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681483

NOTICE OF ENTITLEMENT

I, Aarni Kajaste & Aarre Kilpinen
Nokia Telecommunications Oy
Mäkkylän puistotie 1
of FIN-02600 Espoo
Finland

Reijo Karki
Nokia Mobile Phones Ltd.
Nakolankatu 8
FIN-24100 Salo
Finland

being authorised by the Applicant(s)/Nominated Person(s) in respect of an application entitled:
Method of Transmitting and Receiving Power Control Messages in a CDMA Cellular Radio System
state the following:-

1. The Applicant(s)/Nominated Person(s) has/have, for the following reasons, gained entitlement from the actual inventor(s):-

The Applicant(s)/Nominated Person(s) is the assignee of the actual inventors

2a.* The Applicant(s)/Nominated Person(s) is/are the applicant(s) of the of the basic application(s) listed* ~~on the Patent Request/~~ *in the Declaration under Article 8 of the PCT.

2b.* ~~The Applicant(s)/Nominated Person(s) is/are entitled to rely on the basic application(s) listed* on the Patent Request/ *in the Declaration under Article 8 of the PCT as follows:~~

3.* The basic application(s) listed *~~on the Patent Request/~~ *in the Declaration under Article 8 of the PCT is/are the application(s) first made in a Convention Country in respect of the invention.

4a.* ~~The Applicant(s)/Nominated Person(s) is/are the depositor(s) of the deposit(s) listed in the Schedule hereto.~~

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DATED this 1st day of September 1995

Nokia Telecommunications Oy

Aarni Kajaste
Patent Coordinator

Aarre Kilpinen
Patent Coordinator

Nokia Mobile Phones Ltd.

(Signature)

Reijo Kärki, Senior Patent Engineer
(Name & Title)

* Delete if not applicable.

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METHOD OF TRANSMITTING AND RECEIVING POWER CONTROL MESSAGES IN A CDMA CELLULAR RADIO SYSTEM

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(71) Applicant(s)
NOKIA TELECOMMUNICATIONS OY; NOKIA MOBILE PHONES LTD.

(72) Inventor(s)
ILKKA KESKITALO; KARI RIKKINEN; TERO OJANPERA

(74) Attorney or Agent
SPRUSON & FERGUSON , GPO Box 3898, SYDNEY NSW 2001

(56) Prior Art Documents
EP 0610030
GB 2268365
WO 9406217

(57) Claim

1. A data transmission method in a CDMA cellular radio system, which comprises in each cell at least one base station communicating with mobile stations within a coverage area of said base station and in which system the base station adjusts the transmitting power of the mobile stations within the coverage of said base station area by means of power control messages, comprising the steps of:

both in the transmission direction from the base station to the mobile station and from the mobile station to the base station, performing the transmission on a traffic channel using a similar frame structure; and

when the base station transmits a power control message to the mobile station by using bits of the frame structure of the traffic channel, transmitting the mobile station a predetermined bit pattern to the base station in the corresponding bits of another transmission direction of the traffic channel.

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(71) Applicants *(for all designated States except US)*: NOKIA TELECOMMUNICATIONS OY [FI/FI]; Mäkkylän puistotie 1, FIN-02600 Espoo (FI). NOKIA MOBILE PHONES LTD. [FI/FI]; Nakolankatu 8, FIN-24100 Salo (FI).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: KESKITALO, Ilkka [FI/FI]; Koskitie 5 A 8, FIN-90500 Oulu (FI). RIKKINEN, Kari [FI/FI]; Jalohaukantie 4 C 19, FIN-90250 Oulu (FI). OJANPERÄ, Tero [FI/FI]; Tornipolku 8 B 41, FIN-90100 Oulu (FI).

(74) Agent: TEKNOPOLIS KOLSTER OY; c/o Oy Kolster Ab, Iso Roobertinkatu 23, P.O. Box 148, FIN-00121 Helsinki (FI).

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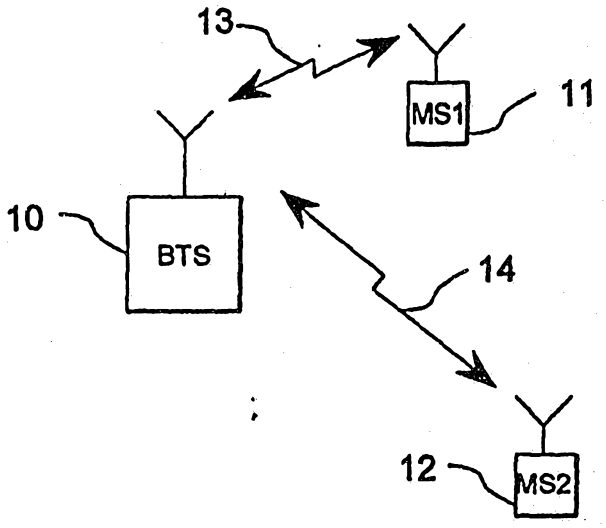
(57) Abstract

The invention relates to a data transmission method in a CDMA cellular radio system, which comprises in each cell at least one base station (10) communicating with mobile stations (11, 12) within its coverage area and in which system the base station adjusts the transmitting power of the mobile stations within its area by means of power control messages. To enable coherent detection also at the base station, i.e. also in the uplink direction (from mobile station to base station), according to the method, the transmission on the traffic channel is performed both in the direction from the mobile station to the base station and from the base station to the mobile station by using a similar frame structure. When the base station transmits a power control message to the mobile station by using bits of the frame structure of the traffic channel, the mobile station transmits a predetermined bit pattern to the base station in the corresponding bits of the other transmission direction of the traffic channel.



Method of transmitting and receiving power control messages in a CDMA cellular radio system

The invention relates to a data transmission method in a CDMA cellular radio system, which comprises in each cell at least one base station communicating with mobile stations within its coverage area and in which system the base station adjusts the transmitting power of the mobile stations within its area by means of power control messages.

CDMA is a multiple access method, which is based on the spread spectrum technique and which has been applied recently in cellular radio systems, in addition to the prior FDMA and TDMA methods. CDMA has several advantages over the prior methods, for example spectral efficiency and the simplicity of frequency planning.

In the CDMA method, the narrow-band data signal of the user is multiplied to a relatively wide band by a spreading code having a considerably broader band than the data signal. In known test systems, bandwidths such as 1.25 MHz, 10 MHz and 25 MHz have been used. In connection with multiplying, the data signal spreads to the entire band to be used. All users transmit by using the same frequency band simultaneously. A separate spreading code is used over each connection between a base station and a mobile station, and the signals of the users can be distinguished from one another in the receivers on the basis of the spreading code of each user.

Correlators provided in the receivers are synchronized with a desired signal, which they recognize on the basis of the spreading code. The data signal is restored in the receiver to the original band by multiplying it again by the same spreading code as

during the transmitting stage. Signals multiplied by some other spreading code do not correlate in an ideal case and are not restored to the narrow band. They appear thus as noise with respect to the desired signal. The spreading codes of the system are preferably selected in such a way that they are mutually orthogonal, i.e. they do not correlate with each other.

In a typical mobile phone environment, the signals between a base station and a mobile station propagate along several paths between the transmitter and the receiver. This multipath propagation is mainly due to the reflections of the signal from the surrounding surfaces. Signals which have propagated along different paths arrive at the receiver at different times due to their different transmission delays. CDMA differs from the conventional FDMA and TDMA in that the multipath propagation can be exploited in the reception of the signal. The receiver generally utilized in a CDMA system is a so-called rake receiver, which consists of one or more rake branches. Each branch is an independent receiver unit, the function of which is to compose and demodulate one received signal component. Each rake branch can be caused to synchronize with a signal component which has propagated along an individual path, and in a conventional CDMA receiver the signals of the receiver branches are preferably combined, either coherently or non-coherently, whereupon a signal of good quality is achieved.

To ensure the effective operation of the CDMA system, power control has to be used over the connection between a mobile station and a base station. The capacity of the base station can be maximized if it receives with the same signal strength from all mobile stations in its area. The mobile station can measure the strength of the signal it has received from the base

station and adjust its transmitting power on the basis of this information. This type of power control method is called "open-loop power control". Furthermore, the base station measures the strength of the signal it has received from the mobile stations and transmits power control messages to the mobile stations which adjust their transmitting power on the basis of these messages. Such a power control method is called "closed-loop power control". These methods may be used simultaneously.

The power control messages required by the closed-loop power control from the base station to a mobile station may be transmitted in two ways to the mobile station. A certain part in the frame structure of a traffic channel may be permanently reserved for power control messages in the transmission direction from base to mobile (i.e. in the downlink direction). This method increases the bandwidth required by the system. The other way is to replace, when necessary, data bits of the user with bits required by the power control messages. In such a case, the bandwidth does not increase, but the quality of the user connection deteriorates slightly when the data bits are replaced with power control messages.

No power control messages are transmitted in the transmission direction from mobile to base (i.e. in the uplink direction). Thus in the uplink direction there would be left unused bandwidth for data transmission, if the frame structure were the same as in the downlink direction. In the conventional systems, the frame structure is therefore designed differently in different transmission directions. However, the same kind of frame structure would be useful due to the similar timing and synchronization requirements of similar frame structures in the transmitter and receiver.

The purpose of the present invention is to enable the use of similar frame structures in both transmission directions in such a way that the bandwidth of the system can be effectively utilized.

This is achieved with the data transmission method described in the preamble, characterized in that both in the transmission direction from the base station to the mobile station and from the mobile station to the base station, the transmission on the traffic channel is performed by using a similar frame structure, and that when the base station transmits a power control message to the mobile station by using bits of the frame structure of the traffic channel, the mobile station transmits a predetermined bit pattern to the base station in the corresponding bits of the other transmission direction of the traffic channel.

In the method according to the invention, a predetermined bit pattern is thus transmitted in the uplink direction in the bit places where the base station in the downlink direction transmits power control information. This makes it possible to utilize the band effectively, since the predetermined bit pattern transmitted by the mobile station enables the base station to receive with a better quality.

In a CDMA cellular radio system, it is possible to use a so-called pilot channel in the downlink direction. A pilot channel is a data-unmodulated signal which is transmitted with a specific spreading code and which does not thus contain any data information. The pilot signal is transmitted using the same frequency band on which the actual traffic channels are situated, the pilot signal being distinguishable from them only on the basis of the spreading code. The pilot signal is a traffic channel known by all users and it is used for

example in power measurements and in the generation of a coherent phase reference.

The arrangement according to the invention enables coherent detection also in the uplink direction. This was not possible before, since the phase reference could not be generated. The pilot channel type of arrangement is possible only in the downlink direction. The previously known bit pattern transmitted by the mobile station can be used in the generation of the phase reference, and thus coherent detection is possible. Coherent detection improves the signal-to-noise ratio that can be achieved by about 3 dB, and in the CDMA cellular system this can be seen directly in an almost double capacity.

In the following, the invention will be described in greater detail with reference to the examples of the accompanying drawings, in which

Figure 1 illustrates a cellular network where the invention can be applied,

Figure 2 shows a frame structure where a part of the bits in the downlink direction are permanently reserved for power control messages,

Figure 3a shows a frame structure without power control messages, and

Figure 3b shows a frame structure where a part of the data bits in the downlink direction are replaced with a power control message.

Figure 1 shows schematically a part of a CDMA cellular network system where the method according to the invention can be applied. A base station 10 communicates with mobile stations 11, 12 within its area. The base station adjusts the transmitting power of the mobile stations with power control messages, which are transmitted to each mobile station on traffic channels 13, 14.

A predetermined recurrent frame structure is used on the traffic channels. Frames of a certain length are formed of the data bits to be transmitted, the frames being coded, modulated and transmitted. In addition to data bits, also other information bits, such as a training sequence, power control bits or signalling bits, can be transmitted in a frame. The form of the frame structure depends on the nature of the information to be transmitted. For example, when a connection is being established, certain type of connection-establishing frames which comprise user information are used, and when the connection is already established, traffic frames where most of the bits are data bits are used.

In the first embodiment of the invention, a certain part in the frame structure of the downlink direction is permanently reserved for the transmission of power control messages. The frame structure may thus be like the one shown in Figure 2. Most of the bits 21 of the frame 20 are used for data transmission, but a part of the bits 22 are reserved for the bits of the power control messages. In the method according to the invention, a similar frame structure is used both in the uplink and downlink transmission direction. Since no power control messages are needed in the uplink direction, a predetermined bit pattern known by the base station may be transmitted in the space reserved for them.

According to one preferred embodiment of the invention, these known bits can be utilized at the base station in the generation of a phase reference for the received signal. By means of the generated phase reference, the received signal can be detected coherently, which in a CDMA network enables an almost double capacity.

According to another preferred embodiment of the invention, known bits can be utilized at the base station in the power measurement of the received signal, which enables better power control than previously. The accuracy of the power control also increases the capacity of the CDMA network, although not as significantly as the coherent detection does.

In another embodiment of the invention, no particular part in the frame structure of the downlink direction is permanently reserved for the transmission of power control messages, but a part of the data bits are replaced, when necessary, with power control bits. Thus the bandwidth required by the system is smaller than in the previous embodiment, but the drawback is the loss of data bits. Figure 3a shows a frame both in the downlink and uplink direction, where power control messages are not transmitted. When the base station needs a band for transmitting power control messages, it replaces some of the data bits of the frame with the bits of the power control message. Figure 3b illustrates this situation. The frame structure is thus in principle similar to that of the previous embodiment. The frame now comprises both data bits 31 and power control bits 32. The mobile station must be informed through signalling or by some other means that some of the data bits are replaced with a power control message. In the uplink direction, the frame structure correspondingly changes to now resemble Figure 3b. Instead of the power control bits, the data bits are now replaced with a predetermined bit pattern known by the base station. This known bit pattern can now be utilized at the base station in the manners described above.

Even though the invention is described above with reference to the example according to the accompanying drawings, it is clear that the invention

is not limited thereto, but it can be varied in many ways within the inventive idea disclosed in the appended claims.

The claims defining the invention are as follows:

1. A data transmission method in a CDMA cellular radio system, which comprises in each cell at least one base station communicating with mobile stations within a coverage area of said base station and in which system the base station adjusts the transmitting power of the mobile stations within the coverage of said base station area by means of power control messages, comprising the steps of:

both in the transmission direction from the base station to the mobile station and from the mobile station to the base station, performing the transmission on a traffic channel using a similar frame structure; and

when the base station transmits a power control message to the mobile station by using bits of the frame structure of the traffic channel, transmitting the mobile station a predetermined bit pattern to the base station in the corresponding bits of another transmission direction of the traffic channel.

2. The method according to claim 1, wherein bits used for the transmission of both the power control message of the base station and correspondingly the predetermined bit pattern of the mobile station are permanently reserved from the frame structure for this purpose.

3. The method according to claim 1, wherein bits used for the transmission of both the power control message of the base station and correspondingly the predetermined bit pattern of the mobile station are temporarily reserved from the frame structure by replacing a number of the data bits of a user with the message or the bit pattern to be transmitted.

4. The method according to claim 1, wherein the predetermined bit pattern transmitted by the mobile station is used at the base station for generating a coherent phase reference.

5. The method according to claim 1, wherein the predetermined bit pattern transmitted by the mobile station is used at the base station for power measurement.

6. A data transmission method in a CDMA cellular radio system, said method being substantially as hereinbefore described with reference to Figs. 1 to 3 of the accompanying drawings.

DATED this Thirtieth Day of May 1997

Nokia Telecommunications OY

Nokia Mobile Phones Limited

Patent Attorneys for the Applicant

SPRUSON & FERGUSON

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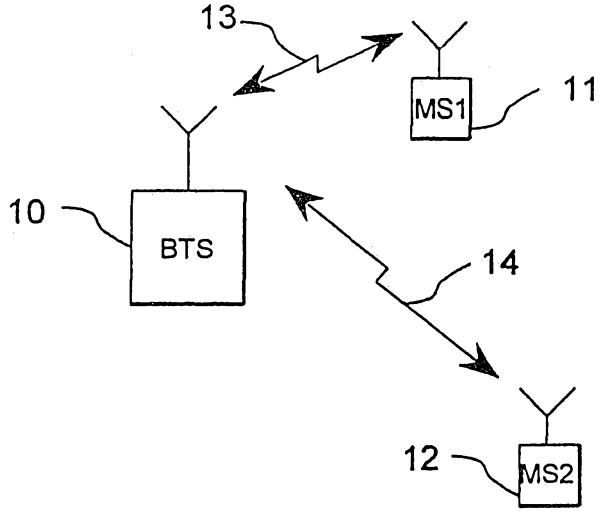

FIG. 1

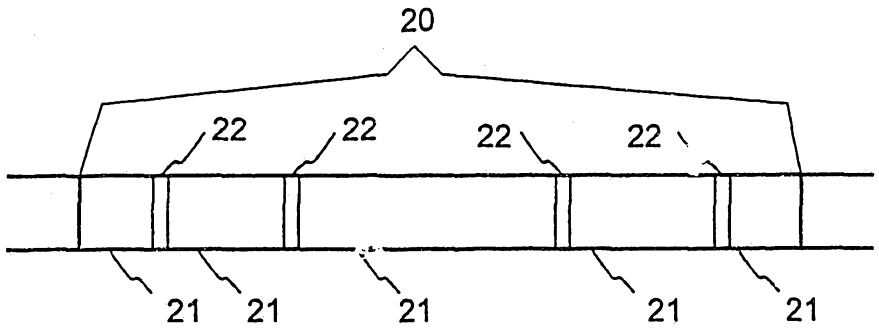

FIG. 2

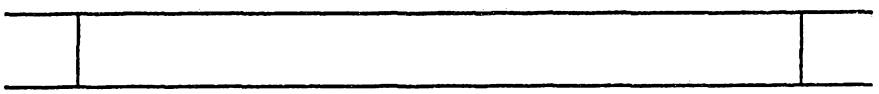

FIG. 3a

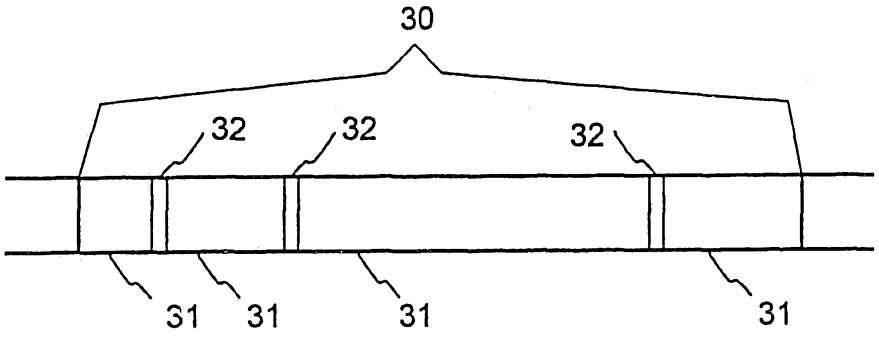

FIG. 3b

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 95/00007

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04B 7/005, H04B 7/26 // H04B 1/66
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04B

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

SE,DK,FI,NO classes as above

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

CLAIMS, WPIL, EPODOC, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB, A, 2268365 (ROKE MANOR RESEARCH LIMITED), 5 January 1994 (05.01.94), page 6, line 16 - page 7, line 23, figures 2-4 --	1-3
P,A	WO, A1, 9406217 (MILLICOM HOLDINGS (UK) LTD.), 17 March 1994 (17.03.94), page 4, line 25 - page 6, line 5; page 25, line 21 - line 26, figures 3,4, claims 4,11,12 --	1-3,5
A	"A study of Code Division Multiple Access", A. FRANZÉN ET AL, Master Thesis, Lund Institute of Technology, December 5th 1992, pp. 23-34, see page 29-33 --	1,2,4,5

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
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"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
12 May 1995	19-05-1995
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Lars Christerson Telephone No. +46 8 782 25 00

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 95/00007

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,A	EP, A2, 0610030 (NOKIA MOBILE PHONES LTD.), 10 August 1994 (10.08.94), column 2, line 46 - column 4, line 40, figures 1,2	1,2,5
A	WO, A1, 9107037 (QUALCOMM, INC.), 16 May 1991 (16.05.91), page 10, line 31 - page 11, line 7, abstract	1-3
A	41st IEEE Vehicular Technology Conferance, Volume, May 1991, W.C.Y. Lee, "Power control in CDMA", page 77 - page 80, see pages 78 - 80	1-2

INTERNATIONAL SEARCH REPORT
Information on patent family members

01/04/95

International application No.
PCT/FI 95/00007

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 2268365	05/01/94	NONE	
WO-A1- 9406217	17/03/94	NONE	
EP-A2- 0610030	10/08/94	NONE	
WO-A1- 9107037	16/05/91	AU-B- 646001	03/02/94
		AU-A- 6728390	31/05/91
		CN-B- 1025402	06/07/94
		CN-A- 1053870	14/08/91
		CN-A- 1090107	27/07/94
		EP-A,A- 0500689	02/09/92
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		US-A- 5257283	26/10/93
		US-A- 5265119	23/11/93
		US-A- 5267262	30/11/93