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(54) **DEVICE AND METHOD FOR INITIALLY SYNCHRONIZING SPREAD-SPECTRUM CODE OF CDMA TRANSMISSION SYSTEM**

VERFAHREN UND ANORDNUNG ZUR VORSYSNCHRONISIERUNG EINES SPREIZSPEKTRUMKODE EINES ÜBERTRAGUNGSSYSTEMS MIT MEHRFACHZUGRIFF DURCH KODEVERTEILUNG

DISPOSITIF ET PROCEDE PERMETTANT DE SYNCHRONISER INITIALEMENT UN CODE A ETALEMENT DU SPECTRE D'UN SYSTEME DE TRANSMISSION A ACCES MULTIPLE PAR DIFFERENCE DE CODE (AMDC)

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Description

TECHNICAL FIELD

[0001] The present invention relates to an apparatus and method for establishing acquisition of a spreading code in a CDMA transmission system which carries out multiple access by using spread spectrum in a mobile communications system.

BACKGROUND ART

[0002] In a direct sequence (DS) CDMA transmission, information data is transmitted after it undergoes a primary modulation, followed by a secondary modulation which spreads the primary modulated signal with a high rate spreading signal. At a receiving side, the wideband received signal (spread signal) is first converted into the original narrowband signal through a process called despreading, and then undergoes a usual demodulation. The despreading at the receiving side is carried out by detecting correlation between the received signal and a replica of the spreading code synchronized in phase with the spreading code in the received signal. Accordingly, it is necessary for recovering the information data to synchronize the spreading code replica with the spreading code in the received signal.

[0003] The synchronization roughly falls into two processes: acquisition and tracking. The acquisition captures the phase difference between the received spreading code and the spreading code replica within a range sufficiently narrower than ± one chip because the autocorrelation of a quadrature code used as the spreading code can usually be obtained only within ± one chip. Then, the tracking keeps the phase difference between the two codes within this range. Since the present invention relates only to the acquisition, a conventional acquisition method will be described below.

[0004] The acquisition of the spreading code is generally carried out as follows: First, the correlation between the received signal and the spreading code replica is taken by multiplying the two codes, and by integrating the product for one spreading code period. Next, the establishment of the acquisition is decided by square-law detecting the correlation output followed by deciding whether or not the detection output exceeds a threshold. Since the phase of the carrier is not synchronized between the transmission side and the reception side, it is difficult to know the phase of the carrier before despreading. Thus, the non coherent method is used in which the effect of the carrier phase is removed by square-law detecting the correlated and integrated signal before performing the threshold decision.

[0005] The correlation of the acquisition can usually be detected using a sliding correlator carrying out time integral, or a matched filter performing space integral. The matched filter is an FIR filter (transversal filer) having the tap number corresponding to the processing gain and using the spreading code as tap coefficients. Since the matched filter achieves the correlation detection between the spreading code in the received signal and the spreading code replica at once by using the space integral, the acquisition is achieved in a fraction of time. However, the matched filter has taps whose number corresponds to the processing gain. In addition, the correlation detection must be performed at a rate at least twice the chip rate because it is necessary for the matched filter to adjust its sampling timing at a peak position with the band-limited received signal. Thus, the matched filter requires the tap number twice the processing gain, which presents a shortage that its circuit scale becomes larger than that of the sliding correlator.

[0006] The present invention relates to the acquisition of a long code with a very long period as compared with an information symbol, and hence it is considered very difficult to realize by using the matched filter. Thus, the acquisition with the sliding correlator will be considered in connection with the present invention.

[0007] The correlation is calculated between the spreading code replica and the received signal including noise, and the correlation output undergoes an envelope detection through a square-law detector. The detected output is integrated for a dwell time τ in an integral & dump circuit. The integrated output undergoes threshold processing. Although the sliding correlation method is simple in circuit configuration, it has a shortage that it takes a long time for the acquisition.

[0008] In the CDMA applied to a cellular, control information is exchanged between a base station and a mobile station through a control channel before a traffic channel is established for transmitting information data represented by voice. Generally speaking, an increasing period of spreading code will provide a greater number of the spreading codes, thereby increasing the number of multiplexing, although a time taken for the acquisition grows longer because of an increase in phase uncertainty. Taking account of this characteristic, a method is proposed in which a short code is used for a control channel and a long code is applied to a traffic channel by superimposing it over the short code, the short code having a period equal to one symbol interval of the information data, and the long code having a much longer period than the information data symbol. Such an acquisition method is disclosed in, for example, Japanese Patent Application Laid Open No. 54-72615. In this method, the acquisition of the control channel is achieve using the short code, and that of the traffic channel is carried out by inserting phase information on the starting position of the long code in the control channel. Thus, the acquisition of the traffic channel is started from a state in which the chip phase is nearly synchronized between the base station and the mobile station. As a result, the acquisition of both channels can be established in a short time.

[0009] This method, however, presents a problem in that it employs a short code in the control channel. Spreading the control channel with the short code will substantially restrict the number of the control channel because the number of the quadrature codes is determined by the code length. When assigning the limited number of the control channels, spreading code management is required in connection with the control channel. To avoid such management, an increasing number of control channel is required, in which case, it is necessary to increase the code length of the control channels to some extent. Thus, it is also required for the control channel to use spreading codes with a period longer than one symbol period of the information data. In this case, speed up of the acquisition becomes important.

DISCLOSURE OF THE INVENTION

[0010] An object of the present invention is to provide an apparatus and method for establishing acquisition of a spreading code in a CDMA transmission system which can establish the acquisition in a short time in the direct sequence CDMA transmission system using a long code.

[0011] According to a first aspect of the present

[0012] invention, there is provided a transmitter in a CDMA transmission system which sends a wideband spread signal generated by spreading transmission information using

long code generating means for generating a long code which is a spreading code with a period longer than information symbol, said transmitter characterised by comprising:
a priori code generating means (26) for generating a priori code representing a phase of said long code, a cross-correlation between the a priori code and the long code being negligibly small;
a priori code insertion means for inserting the a priori code into the spread signal at a predetermined fixed interval to form frames; and
transmission means for transmitting the frames.

[0013] Here, the a priori code may comprise smoothly changing autocorrelation values, and a zero-cross point.

[0014] The autocorrelation values of the a priori code may have a triangular profile.

[0015] The a priori code may have a stepwise profile.

[0016] The a priori code may have a period shorter than the long code.

[0017] The a priori code insertion mean may insert the a priori code into the spread signal within a predetermined range at a beginning of communications.

[0018] The a priori code generating mean may comprise means for generating a predetermined code for a convolution, and calculation means for carrying out the convolution between the code for a convolution and the long code to output the a priori code, and the a priori code insertion means may insert an output of the calculation means into the spread signal.

[0019] In a second aspect of the present invention, there is provided an acquisition apparatus in a CDMA system which demodulates desired information by receiving a wideband spread signal generated by spreading transmission information using a long code which is a spreading code with a period longer than information symbol, the acquisition apparatus comprising:

first correlation means for generating a replica of the long code, and for calculating a correlation between the replica of the long code;
and the wideband spread signal being inserted a priori code which has a negligibly small cross-correlation with the long code and represents a phase of the long code; second correlation means for generating a replica of the a priori code, and for calculating a correlation between the received signal and the replica of the a priori code;
phase estimation means for estimating received phase of the long code based on an output of the second correlation means; and
means for controlling a generation phase of the replica of the long code based on an output of the phase estimation means.

[0020] Here, the a priori code may be inserted into the spread signal at a fixed period, wherein

the second correlation means may comprise paired correlators consisting of a correlator that generates replicas of paired a priori codes consisting of a replica of a first a priori code and a replica of a second a priori code with their correlation detection start timings shifted by an amount of Δ, and that calculates correlations between the replica of the first a priori code and the received signal, and a correlator that calculates correlations between the replica of the second a priori code and the received signal; and the phase estimation means may estimate a received phase of the long code based on outputs of the paired correlators.

[0021] Each of the paired correlators may integrate a product of the received signal and the replica of the a priori code for one period of the a priori code; and

the phase estimation means may estimate a received phase of the long code from two integrated values.

[0022] The second correlation means may comprise m pairs of correlators, where m is an integer greater than one, wherein start timings of correlation detection and integration of adjacent pairs of the correlators are shifted by T_A/m in time, where T_A is a length of the a priori code.

[0023] The phase estimation means may comprise means for selecting one pair of the correlators which produces maximum outputs, and may estimate a received phase of the long code based on the maximum outputs and their detection timings.

[0024] The phase estimation means may obtain a zero-cross point, at which a correlation value between the received signal and the replica of the a priori code becomes zero, from the maximum outputs and their detection timings, and may estimate a received phase of the a priori code from the zero-cross point, and the control means may control a generation phase of the replica of the long code in accordance with the estimated received phase of the a priori code.

[0025] The control means may set the generation phase of the replica of the long code such that the generation phase is centered at the received phase of the a priori code estimated by the phase estimation means, and may carry out non-uniform search in which the generation phase of the replica of the long code is gradually shifted in a wider range when a phase of the replica of the long code is not synchronized with a phase of the long code in the received signal.

[0026] The a priori code may be inserted solely at an initial portion of the spreading code.

[0027] The a priori code may be inserted solely at an initial portion of the spreading code of a control channel.

[0028] The first correlation means may be a sliding correlator.

[0029] The second correlation means may comprise an I-correlator and a Q-correlator, the I correlator detecting correlation between an I-component (inphase component) of a carrier of the received signal after quadrature detection and an I-component of the replica of the a priori code, the Q-correlator detecting correlation between a Q component (quadrature component) of the carrier of the received signal after quadrature detection and a Q-component of the replica of the a priori code, wherein the phase estimation means may estimate a received phase of the long code using both the I-component and the Q-component.

[0030] The phase estimation means may obtain a complex amplitude of an output of the I correlator and an output of the Q-correlator, and may estimate the received phase of the long code using the complex amplitude.

[0031] The phase estimation means may compare an output of the I-correlator with an output of the Q-correlator, and may estimate the received phase of the long code using the output with a greater absolute value.

[0032] The phase estimation means may obtain an estimated received phase of the long code from an output of the I-correlator, and an estimated received phase of the long code from an output of the Q-correlator, and may estimate the received phase of the long code by averaging these two estimated received phases.

[0033] In a third aspect of the present invention, there is provided a receiver in a CDMA transmission system characterised by comprising the acquisition apparatus according to the invention.

[0034] In a fourth aspect of the present invention, there is provided a CDMA transmission system comprising a transmitter according to the first aspect of the invention and a receiver according to the third aspect of the invention.

[0035] In a fifth aspect of the present invention, there is provided a transmission method in a CDMA transmission system for sending a wideband spread signal generated by spreading transmission information using a long code which is a spreading code with a period longer than information symbol, the method comprising the steps of:

generating a priori code representing a phase of the long code, a cross-correlation between the a priori code and the long code being negligibly small;
inserting the a priori code into the spread signal at a predetermined fixed interval to form frames; and
transmitting the frames.

[0036] In a sixth aspect of the present invention, there is provided an acquisition method of a spreading code in a CDMA system which demodulates desired information by receiving a wideband spread signal generated by spreading transmission information using a long code which is a spreading code with a period longer than information symbol, the acquisition method comprising the steps of:

generating a replica of the long code;

calculating a correlation between the replica of the long code, the wideband spread signal being inserted a priori code which has a negligibly small cross-correlation with the long code and represents a phase of the long code;
generating a replica of the a priori code;
calculating a correlation between the received signal and the replica of the a priori code;
estimating received phase of the long code based on the correlation between the received signal and the replica of the a priori code; and
controlling a generation phase of the replica of the long code based on an estimated received phase of the long code.

[0037] In a seventh aspect of the present invention, there is provided a CDMA transmission method comprising a transmission method according to the fifth aspect of the invention and an acquisition method according to the sixth aspect of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0038]

Fig. 1 is a block diagram showing a configuration of a transmitter of a first embodiment of a CDMA system in accordance with the present invention;
Fig. 2 is a schematic diagram showing a transmission frame consisting of a spread signal and an a priori code in accordance with the present invention;
Figs. 3A and 3B are graphs each illustrating an example of the a priori code, and its autocorrelation and correlation with a spreading code;
Figs. 4A and 4B are graphs each illustrating another example of the a priori code, and its autocorrelation and correlation with a spreading code;
Figs. 5A-5C are waveform diagrams illustrating a method for generating an a prior code by convolution, wherein Fig. 5A illustrates the waveform of a spreading code, Fig. 5B illustrates the waveform of a convolution code X, and Fig. 5C illustrates a waveform of the a priori code;
Fig. 6 is a block diagram showing the configuration of a receiver of the first embodiment of the CDMA system in accordance with the present invention;
Fig. 7 is a block diagram showing the internal configuration of a despreader in the receiver shown in Fig. 6;
Fig. 8 is a schematic diagram illustrating timing relationships between paired correlators and a received signal;
Fig. 9 is a graph illustrating a method for estimating the start timing of receiving the a priori code on the basis of maximum correlation outputs R_1 and R_2 of the paired correlators and their detection timings t_1 and t_2;
Fig. 10 is a schematic diagram illustrating the sequences for setting estimation phases in a non-uniform search;
Figs. 11A and 11B are flowcharts showing the operation of the first embodiment;
Figs. 12A and 12B are graphs illustrating inphase and quadrature components of a correlation between a received signal and an a priori code; and
Figs. 13-15 are block diagrams showing configurations of major portions of receivers in a CDMA system in accordance with the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

[0039] The invention will now be described with reference to the accompanying drawings.

EMBODIMENT 1

[0040] Fig. 1 is a block diagram showing the configuration of a transmitter of a CDMA transmission system in accordance with the present invention.
[0041] The transmitter generates a frame as shown in Fig. 2, and transmits it.
[0042] In Fig. 2, a frame 10 is formed by inserting an a priori code 12 at a fixed interval T_B into long code spread sections 11 spread by a long code. Here, the a priori code 12 is information used to estimate the received phase of the long code, and the length of the a priori code is about 10 symbol periods. The length of the long code spread section 11, on the other hand, is equal to the long code period of about 1,000 symbol periods. These lengths can be set rather arbitrarily. In the description below, the length of the a priori code 12 is termed a priori code length T_A, and the combination of the a priori code 12 and the long code spread section 11 is called an a priori block, whose period T_B is referred to as an a priori period.
[0043] Fig. 3A illustrates an a priori code 12A with a step profile, and Fig. 3B illustrates its autocorrelation and cross-

correlation with the long code. As shown in Fig. 3B, the autocorrelation value of the a priori code 12A has a triangular profile 13, and its cross correlation value with the long code is suppressed to nearly zero. Therefore, connecting the a priori code 12A and the long code into frames in a fixed phase relationship to be transmitted, and detecting the autocorrelation value of the a priori code 12A at the receiving side makes it possible to detect the position of the a priori code 12A.

[0044] Fig. 4A illustrates another a priori code 12B, and Fig. 4B illustrates its autocorrelation and cross-correlation with the long code. As shown in Fig. 4B, the autocorrelation value of the a priori code 12B has a triangular profile 14 as in Fig. 3B, and its correlation value with the long code is suppressed nearly to zero.

[0045] Figs. 5A-5C illustrate a method for generating the a priori code 12B. The a priori code 12B as shown in Fig. 5C can be obtained by taking a convolution between the code X with a period T_A as shown in Fig. 5B and a spreading code 15 with a period T_A as shown in Fig. 5A. The convolution is a well-known operation.

[0046] Returning to Fig. 1, transmission information fed to an input terminal 21 of the transmitter is supplied to a frame generating/mapping block 22. The frame generating/mapping block 22 makes frames from the transmission information, and carries out mapping in accordance with a modulation method. The inphase component $D_I(t)$ and the quadrature component $D_Q(t)$ of the transmission information output from the generating/mapping block 22 are fed to multipliers 23_I and 23_Q in a code spreader 23.

[0047] On the other hand, the inphase component $C_I(t)$ and the quadrature component $C_Q(t)$ of the long code as a spreading code, are supplied to the multipliers 23_I and 23_Q from a long code generator 24, respectively. The multiplier 23_I multiplies the transmission information $D_I(t)$ by the long code $C_I(t)$, and the multiplier 23_Q multiplies the transmission information $D_Q(t)$ by the long code $C_Q(t)$. By this, the transmission information is spread by the long code, and the long code spread section 11 in Fig. 2 is generated. The generated long code spread section 11 is fed to a signal switch 25.

[0048] On the other hand, the inphase component $P_I(t)$ and quadrature component $P_Q(t)$ of the a priori code generated by an a priori code generator 26 is directly fed to the signal switch 25 from the a priori generator 26. The signal switch 25 switches the a priori code 12 and the long code spread section 11 in accordance with a switching signal from a switch controller 27 to provide D/A converters 31_I and 31_Q with the frame 10 of the format as shown in Fig. 2.

[0049] The transmission information (spread signal) supplied to the D/A converters 31_I and 31_Q is fed to a quadrature modulator 32 after converted into analog signals. The quadrature modulator 32 carries out quadrature modulation of the carrier signal, which is supplied from an oscillator 33, by the spread signal. The quadrature modulated spread signal is band-limited by a BPF (Band-Pass Filter) 34, and is fed to a frequency converter 35. The frequency converter 35 performs frequency conversion of the quadrature modulated spread signal by a signal from a local oscillator 36, and its output is band-limited by the BPF 37, and is transmitted from an antenna 38.

[0050] Fig. 6 is a block diagram showing the entire configuration of a receiver of the CDMA transmission system in accordance with the present invention. The radio wave received by an antenna 51 is band-limited by a BPF 52 to such a degree that a desired received signal is not distorted. The band-limited received signal is mixed by a mixer 53 with a local signal from a local oscillator 54 to be frequency converted. The frequency converted signal is corrected to a normal level by an AGC (Automatic Gain Controller) 55. The BPF 52 is inserted to ensure the normal operation of the AGC 55.

[0051] Next, the received signal undergoes quasi-coherent quadrature detection by a quasi-coherent quadrature detector 57 using a local signal from a local oscillator 56, the local signal having the same frequency as the carrier of the received signal. The output of the quasi-coherent quadrature detector 57 is converted into digital spread signals by A/D converters 58_I and 58_Q. The spread signals are despread by a despreader 60, thereby deriving the desired signal. The despread signal is demodulated by a demodulator 61, and the desired information is output from an output terminal 62.

[0052] Fig. 7 is a block diagram showing a configuration of the despreader 60. The digital spread signal from the A/D converter 58_I is supplied to multipliers 71 of correlators CR_1 - CR_{2m}, and at the same time to a multiplier 81 of a sliding correlator SC_I. On the other hand, the digital spread signal from the A/D converter 58_Q is fed to a multiplier 81 of a sliding correlator SC_Q. The two sliding correlators SC_I and SC_Q function as a spreading code generator.

[0053] Each multiplier 71 multiplies the spread signal by a replica of the a priori code supplied from the a priori code generator 72, and provides the product to an integral & dump circuit 73. The integral & dump circuit 73 integrates the product over one a priori code length T_A. The multiplier 71, the a priori code generator 72 and the integral & dump circuit 73 constitute the correlator CR_k (k=1-2m). The despreader of Fig. 7 comprises m pairs of correlators CR_1, CR_2, ..., CR_{2m}. The two correlators in each pair have correlation detection (integration) start timings which are shifted by Δ. For example, the correlation detection (integration) start timings of the paired correlators CR_1 and CR_2 are shifted by Δ. In addition, the correlation detection (integration) start timings of adjacent pairs of correlators are shifted by T_A/m. For example, the correlation detection (integration) start timings of the adjacent pairs of correlators CR_1 and CR_3 are shifted by T_A/m.

[0054] The 2m correlation values are stored in a correlation memory 74 together with the correlation detection timings of the correlation values. Here, the correlation detection timings mean the integration start timings in respective correlators. The mT_B/T_A pairs of correlation values and the correlation detection timings stored in the correlation memory 74 are supplied to a maximum correlation detector 76 and a long code phase estimator 77 via a switch 75. The switch 75 is connected to the maximum correlation detector 76 in a received phase estimation mode of the long code, which will be described later, and to the long code phase estimator 77 in the received phase detection mode of the long code. The maximum correlation detector 76 selects the greatest correlation values in the mT_B/T_A pairs of correlation values, and supplies the long code estimator 77 with two correlation values R_1 and R_2 of the pair of correlators associated with the maximum correlation values, and the correlation detection timings t_1 and t_2 of these correlation values.

[0055] The long code phase estimator 77 comprises a zero-cross detector 771, an a priori code phase estimator 772 and a non uniform search controller 773. The zero-cross detector 771 detects a point at which a straight line connecting two points (R_1, t_1) and (R_2, t_2) zero-crosses. The a priori code phase estimator 772 estimates the start timing of receiving the a priori code from the zero-cross point to control the oscillation phase of respective a priori code generators 72. The non-uniform search controller controls the oscillation phase of a long code generator 82 such that its phase is centered on the estimated received phase of the long code derived from the receiving start timing estimated by the a priori code phase estimator 772. Details of these operations will be described later.

[0056] On the other hand, the spread signal supplied to each multiplier 81 is multiplied by a replica of the long code from the long code generator 82 to obtain their correlation values. The correlation values are integrated by an integral & dump circuit 83 over one symbol interval, and are fed a threshold comparator 84. The threshold comparator 84 compares the correlation values with a predetermined threshold value, and shifts the oscillation phase of the long code generator 82 as shown in Fig. 10 when the correlation values are smaller than the threshold value, and keeps the oscillation phase when the correlation values are equal to or greater than the threshold. These elements 81 - 84 constitute the sliding correlator SC_l.

[0057] The controller 88 controls respective portions described above. For example, it controls the switching timings of the switch 75. The operation of the controller 88 will be described later with reference to Figs. 11A and 11B.

[0058] Fig. 8 is a schematic diagram illustrating relationships between the paired correlators CR_k (k = 1 - 2m) and the received signal (spread signal). Each correlator CR_k integrates the correlation value between the a priori code replica and the received signal over one a priori code length T_A, and outputs the integration value and the correlation detection timing every T_A interval. The output values are stored in the correlation memory 74. In this case, the start timings of the integration is shifted by a small amount. That is, the start timings of the two correlators of the same pair are shifted by Δ, and the start timings of the counterpart correlators in the adjacent pairs are shifted by T_A/m. Here, typical® values of Δ and m are $T_A/4$ and 4, respectively. The correlation detection is carried out over at least one a priori period T_B, and usually for several a priori periods. Then, the maximum correlation values are obtained from the pair of correlators which provides the correlation detection timings closest to the start timing of receiving the a priori code 12. Thus, the start timing of receiving the a priori code 12 can be estimated from the correlation values output from the pair of correlators with their integration phase shifted.

[0059] Fig. 9 is a graph illustrating a method for estimating the start timing t_{ap} of receiving the a priori code 12 from the maximum correlation values R_1 and R_2, and their detection timings t_1 and t_2. In Fig. 9, the axis of abscissas represents time and the axis of ordinates represents the correlation level between the received signal and the replica of the a priori code 12. The length of the axis of abscissas equals the a priori code length T_A, and its middle point t_{ap} represents the start timing of receiving the a priori code. In addition, t_1 and t_2 indicate the detection timings of the correlation values R_1 and R_2, that is, the start timings of the integration by the correlators. When the start timings of the integration coincide with the start timings of receiving the a priori code (for example, when $t_1 = t_{ap}$), the correlation level becomes maximum. In Fig. 9, it is shown that the start timings t_1 and t_2 of the integrations associated with the correlation values R_1 and R_2 precede the receiving timing of the a priori code by a small amount.

[0060] The zero-cross detector 771 is supplied with the maximum correlation values R_1 and R_2, and their detection timings t_1 and t_2 from the maximum correlation detector 76. The zero cross detector 771 obtains a zero-cross point t_{z1} at which the straight line joining the two points (t_1, R_1) and (t_2, R_2) crosses the line of zero correlation level. This is for estimating the start timing of receiving the a priori code by utilizing the fact that the zero-cross point is hard to change in the fading environment. In this case, the following cases will occur in accordance with the positions of the correlation detection timings t_1 and t_2.

(1) When both t_1 and t_2 are either at the right-hand side or the left-hand side of the receiving start timing t_{ap} (in Fig. 9, both of them are present at the left-hand side), the zero-cross point can be obtained in the range of Fig. 9 by joining the two points. In other words, time differences between the zero-cross point and the correlation detection timings fall within $T_A/4$ in this case.

(2) When t_1 and t_2 are present at opposite sides with respect to the receiving start timing, the zero-cross point will go beyond the range of Fig. 9. In other words, the time difference between the zero-cross point and the correlation detection timings are above $T_A/4$ in this case.

[0061] The a priori code phase estimator 772 estimates the start timing of receiving the a priori code from the zero-cross point. That is, in case (1), it estimates the timing obtained by shifting the zero-cross timing by $T_A/4$ towards the greater correlation value to be the start timing t_{ap} of receiving the a priori code. On the other hand, in case (2), it estimates the middle point of the two correlation detection timings t_1 and t_2 to be the starting timing t_{ap} of receiving the a priori code.

[0062] The following is the reason for obtaining the zero-cross point before estimating the start timing of receiving the a priori code. On an actual propagation path, the correlation characteristics of the a priori code 12 are often inverted owing to fading on the path. The position at which the correlation value becomes zero, however, is fixed, and the correlation function is kept linear when the a priori code length T_A is short as compared with the fading period, and hence the complex envelope of the fading during the correlation detection integration time can be considered to be constant. Thus, the start timing of receiving the a priori code can be obtained by the above-mentioned method.

[0063] Fig. 10 is a schematic diagram illustrating the searching method by the non-uniform search controller 773. In this figure, the axis of abscissas represents the phase of the long code, and the axis of ordinates represents the time. In addition, numbers in open circles designate search sequence. As shown in this figure, the non-uniform search controller begins with the estimated phase (that is, the start timing of receiving the a priori code), and controls the long code generator 82 so as to gradually widens its search range in both sides. This makes it possible to effectively detects the phase of receiving the long code. This searching method, called NUEA (Non-uniformly Expanded Alternate serial search strategy) is described in detail in V. M. Jovanovic, "Analysis of Strategies for Serial-Search Spread-Spectrum Code Acquisition-Direct Approach", IEEE Trans. on Communications, VOL. COM 36. No. 11, pp. 1208-1220, November 1988.

[0064] Next, the operation of the embodiment will be described with reference to Figs. 11A and 11B.

[0065] Upon starting the acquisition, the controller 88 sets the a priori code in the 2m correlators CR_k at step SP1. Specifically, the same a priori code is set in the a priori code generator 72 of each correlator at an identical phase. Then, the multipliers 71 of respective correlators CR_1 - CR_{2m} obtain correlation between the received signal and the a priori code replica as explained in Fig. 8. The resultant correlation values are fed to the integral & dump circuits 73, and are integrated over time T_A (step SP2). This operation is continued for one a priori period T_B to produce T_B/T_A correlation values and correlation detection timings from the respective correlators. Thus, the total of mT_B/T_A pairs of correlation values and correlation detection timings are obtained. These values are stored in the correlation memory 74 at step SP3.

[0066] The switch 75 is connected to the maximum correlation detector 76 at the start of the acquisition. Accordingly, the correlation values and the correlation detection timings stored in the memory 74 are fed to the maximum correlation detector 76. The maximum correlation detector 76 detects among these data the correlation values R_1 and R_2 and the correlation detection timings t_1 and t_2 of the pair of correlators that outputs the maximum correlation values (step SP4).

[0067] Next, the controller 88 decides at step SP5 whether or not to verify the correlation values and the correlation detection timings by repeating the operations of steps SP1-SP4. When to verify, the process is moved to step SP6 to repeat the operations of steps SP1 - SP4, that is, the operations in block A of Fig. 11A. Then, the controller 88 verifies whether the detection timings of the maximum correlation values are the same as the preceding one at step SP7. If they are different, the operations of block A is repeated at step SP6. If they are the same, the maximum correlation values R_1 and R_2, and their detection timings t_1 and t_2 are fed to the zero-cross detector 771 in the long code phase estimator 77.

[0068] The zero-cross detector 771 obtains the zero-cross point by a method as described in Fig. 9. More specifically, it obtains the zero-cross point t_z by the linear interpolation of the two points (R_1, t_1) and (R_2, t_2) derived from the correlation values R_1 and R_2 and their detection timings t_1 and t_2. The a priori code phase estimator 772 compares t_1 with t_z, and t_2 with t_z at step SP12 to decide whether these differences are equal to or greater than $T_4/4$. If at least one of the differences is equal to or greater than $T_A/4$, the a priori code phase estimator 772 estimates the middle point of the times t_1 and t_2 to be the start timing t_{ap} at step SP13. On the other hand, if both the differences are less than $T_A/4$, the a priori code phase estimator 772 estimates a timing obtained by shifting the zero-cross point t_z towards the greater correlation value R_2 by an amount $T_A/4$ to be the start timing t_{ap} of receiving the a priori code at step SP14. Thus, the a priori code phase estimator 772 outputs the estimated start timing t_{ap} of receiving the a priori code. The received phase of the long code is estimated to be a point elapsed from the estimated start timing t_{ap} by a fixed time.

[0069] The non-uniform search controller 773 carries out the acquisition by controlling the sliding correlators SC_I and SC_Q using the non-uniform search as shown in Fig. 10. More specifically, the non-uniform search controller 773 initially sets the oscillation phase of the long code generator 82 at the estimated received phase of the long code, and shifts the phase of the long code replica in the sequence as shown in Fig. 10. During this, the threshold comparator 84 decides whether the correlation value exceeds the threshold value or not. When the correlation value exceeds the threshold, the long code generator 82 decides that the acquisition has been completed at the current oscillation phase.

[0070] Alternatively, when averaging the start timings t_{ap} of receiving the a priori code by obtaining them several times, the controller 88 controls respective blocks to have them carry out steps SP21 - SP23. Specifically, the correlation between the received signal and the a priori code replica is detected at timings nT_B (n = 1, 2, ...) after the maximum correlation detection timings at step SP22, and the operations in the block B of Fig. 11B, that is, steps SP11 - SP14 are repeated at step SP22. After a plurality of estimated start timings of receiving the a priori code are obtained, the a priori code phase estimator 772 calculates their average to obtain a new start timing of receiving the a priori code at step SP23, followed by the operation at step SP15. Thus, the long code generator 82 completes the acquisition, and enters the tracking mode.

[0071] It is sufficient that the a priori code is inserted during a short time at the start of communications. As described before, when CDMA is applied to a cellular system, control information is exchanged between a base station and a mobile station through a control channel before establishing a traffic channel for transmitting information data represented by voice. Accordingly, it is possible to achieve the acquisition of the control channel using the a priori code, and to carry out the acquisition of the traffic channel by inserting information on the start phase of the long code in the control channel. This will make it possible to start the acquisition of the traffic channel from a state in which the chip phase of the long code is nearly synchronized between the base station and the mobile station. As a result, the acquisition of both channels can be established in a short time.

[0072] The a priori code generator 26 provided in the transmitter in this embodiment can be replaced with other means. For example, it is possible for a combination of a generator for generating the convolution code X as shown in Fig. 5B and a convolution calculator to generate the a priori code by calculating the convolution between the long code fed from the long code generator 24 and the code X.

EMBODIMENT 2

[0073] In the first embodiment described above, the received phase estimation of the long code uses only one of the correlation values of the inphase component (I-component) and the quadrature component (Q-component) of the received signal. In this case, effect of noise can increase owing to the state of complex envelopes of fading, and this will degrade the estimation accuracy. The second embodiment is proposed to ameliorate the estimation accuracy in the fading environment by carrying out phase estimation using both I- and Q-components, thereby making quick acquisition possible.

[0074] Fig. 12A shows the inphase component of the correlation value between the received signal and the a priori code replica, and Fig. 12B shows its quadrature component. In these figures, the axis of abscissas represents, in terms of time difference, the phase difference between the a priori code in the received signal and the a priori code replica generated by the a priori code generator 72. The time t_{ap} designates the zero point of the time difference, at which the correlation level represented by the axis of ordinates becomes maximum. R_{1i} and R_{2i} represent the I components of the correlation values at times t_1 and t_2. Time t_{z1} is a time of zero-cross point at which the correlation value becomes zero. Fig. 12B shows the correlation values R_{1q} and R_{2q} of the Q-component corresponding to the I-component.

[0075] The operation of the received phase estimator using the I- and Q- components will now be described with reference to Figs. 13 - 15. In the following explanation, L_i and L_q represent the magnitude of the I and Q correlation values, respectively, which can be expressed by one of the following equations.

$$L_i = R_{1i}^{\ 2} + R_{2i}^{\ 2}$$

or

$$L_i = \begin{cases} R_{1i2} & (R_{1i2} \geq R_{2i2}) \\ R_{2i2} & (R_{1i2} < R_{2i2}) \end{cases}$$

L_q can be expressed in a similar manner.

[0076] Fig. 13 shows a configuration of a first phase estimator in accordance with the embodiment. In this figure, an I-correlation detector 91 corresponds to the circuit comprising the multiplier 71, the a priori code generator 72, the integral & dump circuit 73, the correlation memory 74, the switch 75 and the maximum correlation detector 76 as shown in Fig. 7. A Q-correlation detector 92 is similarly arranged. The I-correlation detector 91 is provided with the I-component of the spread signal from the A/D converter 58_I in Fig. 6, and the Q-correlation detector 92 is provided with the Q-component of the spread signal from the A/D converter 58_Q. The outputs of the correlators 91 and 92 are fed to a calculator 93. The output of the calculator 93 is supplied to a long code phase estimator 94 which corresponds to the long code phase estimator 77 in Fig. 7.

[0077] With such an arrangement, the calculator 93 obtains complex amplitudes of correlation values from the I- and Q-correlation values supplied from the I- and Q-correlators 91 and 92, respectively, and provides the resultant values to the long code estimator 94. The sign of the greater amplitude of the I- and Q correlation values adopted as the sign of the correlation value. More specifically, the calculator 93 obtains two correlation values from the I-correlation values fed from the I-correlator 91 and the Q-correlation values fed from the Q-correlator 92 by the following expressions.

$$R_1 = \mathrm{sgn}\begin{Bmatrix} R_{1i} & L_i \geq L_q \\ R_{1q} & L_i < L_q \end{Bmatrix}\sqrt{{R_{1i}}^2 + {R_{1q}}^2} \qquad (1)$$

$$R_2 = \mathrm{sgn}\begin{Bmatrix} R_{2i} & L_i \geq L_q \\ R_{2q} & L_i < L_q \end{Bmatrix}\sqrt{{R_{2i}}^2 + {R_{2q}}^2} \qquad (2)$$

where sgn(a) represents the sign of a. The long code phase estimator 94 estimates the phase of the received long code using the resultant R_1 and R_2, and t_1 and t_2 as described in the first embodiment.

[0078] Fig. 14 shows a configuration of a second phase estimator of this embodiment. The system differs from that of Fig. 13 in that it uses a correlation comparator 95 instead of the calculator 93.

[0079] With this arrangement, the correlation comparator 95 is provided with the I-correlation values from the I-correlation detector 91 and the Q-correlation values from the Q-correlation detector 92. The correlation comparator 95 compares these two correlation values, and outputs the greater one. The long code phase estimator 94 estimates the phase of the received spread code using the greater correlation values. More specifically, it estimates the phase of the received spread code using R_1 and R_2, and t_1 and t_2 obtained by the following expressions.

$$R_1 = \begin{cases} R_{1i} & (L_i \geq L_q) \\ R_{1q} & (L_i < L_q) \end{cases} \qquad (3)$$

$$R_2 = \begin{cases} R_{2i}, & (L_i \geq L_q) \\ R_{2q}, & (L_i < L_q) \end{cases} \qquad (4)$$

[0080] Fig. 15 shows a third phase estimator of the present embodiment. In Fig. 15, the I-correlator 91 and the Q-correlator 92 are connected to a long code phase estimator 96. The long code phase estimator 92 comprises two long code phase pre estimators 97 and 98, and a calculator 99.

[0081] With such an arrangement, the long code phase pre-estimators 97 and 98 estimate the phases for individual components using the I-correlation values fed from the I-correlator 91 and the Q correlation values fed from the Q-correlator 92.

[0082] There are two methods for combining the resultant two estimated phases: a simple averaging; and a weighted averaging in accordance with the respective correlation levels. Using the weighted averaging will provide a higher estimation accuracy. Assuming that t_{api} represents the start timing of receiving the estimated a priori code obtained from the I-correlation values R_{1i} and R_{2i} and their detection timings t_1 and t_2, and that t_{apq} represents the start timing of receiving the estimated a priori code obtained from the Q-correlation values R_{1q} and R_{2q} and their detection timings t_1 and t_2, the final start timing t_{ap} of receiving the estimated a priori code is obtained by the following expressions.

(1) When the simple averaging is used:

$$T_{ap} = \frac{T_{api} + T_{apq}}{2} \quad (5)$$

(2) When the weighted averaging is used:

$$T_{ap} = \frac{L_i \times t_{api} + L_q \times t_{api}}{L_i + L_q} \quad (6)$$

These operations are carried out by the calculator 99.

Claims

1. A transmitter for a CDMA transmission system which sends a wideband spread signal generated by spreading transmission information using long code generating means for generating a long code which is a spreading code with a period longer than an information symbol, said transmitter **characterised by** comprising:

   a priori code generating means (26) for generating a priori code representing a phase of said long code, a cross-correlation between said a priori code and said long code being negligibly small;
   a priori code insertion means (25, 27) for inserting said a priori code into said spread signal at a predetermined fixed interval to form frames; and
   transmission means (31-38) for transmitting said frames.

2. The transmitter as claimed in claim 1, **characterized in that** said a priori code comprises smoothly changing autocorrelation values, and a zero-cross point.

3. The transmitter as claimed in claim 2, **characterized in that** said autocorrelation values of said a priori code have a triangular profile.

4. The transmitter as claimed in claim 2, **characterized in that** said a priori code has a stepwise profile.

5. The transmitter as claimed in claim 1, **characterized in that** said a priori code has a period shorter than said long code.

6. The transmitter as claimed in claim 1, **characterized in that** said a priori code insertion means inserts said a priori code into said spread signal within a predetermined range at a beginning of communications.

7. The transmitter as claimed in claim 1, **characterized in that** said a priori code generating means comprises means for generating a predetermined code for a convolution, and calculation means for carrying out said convolution between said code for a convolution and said long code to output said a priori code, and said a priori code insertion means inserts an output of said calculation means into said spread signal.

8. An acquisition apparatus of a spreading code for a CDMA transmission system which demodulates desired information by receiving a wideband spread signal being generated by spreading transmission information using a long code which is a spreading code with a period longer than an information symbol, said acquisition apparatus **characterised by** comprising:

   first correlation means (SC) for generating a replica of said long code, and for calculating a correlation between said replica of said long code and said wideband spread signal being inserted a priori code which has a negligibly small cross-correlation with said long code, and represents a phase of said long code,
   second correlation means (CR) for generating a replica of said a priori code, and for calculating a correlation between said received signal and said replica of said a priori code;
   phase estimation means (77) for estimating received phase of said long code based on an output of said second correlation means; and
   means (772) for controlling a generation phase of said replica of said long code based on an output of said phase estimation means.

9. The acquisition apparatus of the spreading code as claimed in claim 8, **characterized in that** said a priori code is inserted into said spread signal at a fixed period, and **characterized in that** said second correlation means comprises paired correlators consisting of a correlator that generates replicas of paired a priori codes consisting of a replica of a first a priori code and a replica of a second a priori code with their correlation detection start timings shifted by an amount of Δ, and that calculates correlations between said replica of said first a priori code and said received signal, and a correlator that calculates correlations between said replica of said second a priori code and said received signal; and

said phase estimation means estimates a received phase of said long code based on outputs of said paired correlators.

10. The acquisition apparatus of the spreading code as claimed in claim 8, **characterized in that**

each of said paired correlators integrates a product of said received signal and said replica of said a priori code for one period of said a priori code; and
said phase estimation means estimates a received phase of said long code from two integrated values.

11. The acquisition apparatus of the spreading code as claimed in claim 10, **characterized in that** said second correlation means comprises m pairs of correlators, where m is an integer greater than one, and **characterized in that** start timings of correlation detection and integration of adjacent pairs of said correlators are shifted by T_A/m in time, where T_A is a length of said a priori code.

12. The acquisition apparatus of the spreading code as claimed in claim 11, **characterized in that** said phase estimation means comprises means for selecting one pair of said correlators which produces maximum outputs, and estimates a received phase of said long code based on said maximum outputs and their detection timings.

13. The acquisition apparatus of the spreading code as claimed in claim 12, **characterized in that** said phase estimation means obtains a zero-cross point, at which a correlation value between said received signal and said replica of said a priori code becomes zero, from said maximum outputs and their detection timings, and estimates a received phase of said a priori code from said zero-cross point, and said control means controls a generation phase of said replica of said long code in accordance with the estimated received phase of said a priori code.

14. The acquisition apparatus of the spreading code as claimed in claim 13, **characterized in that** said control means sets the generation phase of said replica of said long code such that the generation phase is centered at the received phase of said a priori code estimated by said phase estimation means, and carries out non-uniform search in which the generation phase of said replica of said long code is gradually shifted in a wider range when a phase of said replica of said long code is not synchronized with a phase of said long code in said received signal.

15. The acquisition apparatus of the spreading code as claimed in claim 8, **characterized in that** said a priori code is inserted solely at an initial portion of said spreading code.

16. The acquisition apparatus of the spreading code as claimed in claim 8, **characterized in that** said a priori code is inserted solely at an initial portion of said spreading code of a control channel.

17. The acquisition apparatus of the spreading code as claimed in claim 8, **characterized in that** said first correlation means is a sliding correlator.

18. The acquisition apparatus of the spreading code as claimed in claim 8, **characterized in that** said second correlation means comprises an I-correlator and a Q-correlator, said I correlator detecting correlation between an I-component (inphase component) of a carrier of said received signal after quadrature detection and an I-component of said replica of said a priori code, said Q-correlator detecting correlation between a Q component (quadrature component) of the carrier of said received signal after quadrature detection and a Q-component of said replica of said a priori code, and **characterized in that** said phase estimation means estimates a received phase of said long code using both said I-component and said Q-component.

19. The acquisition apparatus of the spreading code as claimed in claim 18, **characterized in that** said phase estimation means obtains a complex amplitude of an output of said I correlator and an output of said Q-correlator, and estimates said received phase of said long code using the complex amplitude.

20. The acquisition apparatus of the spreading code as claimed in claim 18, **characterized in that** said phase estimation means compares an output of said I-correlator with an output of said Q-correlator, and estimates said received phase of said long code using the output with a greater absolute value.

21. The acquisition apparatus of the spreading code as claimed in claim 18, **characterized in that** said phase estimation means obtains an estimated received phase of said long code from an output of said I-correlator, and an estimated received phase of said long code from an output of said Q-correlator, and estimates said received phase of said long code by averaging these two estimated received phases.

22. A receiver for a CDMA transmission system **characterized by** comprising the acquisition apparatus as claimed in claim 8.

23. A CDMA transmission system **characterized by** comprising a transmitter as claimed in claim 1 and a receiver as claimed in claim 22.

24. A transmission method for use in a CDMA transmission system for sending a wideband spread signal generated by spreading transmission information using a long code which is a spreading code with a period longer than an information symbol, said method **characterized by** comprising the steps of:

generating a priori code representing a phase of said long code, a cross-correlation between said priori code and said long code being negligibly small;
inserting said a priori code into said spread signal at a predetermined fixed interval to form frames; and
transmitting said frames.

25. An acquisition method of a spreading code for use in a CDMA transmission system which demodulates desired information by receiving a wideband spread signal generated by spreading transmission information using a long code which is a spreading code with a period longer than an information symbol, said acquisition method **characterized by** comprising the steps of:

generating a replica of said long code;
calculating a correlation between said replica of said long code said wideband spread signal being inserted a priori code which has a negligbly small cross-correlation with said long code and represents a phase of said long code;
generating a replica of said a priori code;
calculating a correlation between said received signal and said replica of said a priori code;
estimating received phase of said long code based on said correlation between said received signal and said replica of said a priori code; and
controlling a generation phase of said replica of said long code based on an estimated received phase of said long code.

26. A CDMA transmission method **characterized by** comprising a transmission method as claimed in claim 24 and an acquisition method as claimed in claim 25.

Patentansprüche

1. Übertragungseinrichtung für ein CDMA-Übertragungssystem, das ein Breitbandspreizsignal sendet, das durch Spreizübertragungsinformationen unter Verwendung einer Langcodeerzeugungseinrichtung zum Erzeugen eines Langcodes erzeugt wird, welcher ein Spreizcode mit einer längeren Periode als ein Informationssymbol ist, die Übertragungseinrichtung ist **gekennzeichnet durch**:

eine a-priori-Code-Erzeugungseinrichtung (26) zum Erzeugen eines a-priori-Codes, der eine Phase des Langcodes repräsentiert, wobei eine Kreuzkorrelation zwischen dem a-priori-Code und dem Langcode vernachlässigbar gering ist;
eine a-priori-Code-Einfügeeinrichtung (25, 27) zum Einfügen des a-priori-Codes in das Spreizsignal mit einem vorbestimmten festen Intervall zur Ausbildung von Datenübertragungsblöcken; und
einer Übertragungseinrichtung (31-38) zum Übertragen der Datenübertragungsblöcke.

2. Übertragungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der a-priori-Code sich sanft verändernde Autokorrelationswerte und einen Nulldurchlaufpunkt aufweist.

3. Übertragungseinrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** Autokorrelationswerte des a-priori-Codes ein Dreiecksprofil aufweisen.

4. Übertragungseinrichtung nach Anspruch 2, **dadurch gekennzeichnet, dass** der a-priori-Code ein Stufenprofil aufweist.

5. Übertragungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** der a-priori-Code eine kürzere Periode als der Langcode aufweist.

6. Übertragungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die a-priori-Code-Einfügeeinrichtung den a-priori-Code in das Spreizsignal innerhalb eines vorbestimmten Bereichs am Anfang von Kommunikationsvorgängen einfügt.

7. Übertragungseinrichtung nach Anspruch 1, **dadurch gekennzeichnet, dass** die a-priori-Code-Erzeugungseinrichtung eine Einrichtung zum Erzeugen eines vorbestimmten Codes für eine Faltung sowie eine Berechnungseinrichtung zum Ausführen der Faltung zwischen dem Code für eine Faltung und dem Langcode aufweist, um den a-priori-Code auszugeben, und wobei die a-priori-Code-Einfügeeinrichtung eine Ausgabe der Berechnungseinrichtung in das Spreizsignal einfügt.

8. Gerät zur Erlangung eines Spreizcodes für ein CDMA-Übertragungssystem, welches gewünschte Informationen durch den Empfang eines Breitbandspreizsignals demoduliert, das durch Spreizübertragungsinformationen unter Verwendung eines Langcodes erzeugt wird, welcher ein Spreizcode mit einer längeren Periode als ein Informationssymbol ist, das Erlangungsgerät ist **gekennzeichnet durch**:

   eine erste Korrelationseinrichtung (SC) zum Erzeugen einer Nachbildung des Langcodes und zum Berechnen einer Korrelation zwischen der Nachbildung des Langcodes und dem Breitbandspreizsignal, dem ein a-priori-Code eingefügt wurde, Welcher eine vernachlässigbar geringe Kreuzkorrelation mit dem Langcode aufweist, und der eine Phase des Langcodes repräsentiert,
   eine zweite Korrelationseinrichtung (CR) zum Erzeugen einer Nachbildung des a-priori-Codes und zum Berechnen einer Korrelation zwischen dem empfangenen Signal und der Nachbildung des a-priori-Codes;
   eine Phasenabschätzungseinrichtung (77) zum Abschätzen einer empfangenen Phase des Langcodes auf der Grundlage einer Ausgabe der zweiten Korrelationseinrichtung; und
   eine Einrichtung (772) zum Steuern einer Erzeugungsphase der Nachbildung des Langcodes auf der Grundlage einer Ausgabe der Phasenabschätzungseinrichtung.

9. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** der a-priori-Code in das Spreizsignal mit einer festen Periode eingefügt wird, und dass die zweite Korrelationseinrichtung gepaarte Korrelatoren umfasst, die aus einem Korrelator, der Nachbildungen von gepaarten a-priori-Codes erzeugt, welche aus einer Nachbildung eines ersten a-priori-Codes und einer Nachbildung eines zweiten a-priori-Codes besteht, wobei deren Korrelationserfassungsstartzeitpunkt um einen Betrag Δ verschoben ist, und der Korrelationen zwischen der Nachbildung des ersten a-priori-Codes und des empfangenen Signals berechnet, sowie einem Korrelator bestehen, der Korrelationen zwischen der Nachbildung des zweiten a-priori-Codes und des empfangenen Signals berechnet; und
   die Phasenabschätzungseinrichtung eine empfangene Phase des Langcodes auf der Grundlage von Ausgaben der gepaarten Korrelatoren abschätzt.

10. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** jeder der gepaarten Korrelatoren ein Produkt des empfangenen Signals sowie die Nachbildung des a-priori-Codes für eine Periode des a-priori-Codes integriert; und
    die Phasenabschätzungseinrichtung eine empfangene Phase des Langcodes aus zwei integrierten Werten abschätzt.

11. Gerät zur Erlangung eines Spreizcodes nach Anspruch 10, **dadurch gekennzeichnet, dass** die zweite Korrelationseinrichtung m Paare Korrelatoren umfasst, wobei m eine ganze Zahl größer eins ist, und dass die Startzeitpunkte der Korrelationserfassung und der Integration von benachbarten Paaren der Korrelatoren um T_A/m zeitlich

verschoben sind, wobei T_A die Länge des a-priori-Codes ist.

12. Gerät zur Erlangung eines Spreizcodes nach Anspruch 11, **dadurch gekennzeichnet, dass** die Phasenabschätzungseinrichtung eine Einrichtung zur Auswahl eines Paares der Korrelatoren aufweist, das maximale Ausgaben erzeugt, und das eine empfangene Phase des Langcodes auf der Grundlage der maximalen Ausgaben und ihrer Erfassungszeitpunkte abschätzt.

13. Gerät zur Erlangung eines Spreizcodes nach Anspruch 12, **dadurch gekennzeichnet, dass** die Phasenabschätzungseinrichtung einen Nulldurchlaufpunkt aus den maximalen Ausgaben und ihrer Erfassungszeitabläufe erhält, bei dem ein Korrelationswert zwischen dem empfangenen Signal und der Nachbildung des a-priori-Codes Null wird, und das eine empfangene Phase des a-priori-Codes aus dem Nulldurchlaufspunkt abschätzt, und wobei die Steuereinrichtung eine Erzeugungsphase der Nachbildung des Langcodes gemäß der abgeschätzten empfangenen Phase des a-priori-Codes steuert.

14. Gerät zur Erlangung eines Spreizcodes nach Anspruch 13, **dadurch gekennzeichnet, class** die Steuereinrichtung die Erzeugungsphase der Nachbildung des Langcodes derart einstellt, dass die Erzeugungsphase bei der empfangenen Phase des durch die Phasenabschätzungseinrichtung abgeschätzten a-priori-Codes zentriert ist, und dass sie eine nicht homogene Suche ausführt, bei der die Erzeugungsphase der Nachbildung des Langcodes in einem breiteren Bereich graduell verschoben ist, wenn eine Phase der Nachbildung des Langcodes nicht mit einer Phase des Langcodes in dem empfangenen Signal synchronisiert ist.

15. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** der a-priori-Code ausschließlich an einem Anfangspunkt des Spreizcodes eingefügt ist.

16. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** der a-priori-Code ausschließlich an einem Anfangspunkt des Spreizcodes eines Steuerkanals eingefügt ist.

17. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** die erste Korrelationseinrichtung ein Schiebkorrelator ist.

18. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** die zweite Korrelationseinrichtung einen I-Korrelator und einen Q-Korrelator umfasst, wobei der I-Korrelator eine Korrelation zwischen einer 1-Komponente (gleichphasige Komponente) eines Trägers des empfangenen Signals nach einer Quadraturerfassung und einer I-Komponente der Nachbildung des a-priori-Codes erfasst, wobei der Q-Korrelator eine Korrelation zwischen einer Q-Komponente (Quadraturkomponente) des Trägers des empfangenen Signals nach einer Quadraturerfassung sowie eine Q-Komponente der Nachbildung des a-priori-Codes erfasst, und wobei die Phasenabschätzungseinrichtung eine empfangene Phase des Langcodes unter Verwendung sowohl der I-Komponente als auch der Q-Komponente abschätzt.

19. Gerät zur Erlangung eines Spreizcodes nach Anspruch 18, **dadurch gekennzeichnet, dass** die Phasenabschätzungseinrichtung eine komplexe Amplitude einer Ausgabe des I-Korrelators sowie eine Ausgabe des Q-Korrelators erhält, und die empfangene Phase des Langcodes unter Verwendung der komplexen Amplitude abschätzt.

20. Gerät zur Erlangung eines Spreizcodes nach Anspruch 8, **dadurch gekennzeichnet, dass** die Phasenabschätzungseinrichtung eine Ausgabe des I-Korrelators mit einer Ausgabe des Q-Korrelators vergleicht, und die empfangene Phase des Langcodes unter Verwendung der Ausgabe mit einem größeren Absolutwert abschätzt.

21. Gerät zur Erlangung eines Spreizcodes nach Anspruch 18, **dadurch gekennzeichnet, dass** die Phasenabschätzungseinrichtung eine abgeschätzte empfangene Phase des Langcodes von einer Ausgabe des I-Korrelators sowie eine abgeschätzte empfangene Phase des Langcodes aus einer Ausgabe des Q-Korrelators erhält, und die empfangene Phase des Langcodes durch Durchschnittswertbildung aus diesen beiden abgeschätzten empfangenen Phasen abschätzt.

22. Empfänger für ein CDMA-Übertragungssystem, **gekennzeichnet durch** das Erlangungsgerät nach Anspruch 8.

23. CDMA-Übertragungssystem, **gekennzeichnet durch** eine Übertragungseinrichtung nach Anspruch 1 und einen Empfänger nach Anspruch 22.

24. Übertragungsverfahren zur Verwendung in einem CDMA-Übertragungssystem zum Senden eines Breitbandspreizsignals, das durch Spreizübertragungsinformationen unter Verwendung eines Langcodes erzeugt wird, welcher ein Spreizcode mit einer längeren Periode als ein Informationssymbol ist, das Verfahren ist **gekennzeichnet durch** die Schritte:

Erzeugen eines eine Phase des Langcodes repräsentierenden a-priori-Codes, wobei eine Kreuzkorrelation zwischen dem a-priori-Code und dem Langcode vernachlässigbar gering ist;
Einfügen des a-priori-Codes in das Spreizsignal mit einem vorbestimmten festen Intervall zur Ausbildung von Datenübertragungsblöcken; und
Übertragen der Datenübertragungsblöcke.

25. Verfahren zur Erlangung eines Spreizcodes zur Verwendung bei einem CDMA-Übertragungssystem, das gewünschte Informationen durch den Empfang eines Breitbandspreizsignals demoduliert, welches durch Spreizübertragungsinformationen unter Verwendung eines Langcodes erzeugt wird, welcher ein Spreizcode mit einer längeren Periode als ein Informationssymbol ist, das Erlangungsverfahren ist **gekennzeichnet durch** die Schritte:

Erzeugung einer Nachbildung des Langcodes;
Berechnen einer Korrelation zwischen der Nachbildung des Langcodes und dem Breitbandspreizsignal, dem ein a-priori-Code eingefügt ist, das eine vernachlässigbar geringe Kreuzkorrelation mit dem Langcode aufweist und eine Phase des Langcodes repräsentiert;
Erzeugen einer Nachbildung des a-priori-Codes;
Berechnen einer Korrelation zwischen dem empfangenen Signal und der Nachbildung des a-priori-Codes;
Abschätzen einer empfangenen Phase des Langcodes auf der Grundlage der Korrelation zwischen dem empfangenen Signal und der Nachbildung des a-priori-Codes; und
Steuern einer Erzeugungsphase der Nachbildung des Langcodes auf der Grundlage einer abgeschätzten empfangenen Phase des Langcodes.

26. CDMA-Übertragungsverfahren, **gekennzeichnet durch** ein Übertragungsverfahren nach Anspruch 24 und ein Erlangungsverfahren nach Anspruch 25.

Revendications

1. Emetteur pour un système de transmission CDMA qui envoie un signal d'étalement à larges bandes produit par des informations de transmission d'étalement en utilisant des moyens de production de code long pour produire un code long qui est un code d'étalement avec une période plus longue qu'un symbole d'information, l'émetteur étant **caractérisé par** le fait de comporter :

des moyens (26) de production de code à priori pour produire un code à priori représentant une phase du code long, une corrélation croisée entre le code à priori et le code long étant petite de manière négligeable;
des moyens (25, 27) d'insertion de code à priori pour insérer le code à priori dans le signal d'étalement à un intervalle fixe déterminé à l'avance pour former des trames; et
des moyens (31-38) de transmission pour émettre les trames.

2. Emetteur suivant la revendication 1, **caractérisé en ce que** le code à priori comporte des valeurs d'auto-corrélation changeant en douceur, et un point de traversée du zéro.

3. Emetteur suivant la revendication 2, **caractérisé en ce que** les valeurs d'auto-corrélation du code à priori ont un profil triangulaire.

4. Emetteur suivant la revendication 2, **caractérisé en ce que** le code à priori a un profil en échelon.

5. Emetteur suivant la revendication 1, **caractérisé en ce que** le code à priori a une période plus courte que le code long.

6. Emetteur suivant la revendication 1, **caractérisé en ce que** les moyens d'insertion de code à priori insèrent le code à priori dans le signal d'étalement à l'intérieur d'un domaine déterminé à l'avance à un début de communication.

7. Emetteur suivant la revendication 1, **caractérisé en ce que** les moyens de production de code à priori comportent des moyens pour produire un code déterminé à l'avance pour une convolution, et des moyens de calcul pour effectuer la convolution entre le code pour une convolution et le code long pour émettre en sortie le code à priori, et les moyens d'insertion de code à priori insèrent une sortie des moyens de calcul dans le signal d'étalement.

8. Dispositif d'acquisition d'un code d'étalement pour un système de transmission CDMA qui démodule des informations souhaitées en recevant un signal d'étalement large bande qui est produit en étalant des informations de transmission en utilisant un code long qui est un code d'étalement avec une période plus longue qu'un symbole d'information, le dispositif d'acquisition étant **caractérisé par** le fait de comporter :

des premiers moyens (SC) de corrélation pour produire une réplique du code long, et pour calculer une corrélation entre la réplique du code long et le signal d'étalement large bande dans lequel est inséré un code à priori qui a une corrélation croisée petite de manière négligeable avec le code long, et représente une phase du code long,
des deuxièmes moyens (CR) de corrélation pour produire une réplique du code à priori, et pour calculer une corrélation entre le signal reçu et la réplique du code à priori;
des moyens (77) d'estimation de phase pour estimer une phase reçue du code long sur la base d'une sortie des deuxièmes moyens de corrélation; et
des moyens (772) de commande d'une phase de production de la réplique du code long sur la base d'une sortie des moyens d'estimation de phase.

9. Dispositif d'acquisition du code d'étalement suivant la revendication 8, **caractérisé en ce que** le code à priori est inséré dans le signal d'étalement à une période fixe, et **caractérisé en ce que** les deuxièmes moyens de corrélation comportent des corrélateurs par paire constitués d'un corrélateur qui produit des répliques de code à priori par paire constitué d'une réplique d'un premier code à priori et d'une réplique d'un deuxième code à priori, leur synchronisation de départ de détection de corrélation étant décalée d'une quantité de Δ, et qui calcule des corrélation entre la réplique du premier code à priori et le signal reçu, et un corrélateur qui calcule des corrélations entre la réplique du deuxième code à priori et le signal reçu; et
les moyens d'estimation de phase estimant une phase reçue du code long sur la base de sorties des corrélateurs par paire.

10. Dispositif d'acquisition du code d'étalement suivant la revendication 8, **caractérisé en ce que** chaque corrélateur des corrélateurs par paire intègre un produit du signal reçu et de la réplique du code à priori pour une période du code à priori; et
les moyens d'estimation de phase estiment une phase reçue du code long à partir de deux valeurs intégrées.

11. Dispositif d'acquisition du code d'étalement suivant la revendication 10, **caractérisé en ce que** les deuxièmes moyens de corrélation comportent m paires de corrélateurs, où m est un entier supérieur à un, et **caractérisé en ce que** des synchronisations de départ de la détection de corrélation et de l'intégration de paires adjacentes des corrélateurs sont décalées de T_A/m dans le temps, où T_A est une longueur du code à priori.

12. Dispositif d'acquisition du code d'étalement suivant la revendication 11, **caractérisé en ce que** les moyens d'estimation de phase comportent des moyens pour sélectionner une paire des corrélateurs qui produit des sorties maximum, et estime une phase reçue du code long sur la base des sorties maximum et de leur synchronisation de détection.

13. Dispositif d'acquisition du code d'étalement suivant la revendication 12, **caractérisé en ce que** les moyens d'estimation de phase obtiennent un point de traversée du zéro, auquel une valeur de corrélation entre le signal reçu et la réplique du code à priori devient nulle, à partir des sorties maximum et de leur synchronisation de détection, et estiment une phase reçue du code à priori à partir du point de traversée du zéro, et les moyens de commande commandent une phase de production de la réplique du code long conformément à la phase reçue estimée du code à priori.

14. Dispositif d'acquisition du code d'étalement suivant la revendication 13, **caractérisé en ce que** les moyens de commande règlent la phase de production de la réplique du code long de sorte que la phase de production est centrée à la phase reçue du code à priori estimé par les moyens d'estimation de phase, et effectuent une recherche non uniforme dans laquelle la phase de production de la réplique du code long est décalée graduellement dans un domaine plus grand lorsqu'une phase de la réplique du code long n'est pas synchronisée avec une phase du code long dans le signal reçu.

15. Dispositif d'acquisition du code d'étalement suivant la revendication 8, **caractérisé en ce que** le code à priori est inséré uniquement à une partie initiale du code d'étalement.

16. Dispositif d'acquisition du code d'étalement suivant la revendication 8, **caractérisé en ce que** le code à priori est inséré uniquement à une partie initiale du code d'étalement d'un canal de commande.

17. Dispositif d'acquisition du code d'étalement suivant la revendication 8, **caractérisé en ce que** les premiers moyens de corrélation sont un corrélateur à glissement.

18. Dispositif d'acquisition du code d'étalement suivant la revendication 8, **caractérisé en ce que** les deuxièmes moyens de corrélation comportent un corrélateur I et un corrélateur Q, le corrélateur I détectant une corrélation entre un composant I (composant en phase) d'un porteur du signal reçu après la détection en quadrature et un composant I de la réplique du code à priori,

le corrélateur Q détectant la corrélation entre un composant Q (composant en quadrature) du porteur du signal reçu après détection de la quadrature et un composant Q de la réplique du code à priori, et **caractérisé en ce que** les moyens d'estimation de phase estiment une phase reçue du code long en utilisant à la fois le composant I et le composant Q.

19. Dispositif d'acquisition du code d'étalement suivant la revendication 18, **caractérisé en ce que** les moyens d'estimation de phase obtiennent une amplitude complexe d'une sortie du corrélateur I et d'une sortie du corrélateur Q, et estiment la phase reçue du code long en utilisant l'amplitude complexe.

20. Dispositif d'acquisition du code d'étalement suivant la revendication 18, **caractérisé en ce que** les moyens d'estimation de phase comparent une sortie du corrélateur I avec une sortie du corrélateur Q, et estiment la phase reçue du code long en utilisant la sortie avec une valeur absolue plus grande.

21. Dispositif d'acquisition du code d'étalement suivant la revendication 18, **caractérisé en ce que** les moyens d'estimation de phase obtiennent une phase reçue estimée du code long à partir d'une sortie du corrélateur I, et une phase reçue estimée du code long à partir d'une sortie du corrélateur Q, et estiment la phase reçue du code long en effectuant une moyenne de ces deux phases reçues estimées.

22. Récepteur pour un système de transmission CDMA **caractérisé par** le fait de comporter le dispositif d'acquisition suivant la revendication 8.

23. Système de transmission CDMA **caractérisé par** le fait de comporter un émetteur suivant la revendication 1 et un récepteur suivant la revendication 22.

24. Procédé de transmission à utiliser dans un système de transmission CDMA pour envoyer un signal d'étalement large bande produit par l'étalement d'informations de transmission en utilisant un code long qui est un code d'étalement avec une période plus longue qu'un symbole d'information, le procédé étant **caractérisé par** le fait de comporter les étapes qui consistent :

à produire un code à priori représentant une phase du code long, une corrélation croisée entre le code à priori et le code long étant petite de manière négligeable;
à insérer le code à priori dans le signal d'étalement à un intervalle prédéterminé fixe pour former des trames; et
à émettre les trames.

25. Procédé d'acquisition d'un code d'étalement à utiliser dans un système de transmission CDMA qui démodule des informations souhaitées en recevant un signal d'étalement large bande produit en étalant des informations de transmission en utilisant un code long qui est un code d'étalement avec une période plus longue qu'un symbole d'information, le procédé d'acquisition étant **caractérisé par** le fait de comporter les étapes qui consistent :

à produire une réplique du code long;
à calculer une corrélation entre la réplique du code long et le signal d'étalement large bande dans lequel est inséré un code à priori qui a une corrélation croisée petite de manière négligeable avec le code long et représente une phase du code long;

à produire une réplique du code à priori;
à calculer une corrélation entre le signal reçu et la réplique du code à priori;
à estimer une phase reçue du code long sur la base de la corrélation entre le signal reçu et la réplique du code à priori; et
à commander une phase de production de la réplique du code long sur la base d'une phase reçue estimée du code long.

26. Procédé de transmission CDMA **caractérisé par** le fait de comporter un procédé de transmission suivant la revendication 24 et un procédé d'acquisition suivant la revendication 25.

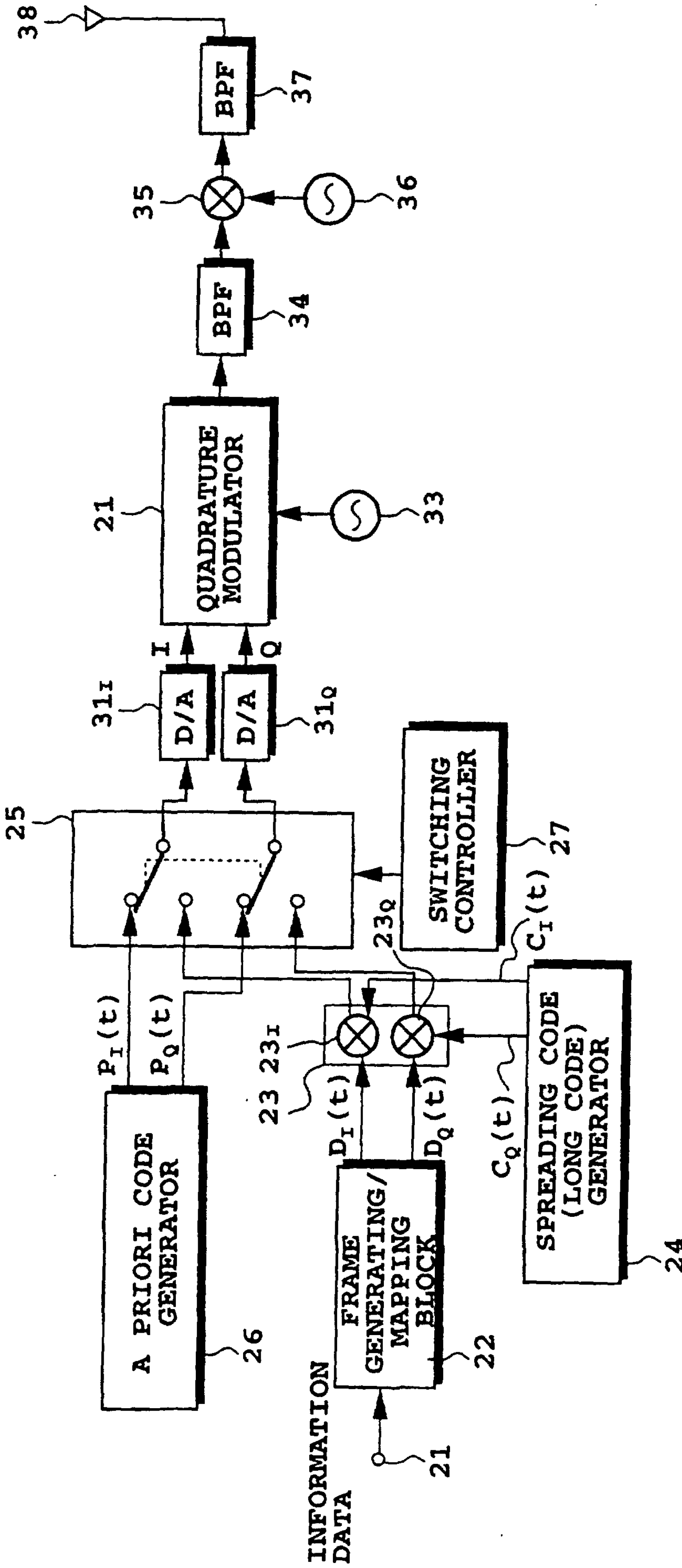

38
BPF
37
35
36
BPF
34
21
QUADRATURE MODULATOR
33
I
Q
31I
D/A
D/A
31Q
25
SWITCHING CONTROLLER
27
A PRIORI CODE GENERATOR
26
PI(t)
PQ(t)
23 23I
23Q
CI(t)
CQ(t)
DI(t)
DQ(t)
FRAME GENERATING/ MAPPING BLOCK
22
SPREADING CODE (LONG CODE) GENERATOR
24
INFORMATION DATA
21

FIG. 1

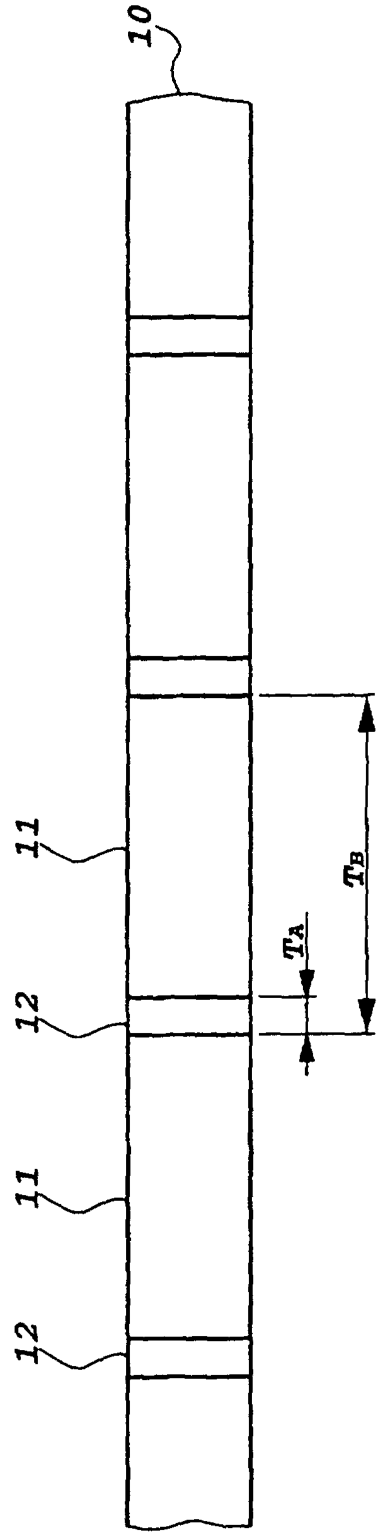


FIG. 2

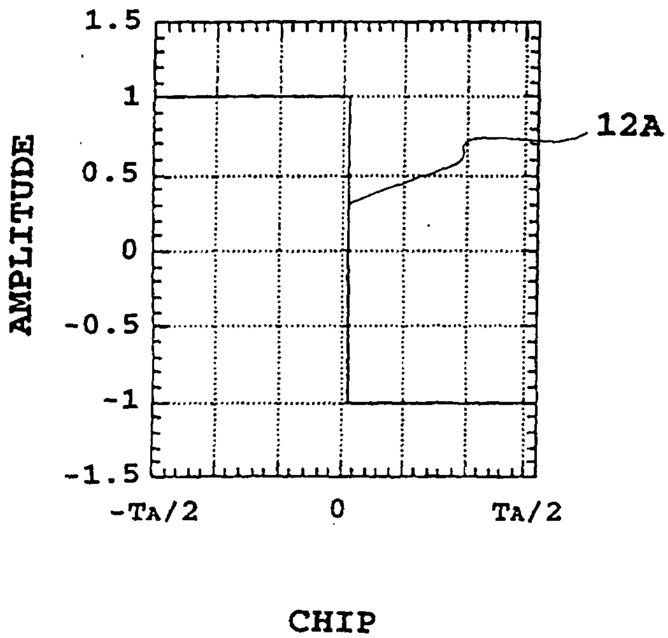


FIG.3A

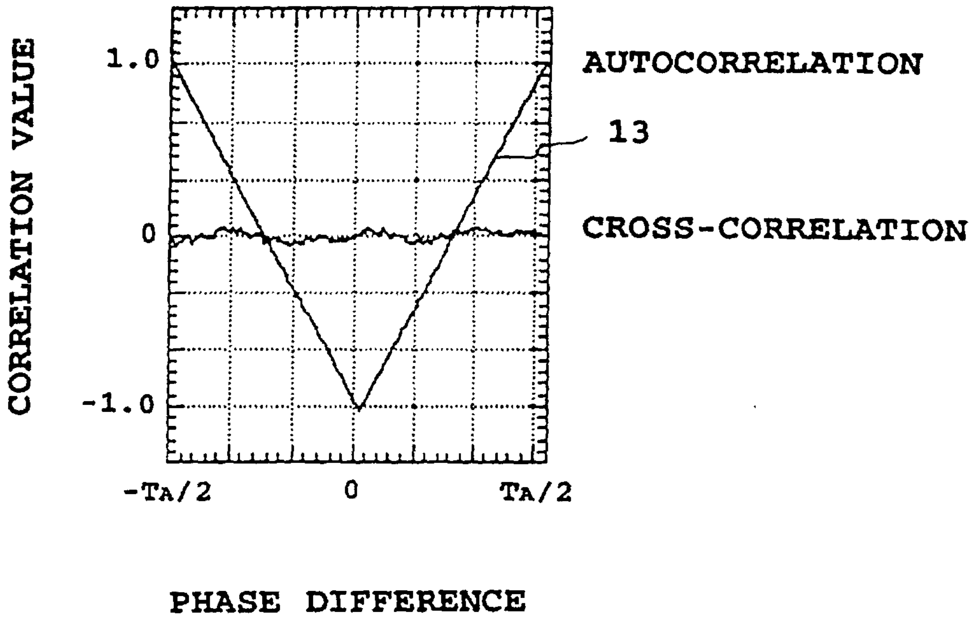

CORRELATION VALUE
1.0
0
-1.0
AUTOCORRELATION
13
CROSS-CORRELATION
-TA/2
0
TA/2
PHASE DIFFERENCE

FIG.3B

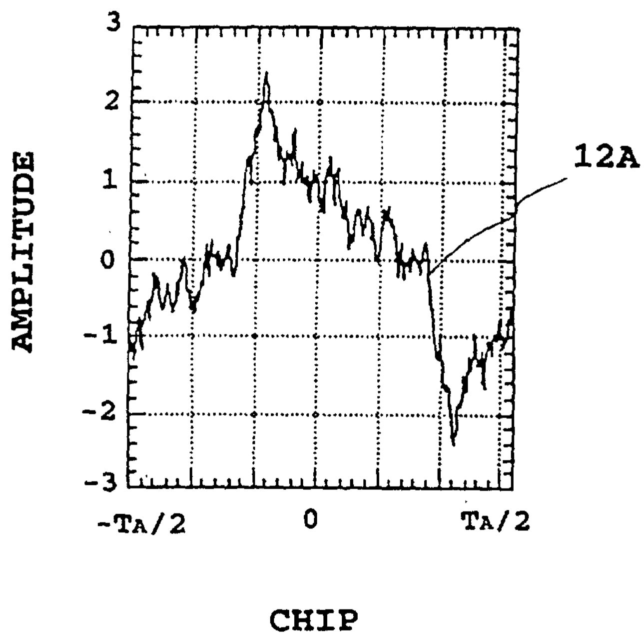


FIG.4A

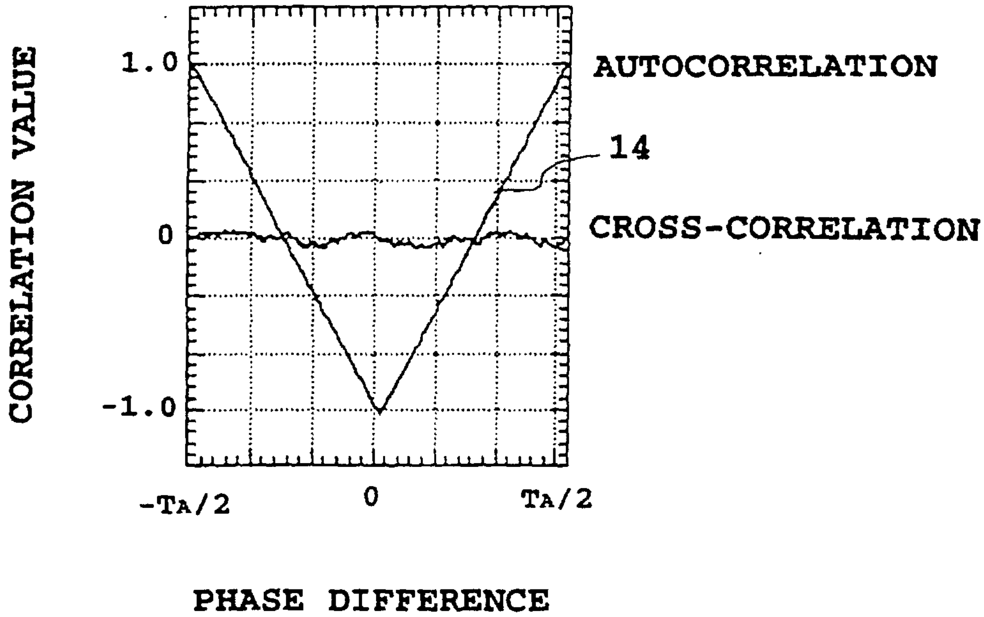

CORRELATION VALUE
1.0
0
-1.0
AUTOCORRELATION
14
CROSS-CORRELATION
-TA/2
0
TA/2
PHASE DIFFERENCE

FIG.4B

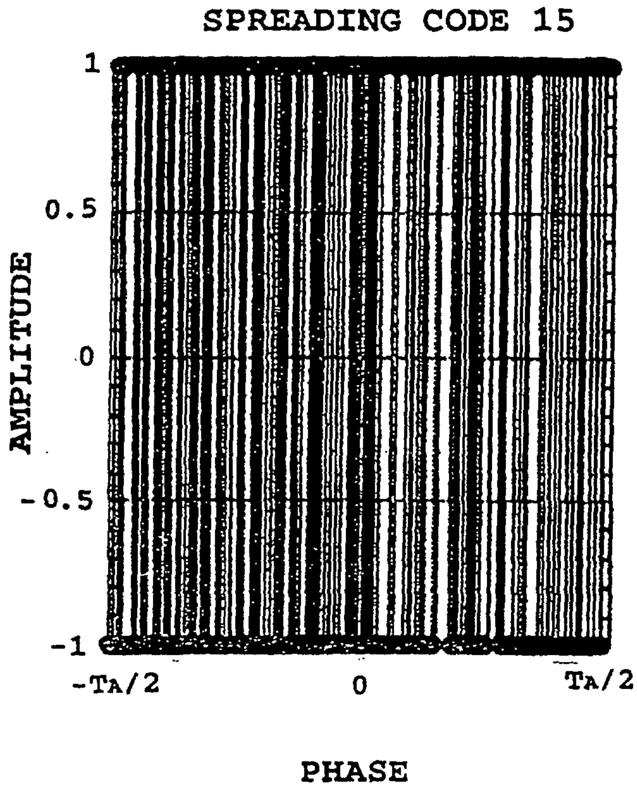


FIG.5A

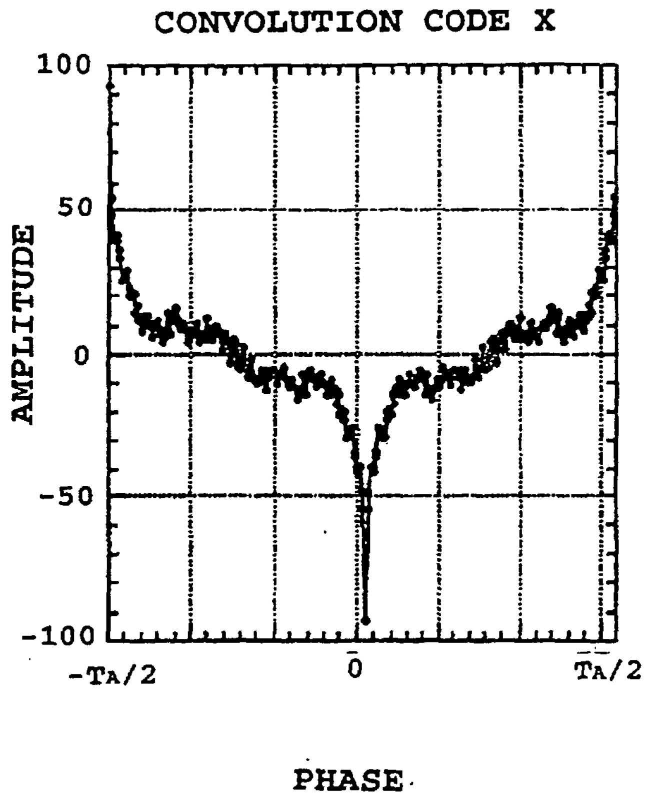


FIG. 5B

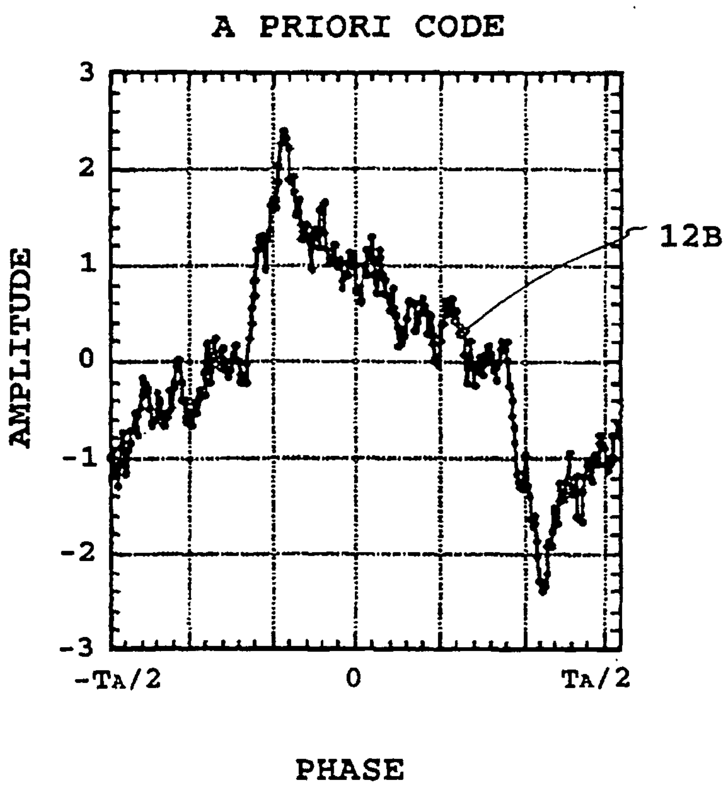


FIG.5C

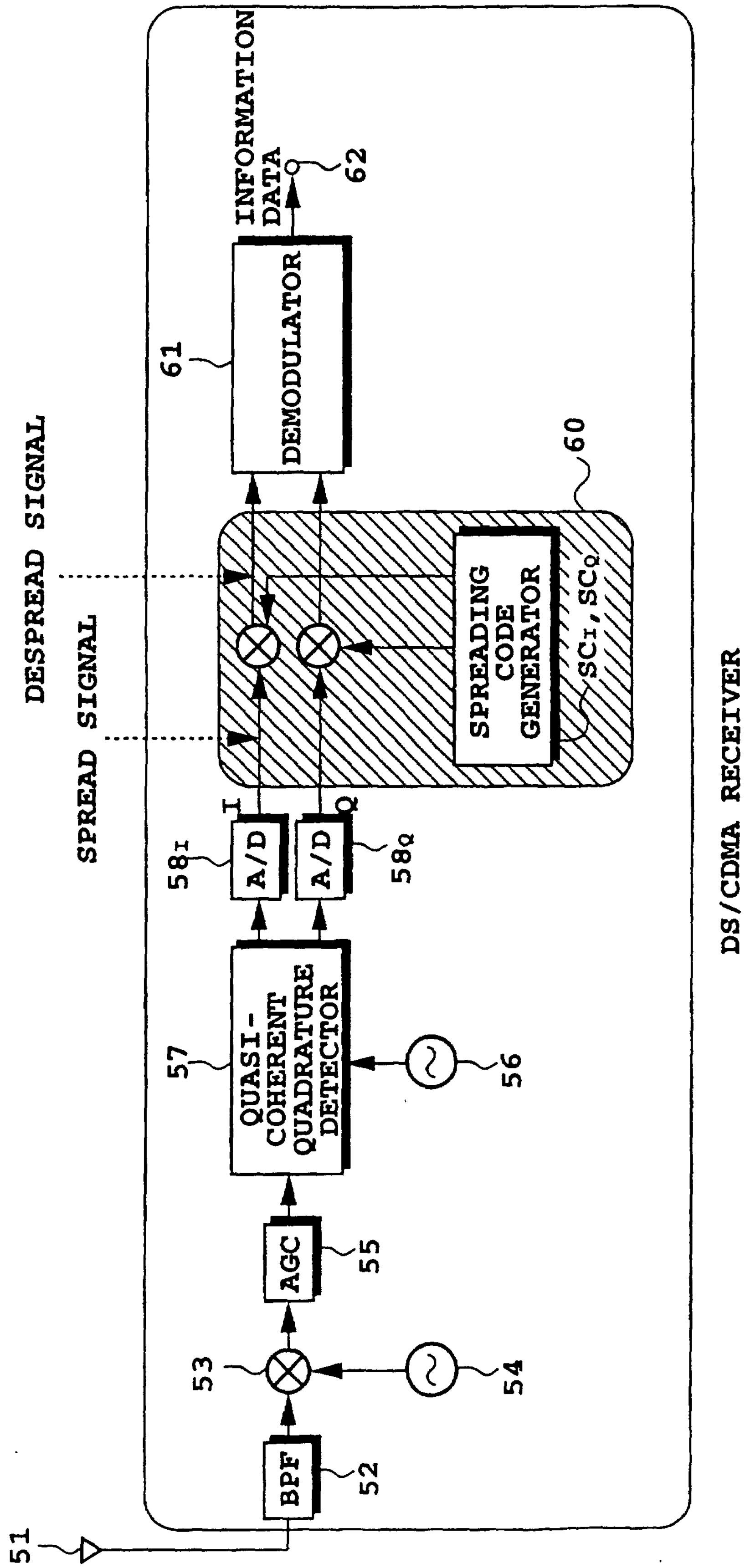

DESPREAD SIGNAL
SPREAD SIGNAL
INFORMATION DATA
62
61
DEMODULATOR
60
SPREADING CODE GENERATOR
SCI, SCQ
I
Q
58I
A/D
A/D
58Q
57
QUASI-COHERENT QUADRATURE DETECTOR
56
55
AGC
53
54
BPF
52
51
DS/CDMA RECEIVER

FIG.6

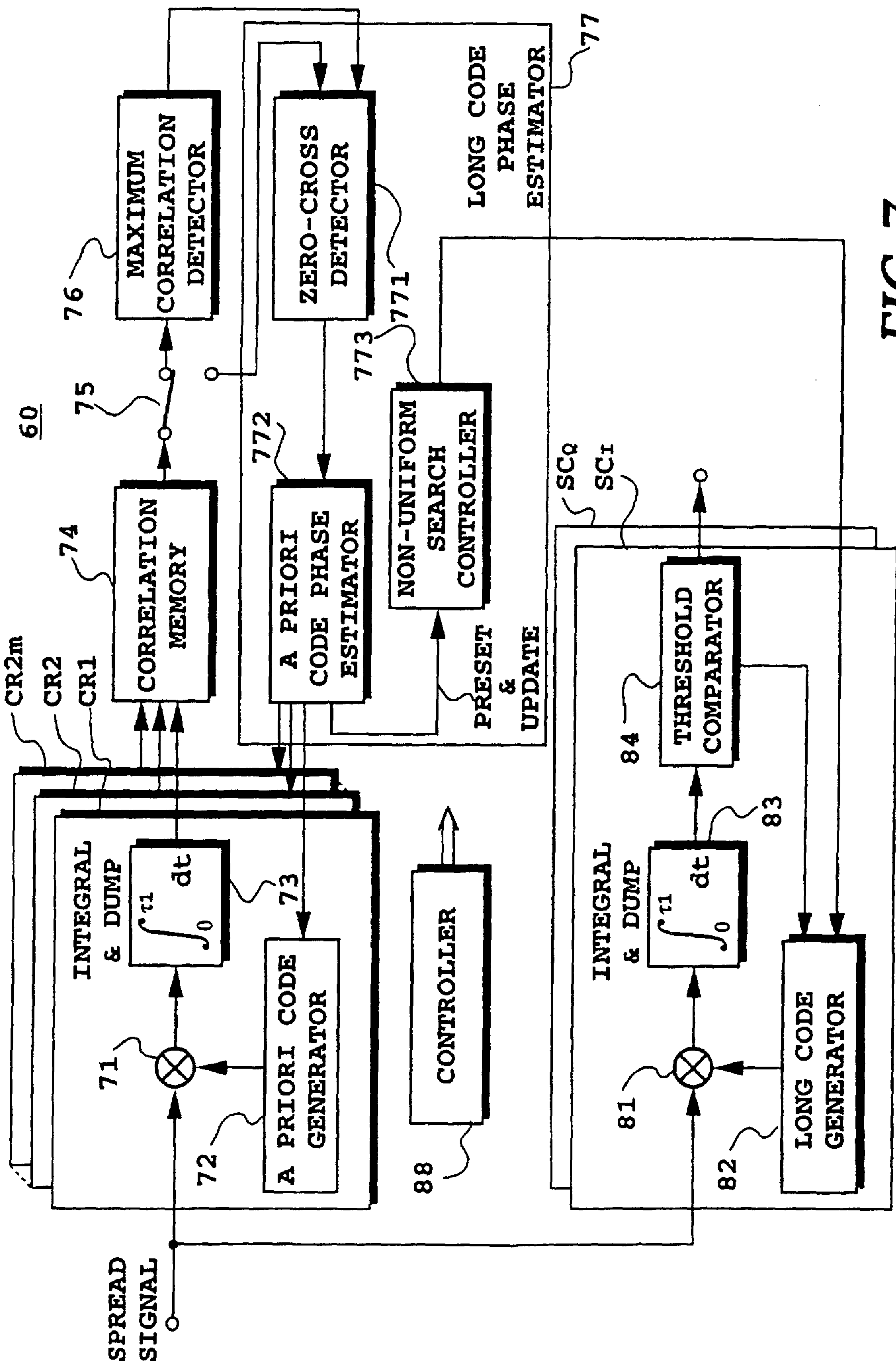

60
SPREAD SIGNAL
71
72
A PRIORI CODE GENERATOR
INTEGRAL & DUMP
dt
73
CR2m
CR2
CR1
74
CORRELATION MEMORY
75
76
MAXIMUM CORRELATION DETECTOR
772
A PRIORI CODE PHASE ESTIMATOR
ZERO-CROSS DETECTOR
771
773
NON-UNIFORM SEARCH CONTROLLER
PRESET & UPDATE
LONG CODE PHASE ESTIMATOR
77
CONTROLLER
88
81
82
LONG CODE GENERATOR
INTEGRAL & DUMP
83
84
THRESHOLD COMPARATOR
SCQ
SCI

FIG.7

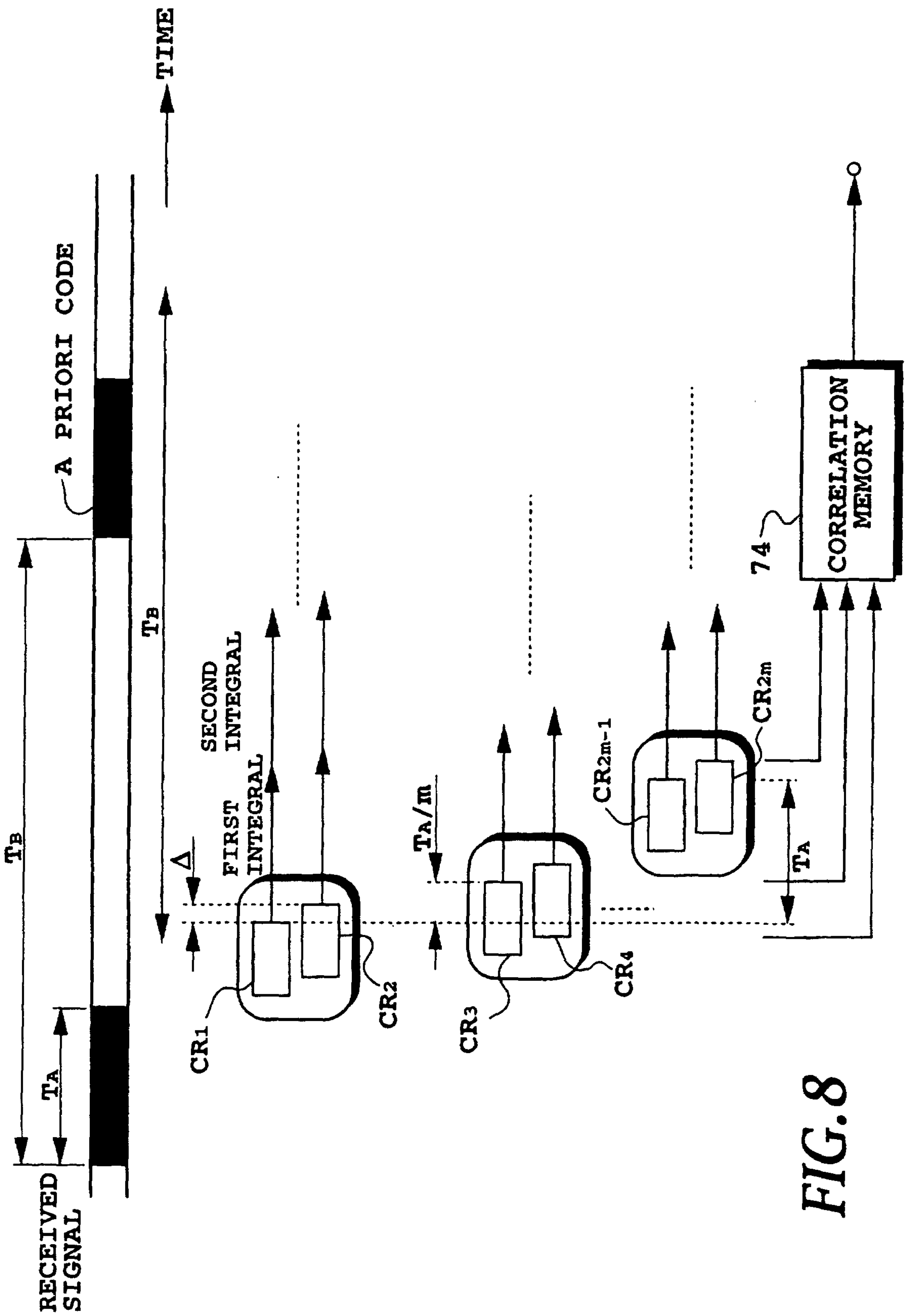

RECEIVED SIGNAL
A PRIORI CODE
TIME
T_B
T_B
T_A
Δ
FIRST INTEGRAL
SECOND INTEGRAL
T_A/m
T_A
CR_1
CR_2
CR_3
CR_4
CR_{2m-1}
CR_{2m}
74
CORRELATION MEMORY

FIG.8

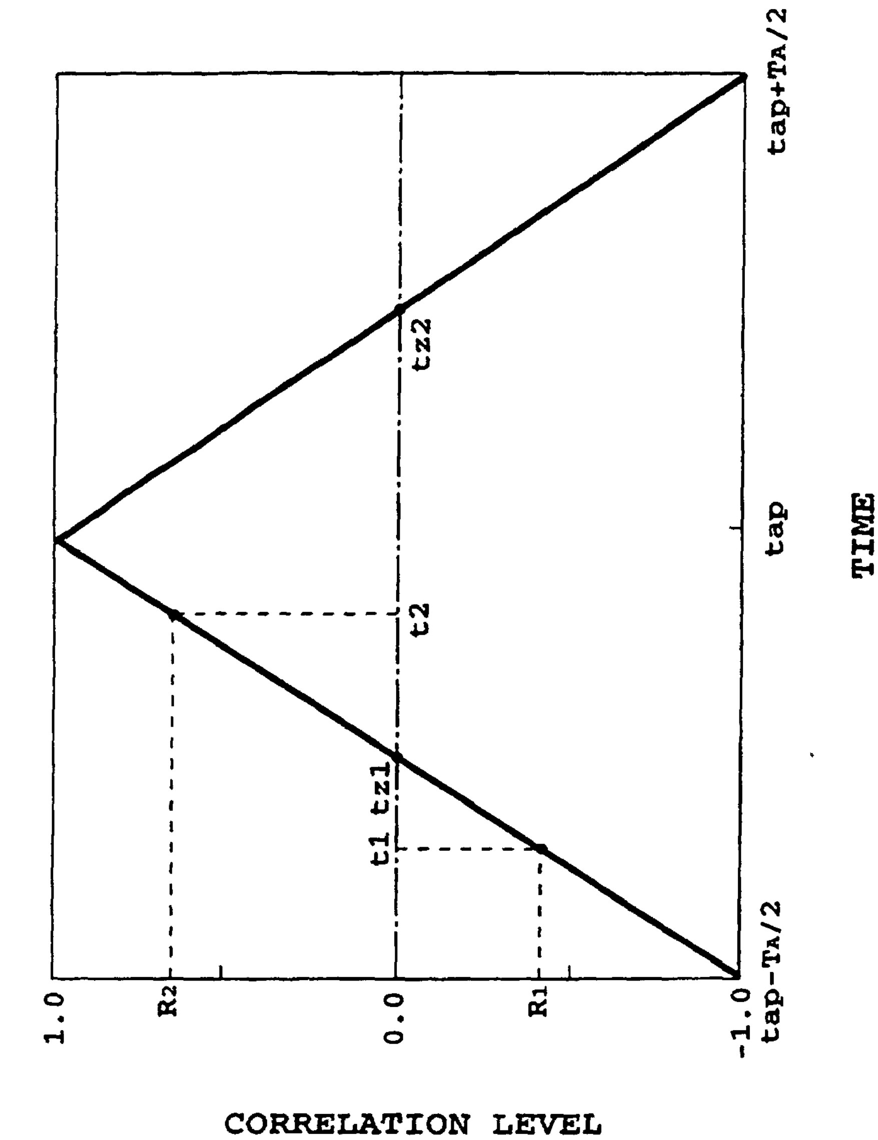

1.0
R2
0.0
R1
-1.0
tap-TA/2
t1 tz1
t2
tap
tz2
tap+TA/2
TIME
CORRELATION LEVEL

FIG.9

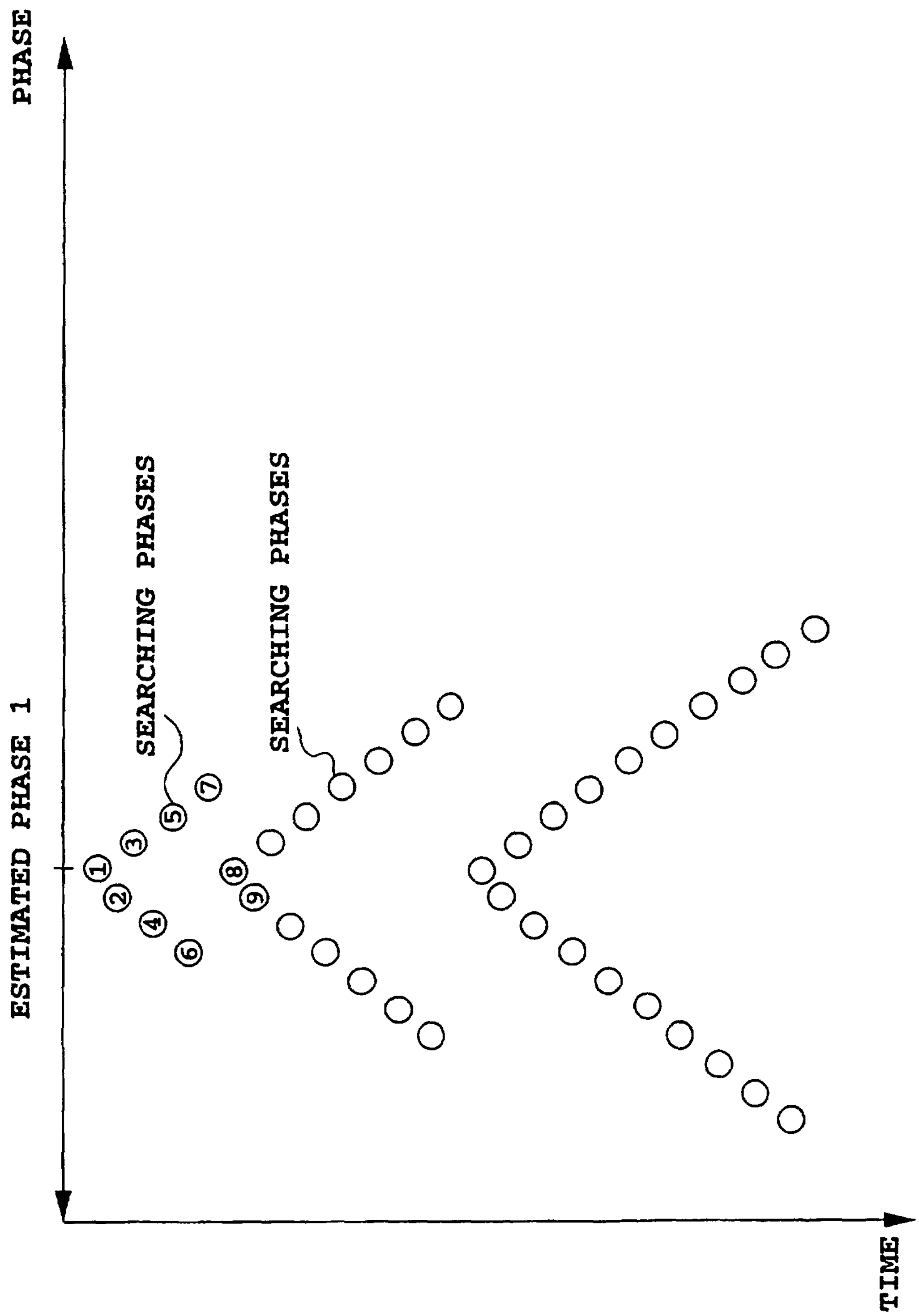

PHASE
ESTIMATED PHASE 1
SEARCHING PHASES
SEARCHING PHASES
TIME
1
2
3
4
5
6
7
8
9

FIG.10

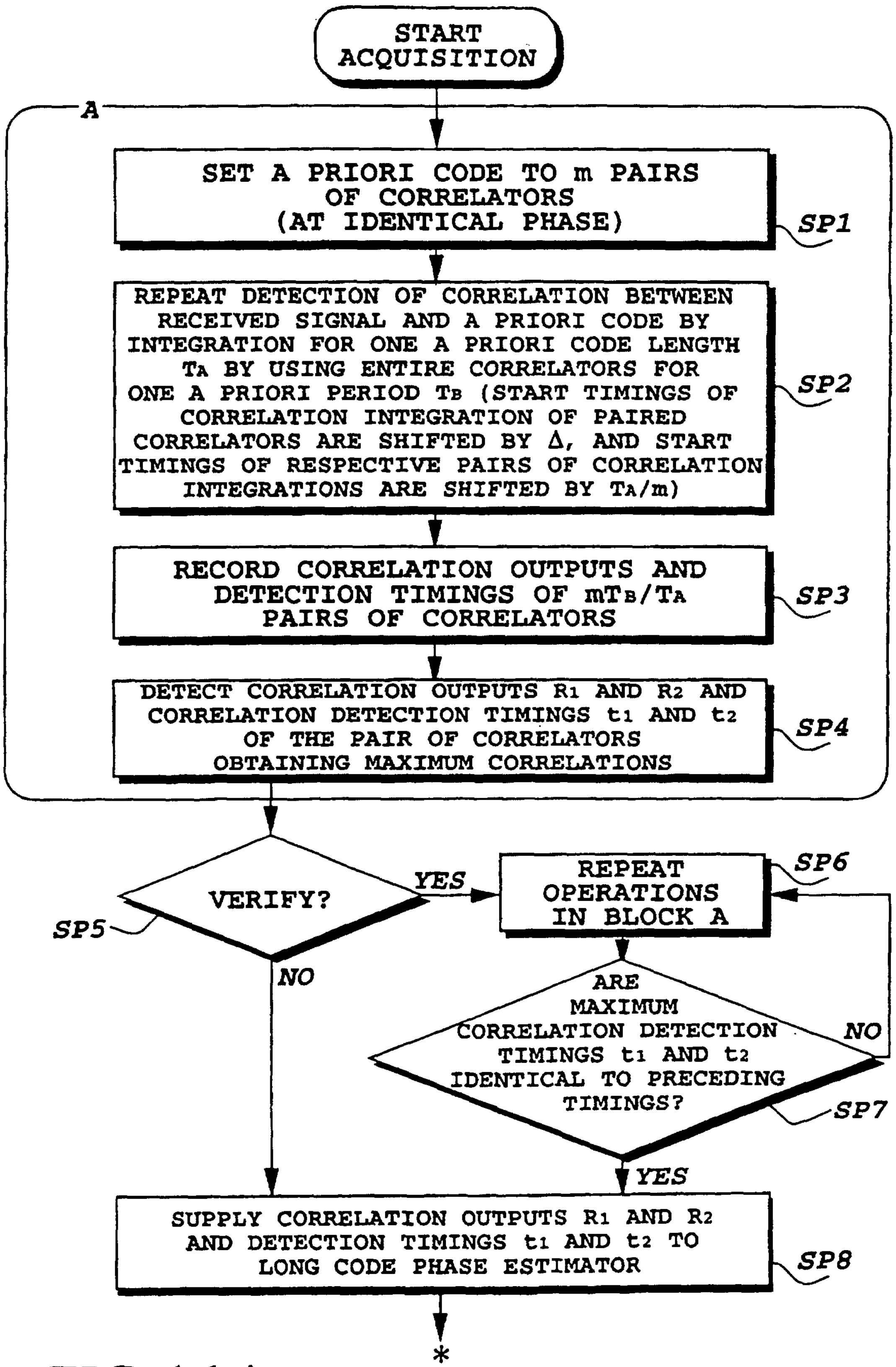

START ACQUISITION
A
SET A PRIORI CODE TO m PAIRS OF CORRELATORS (AT IDENTICAL PHASE)
SP1
REPEAT DETECTION OF CORRELATION BETWEEN RECEIVED SIGNAL AND A PRIORI CODE BY INTEGRATION FOR ONE A PRIORI CODE LENGTH TA BY USING ENTIRE CORRELATORS FOR ONE A PRIORI PERIOD TB (START TIMINGS OF CORRELATION INTEGRATION OF PAIRED CORRELATORS ARE SHIFTED BY Δ, AND START TIMINGS OF RESPECTIVE PAIRS OF CORRELATION INTEGRATIONS ARE SHIFTED BY TA/m)
SP2
RECORD CORRELATION OUTPUTS AND DETECTION TIMINGS OF mTB/TA PAIRS OF CORRELATORS
SP3
DETECT CORRELATION OUTPUTS R1 AND R2 AND CORRELATION DETECTION TIMINGS t1 AND t2 OF THE PAIR OF CORRELATORS OBTAINING MAXIMUM CORRELATIONS
SP4
VERIFY?
SP5
YES
NO
REPEAT OPERATIONS IN BLOCK A
SP6
ARE MAXIMUM CORRELATION DETECTION TIMINGS t1 AND t2 IDENTICAL TO PRECEDING TIMINGS?
NO
SP7
YES
SUPPLY CORRELATION OUTPUTS R1 AND R2 AND DETECTION TIMINGS t1 AND t2 TO LONG CODE PHASE ESTIMATOR
SP8
*

FIG.11A

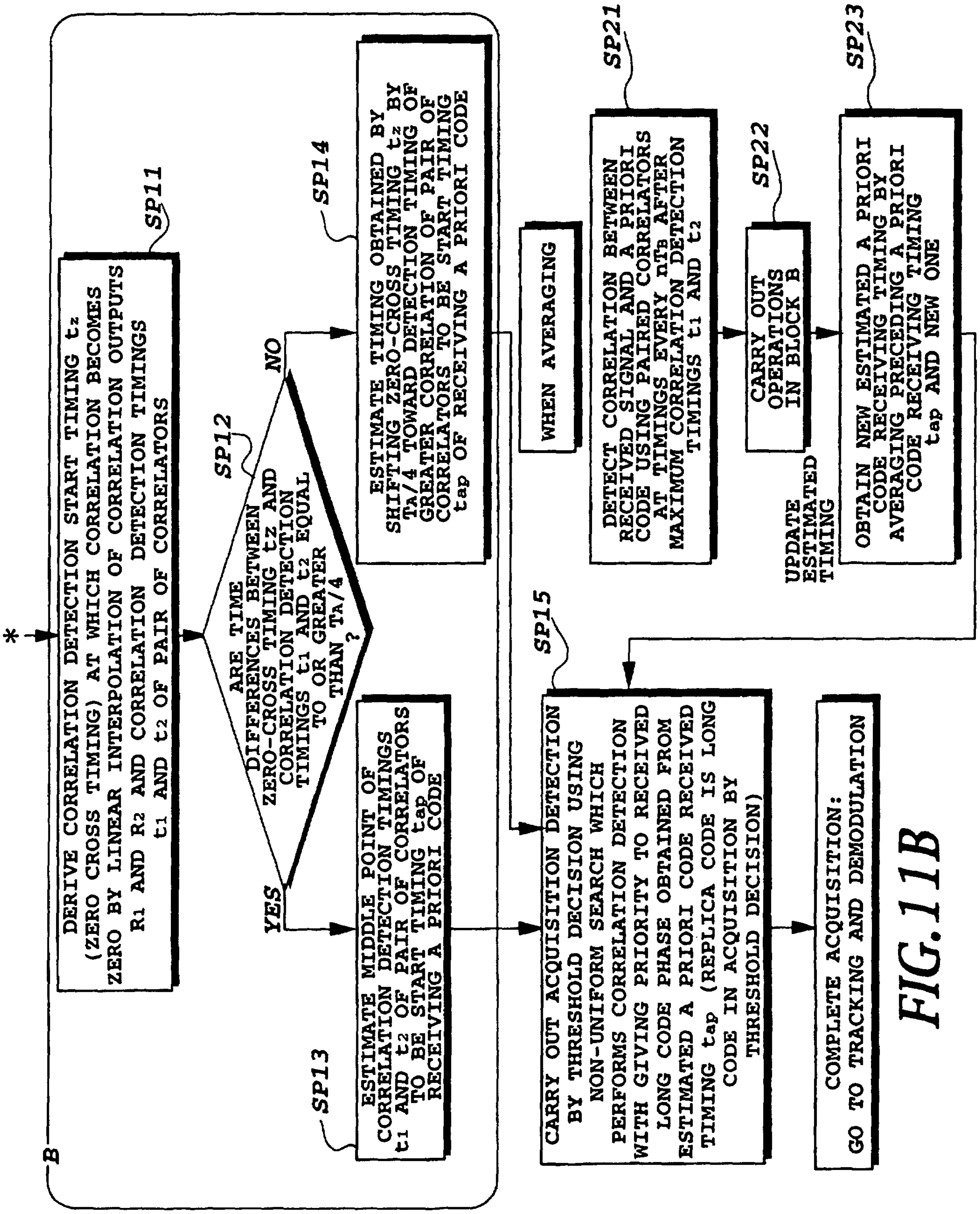
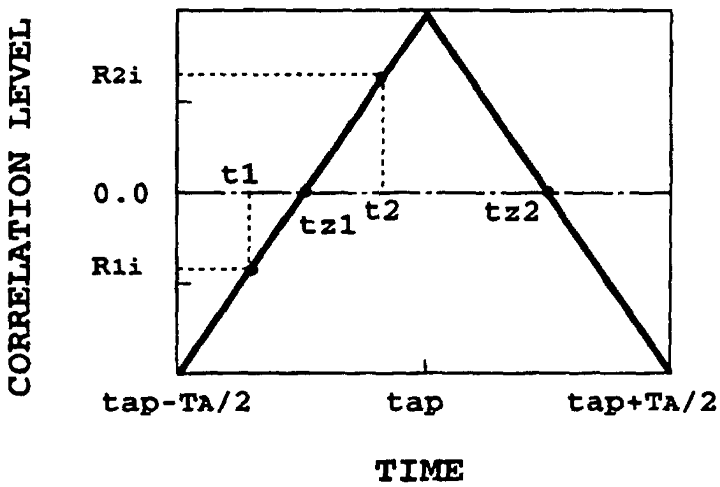
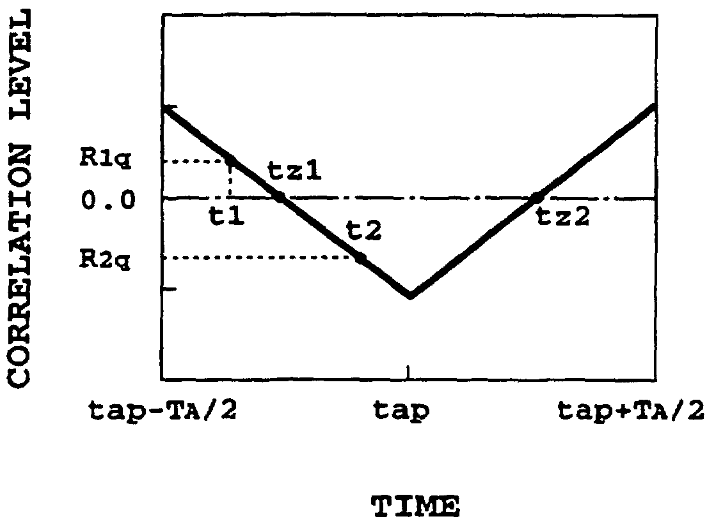

B
*
SP11
DERIVE CORRELATION DETECTION START TIMING tz (ZERO CROSS TIMING) AT WHICH CORRELATION BECOMES ZERO BY LINEAR INTERPOLATION OF CORRELATION OUTPUTS R1 AND R2 AND CORRELATION DETECTION TIMINGS t1 AND t2 OF PAIR OF CORRELATORS
SP12
ARE TIME DIFFERENCES BETWEEN ZERO-CROSS TIMING tz AND CORRELATION DETECTION TIMINGS t1 AND t2 EQUAL TO OR GREATER THAN TA/4 ?
YES
NO
SP13
ESTIMATE MIDDLE POINT OF CORRELATION DETECTION TIMINGS t1 AND t2 OF PAIR OF CORRELATORS TO BE START TIMING tap OF RECEIVING A PRIORI CODE
SP14
ESTIMATE TIMING OBTAINED BY SHIFTING ZERO-CROSS TIMING tz BY TA/4 TOWARD DETECTION TIMING OF GREATER CORRELATION OF PAIR OF CORRELATORS TO BE START TIMING tap OF RECEIVING A PRIORI CODE
SP15
CARRY OUT ACQUISITION DETECTION BY THRESHOLD DECISION USING NON-UNIFORM SEARCH WHICH PERFORMS CORRELATION DETECTION WITH GIVING PRIORITY TO RECEIVED LONG CODE PHASE OBTAINED FROM ESTIMATED A PRIORI CODE RECEIVED TIMING tap (REPLICA CODE IS LONG CODE IN ACQUISITION BY THRESHOLD DECISION)
COMPLETE ACQUISITION: GO TO TRACKING AND DEMODULATION
WHEN AVERAGING
SP21
DETECT CORRELATION BETWEEN RECEIVED SIGNAL AND A PRIORI CODE USING PAIRED CORRELATORS AT TIMINGS EVERY nTB AFTER MAXIMUM CORRELATION DETECTION TIMINGS t1 AND t2
SP22
CARRY OUT OPERATIONS IN BLOCK B
UPDATE ESTIMATED TIMING
SP23
OBTAIN NEW ESTIMATED A PRIORI CODE RECEIVING TIMING BY AVERAGING PRECEDING A PRIORI CODE RECEIVING TIMING tap AND NEW ONE

FIG.11B



IN PHASE COMPONENT OF
CORRELATION BETWEEN
RECEIVED SIGNAL AND
A PRIORI CODE (I CORRELATION)

FIG.12A



QUADRATURE COMPONENT
OF CORRELATION BETWEEN
RECEIVED SIGNAL AND
A PRIORI CODE (Q CORRELATION)

FIG.12B

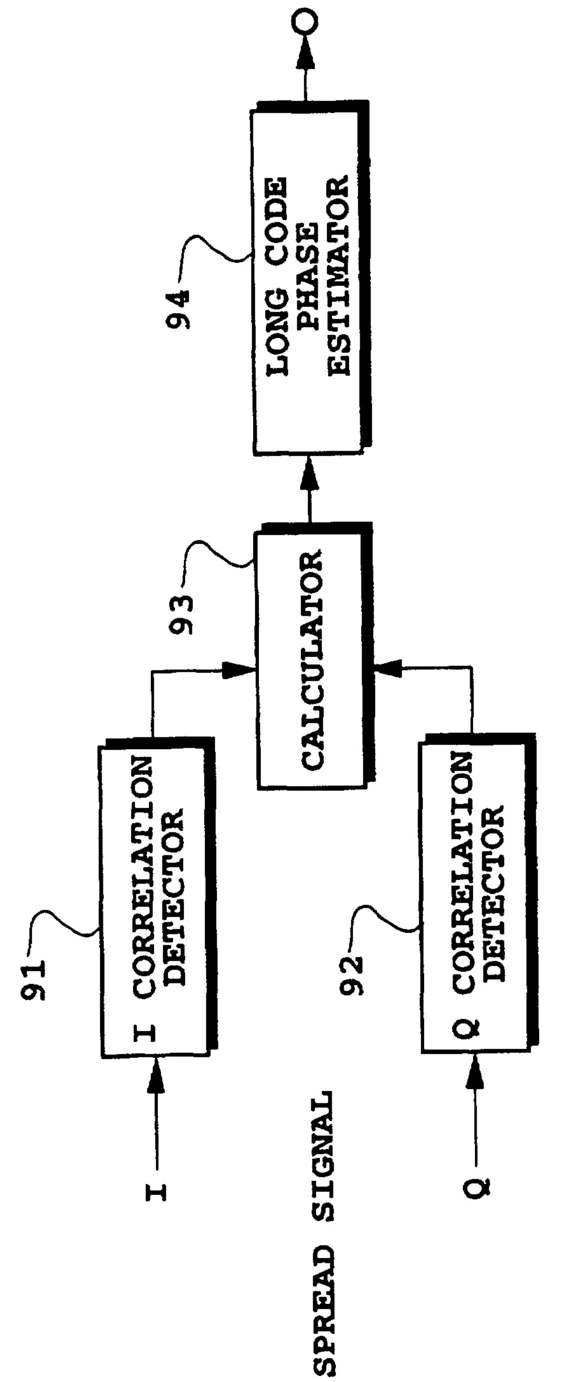

SPREAD SIGNAL
I
Q
91
I CORRELATION DETECTOR
92
Q CORRELATION DETECTOR
93
CALCULATOR
94
LONG CODE PHASE ESTIMATOR

FIG.13

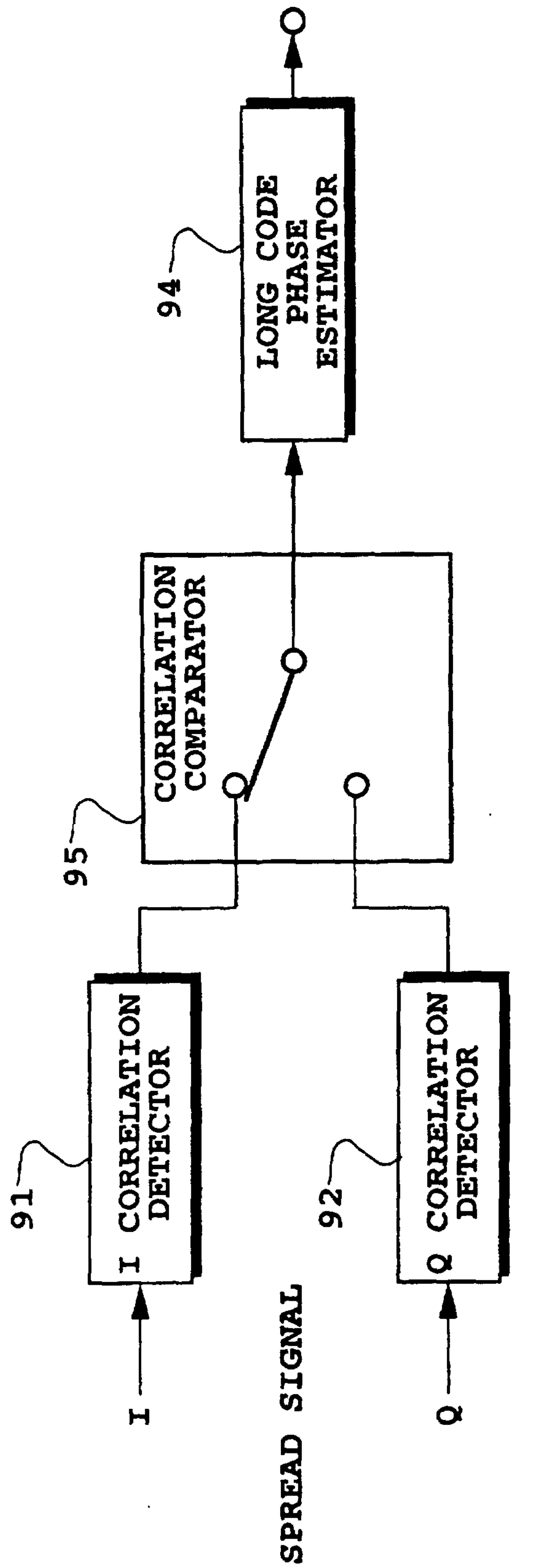

LONG CODE PHASE ESTIMATOR
94
CORRELATION COMPARATOR
95
I CORRELATION DETECTOR
91
Q CORRELATION DETECTOR
92
I
SPREAD SIGNAL
Q

FIG.14

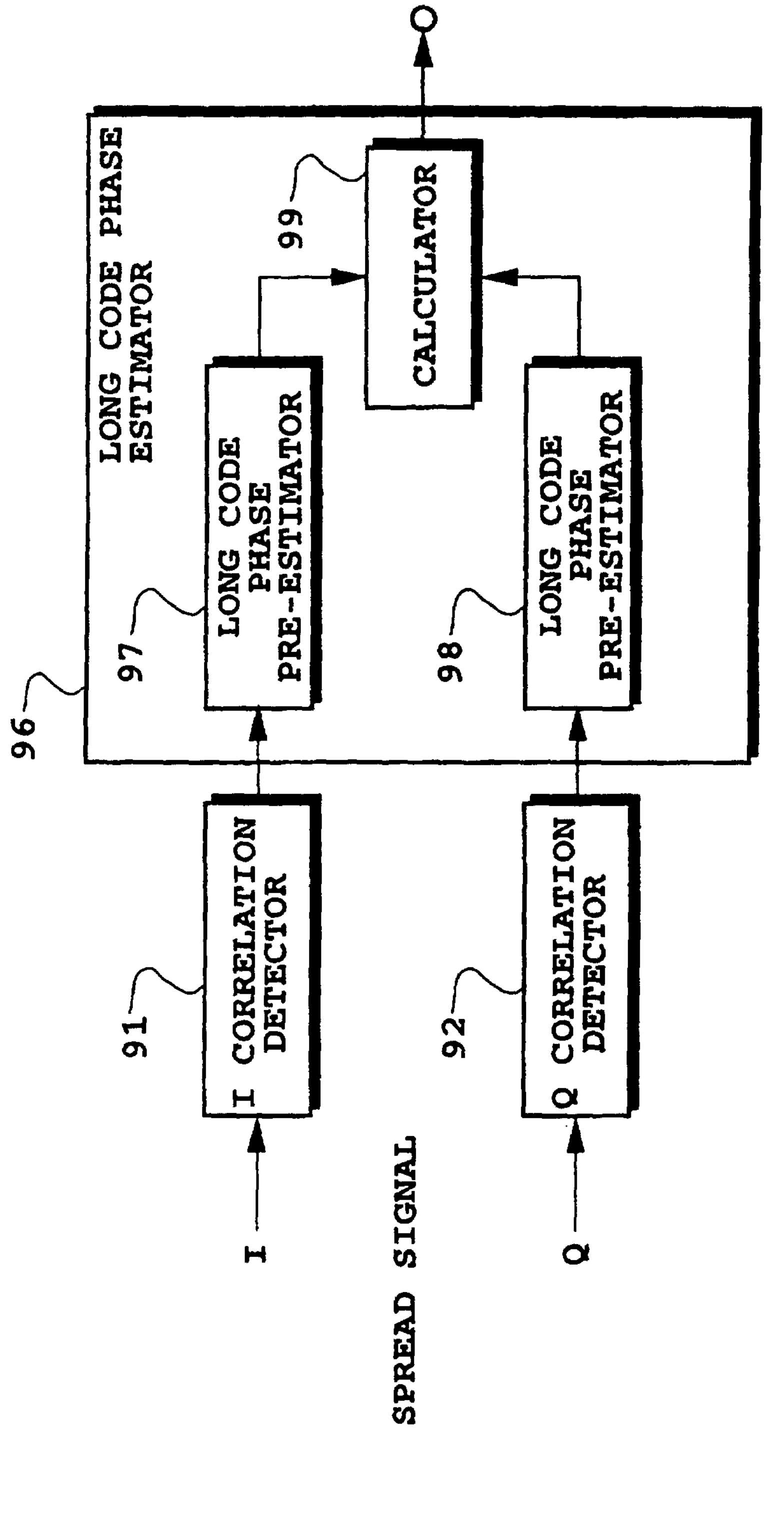

LONG CODE PHASE ESTIMATOR
96
97
LONG CODE PHASE PRE-ESTIMATOR
98
LONG CODE PHASE PRE-ESTIMATOR
99
CALCULATOR
91
I CORRELATION DETECTOR
92
Q CORRELATION DETECTOR
I
Q
SPREAD SIGNAL

FIG.15