal becomes off, all of the hold signals (1) through (4) change from a normal state to a hold state, and the variety of parameters in the modem are held. Since the judgement result centers in the vicinity of an origin when the carrier is interrupted, the hold signal (5) changes to a hold state.

The bottom line shows the data received in the modem. The received data have no relation to the pseudo CD signal and become abnormal immediately after the carrier is interrupted, that is, data cannot be received from the modem of the opposite station.

When the carrier is restored before the timeout time (15 seconds in this case) elapses, the pseudo CD signal becomes on after the lapse of the internal delay time of the modem. Then, simultaneously the hold signals (1) and (4) change from a hold state to a normal state.

When the pseudo CD signal becomes on, the 2.5-second counter 142 starts counting and the hold signals (2) and (3) change from a hold state to a normal state 2.5 seconds later (shown as " a certain time" in Fig. 10) after the pseudo CD signal becomes on. Then, simultaneously the data reception is restored to a normal state.

Each unit to be controlled by each of the hold signals (1) or (4) cancels the holding and starts a "pulling-in" (the update of the control parameters) immediately after the carrier becomes on as described above. However, it takes a certain amount of time for the "pulling-in" to be completed (for the fluctuations of the parameters to be reduced). For the "2.5 seconds" described above, a time needed for this "pulling-in" to be completed is set. Then, the holding of each unit to be controlled by the hold signals (2) and (3) is cancelled after the "pulling-in" is completed, and thereby a rapid reduction of the fluctuations of the parameters can be achieved.

Fig. 11 shows a case where the carrier-off period is longer than the timeout time.

The operation in the case when the carrier is interrupted is the same as that in the case shown in Fig. 10. When the timeout time (15 seconds) elapses, the hold signals (2) through (4) change to a normal state. That is, in this case, the hold signals (2) through (4) change from a hold state to a normal state only by the timeout of a 15-second timer regardless of the state of the pseudo CD signal.

When the carrier is restored, the pseudo CD signal becomes on after the lapse of the internal delay time. Then, simultaneously the hold signal (1) changes from a hold state to a normal state. After the pseudo CD signal becomes on, the "pulling-in" of the RT PLL 112, that is, the initial synchronization establishing operation with received signals is re-started. After the "pulling-in" finishes, normal data can be received.

To sum up the operation shown in Figs. 10 and 11, when the carrier-off period is long, a new synchronization establishing operation with received signals of the modem is needed. In this case, in the example of Fig. 8, it is desirable to cancel the holding and to clear the variety of parameters 15 seconds after the pseudo CD signal becomes on. When the carrier is restored after a short time, the initial synchronization establishing operation is not performed, and the holding is cancelled a certain time later (2.5 seconds in the example of Fig. 6) after the restoration of the carrier.

In the case of Fig. 11, since the pseudo CD signal becomes on after the timeout time (15 seconds) elapses, the "pulling-in" of the RT PLL 112 is performed after the pseudo CD signal becomes on. Thus, in this case, the 2.5-second counter 142 does not operate.

However, even when the carrier is restored after the lapse of the timeout time, the 2.5-second counter can also be operated in the cancellation of the holding, if necessary.

Fig. 12 shows the configuration of a momentary interruption coping unit 114c in the modem as a third preferred embodiment of the present invention.

The differences in configuration between the modems shown in Fig. 12 and Fig. 8 are as follows.

(1) To the 2.5-second counter 142, the output of the 15-second counter 143 is inputted.

(2) The hold signal (2) is the output of the 2.5-second counter.

(3) The hold signal (3) is the output of the logical product unit 146 to which both RT and the output of the 2.5-second counter 142 acting as hold signal (2) are inputted.

According to such a configuration, in the momentary interruption coping unit 114c shown in Fig. 12, both the hold signals (2) and (3) always change to a hold cancel state 2.5 seconds later after the output of the 15-second counter 143 becomes on.

Figs. 13 and 14 are timing charts showing the output waveform of each unit in the momentary interruption coping unit 114c shown in Fig. 12. The hold signal (5) shown in Fig. 12 is omitted in Figs.

13 and 14.

Fig. 13 shows a case where the carrier-off period is less than 15 seconds, being the timeout time. In Fig. 13, when the carrier is interrupted, the pseudo CD signal becomes off after the lapse of the internal delay time. Then, simultaneously the outputs of the 15-second counter 143 and 2.5-second counter 142 both become off. The 15-second counter 143 starts counting. The hold signals (1) through (4) change to a hold state. Received data become normal simultaneously with the carrier interruption.

If the carrier is restored before the lapse of 15 seconds, the pseudo CD signal becomes on after the lapse of the internal delay time. Simultaneously with this, the output of the 15-second counter 143 becomes on even before the lapse of 15 seconds.

When the pseudo CD signal becomes on, the hold signal (1) changes to a normal state only when RT is on. When RT is off, it is always in a normal state regardless of the existence/non-existence of the carrier . When the output of the 15-second counter 143 becomes on before the lapse of 15 seconds, the hold signal (4) changes from a hold state to a normal state.

When the output of the 15-second counter 143 becomes on, the 2.5-second counter 142 starts counting. After 2.5 seconds elapse, the hold signal (2) changes from a hold state to a normal state. When RT is on, the hold signal (3) also changes from a hold state to a normal state at this time. Like the hold signal (1), when RT is off, the hold signal (3) always maintains a normal state.

When the holding of the parameters of each unit is cancelled (when the 2.5-second counter 142 is on), the reception of data becomes normal.

Fig. 14 is a timing chart showing a case where the carrier-off period exceeds 15sec i.e. exceeds the timeout time. Since the operation at the time of a carrier interruption is the same as that shown in Fig. 13, it is not described here.

When 15 seconds elapse before the carrier is restored, the output of the 15-second counter 143 becomes on. Thus, the hold signal (4) changes from a hold state to a normal state. The 2.5-second counter 142 starts counting.

When a further 2.5 seconds elapse, the output of the 2.5-second counter 142 becomes on. For this reason, both the hold signals (2) and (3) change from a hold state to a normal state.

When further time elapses and the carrier is restored, the pseudo CD signal becomes on after the lapse of the internal delay time. For this reason, the hold signal (1) changes from a hold state to a normal state. Furthermore, when the pseudo CD signal becomes on, the "pulling-in" of the RT PLL 112 is re-started. After the "pulling-in" finishes, data can be received normally.

In this way, in the momentary interruption coping unit 114c described with reference to Figs. 12 through 14, the hold signals (2) and (3) always transit from a hold state to a normal state after the counting by the 2.5-second counter 142 finishes. In this example, a time difference can be set in this timing for the cancellation of the holding according to targets to be controlled.

It goes without saying that the timeout time of 15 seconds and the delay time of 2.5 seconds can be changed as appropriate for both the use environment of the apparatus and a time needed for the "pulling-in" of each unit. For the delay time, two or more values can also be set, if necessary.

Although in Figs. 8 and 11, five hold signals are used, selected ones may be used and the others not used. Alternatively, another kind of a hold signal can also be further set.

For example, out of the hold signals (1) through (5) shown in Fig. 8, only the hold signal (2) can be used by itself; or, the combination of the hold signals (1) and (3) can be used by themselves.

Likewise, in Fig. 12, the combination of the hold signals (1) and (2) can also be used. Alternatively, the hold signal (3) alone can be used.

Since in this way, a plurality of hold signals are set, and the conditions for the holding /cancellation of the holding are changed for each hold signal, as a result, the conditions for the holding /cancellation of the holding of a variety of parameters can be changed. To be more specific, the conditions for the holding/cancellation of the holding can be changed according to the lapse of time after the restoration of the carrier or targets to be controlled.

In an embodiment of the invention, when the carrier is restored within the timeout time, the holding is cancelled a prescribed time later after the carrier restoration, whereas when the timeout time elapses before the carrier restoration, the holding is cancelled simultaneously with the carrier restoration. In a conventional apparatus, even when the carrier is restored within the timeout time, the holding has been rapidly cancelled. However, in this case, since a "re-pulling-in" is not performed to establish a synchronization, the timing cannot be matched and thereby the synchronization cannot be obtained. For this reason, there is a possibility that a data error will occur. However, in an embodiment of present invention, since the holding is configured to be cancelled after the lapse of a prescribed time, the possibility that such a data error occurs is reduced.

In another embodiment of the invention, the holding is cancelled immediately after the carrier restoration according to targets to be controlled or a prescribed time after the carrier restoration. Conventionally, the holding of the control targets are cancelled simultaneously. Therefore, in this case, depending on control targets there is a possibility that synchronization cannot be obtained after the carrier restoration. However, according to this aspect of the present invention, such a possibility is reduced.

According to another embodiment of the invention, since the holding/cancellation of the holding of each control parameter is independently performed, the holding of parameters in which a deviation will be generated at the time of a short interruption, can be cancelled immediately after the finish of the interruption, and the holding of the other parameters can be cancelled after the apparatus is synchronized with the signals received from the opposite station at an optimum level, and the holding is delayed until the synchronization is completed. In this way, a secure and prompt restoration can be realized against a momentary line interruption.

CLAIMS:

1. An apparatus for transmitting and receiving data through a communication network, comprising:

output means (114c) for outputting a plurality of hold signals for instructing a holding/cancellation of a holding of a plurality of parameters related to a receiving operation of data transmitted through the communication network;

detecting means (113) for detecting an existence/non-existence of signals transmitted through the communication network;

hold setting means (141, 142, 145, 146) for holding the parameters according to instructions of said hold signals when said detecting means (113) detects a non-existence of the signals; and

hold cancel setting means (141, 142, 145, 146) for cancelling the holding of the parameters in order according to the instructions of said hold signals when said detecting means detects an existence of the signals after said detecting means (113) detects the non-existence of the signals.

2. The apparatus according to claim 1, wherein said hold cancel setting means (141, 142, 145, 146) cancels

the holding of the parameters in an order different from the order set when said detecting means detects the existence of the signals before a lapse of a prescribed time, according to the instructions of the plurality of said hold signals when said detecting means continues to detect the non-existence of the signals after the lapse of the prescribed time.

3. A method of coping with a momentary line interruption in an apparatus for transmitting and receiving data through a communication network, comprising the steps of:

detecting an existence/non-existence of signals transmitted through the communication network;

holding a plurality of parameters related to a receiving operation of data transmitted through the communication network when a non-existence of the signals is detected; and

cancelling a holding of said parameters in a predetermined order, when an existence of the signals is newly detected after the non-existence of the signals is detected.

4. The method according to claim 3, wherein the step of cancelling the holding cancels the holding in an

order different from the order set when the existence of the signals is detected before a lapse of a prescribed time, when a detection of the non-existence of the signals continues after the lapse of the prescribed time.

5. An apparatus for transmitting and receiving data through a communication network, said apparatus having hold signals for instructing a holding of parameters related to a receiving operation of data through the communication network, comprising:

pseudo CD (carrier detect) signal generating means (113) for detecting a carrier for signals transmitted through the communication network and outputting a detection result as a pseudo CD signal;

a first counter (142) for starting counting according to the pseudo CD signal and detecting a lapse of a first time;

a second counter (143) for starting counting according to the pseudo CD signal and detecting the lapse of a second time longer than the first time;

first hold signal generating means (144) for generating a first hold signal from a logical sum of detection results of the first counter (142) and the second counter (143);

second hold signal generating means (141) for generating a second hold signal from the pseudo CD signal;

third hold signal generating means (146) for generating a third hold signal from the first hold signal; and

fourth hold signal generating means (145) for generating a fourth hold signal from a logical sum of the detection result of the pseudo CD signal and the second counter (143).

6. An apparatus for transmitting and receiving data through a communication network, said apparatus having hold signals for instructing a holding of parameters related to a receiving operation of data through the communication network, comprising:

pseudo CD (carrier detect) signal generating means (113) for detecting a carrier for signals transmitted through the communication network and outputting a detection result as a pseudo CD signal;

a first counter (143) for starting counting according to the pseudo CD signal and detecting a lapse of a first time;

a second counter (142) for starting counting according to the detection result of the first counter

(143), detecting the lapse of a second time and generating a first hold signal from the detection result;

second hold signal generating means (141) for generating a second hold signal from the pseudo CD signal;

third hold signal generating means (146) for generating a third hold signal from the first hold signal; and

fourth hold signal generating means (145) for generating a fourth hold signal from a logical sum of an output of the pseudo CD signal and the detection result of the first counter (143).

7. An apparatus for transmitting and receiving data through a communication network, said apparatus having hold signals for instructing a holding of parameters related to a receiving operation of data through the communication network, comprising:

first hold signal generating means (113, 142) for detecting a carrier for signals transmitted through the communication network, starting counting according to a detection result and generating a first hold signal whose instructions change after a lapse of a first time; and second hold signal generating means (113, 143) for detecting the carrier for the signals, starting counting according to the detection result and generating a second hold signal whose instructions change after the lapse of a second time longer than the first time.

8. An apparatus for transmitting and receiving data through a communication network, said apparatus having hold signals for instructing a holding of parameters related to a receiving operation of data through the communication network, comprising:

detecting means (131) for detecting a lapse of a prescribed time after interruption of data transmitted through the communication network; and

instruction changing means (132) for changing instructions on a holding of the parameters by the hold signals according to a detection result of said detecting means.

9. A method of coping with a momentary line interruption in an apparatus for transmitting and receiving data through a communication network, comprising the steps of:

detecting an existence/non-existence of a carrier for signals transmitted through the communication network;

generating a first hold signal for instructing a cancellation of a holding of parameters related to a receiving operation of data transmitted through the communication network, when a carrier is detected; and

generating a second hold signal for instructing the cancellation of the holding of the parameters related to the receiving operation of data through the communication network, different from the first hold signal, a prescribed time after the carrier is detected.

10. An apparatus for transmitting and receiving data through a communication network, said apparatus having hold signals for instructing a holding of parameters related to a receiving operation of data through the communication network, comprising:

means (131) for generating a first hold signal when data transmitted through the communication network are detected; and

means (132) for generating a second hold signal for instructing the holding of the parameters which has a timing different from an instruction by the first hold signal and is different from the first hold signal.

11. A method of coping with a momentary line interruption in an apparatus for transmitting and receiving data through a communication network, comprising the steps of:

detecting an existence/non-existence of a carrier for signals transmitted through the communication network;

instructing a cancellation of a holding of parameters related to a receiving operation of data transmitted through the communication network after a second time has elapsed since existence of the carrier is detected, when the existence of the carrier is detected before a lapse of a first time after the non-existence of the carrier is detected; and

instructing a cancellation of a holding of the parameters related to the receiving operation of the data transmitted through the communication network after the lapse of the first time, when the existence of the carrier is not detected before a lapse of a first time after the non-existence of the carrier is detected.

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Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK Cl (Ed.Q): H4P (PAL, PAN, PAQ, PPF, PSEX, PSX); H4K (KOD5)

Int Cl (Ed.6): H04L 7/00, 7/10, 27/38, 29/14; H04M 11/06

Other: Online EPODOC

Documents considered to be relevant:

Category	Identity of document and relevant passage		Relevant to claims
A	GB 2305337 A	Fujitsu - see page 34, line 19 to page 37, line 15	1,3,5,6,7, 8,9,10,11
X	GB 2275396 A	Fujitsu - see whole specification (& US 5388122)	1,3,5,6,7, 8,9,10,11
A	GB 2275395 A	Fujitsu - see page 34, line 19 to page 37, line 15	1,3,5,6,7, 8,9,10,11
A	EP 0204308 A2	Fujitsu - see column 15, line 38 onwards (& US 4868850)	1,3,5,6,7, 8,9,10,11
A	US 4621366	Universal Data Systems Inc. - see abstract	1,3,5,6,7, 8,9,10,11

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