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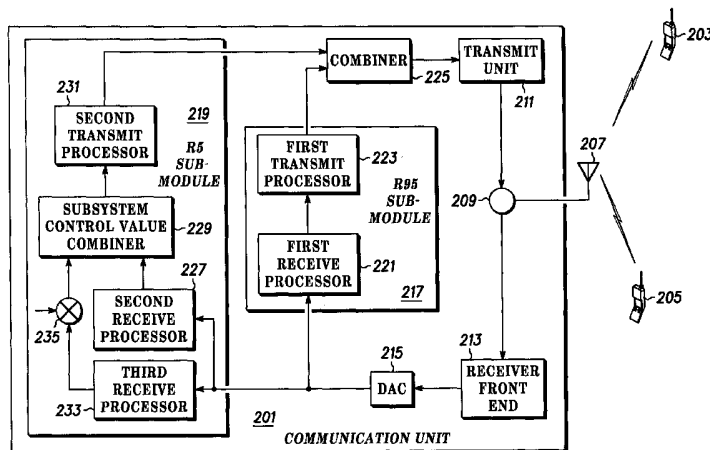
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(54) Title: A COMMUNICATION UNIT AND A METHOD OF GENERATING A CONTROL SIGNAL THEREFOR



(57) Abstract: The system in the base station allows power control values generated by the first subsystem based on the DPCCH (3GPP 25.214 Rel. 99-UMTS technical specifications) to be replaced by power control values based on the HS-DPCCH (3GPP 25.214 Rel.5-UMTS technical specifications) by adding a new subsystem. The subsystem would be used in case the base station is the serving base station of a user equipment in soft handover. The Release 99 power control command generation procedure is duplicated by the Release 5 processing entity. The duplicated Release 99 power control command is then negated and added to the Release 5 power control command (which is based on HS-DPCCH for HS-DSCH serving base station). After summing of the outputs of the Release 99 and Release 5 processing entities, this has the effect of cancelling the power control command based on HS-DPCCH. This allows the implementation of the new Release 5 features without changing Release 99 functionality.

A COMMUNICATION UNIT AND A METHOD OF GENERATING A CONTROL SIGNAL THEREFOR

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Field of the invention

The invention relates to a communication unit and a method of generating a control signal therefor and in particular to a communication unit for a
10 CDMA communication system.

Background of the Invention

15 FIG. 1 illustrates the principle of a conventional cellular communication system 100 in accordance with prior art. A geographical region is divided into a number of cells 101, 103, 105, 107 each of which is served by base station 109, 111, 113, 115. The base stations are interconnected by a fixed network which can communicate data between the base stations 101, 103,
20 105, 107. A mobile station is served via a radio communication link by the base station of the cell within which the mobile station is situated. In the example of FIG. 1, mobile station 117 is served by base station 109 over radio link 119, mobile station 121 is served by base station 111 over radio link 123 and so on.

25

As a mobile station moves, it may move from the coverage of one base station to the coverage of another, i.e. from one cell to another. For example, mobile station 125 is initially served by base station 113 over radio link 127. As it moves towards base station 115 it enters a region of
30 overlapping coverage of the two base stations 111 and 113 and within this overlap region it changes to be supported by base station 115 over radio link 129. As the mobile station 125 moves further into cell 107, it

continues to be supported by base station 115. This is known as a handover or handoff of a mobile station between cells.

A typical cellular communication system extends coverage over typically
5 an entire country and comprises hundred or even thousands of cells supporting thousands or even millions of mobile stations. Communication from a mobile station to a base station is known as uplink, and communication from a base station to a mobile station is known as downlink.

10

The fixed network interconnecting the base stations is operable to route data between any two base stations, thereby enabling a mobile station in a cell to communicate with a mobile station in any other cell. In addition the fixed network comprises gateway functions for interconnecting to external
15 networks such as the Public Switched Telephone Network (PSTN), thereby allowing mobile stations to communicate with landline telephones and other communication terminals connected by a landline. Furthermore, the fixed network comprises much of the functionality required for managing a conventional cellular communication network including functionality for
20 routing data, admission control, resource allocation, subscriber billing, mobile station authentication etc.

Currently the most ubiquitous cellular communication system is the 2nd generation communication system known as the Global System for Mobile
25 communication (GSM). GSM uses a technology known as Time Division Multiple Access (TDMA) wherein user separation is achieved by dividing frequency carriers into 8 discrete time slots, which individually can be allocated to a user. A base station may be allocated a single carrier or a multiple of carriers. One carrier is used for a pilot signal which further
30 contains broadcast information. This carrier is used by mobile stations for measuring of the signal level of transmissions from different base stations,

and the obtained information is used for determining a suitable serving cell during initial access or handovers. Further description of the GSM TDMA communication system can be found in 'The GSM System for Mobile Communications' by Michel Mouly and Marie Bernadette Pautet,
5 Bay Foreign Language Books, 1992, ISBN 2950719007.

Currently, 3rd generation systems are being rolled out to further enhance the communication services provided to mobile users. The most widely adopted 3rd generation communication systems, such as the Universal
10 Mobile Telecommunication System (UMTS), are based on Code Division Multiple Access (CDMA) wherein user separation is obtained by allocating different spreading and scrambling codes to different users on the same carrier frequency. These systems divide the frequency into one or few wide band channels, which for UMTS has a bandwidth of 5 MHz. Typically, one
15 wide band frequency channel is used for uplink in all cells and a different wide band frequency channel is used for downlink. In this case, separation between cells is achieved through the use of spread spectrum techniques, where each cell is allocated a cell specific long user spreading code.

20 In these systems, a signal to be transmitted is multiplied by the spreading code, which has a chip rate typically much larger than the data rate of the signal. Consequently, a narrowband signal is spread over the wideband frequency channel. In the receiver, the received signal is multiplied by the same spreading code thereby causing the original narrowband signal to be
25 regenerated. However, signals from other cells having a different spreading code are not despread by the multiplication in the receiver, and remain wideband signals. The majority of the interference from these signals can consequently be removed by filtering of the despread narrowband signal, which can then be received.

30

Separation between mobile stations of the same cell is also achieved by use of spread spectrum techniques. The signal to be transmitted is multiplied by a shorter user specific code. Similarly, the receiver multiplies the received signal with the user specific code, thereby recovering the
5 originally transmitted signal without despreading signals from any of the other mobile stations. Thus, the interference from all other mobile stations, whether in the same or a different cell, can effectively be reduced by filtering.

10 A consequence of the spread spectrum techniques employed is that the amount of the interfering signals, which fall within the bandwidth of the narrowband signal cannot be removed by filtering, and will thus reduce the signal to interference ratio of the received signal. Consequently, it is of the outmost importance that the interference between mobile stations is
15 optimised in order to maximise the capacity of the system. The reduction of the interference from an unwanted mobile station is equal to the ratio between the bandwidth of the spread signal and the narrowband despread signal, equivalent to the ratio between the chip rate and the symbol rate of the transmitted signal. This ratio is known as the processing gain. Further
20 description of CDMA and specifically of the Wideband CDMA (WCDMA) mode of UMTS can be found in 'WCDMA for UMTS', Harri Holma (editor), Antti Toskala (Editor), Wiley & Sons, 2001, ISBN 0471486876.

Common for all types of cellular communication systems is that it is
25 imperative to manage the radio links between the base stations such that the resource used by a given communication link is as low as possible. Thus, it is important to minimise the interference caused by the communication to or from a mobile station, and consequently it is important to use the lowest possible transmit power. As the required
30 transmit power depends on the instantaneous propagation conditions, it is necessary to dynamically control transmit powers to closely match the

conditions. For this purpose, the base stations and mobile stations operate power control loops, where the receiving end reports information on the receive quality back to the transmitting end, which in response adjusts its transmit power.

5

In WCDMA, both an inner power control loop and an outer power control loop are implemented. Inner loop power control operates as follows. The receiving entity of a radio link measures the received signal to noise ratio (SIR), and compares it to a locally stored target SIR. A command is sent
10 back to the transmitter to increase transmitted power if the measured SIR is less than the target. Conversely, if the measured SIR is greater than the target, a command is sent to the transmitter to decrease the transmitted power. The target SIR is set by a feature called outer loop power control. Its function is to maintain the frame error rate (FER) of the radio link at
15 or below a given value or threshold. The frame error rate of the received signal is measured by one of a number of known techniques, and the SIR target is adjusted to try to ensure that the FER is at or below the given value.

20 In order to further reduce the resource consumption and caused interference, most CDMA cellular communication systems comprise soft handovers. A mobile station approaching the edges of a cell will initialise a communication link to one or more neighbour base stations while retaining the communication link to the serving base station. The signals
25 communicated along the plurality of communication links are combined in the mobile station for downlink communication and in the network for uplink communication. The mobile station is therefore simultaneously connected to a plurality of base stations, and advantage can be taken of diversity techniques whereby transmit powers can be reduced.

30

In a communication system, such as WCDMA, the communication with a mobile station is supported by a plurality of different logical channels, including control channels, broadcast channels, dedicated traffic channels and shared traffic channels. Specifically, many control values are communicated between the base stations and mobile stations in order to setup, maintain and optimise the communication. A specific example of such control values are power control values transmitted from the base station to a mobile station informing the mobile station to increase or decrease the transmit power. However as a communication system is further developed and standardised, the development may result in conflicts between the new and the old requirements, or may require that completely new equipment is introduced. A frequently encountered problem is that new features or functionality require that existing control values are removed or replaced by other control values thereby necessitating modification or replacement of existing equipment. Therefore a system having improved flexibility in allowing for new or additional control values to be used would be advantageous.

Summary of the Invention

Accordingly the Invention seeks to provide a system having improved flexibility with respect to control values.

Accordingly there is provided a method of generating a control signal in a cellular communication system, the method comprising the steps of: determining a control value in a first subsystem of a communication unit of the cellular communication system according to a first algorithm; determining a second control value in a second subsystem of the communication unit according to a second algorithm; determining a third control value in the second subsystem of the communication unit

according to the first algorithm, the third control value corresponding to the first control value; combining the first, second and third power control value into a fourth control value such that the contribution from the third control value reduces the contribution from the first power control value;
5 and transmitting the control signal comprising the fourth control value to at least a second communication unit.

Hence, a system is provided which allows new control values to be introduced while the effect of existing control values is reduced. The
10 system allows for equipment to be upgraded, and/or the control values to be modified, simply by adding a new subsystem without requiring modifications to existing subsystems. A new communication algorithm can thus be introduced without replacing or modifying functionality of existing equipment.

15 According to one feature of the invention, the first, second, third and fourth control values are power control values and the first and second algorithms are different power control algorithms. Hence the system provides for a simple and cost efficient way of upgrading and modifying
20 power control performance without replacing or modifying existing circuitry.

According to a different feature of the invention, the step of combining comprises a summation of the first and second control value and
25 subtraction of the third control value. This provides for a low complexity and easy to implement method of combining the control values.

According to another feature of the invention, the first algorithm is based on a first communication channel and the second algorithm is based on a
30 second communication channel.

Preferably, the first communication unit is a base station and the at least second communication unit is a user equipment. Thus the system provides for a system suitable for controlling communication between a base station and a user equipment.

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According to another feature of the invention, each control value is a binary value providing for a very simple manipulation of the control values such as a very simple combining of control values.

10 According to one feature of the invention, the third power control value is substantially equal to the first power control value. This provides for the combining resulting in the third control value substantially cancelling out the first control value.

15 According to another feature of the invention, the first and second subsystems are physically distinct subsystems. Preferably, the communication unit comprises a plurality of physical modules and the first subsystem is comprised in a first physical module and the second subsystem is comprised in a second physical module. Specifically, the first
20 and second physical modules are preferably separate printed circuit boards. Hence, a very simple method for upgrading existing equipment simply by addition of a separate physical entity is provided. The new subsystem can easily be added thereby providing new functionality and modifying the functionality of existing subsystems.

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According to another feature of the invention, the step of combining comprises scaling at least the first and third control values to have substantially corresponding magnitudes. Thus, the first and third control values are scaled such that the cancelling out effect is increased.

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Preferably the communication system is a CDMA communication system and in particular a Universal Mobile Telecommunication System (UMTS).

According to one feature of the invention, the communication unit is a
5 base station and the second communication unit is a user equipment in soft handover. Thus the system provides for an enhancement of control values for a user equipment in soft handover.

According to a different feature of the invention, the method further
10 comprises the step of determining if the communication unit is a serving base station, and wherein the step of transmitting comprises including the first control value rather than the fourth control value in the control signal if the first communication unit is not the serving base station. Hence, the control performance can be improved for a serving cell
15 operation while retaining the same control performance for a non serving cell operation.

According to another feature of the invention, the method as claimed further comprises the step of spreading the first, second and third control
20 values prior to the step of combining. This provides for the combining to be performed at a late stage of the transmit process. This is particularly advantageous when the subsystems include most steps of the transmit process.

25 According to another feature of the invention, the step of spreading comprises a substantially similar spreading of the first, second and third control values. This increases the cancelling out effect between the first and third control values.

30 According to one feature of the invention, the first algorithm comprises consideration of characteristics of a Dedicated Physical Control CHannel

(DPCCH) and the second algorithm comprises consideration of characteristics of a High Speed - Dedicated Physical Control Channel (HS-DPCCH). Thereby, the system allows for control values generated by the first subsystem based on the DPCCH to be replaced by control values
5 based on the HS-DPCCH.

According to another feature of the invention, the first algorithm comprises a power control value algorithm in accordance with Release 99 of the Third Generation Partnership Project Technical Specification 25.214
10 (3GPP TS 25.214 Rel. 99) and the second algorithm comprises a power control value algorithm in accordance with Release 5 of the Third Generation Partnership Project Technical Specification 25.214 (3GPP TS 25.214 Rel. 5). Hence, the system provides for control performance according to Release 99 of the UMTS Technical Specifications to be
15 replaced by control performance according to Release 5 of the UMTS Technical Specifications, simply by adding a new subsystem.

According to a different aspect of the invention, there is provided a communication unit for a cellular communication system, the
20 communication unit comprising: means for determining a control value in a first subsystem of the communication unit of the cellular communication system according to a first algorithm; means for determining a second control value in a second subsystem of the communication unit according to a second algorithm; means for determining a third control value in the
25 second subsystem of the communication unit according to the first algorithm, the third control value corresponding to the first control value; means for combining the first, second and third power control value into a fourth control value such that the contribution from the third control value reduces the contribution from the first power control value; and
30 means for transmitting the control signal comprising the fourth control value to at least a second communication unit.

According to a third aspect of the invention, there is provided a Code Division Multiple Access (CDMA) base station comprising a communication unit according to the second aspect of the invention.

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Preferably, the CDMA base station further comprises means for determining if the second communication unit is in a soft handover; and means for determining if the first communication unit is a serving base station; and wherein the means for transmitting are operable to include the first control value rather than the fourth control value in the control signal if the second communication unit is not in the soft handover or the CDMA base station is not the serving base station. Thus the system provides an easy method of upgrading control performance for the serving base station of a soft handover without impacting existing circuitry or the control performance in other situations.

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According to a fourth aspect of the invention, there is provided a communication system comprising a communication unit according to the second aspect of the invention or a base station according to the third aspect of the invention.

20

Brief Description of the Drawings

25 An embodiment of the invention will be described, by way of example only, with reference to the drawings, in which

FIG. 1 is an illustration of a cellular communication system in accordance with the prior art;

30

FIG.2 is an illustration of a communication unit in accordance with an embodiment of the invention; and

FIG. 3 is an illustration of a flowchart for a method of generating a control signal in accordance with an embodiment of the invention.

Detailed Description of a Preferred Embodiment of the Invention

The invention will in the following be described with specific reference to the UMTS communication system standardised by the Third Generation Partnership Project (3GPP), but it will be apparent that the invention is not limited to this application but is equally applicable to many other communication systems.

15

Release 99 of the UMTS technical specifications prescribe the use of a number of traffic and control channels to support a communication between a base station (known as a node B for UMTS) and a user equipment such typically mobile stations, communication terminals, wireless devices, remote terminals, subscriber units etc. These channels include the Dedicated Physical Control CHannel (DPCCH) which includes pilot symbols, power control data and transmit format information.

20

Another logical channel that has been defined in Release 99 is the Dedicated Physical Data CHannel (DPDCH) which is a traffic channel dedicated to a single user equipment. Communication between a base station and a user equipment is typically achieved through the allocation of at least uplink and downlink DPCCH and DPDCHs with the DPDCHs being used for the communication of data and the DPCCHs being used to control and maintain the communication links.

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Currently, the 3GPP RAN WG1 standards body is specifying the air interface for High Speed Downlink Packet Access (HSDPA) for Release 5 of the 3GPP Technical Specifications. The HSDPA provides fast access through efficient scheduling in the base station, using very short
5 scheduling intervals of 2 msec and taking advantage of information fed back from the user equipment related to the quality of the channel between the base stations and the user equipment. A total peak data rate of up to 10.8 Mbps can be achieved with an average data rate of approximately 3 Mbps.

10

In order to implement the HSDPA, a number of additional logical channels have been and are being specified in Release 5 of the UMTS Technical Specifications. These include the High Speed Downlink Shared CHannel (HS-DSCH) which provides a shared channel over which communication
15 to a user equipment is effected once a scheduling slot has been allocated to that user equipment. The data for the individual user equipment on the HS-DSCH is thus intermittent as the HS-DSCH is shared between user equipments. In addition, a High Speed Shared Control CHannel (HS-SCCH) has been defined for the downlink which comprises information for
20 the user equipment related to the allocation of the HS-DSCH. The user equipment monitors the HS-SCCH to detect if the HS-DSCH will comprise data for that user equipment. Further, a dedicated low data rate control channel is setup in the uplink direction for each user equipment registered for the HS-DSCH. Thus a High Speed Dedicated Physical Control
25 CHannel (HS-DPCCH) has been defined comprising information related to error feedback information and quality reports. Typically, a user equipment using the HSDPA additionally has at least one DPDCH and DPCCH operating in parallel to the High Speed channels in both uplink and downlink directions.

30

For a user equipment in soft-handover there are two or more uplink channels connecting the user equipment to the serving base station and target base stations (base stations included in the soft handover). For a user equipment supporting HSDPA there are three types of uplink channels: a) the uplink DPDCH which is used to carry uplink data; b) the uplink DPCCH which is used to carry control information generated by layer 1 which consists of pilot bits, transmit power control(TPC) command and transport format combination indicator (TFCI); and c) High Speed dedicated physical control channel (HS-DPCCH) which is used to carry ACK/NACK, Pilot bits and the channel quality indication (CQI) corresponding to the high speed downlink shared channel.

Conventionally, there are two ways to perform power control for uplink connections. In the first method, the DPDCH, DPCCH and HS-DPCCH are power controlled based on power control bits from base stations in the active set such that the combined signals are of sufficient quality. In this scenario, the HS-DPCCH is controlled from all the base stations in the active set. However, as the HS-DPCCH is only transmitted from the serving base station, even when the user equipment is in a soft handover, this scheme suffers from the significant drawback, that when the serving base station is not dominant, the HS-DPCCH will be received with low reliability. This is especially critical as the HS-DPCCH includes error feedback information used in an Automatic ReQuest scheme, the performance of which is very sensitive errors in the feedback information. To overcome this problem, the HS-DPCCH may be transmitted at a much higher power (e.g. 15dB) compared to the no soft-handover situation. In the second method, the HS-DPCCH is only power controlled from the serving base station, while the DPDCH and the DPCCH is power controlled from all of the base stations in the active set. This scheme requires two independent power control streams and thus requires one additional power control bit to maintain 1500Hz power control rate.

Alternatively, if the current 3GPP slot structure is to be maintained the power control rate can be reduced during soft-handover. Both of these methods are inefficient and require modifications to the existing functionality of UMTS communication systems.

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A method of power control addressing these issues is described in United States of America patent application US 60/379,323, the contents of which are hereby explicitly incorporated by reference. This power control technique enables efficient control of the new uplink HS-DPCCH channel during soft handover without the need for additional power control commands to be transmitted from the base station. According to the technique, the power control information for the serving base station is determined based on the quality (such as the signal to noise ratio) of the uplink HS-DPCCH whereas for all other base stations the generated power control information is based on the quality of the DPCCH. Thus the HS-DPCCH can be accurately controlled as the power control information from the serving base station relates to this channel. At the same time, the remaining channels can be accurately controlled from the power control information of the other base stations together with the power control information of the HS-DPCCH combined with information of the relative transmit power of the HS-DPCCH and DPCCH channels.

However, as is frequently the case with the introduction of new improved techniques and especially control value techniques, it is required to replace or modify existing equipment. Specifically, this above mentioned power control technique would require changing Release 99 functionality in already deployed base stations, since the power control data of the serving cell must be based on the HS-DPCCH rather than the DPCCH and DPDCH as described in Release 99, and consequently implemented in currently deployed base stations. The specific example described thus

illustrates how introduction of new techniques often requires modification or replacement of existing equipment and/or functionality.

Hence, in accordance with a preferred embodiment of the current
5 invention, a control signal is generated by determining a control value in a first subsystem of a communication unit of the cellular communication system according to a first algorithm, determining a second control value in a second subsystem of the communication unit according to a second algorithm; determining a third control value in the second subsystem of
10 the communication unit according to the first algorithm, the third control value corresponding to the first control value; combining the first, second and third power control value into a fourth control value such that the contribution from the third control value reduces the contribution from the first power control value; and transmitting the control signal comprising
15 the fourth control value to at least a second communication unit.

In the preferred embodiment, which is specifically suited for the UMTS example described above, all control values are power control values and the first algorithm is a Release 99 UMTS power control algorithm whereas
20 the second algorithm is not a Release 99 UMTS power control algorithm. Rather the second algorithm is preferably a Release 5 UMTS power control algorithm.

FIG.2 is an illustration of a communication unit in accordance with an
25 embodiment of the invention. Specifically, FIG. 2 illustrates an example of a UMTS base station in accordance with the preferred embodiment.

The base station 201 communicates with a number of user equipment 203,
205 over radio links. The base station 201 comprises an antenna 207
30 connected to a duplexer 209. The duplexer 209 is connected to a transmitter unit 211 and a receiver front-end 213 and is operable to

separate the signals such that the same antenna 203 can be used simultaneously for both receiving and transmitting signals.

The receiver front end 213 filters, amplifies and down-converts the received signals as is well known in the art. The receiver front end 213 is connected to a Digital to Analog Converter (DAC) 215, and in the preferred embodiment the output signal from the receiver front end 213 is digitised by the DAC. In the described embodiment, the output signal from the receiver front end is a base band signal.

The DAC 215 is connected to two separate subsystems 217, 219 of the base station 201. The first subsystem 217 is operable to operate in accordance with a first mode of communication and the second subsystem 219 is operable to operate in accordance with a second mode of communication.

Specifically in the preferred embodiment, the first subsystem 217 operates in accordance with Release 99 of the UMTS Technical Specifications. The second subsystem 219 is operable to operate at least in accordance with a different release of the UMTS technical specifications, and preferably in accordance with Release 5 of the UMTS Technical Specifications. In the described embodiment the first and second subsystem 217, 219 are physically distinct subsystems. For example, the subsystems can be individually removed from the base station, and preferably the base station can provide the functionality of each of the subsystems independently of the presence of the other subsystem. In the preferred embodiment, the communication unit comprises a plurality of physical modules and the first subsystem is comprised in a first physical module 217 and the second subsystem is comprised in a second physical module 219. Thus in this embodiment, each of the first 217 and second physical module 219 can preferably be independently removed, replaced or modified. Specifically, the first and second physical modules are separate printed circuit boards (PCBs). These PCBs are in the preferred

embodiment mounted in a suitable rack wherein each PCB can be individually inserted.

The first module 217 comprises a first receive processor 221 and a first
5 transmit processor 223. The first receive processor 221 receives the digitised signal from the DAC and processes the received signal in accordance with Release 99 protocols and algorithms. Specifically, the first receive processor 221 is operable to determine a control value in a first subsystem of the communication unit 201 of the cellular communication
10 system according to a first algorithm. Specifically, the control value is a power control value determined in response to Release 99 power control algorithms, and as such it is based on processing of the DPCCH as known in the art. In accordance with Release 99, and the UMTS technical Specifications in general, the power control value is a binary value simply
15 indicating whether the transmit power should be increased or decreased. The first receive processor 221 is connected to the first transmit processor 223 which performs the operations necessary to perform, control and optimise the communication in accordance with Release 99 of the UMTS specifications. As such, the transmit processor 223 specifically performs
20 the function of generating the necessary control signals, allocating data into logical channels, spreading the signal etc as is well known in the art.

The first transmit processor 223 is connected to a combiner 225 which combines signals to be transmitted from different physical modules. The
25 combiner 225 is connected to the transmitter unit 211 which modulates, up-converts, amplifies etc. the signal to be transmitted, as is well known in the art. The transmitter unit 211 is connected to the antenna 207 through the duplexer 209.

30 The base station 201 further comprises a second subsystem or module 219. This module 219 may not have been part of the original base station

configuration but rather in the preferred embodiment represents an upgrade module further enhancing features and /or performance of the base station 201. Specifically, the second module 219 is a processor subsystem providing functionality required for the base station to operate
5 in accordance with Release 5 of the UMTS Technical Specifications and can thus be used to upgrade a Release 99 base station to Release 5.

The second module 219 comprises a second receive processor 227 connected to the DAC. The second receive processor 227 performs at least
10 some of the receive functions required for the base station 201 to operate in accordance with Release 5 of the UMTS Technical Specifications. In particular, the second receive processor 227 is operable to determine a second control value in a second subsystem of the communication unit according to a second algorithm and specifically, the control value is a
15 power control value determined in response to Release 5 power control algorithms. In accordance with the preferred embodiment, the second algorithm comprises consideration of characteristics of a High Speed - Dedicated Physical Control Channel (HS-DPCCH) and preferably the power control value is determined from the signal to noise ratio of the HS-
20 DPCCH.

The second receive processor 227 is connected to a subsystem control value combiner 229 which combines the control value generated by the second receive processor 227 with control values generated by other means as will
25 be described. The subsystem control value combiner 229 is connected to a second transmit processor 231 which performs at least some of the transmit functions required for the base station 201 to transmit signals in accordance with Release 5 of the UMTS Technical Specifications. Specifically, the second transmit processor 231 performs the necessary
30 functions for the control values to be transmitted. The second transmit

processor 231 is connected to the combiner 225 whereby the signals of the first 217 and second modules 219 are combined.

In addition, the second module 219 comprises a third receive processor 233 which is operable to perform a number of receive operations, and specifically to determine a third control value in the second subsystem of the base station 201 according to the first algorithm, the third control value corresponding to the first control value. Thus in the preferred embodiment, the third receive processor 233 performs some of the same operations as the first receive processor 221 and specifically it uses the same algorithm to determine the third control value. Hence, preferably the third receive processor 233 determines a binary power control value in accordance with the algorithms of Release 99 of the UMTS Technical Specifications. In particular, the power control value is determined from the DPCCH. Hence, the third receive processor 233 replicates the control value determination of the first receive processor 221 and as the two receive processors 221, 233 are fed the same digitised signal and preferably performs the same algorithm, the first and second control values are in the preferred embodiment substantially identical.

The determined third control value is inverted by multiplication by -1 in a multiplier 235 before being fed to the subsystem control value combiner 229. Hence, the control value originating from the second module 219 corresponds to a contribution from the Release 5 algorithm and a negative or inverted contribution from the Release 99 algorithm. Hence, the effect of the subsystem control value combiner 229 and the combiner 225 is that the first, second and third control values are combined into a fourth control value such that the contribution from the third control value reduces the contribution from the first power control value. The fourth control value is transmitted by the transmitter unit 211 as part of a control signal.

As a consequence, in the preferred embodiment the control value transmitted is substantially identical to the second control value, and the contribution of the first control value has been removed or at least reduced or attenuated. This allows for a new control value to be introduced to the system without requiring any modification to the first module. Rather, the modification required to the original operation when upgrading is achieved by the additional module without any modification or replacement of existing modules.

In the preferred embodiment, the combining and transmitting operations are linear and the order and number of the transmit functions and combinations may be varied as suitable for the specific implementation. Specifically, the combination of the three control values may be performed in one or two combiners or combining steps. In addition, the combination may be performed at any suitable stage in the transmit path but is preferably performed in the digital domain. As a specific example, the spreading operation of a CDMA system is a linear operation and the combining may therefore be performed before or after the spreading operation. If performed after the spreading operation, the spreading applied to the control values is preferably substantially identical thereby reducing the combination inaccuracies.

Further, in order to achieve as high attenuation of the first control value as possible, the first and/or third control values are scaled such that they have substantially corresponding magnitudes. In some embodiments, for example where the control value is a binary value, the scaling of the control value is by scaling of the signal comprising the control value. Preferably, the magnitude or power of the transmit signal from the first module is determined and the signal from the second module is adjusted

such that the third control value will substantially cancel out the first control value following the combining.

FIG. 3 is an illustration of a flowchart for a method of generating a control
5 signal in accordance with an embodiment of the invention. The method of
FIG. 3 will be described with reference to the base station of FIG. 2.

In step 301, a received signal is processed and information required for the
following steps are extracted from the received signal. Specifically, a
10 signal to interference ratio for a DPCCH channel for a first user
equipment is calculated according to any suitable technique. In step 303, a
control value is determined according to a first algorithm. Specifically in
the preferred embodiment, a power control value is determined according
to a power control algorithm specified in Release 99 of the UMTS
15 Technical Specifications thus comprising consideration of characteristics of
a Dedicated Physical Control Channel (DPCCH). Steps 301 and 303 are
performed in the first module 217 of the base station 201.

In the second module 219 of the base station 201, steps 305 to 317 of the
20 method of the preferred embodiment are performed. In step 305, a
received signal is processed and information required for subsequent steps
are derived. Specifically, information related to a first channel such as the
HS-DPCCH is determined. In the preferred embodiment, the signal to
interference ratio for the HS-DPCCH is determined. In step 307, the
25 received signal is processed and information related to a second channel,
such as the DPPCH is derived. In the preferred embodiment, the signal to
interference ratio for the DPCCH is determined. The second channel thus
corresponds to the first channel processed in step 301 by the first module
217.

30

In step 309, the second module evaluates if the given user equipment is in a soft handover and if so, whether the base station 201 is the serving base station. If the user equipment is not in a soft handover, or if the base station is not the serving base station, the method proceeds in step 311 by
5 setting the power control value from the second module 219 to zero. In addition, the third control value is set to the default value of zero.

However, if the user equipment is in a soft handover and the base station 201 is the serving base station, the method continues in step 313 by calculating a second control value based on the information of the second
10 channel as determined in step 307. Hence, in the preferred embodiment, a second power control value is determined based on the signal to interference ratio of the HS-DPCCH. The determination of the control value of step 313 is thus in accordance with a second algorithm which specifically is a Release 5 power control algorithm.

15 The method then proceeds in step 315 where a third control value is determined in accordance with the first algorithm and based on the first channel. Specifically, the determination of the third control value is based on the information derived in step 305. Thus in the preferred embodiment,
20 the processing of step 303 is replicated and a third power control value based on the DPCCH and a Release 99 power control algorithm is determined. The determined third control value is negated, inverted or otherwise manipulated in step 317 such that in a following combination, the third power control value will have a cancelling out or opposing effect
25 on the first power control value determined in the first module. In the preferred embodiment, where all control values are binary values, the third control value may simply be inverted in step 317 depending on the exact implementation of the combiners 225, 229.

30 Following step 303, 311 or 317, the method continues in step 319. In step 319, the three determined control values are combined such that the

effects of the first and third control values counteract each other. In the preferred embodiment, the first and second control values are approximately of equal magnitude but having opposite polarity. Thus the third value effectively reduces the impact of the first control value and preferably substantially cancels it out. In the preferred embodiment, where all power control values are binary, the combining is simply achieved by addition of the binary values. As the third control value is inverted in step 317, the first and second control values will cancel out. In one embodiment all control values are simply combined in a complement two addition of the binary values and in this embodiment the third control value is unmodified in step 317.

Following the combining in step 319, the resulting fourth control value is embedded in a control signal to be transmitted to the user equipment in step 321. In the preferred embodiment, the final control value is embedded as a transmit power control bit in the downlink DPCCH as specified in the UMTS Technical Specifications. Step 321 is followed by step 323 wherein the control signal is transmitted to the user equipment.

Thus in the preferred embodiment, the Release 99 power control command generation procedure is duplicated by the Release 5 processing entity. The duplicated Release 99 power control command is then negated and added to the Release 5 power control command (which is based on HS-DPCCH for HS-DSCH serving base station). After summing of the outputs of the Release 99 and Release 5 processing entities, this has the effect of cancelling the power control command generated by the Release 99 base station and replacing it with the power control command based on HS-DPCCH. Hence, the combining of the preferred embodiment is performed whenever a base station is implemented that supports new Release 5 features without changing Release 99 functionality. This provides for a very simple, cost effective way of introducing new functionality for UMTS

without requiring modifications to the existing functionality of already deployed equipment. Further a very simple upgrading of existing circuitry can be achieved simply by addition of new circuitry, and in particular simply by adding a new module to an existing base station. In the
5 described way, the preferred embodiment provides a system for changing data sent by existing Release 99 processing entities without the need for changing these entities

It will be clear, that the above description is by way of example and that
10 many variations and modifications may be made by a person skilled in the art without detracting from the current invention. Thus the order and interrelationship of the steps of the method described with reference to FIG. 3 may be changed and modified in any suitable form. For example, rather than setting a control value to zero in step 311, the whole process of
15 the second module may be skipped if the base station is not the serving base station or the user equipment is not in a soft handover. Likewise, it is within the contemplation of the invention that different partitioning of functionality between different modules and processors than the one hereinabove described can be implemented in different embodiments.

20 The invention can be implemented in any suitable form including hardware, software, firmware or any combination of these. However, preferably, the invention is implemented as computer software running on one or more data processors. The elements and components of an
25 embodiment of the invention are preferably but not necessarily located in a base station. The functionality may be implemented in a single unit, in a plurality of units or as part of other functional units. As such, the invention may be implemented in a single unit or may be physically and functionally distributed in the network. However, in the preferred
30 embodiment the functionality of the first subsystem and second subsystem

is implemented in separate single first and second processing units of a base station.

Claims

1. A method of generating a control signal in a cellular communication system, the method comprising the steps of:
 - 5 determining a control value in a first subsystem of a communication unit of the cellular communication system according to a first algorithm;
determining a second control value in a second subsystem of the communication unit according to a second algorithm;
determining a third control value in the second subsystem of the communication unit according to the first algorithm, the third control value corresponding to the first control value;
combining the first, second and third power control value into a fourth control value such that the contribution from the third control value reduces the contribution from the first power control value; and
15 transmitting the control signal comprising the fourth control value to at least a second communication unit.
2. A method of as claimed in claim 1 wherein the first, second, third and fourth control values are power control values and the first and
20 second algorithms are different power control algorithms.
3. A method as claimed in any previous claim wherein the step of combining comprises a summation of the first and second control value and subtraction of the third control value.
25
4. A method as claimed in any previous claim wherein the first algorithm is based on a first communication channel and the second algorithm is based on a second communication channel.

5. A method as claimed in any previous claim wherein the first communication unit is a base station and the at least second communication unit is a user equipment.

5 6. A method as claimed in any previous claim wherein each control value is a binary value.

7. A method as claimed in any previous claim wherein the third power control value is substantially equal to the first power control value.

10

8. A method as claimed in any previous claim wherein the first and second subsystem are physically distinct subsystems.

9. A method as claimed in claim 8 wherein the communication unit
15 comprises a plurality of physical modules and the first subsystem is comprised in a first physical module and the second subsystem is comprised in a second physical module.

10. A method as claimed in claim 9 wherein the first and second
20 physical modules are separate printed circuit boards.

11. A method as claimed in any previous claim wherein the step of combining comprises scaling at least the first and third control values to have substantially corresponding magnitudes.

25

12. A method as claimed in any previous claim wherein the communication system is a CDMA communication system.

13. A method as claimed in claim 12 wherein the communication unit is
30 a base station and the second communication unit is a user equipment in soft handover.

14. A method as claimed in claim 13 further comprising the step of determining if the communication unit is a serving base station, and wherein the step of transmitting comprises including the first control
5 value rather than the fourth control value in the control signal if the first communication unit is not the serving base station.

15. A method as claimed in claimed in any of the claims 12 to 14 further comprising the step of spreading the first, second and third control values
10 prior to the step of combining.

16. A method as claimed in claim 15 wherein the step of spreading comprises a substantially similar spreading of the first, second and third control values.

15

17. A method as claimed in any of the claims 12 to 15 wherein the communication system is a Universal Mobile Telecommunication System (UMTS).

20 18. A method as claimed in claim 17 wherein the first algorithm comprises consideration of characteristics of a Dedicated Physical Control Channel (DPCCH) and the second algorithm comprises consideration of characteristics of a High Speed - Dedicated Physical Control Channel (HS-DPCCH).

25

19. A method as claimed in claim 17 wherein the first algorithm comprises a power control value algorithm in accordance with Release 99 of the Third Generation Partnership Project Technical Specification 25.214 (3GPP TS 25.214 Rel. 99) and the second algorithm comprises a power
30 control value algorithm in accordance with Release 5 of the Third

Generation Partnership Project Technical Specification 25.214 (3GPP TS 25.214 Rel. 5).

20. A communication unit for a cellular communication system, the
5 communication unit comprising:

means for determining a control value in a first subsystem of the communication unit of the cellular communication system according to a first algorithm:

10 means for determining a second control value in a second subsystem of the communication unit according to a second algorithm;

means for determining a third control value in the second subsystem of the communication unit according to the first algorithm, the third control value corresponding to the first control value;

15 means for combining the first, second and third power control value into a fourth control value such that the contribution from the third control value reduces the contribution from the first power control value; and

means for transmitting the control signal comprising the fourth control value to at least a second communication unit.

20

21. A communication unit as claimed in claim 20 wherein the first, second, third and fourth control values are power control values and the first and second algorithms are different power control algorithms.

25 22. A communication unit as claimed in any previous claim 20 to 21 wherein the first and second subsystems are physically distinct subsystems.

23. A communication unit as claimed in claim 22 wherein the
30 communication unit comprises a plurality of physical modules and the

first subsystem is comprised in a first physical module and the second subsystem is comprised in a second physical module.

24. A communication unit as claimed in claim 23 wherein the first and
5 second physical modules are separate printed circuit boards.

25. A Code Division Multiple Access (CDMA) base station comprising a communication unit in accordance with any of the claims 20 to 24 and wherein the second communication unit is a user equipment.

10

26. A CDMA base station as claimed in claim 25 further comprising means for determining if the second communication unit is in a soft handover; and

15

means for determining if the first communication unit is a serving base station; and

wherein the means for transmitting are operable to include the first control value rather than the fourth control value in the control signal if the second communication unit is not in the soft handover or the CDMA base station is not the serving base station.

20

27. A CDMA base station as claimed in any of the claims 25 or 26 wherein the CDMA base station is a Universal Mobile Telecommunication System (UMTS) base station.

25

28. A UMTS base station as claimed in claim 27 wherein the first algorithm comprises consideration of characteristics of a Dedicated Physical Control Channel (DPCCH) and the second algorithm comprises consideration of characteristics of a High Speed - Dedicated Physical Control Channel (HS-DPCCH).

30

29. A UMTS base station as claimed in claim 28 wherein the first algorithm comprises a power control value algorithm in accordance with Release 99 of the Third Generation Partnership Project Technical Specification 25.214 (3GPP TS 25.214 Rel. 99) and the second algorithm
5 comprises a power control value algorithm in accordance with Release 5 of the Third Generation Partnership Project Technical Specification 25.214 (3GPP TS 25.214 Rel. 5).

30. A communication system comprising a communication unit
10 according to any of the claims 20 to 29.

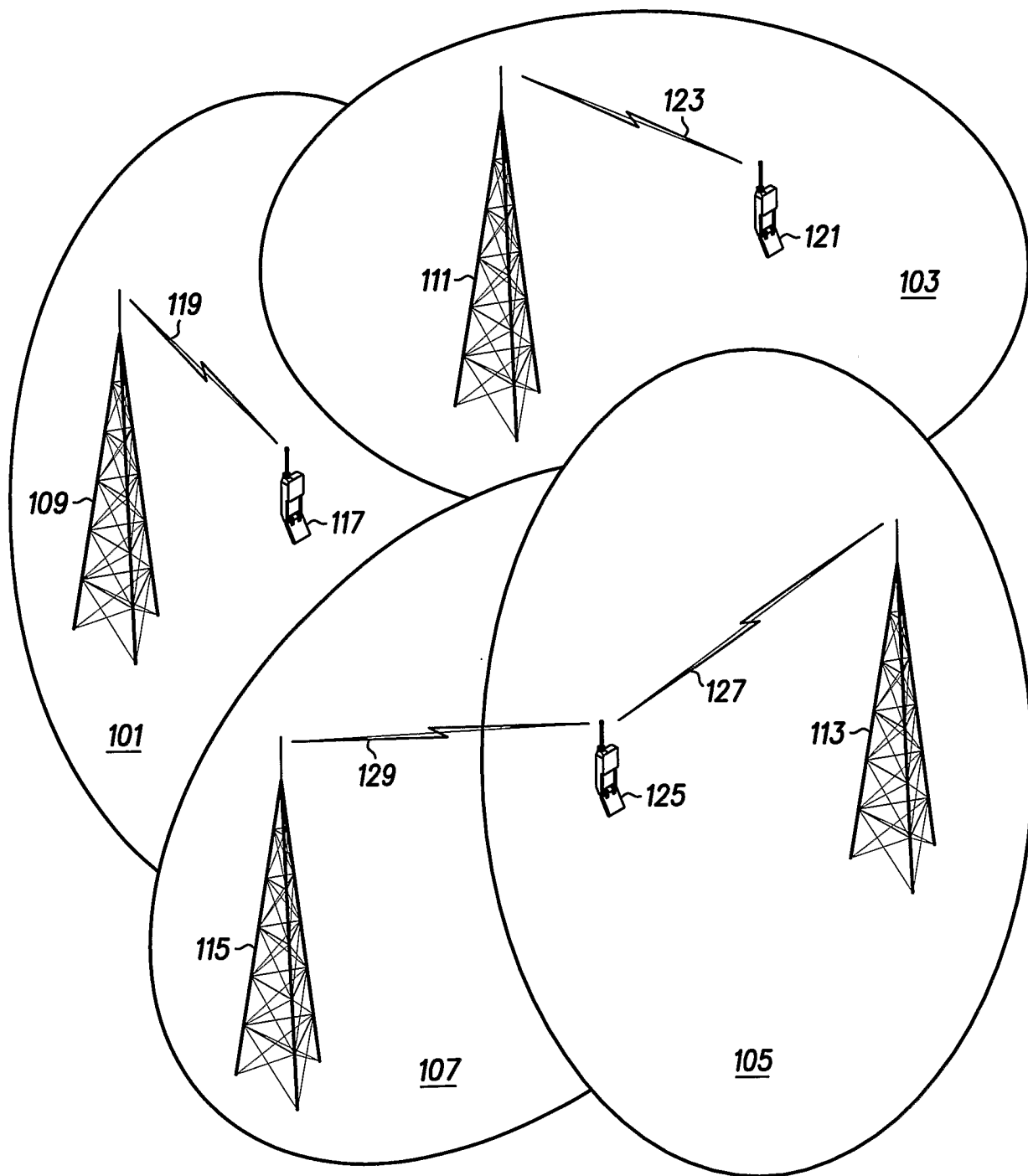
31. A communication system as claimed in claim 30 wherein the communication system is a Code Division Multiple Access (CDMA) communication system.

15

32. A communication system as claimed in claim 31 wherein the communication system is a Universal Mobile Telecommunication System (UMTS) communication system.

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- PRIOR ART -

FIG. 1

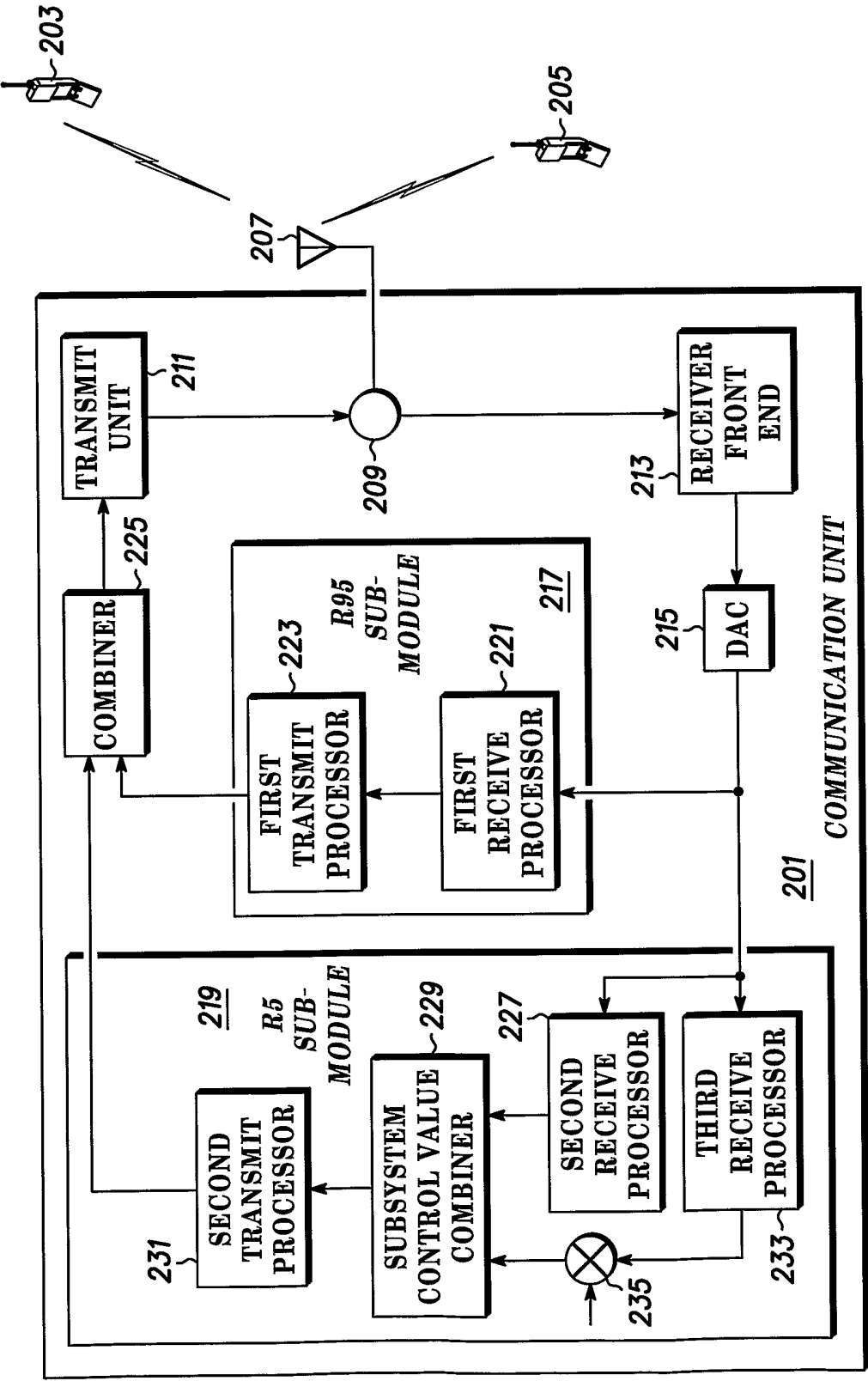
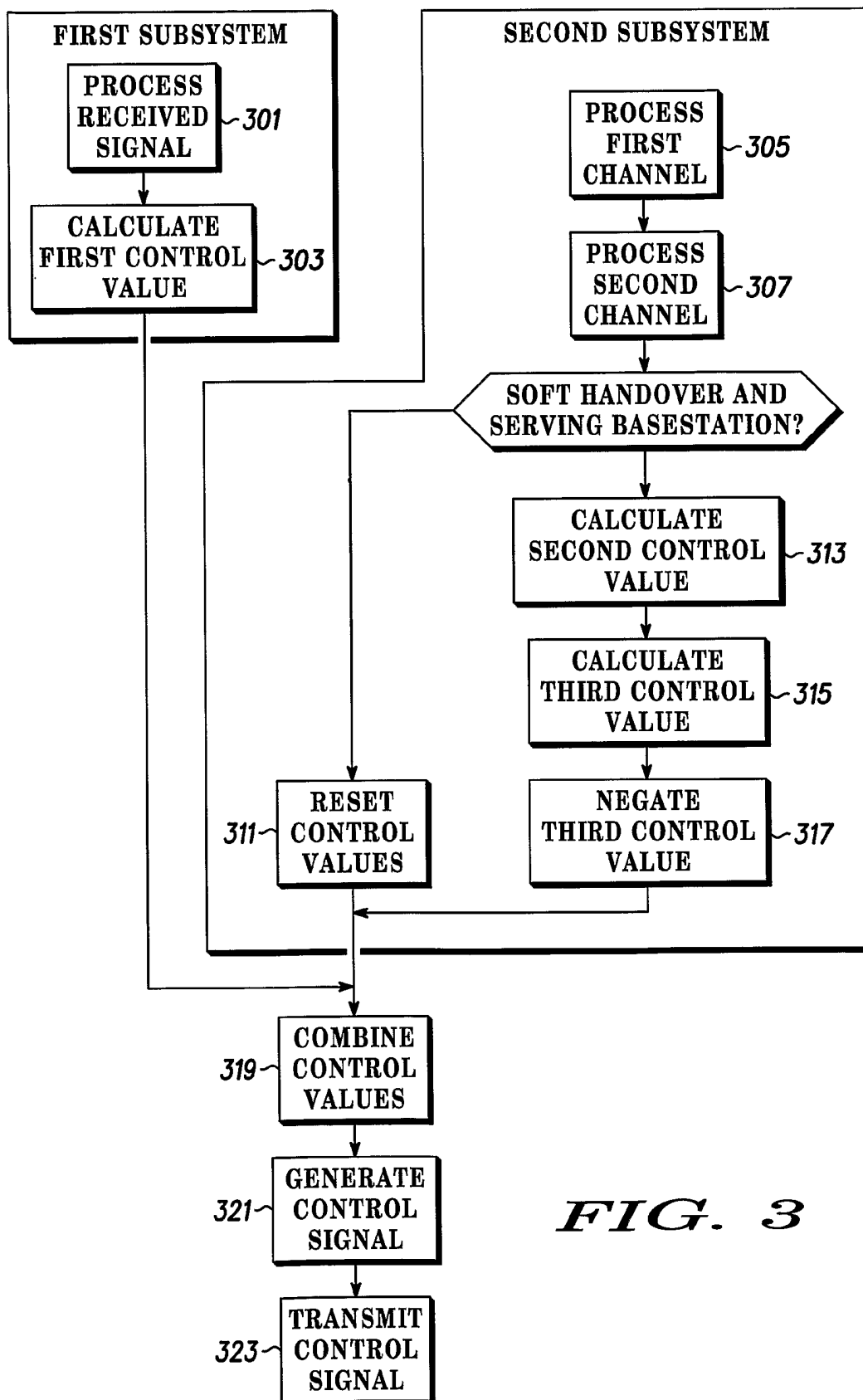


FIG. 2

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*FIG. 3*

INTERNATIONAL SEARCH REPORT

International Application No
PCT/EP 03/05262

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/005 G06F9/445 H04Q7/32

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 H04B G06F H04Q

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

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

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2002/086688 A1 (KANG SUNG-MIN) 4 July 2002 (2002-07-04) claim 2; figure 2 paragraph '0012! - paragraph '0014! paragraph '0028! - paragraph '0029! paragraph '0032! - paragraph '0033! paragraph '0035! - paragraph '0036! ----	1-32
A	MOTOROLA: "HS-DPCCH Power Control in Soft-Handoff" 3GPP TSG-RAN1#26/ TSGR1-02-0824, 13 - 16 May 2002, XP002256284 GyeongJu, Korea the whole document -----	1-32

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

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No...

PCT/EP 03/05262

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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