



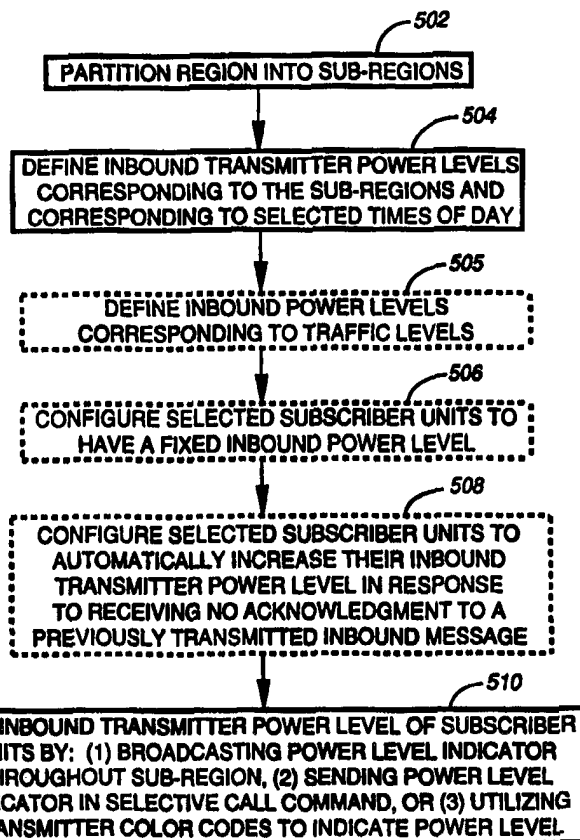
INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: METHOD AND APPARATUS FOR SETTING AN INBOUND TRANSMITTER POWER LEVEL

(57) Abstract

A region (105) is partitioned (502) into a plurality of sub-regions (106, 108) having a corresponding plurality of predetermined inbound channel loss figures. A plurality of inbound transmitter power levels corresponding to the plurality of sub-regions are then defined (504). The plurality of inbound transmitter power levels are based upon the plurality of predetermined inbound channel loss figures. The inbound transmitter power level for a subscriber unit (104) is then set (510) in accordance with one of the plurality of inbound transmitter power levels corresponding to one of the plurality of sub-regions within which the subscriber unit is positioned. The setting step comprises the step of transmitting a power level indicator over an outbound channel.



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METHOD AND APPARATUS FOR SETTING AN INBOUND TRANSMITTER POWER LEVEL

Field of the Invention

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This invention relates in general to radio communication systems, and more specifically to a method and apparatus for setting an inbound transmitter power level of a subscriber unit in a two-way radio messaging system.

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Background of the Invention

As two-way radio messaging systems have become more mature, new applications have been developed which require higher power for the inbound (subscriber unit to fixed equipment) channels. One such application is for subscriber units transported in automobiles on rural highways along which inbound receivers may be sparse. Another such application is for fixed subscriber units used with, for example, vending machines, which may be located in areas of poor transmission and reception.

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High power inbound transmissions are necessary and acceptable in regions designed to accommodate high power, e.g., sparsely populated areas with sparse distribution of inbound receivers. In densely populated areas with closely distributed inbound receivers, however, high power inbound transmissions can cause interference that can negatively impact the operation of lower powered subscriber units.

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Thus what is needed is a method and apparatus for controlling inbound transmitter power levels of subscriber units in a two-way messaging system, such that high power is used where required, while lower power is used where high power is not desirable. Preferably, the method and apparatus will be administratively simple and will operate without a requirement for measuring received signal levels.

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Summary of the Invention

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An aspect of the present invention is a method for setting an inbound transmitter power level of a subscriber unit in a two-way radio

messaging system providing radio coverage within a region. The method operates without measuring a received signal. The method comprises the steps of partitioning the region into a plurality of sub-regions having a corresponding plurality of predetermined inbound channel loss figures, and defining a plurality of inbound transmitter power levels corresponding to the plurality of sub-regions. The plurality of inbound transmitter power levels are based upon the plurality of predetermined inbound channel loss figures. The method further comprises the step of setting the inbound transmitter power level for the subscriber unit in accordance with one of the plurality of inbound transmitter power levels corresponding to one of the plurality of sub-regions within which the subscriber unit is positioned. The setting step comprises the step of transmitting a power level indicator over an outbound channel.

Another aspect of the present invention is a controller for setting an inbound transmitter power level of a subscriber unit in a two-way radio messaging system providing radio coverage within a region. The controller operates without measuring a received signal. The region is partitioned into a plurality of sub-regions having a corresponding plurality of predetermined inbound channel loss figures. The controller comprises an input interface for receiving a message, and a processor coupled to the input interface for processing the message. The controller further comprises an output interface coupled to the processor for outputting the message, and a memory coupled to the processor for storing software elements for programming the processor. The software elements comprise a definer for defining a plurality of inbound transmitter power levels corresponding to the plurality of sub-regions, the plurality of inbound transmitter power levels based upon the plurality of predetermined inbound channel loss figures; and a setter coupled to the definer for controlling the processor to set the inbound transmitter power level for the subscriber unit in accordance with one of the plurality of inbound transmitter power levels corresponding to one of the plurality of sub-regions within which the subscriber unit is positioned, the setter controlling a transmitter to transmit a power level indicator over an outbound channel.

Another aspect of the present invention is a subscriber unit for setting an inbound transmitter power level in a two-way radio messaging system providing radio coverage within a region partitioned into a

plurality of sub-regions having a corresponding plurality of predetermined inbound channel loss figures. A plurality of inbound transmitter power levels are defined corresponding to the plurality of sub-regions. The plurality of inbound transmitter power levels are based upon the plurality of predetermined inbound channel loss figures. The subscriber unit sets the inbound transmitter power level without measuring a received signal. The subscriber unit comprises a receiver for receiving over an outbound channel a radio signal including information comprising a power level indicator corresponding to one of the plurality of sub-regions in which the subscriber unit is positioned, and a processor coupled to the receiver for processing the information. The subscriber unit further comprises a user interface for conveying portions of the information to a user and for providing control of the subscriber unit by the user, and a transmitter coupled to the processor for transmitting an inbound signal at the inbound transmitter power level. The subscriber unit also includes a memory coupled to the processor for storing software elements for programming the processor. The software elements comprise a setter for controlling the processor to set the inbound transmitter power level of the subscriber unit in accordance with the power level indicator.

Brief Description of the Drawings

FIG. 1 is an electrical block diagram of a two-way radio messaging system in accordance with the present invention.

FIG. 2 is a diagram of an outbound data block in accordance with the present invention.

FIG. 3 is an electrical block diagram of a controller in accordance with the present invention.

FIG. 4 is an electrical block diagram of a subscriber unit in accordance with the present invention.

FIG. 5 is a flow diagram depicting operation of the two-way radio messaging system in accordance with the present invention.

Detailed Description of the Drawings

Referring to FIG. 1, an electrical block diagram depicts a two-way radio messaging system 100 in accordance with the present invention.

5 The messaging system 100 comprises at least two conventional base stations 102, the base stations 102 providing radio coverage in first and second sub-regions 106, 108 of a region 105 in which the system 100 provides service. Depending upon how it is defined, a sub-region 106, 108 can include an area served by a large number of transmitters, or only a

10 single transmitter. A sub-region 106, 108 also can include many subscriber units 104, or as few as a single subscriber unit 104. The base stations 102 are coupled by radio paths 110 to subscriber units 104. The subscriber units 104 are preferably two-way messaging units, which can generate inbound responses to the base stations 102. The first sub-region

15 106 is depicted with a plurality of conventional inbound channel receivers 112 and represents a sub-region having a relatively low mean inbound channel loss figure, corresponding, for example, to a metropolitan area. The second sub-region 108 is depicted with a single inbound channel receiver 112 and represents a sub-region having a

20 relatively high mean inbound channel loss figure, corresponding, for example, to a rural area. Thus, it is likely that the second sub-region 108 will benefit from the use of a higher inbound transmitter power (for greater range), while the first sub-region 106 will benefit from the use of a lower inbound transmitter power (for reduced interference). For these

25 reasons a controller 114 in accordance with the present invention controls the base stations 102 to transmit a power level indicator over the outbound channel for controlling the inbound transmitter power of the subscriber units 104 according to the requirements of each sub-region 106, 108 for best inbound performance. Inbound channel loss figures are

30 affected by the transmission speed used for the inbound channel, and the radio propagation characteristics of the sub-region. Inbound channel loss figures can be calculated or determined through measurements using well-known radio coverage analysis techniques.

The base stations 102 are coupled by communication links 116 to the

35 controller 114 for controlling the base stations 102 using techniques well known in the art. The controller 114 is coupled through an additional communication link 118 to an input entity (not shown) for generating

message originations using well-known techniques. The input entity can be, for example, a telephone set, a video display terminal, another controller, or a network interconnecting any or all of the above input entities. The signals over the radio paths 110 preferably utilize a well-known messaging protocol, such as a member of Motorola's FLEX™ family of protocols. These protocols comprise error detection and correction mechanisms, which give the protocols the necessary robustness for use in radio messaging systems.

Referring to FIG. 2, a diagram depicts an outbound (base station to subscriber unit) data block 200 in accordance with the present invention. The data block 200 comprises a sync portion 202 for use in synchronizing the subscriber units 104 with transmissions of the base stations 102 using techniques well known in the art. The sync portion 202 also carries a transmitter color code 212 for identifying a transmitter of the base station 102 and for controlling inbound transmitter power in one embodiment according to the present invention. The data block 200 further comprises a block information word (BIW) 204, which provides system configuration information to the subscriber units 104 and further provides inbound transmitter power control in another embodiment according to the present invention. The data block 200 also includes selective call addresses 206 of selected subscriber units 104 for which the remainder of the data block is intended. The addresses 206 point to vectors 208, which in turn point to messages 210, using well known techniques. In yet another embodiment according to the present invention the selective call addresses and associated messages can provide inbound transmitter power control, as described further below.

Referring to FIG. 3, an electrical block diagram depicts the controller 114 in accordance with the present invention, comprising an input interface 302 coupled to the communication link 118 for receiving a message from a message originator. The controller 114 further comprises a processor 308 for processing the message, and an output interface 306 coupled to the communication link 116 for outputting the message through the base stations 102. The processor 308 is coupled to a memory 310 for storing software elements for programming the processor 308 in accordance with the present invention. The software elements comprise a message processing element 312 for processing the message. The software elements further comprise a definer 314 for defining a plurality

of inbound transmitter power levels corresponding to the plurality of sub-regions 106, 108, the plurality of inbound transmitter power levels based upon a plurality of predetermined inbound channel loss figures determined for the plurality of sub-regions 106, 108 through well-known measurement and/or calculation techniques. In one embodiment according to the present invention, the definer 314 includes a time-variant element 316 for controlling the processor 308 to define time-variant inbound transmitter power levels. For example, one set of inbound transmitter power levels can be utilized for a sub-region during one time of day, while another set is utilized during a different time of day. This feature is useful, for example, for a subscriber unit 104 used in a vending machine for reporting inventory. Such a subscriber unit 104 can be restricted to low inbound power during high traffic hours, if the inventory reports are considered not to be urgent. During low traffic hours the subscriber unit 104 can be allowed to operate at high power when necessary to overcome high inbound channel transmission loss. Alternatively, such subscriber units 104 can be internally programmed to transmit only during predetermined times of day. In another embodiment according to the present invention, the definer 314 includes a traffic-variant element 317 for controlling the processor 308 to define traffic-variant inbound transmitter power levels. For example, power can be increased in a sub-region 106, 108 when average traffic is low in the sub-region, and vice versa. Average traffic for each sub-region 106, 108 can be determined by the controller 114 using well known techniques.

The software elements further comprise a setter 318 for controlling the processor 308 to set the inbound transmitter power level for the subscriber unit 104 in accordance with one of the plurality of inbound transmitter power levels corresponding to one of the plurality of sub-regions 106, 108 within which the subscriber unit 104 is positioned. The setter 318 cooperates with the processor 308 to control a transmitter of the base station 102 to transmit a power level indicator over an outbound channel. In one embodiment in accordance with the present invention the setter 318 comprises a broadcaster 324 for controlling the processor 308 to broadcast the power level indicator throughout a sub-region 106, 108 for setting the inbound transmitter power level of the subscriber unit 104 when the subscriber unit 104 is positioned within the sub-region 106, 108. In this embodiment the power level indicator is preferably a special block

information word (BIW) 204, which carries the inbound transmitter power level indicator as, for example, a two-bit field representing four predetermined power levels.

In another embodiment in accordance with the present invention
5 the setter 318 comprises a selective sender 320 for controlling the processor 308 to send the power level indicator in a selective call command to the subscriber unit 104 to set the inbound transmitter power level thereof in accordance with an identifiable sub-region. This embodiment is useful when the subscriber unit 104 is known to be
10 positioned within the identifiable sub-region, e.g., a subscriber unit 104 installed in a fixed position such as in a vending machine. Preferably, the selective call command is sent as a Change Registration Command in which one or more of the command's bits are used to designate the power level in accordance with the present invention. The Change
15 Registration Command is defined in Motorola's well-known ReFLEX™ protocol specification. It will be appreciated that, alternatively, other similar selective call commands can be used as well to set the inbound transmitter power level of a subscriber unit 104.

In yet another embodiment in accordance with the present
20 invention the setter 318 comprises a color code coordinator 322 for controlling the processor 308 to utilize a plurality of color codes transmitted by the base stations 102 as the power level indicator. Color codes are typically used for differentiating between and among nearby transmitters for determining the position of the subscriber unit 104. In
25 this embodiment, color codes are grouped in a predetermined manner, each group of color codes representing a predetermined inbound transmitter power level. When the subscriber unit 104 is in a cell covered by a transmitter, the subscriber unit 104 receives the color code of the transmitter and sets the inbound transmitter power level of the
30 subscriber unit 104 accordingly. This embodiment advantageously allows control of inbound power in smaller geographic increments than by sending the power level indicator in the BIW 204, which generally affects multiple transmitter coverage areas simultaneously. It will be appreciated that, alternatively, other types of transmitter identifiers can be
35 utilized as well for setting the inbound transmitter power level of the subscriber unit 104.

Referring to FIG. 4, an electrical block diagram depicts the subscriber unit 104 in accordance with the present invention, comprising an antenna 404 for intercepting transmissions from the base stations 102. The antenna 404 is coupled to a conventional receiver 408 for receiving the transmissions to derive information therefrom. The receiver 408 is coupled to a processor 410 for processing the received information, including a power level indicator for controlling inbound transmitter power, as is discussed further herein below. The processor 410 is coupled to a user interface 414 for conveying portions of the received information to a user, via, for example, a conventional display 416. The user interface 414 also includes a conventional alert 418 for alerting the user that new information has arrived. In addition, the user interface includes conventional user controls 420 for controlling the subscriber unit 104. The processor 410 is further coupled to a transmitter 406 for communicating a transmission data packet to the receivers 112 through an inbound channel. In accordance with the present invention the processor 410 adjusts the power of the transmitter 406 in response to a power level indicator received from the base station 102 over an outbound channel, using well-known transmitter power adjustment techniques. The transmitter 406 is coupled to an antenna 402 for emitting a radio signal comprising the transmission data packet. It will be appreciated that, alternatively, the two antennas 402, 404 can be replaced with a single antenna used for both transmitting and receiving. In this case, a switch or other means can be used to isolate the receiver 408 and the transmitter 406.

The processor 410 is further coupled to a conventional memory 412 for storing software and variables for programming the processor 410 in accordance with the present invention. The memory 412 comprises a message processing element 422 for processing received messages using well-known techniques. The memory 412 further comprises a selective call address 424 for identifying the subscriber unit 104. In addition, the memory 412 includes a setter 426 for controlling the processor 410 to set the inbound transmitter power level of the subscriber unit 104 in accordance with the power level indicator. In one embodiment according to the present invention the setter 426 comprises a BIW responder for setting the inbound transmitter power level of the subscriber unit 104 in accordance with a received block information word. In another

embodiment according to the present invention the setter 426 comprises a selective responder 430 for setting the inbound transmitter power level of the subscriber unit 104 in accordance with a received selective call command, such as the Change Registration Command discussed herein above. In a third embodiment according to the present invention the setter 426 comprises a color code responder 432 for setting the inbound transmitter power level of the subscriber unit 104 in accordance with a received color code utilized as the power level indicator. In a fourth embodiment according to the present invention the setter 426 comprises a fixed power element 434 for setting a fixed inbound transmitter power level. In a fifth embodiment according to the present invention the setter 426 comprises an increaser 436 for automatically increasing the inbound transmitter power level in response to the subscriber unit 104 receiving no acknowledgment to a previously transmitted inbound message. In a sixth embodiment the increaser 436 is coupled to the user interface 414 such that the user can control the increaser 436 to increase the inbound transmitter power, for example, during an emergency. It will be appreciated that selected ones of the setter elements forming the six embodiments can be simultaneously active and can operate with predetermined priorities, when appropriate, in a single subscriber unit 104.

Referring to FIG. 5, a flow diagram 500 depicts operation of the two-way radio messaging system 100 in accordance with the present invention. The flow diagram 500 begins with partitioning 502 the region 105 into sub-regions 106, 108 dependent upon the particular embodiment. For example, in a system using transmitter color codes as power level indicators the sub-regions 106, 108 correspond to individual transmitter coverage areas. Next, the inbound transmitter power levels are defined 504 for each of the sub-regions 106, 108 based upon the mean inbound channel loss determined for the sub-region 106, 108. If desired, more than one inbound transmitter power level can be defined for each of the sub-regions 106, 108, each power level corresponding to a different time of day or day of week. Optionally, the controller 114 can define 505 the inbound transmitter power levels based on average traffic level for one or more sub-regions 106, 108. Also optionally, selected subscriber units 104 can be configured 506 to have a fixed inbound power level. As an additional option, other selected subscriber units 104 can be configured 508 to

automatically increase their inbound transmitter power level in response to receiving no acknowledgment to a previously transmitted inbound message. Next, the controller 114 and the base stations 102 cooperate to remotely and dynamically set 510 the inbound transmitter power level of ones of the subscriber units 104. The technique utilized for setting the power depends upon the embodiment selected. The three embodiments comprise (1) broadcasting the power level indicator throughout a sub-region in, for example, the BIW; (2) sending the power level indicator in a selective call command, e.g., the Change Registration Command; and (3) utilizing the transmitter color codes to indicate the inbound transmitter power level.

Thus, it should be clear from the foregoing disclosure that the present invention provides a method and apparatus for controlling inbound transmitter power levels of subscriber units in a two-way messaging system, such that high power is used where required, while lower power is used where high power is not desirable. The method and apparatus advantageously is administratively simple and operates without a requirement for ongoing measurement of received signal levels.

While the foregoing has disclosed by way of example an embodiment in accordance with the present invention, it will be appreciated that many alternative embodiments in accordance with the present invention may occur to one of ordinary skill in the art, given the teachings of this disclosure. Consequently, the scope of the invention is delimited only according to the following claims.

What is claimed is:

CLAIMS

1. A method for setting an inbound transmitter power level of a subscriber unit in a two-way radio messaging system providing radio coverage within a region, the method operating without measuring a received signal, the method comprising the steps of:

partitioning the region into a plurality of sub-regions having a corresponding plurality of predetermined inbound channel loss figures;

defining a plurality of inbound transmitter power levels corresponding to the plurality of sub-regions, the plurality of inbound transmitter power levels based upon the plurality of predetermined inbound channel loss figures; and

setting the inbound transmitter power level for the subscriber unit in accordance with one of the plurality of inbound transmitter power levels corresponding to one of the plurality of sub-regions within which the subscriber unit is positioned, the setting step comprising the step of transmitting a power level indicator over an outbound channel.

2. The method of claim 1, wherein the setting step comprises the step of

broadcasting the power level indicator throughout a sub-region for setting the inbound transmitter power level of the subscriber unit when the subscriber unit is positioned within the sub-region.

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3. The method of claim 1,

wherein the subscriber unit is known to be positioned within an identifiable sub-region, and

wherein the setting step comprises the step of sending the power level indicator in a selective call command to the subscriber unit to set the inbound transmitter power level thereof in accordance with the identifiable sub-region.

4. The method of claim 1,

wherein the plurality of sub-regions receive radio coverage from a plurality of transmitters transmitting a plurality of color codes, and

wherein the setting step comprises the step of utilizing a received one of the plurality of color codes as the power level indicator.

5 5. The method of claim 1,
 wherein the defining step comprises the step of defining a time-variant inbound transmitter power level.

 6. The method of claim 1, further comprising the step of configuring the subscriber unit to have a fixed inbound transmitter
10 power level.

 7. The method of claim 1, further comprising the step of configuring the subscriber unit to automatically increase its inbound transmitter power level in response to receiving no acknowledgment to a
15 previously transmitted inbound message.

 8. The method of claim 1,
 wherein the defining step comprises the step of defining a traffic-variant inbound transmitter power level.

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 9. A controller for setting an inbound transmitter power level of a subscriber unit in a two-way radio messaging system providing radio coverage within a region, the controller operating without measuring a received signal, the region partitioned into a plurality of sub-regions
25 having a corresponding plurality of predetermined inbound channel loss figures, the controller comprising:

 an input interface for receiving a message;
 a processor coupled to the input interface for processing the message;
30 an output interface coupled to the processor for outputting the message; and

 a memory coupled to the processor for storing software elements for programming the processor, the software elements comprising:

35 a definer for defining a plurality of inbound transmitter power levels corresponding to the plurality of sub-regions,

the plurality of inbound transmitter power levels based upon the plurality of predetermined inbound channel loss figures; and

a setter coupled to the definer for controlling the processor to set the inbound transmitter power level for the subscriber unit in accordance with one of the plurality of inbound transmitter power levels corresponding to one of the plurality of sub-regions within which the subscriber unit is positioned, the setter controlling a transmitter to transmit a power level indicator over an outbound channel.

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10. The controller of claim 9, wherein the setter comprises

a broadcaster for controlling the processor to broadcast the power level indicator throughout a sub-region for setting the inbound transmitter power level of the subscriber unit when the subscriber unit is positioned within the sub-region.

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11. The controller of claim 9,

wherein the subscriber unit is known to be positioned within an identifiable sub-region, and

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wherein the setter comprises a selective sender for controlling the processor to send the power level indicator in a selective call command to the subscriber unit to set the inbound transmitter power level thereof in accordance with the identifiable sub-region.

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12. The controller of claim 9,

wherein the plurality of sub-regions receive radio coverage from a plurality of transmitters transmitting a plurality of color codes, and

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wherein the setter comprises a color code coordinator for controlling the processor to utilize the plurality of color codes as the power level indicator.

13. The controller of claim 9,

wherein the definer comprises a time-variant element for controlling the processor to define a time-variant inbound transmitter power level.

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14. The controller of claim 9,
wherein the definer comprises a traffic-variant element for controlling the processor to define a traffic-variant inbound transmitter power level.

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15. A subscriber unit for setting an inbound transmitter power level in a two-way radio messaging system providing radio coverage within a region partitioned into a plurality of sub-regions having a corresponding plurality of predetermined inbound channel loss figures, a plurality of inbound transmitter power levels defined corresponding to
10 the plurality of sub-regions, the plurality of inbound transmitter power levels based upon the plurality of predetermined inbound channel loss figures, the subscriber unit setting the inbound transmitter power level without measuring a received signal, the subscriber unit comprising:

15 a receiver for receiving over an outbound channel a radio signal including information comprising a power level indicator corresponding to one of the plurality of sub-regions in which the subscriber unit is positioned;

20 a processor coupled to the receiver for processing the information;

a user interface for conveying portions of the information to a user and for providing control of the subscriber unit by the user;

a transmitter coupled to the processor for transmitting an inbound signal at the inbound transmitter power level; and

25 a memory coupled to the processor for storing software elements for programming the processor, the software elements comprising:

30 a setter for controlling the processor to set the inbound transmitter power level of the subscriber unit in accordance with the power level indicator.

16. The subscriber unit of claim 15,

wherein the setter comprises a block information word (BIW) responder for setting the inbound transmitter power level of the
35 subscriber unit in accordance with a received BIW.

17. The subscriber unit of claim 15,
wherein the setter comprises a selective responder for setting
the inbound transmitter power level of the subscriber unit in accordance
with a received selective call command.

5

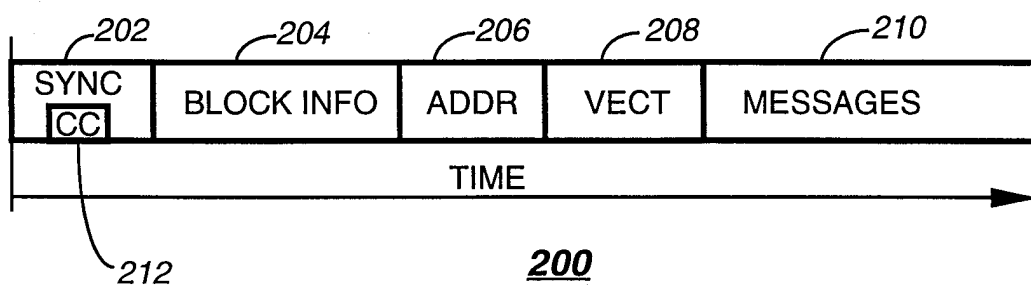
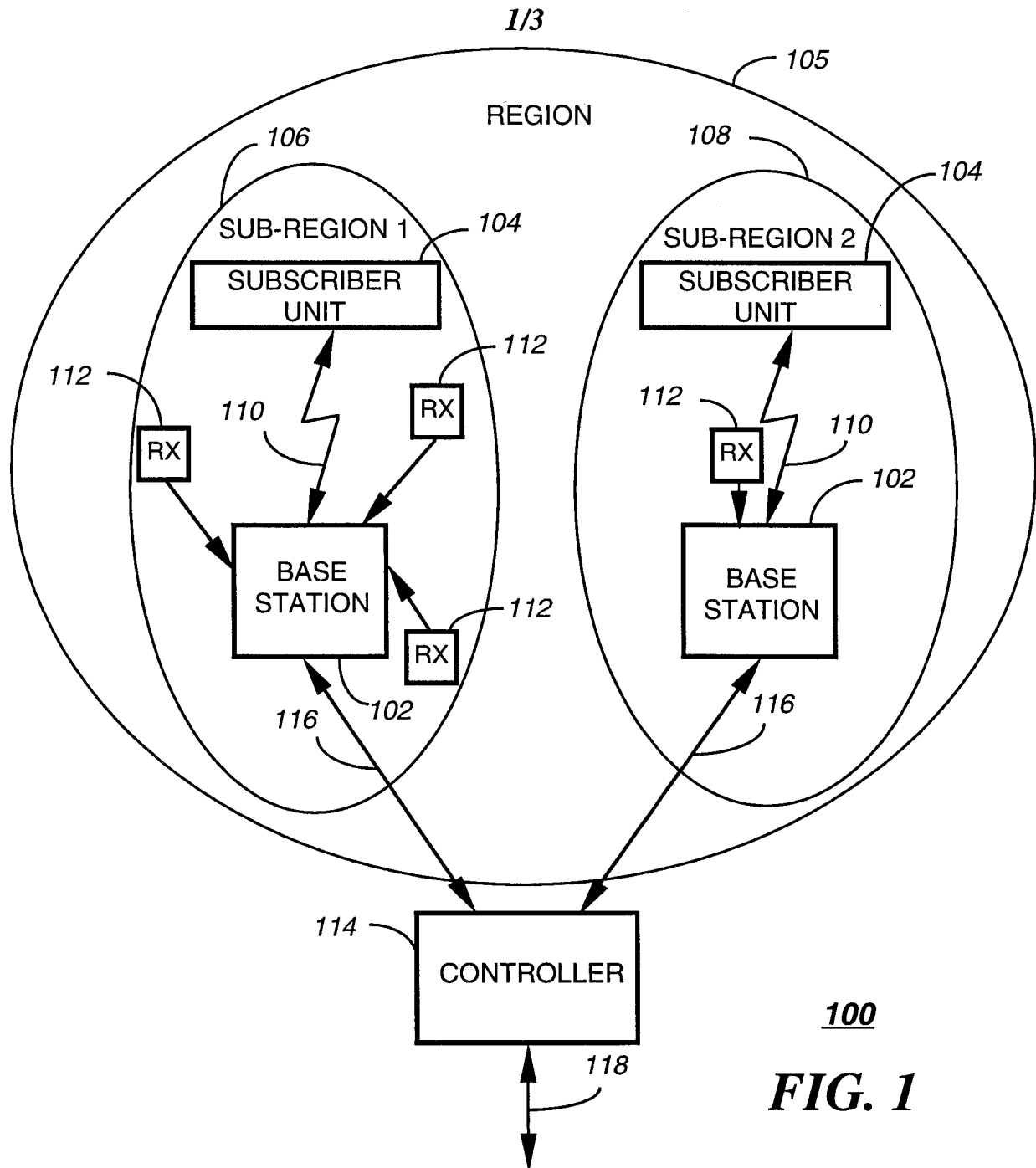
18. The subscriber unit of claim 15,
wherein the setter comprises a color code responder for
setting the inbound transmitter power level of the subscriber unit in
accordance with a received color code utilized as the power level
indicator.

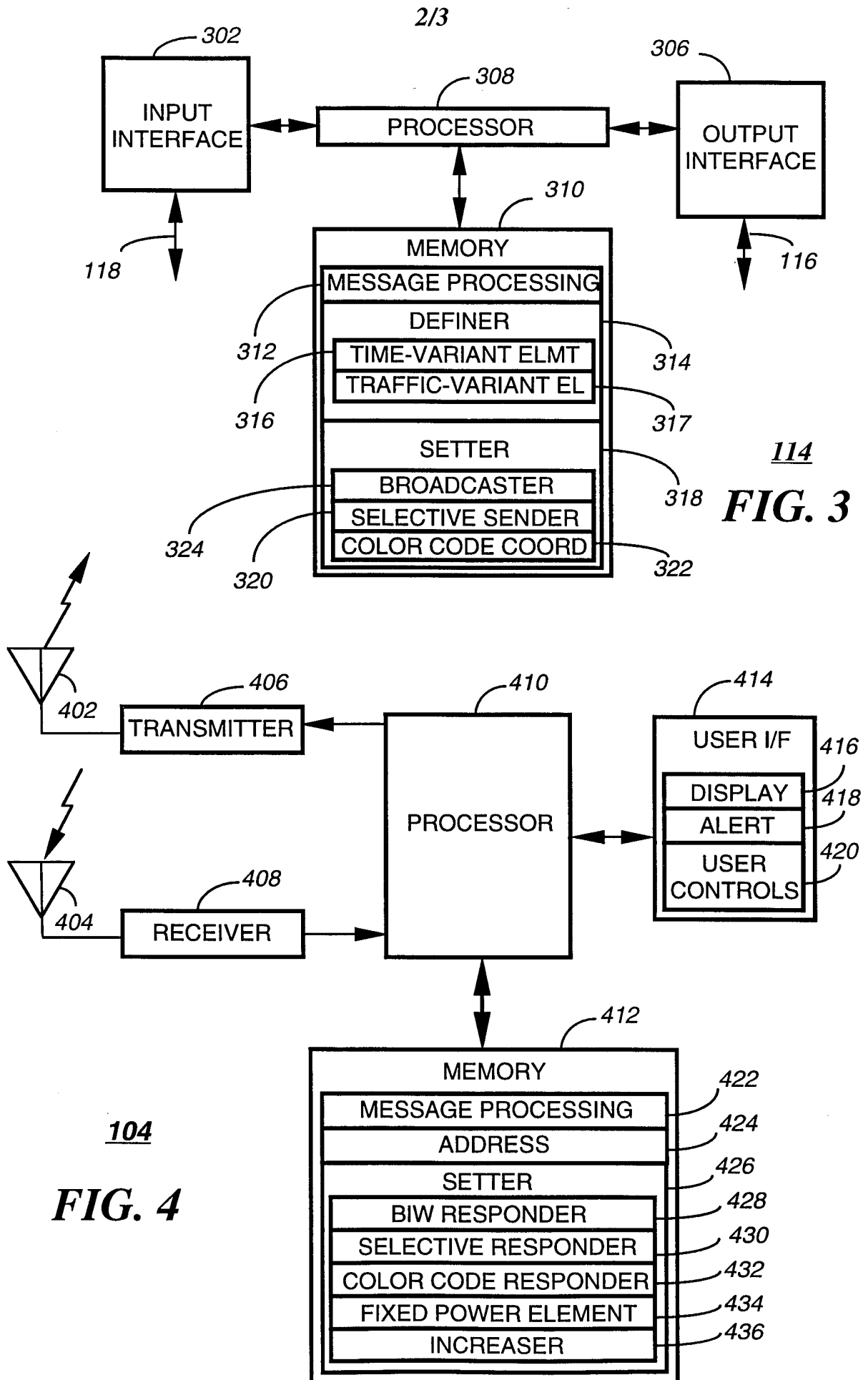
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19. The subscriber unit of claim 15, wherein the setter comprises a
fixed power element for setting a fixed inbound transmitter power level.

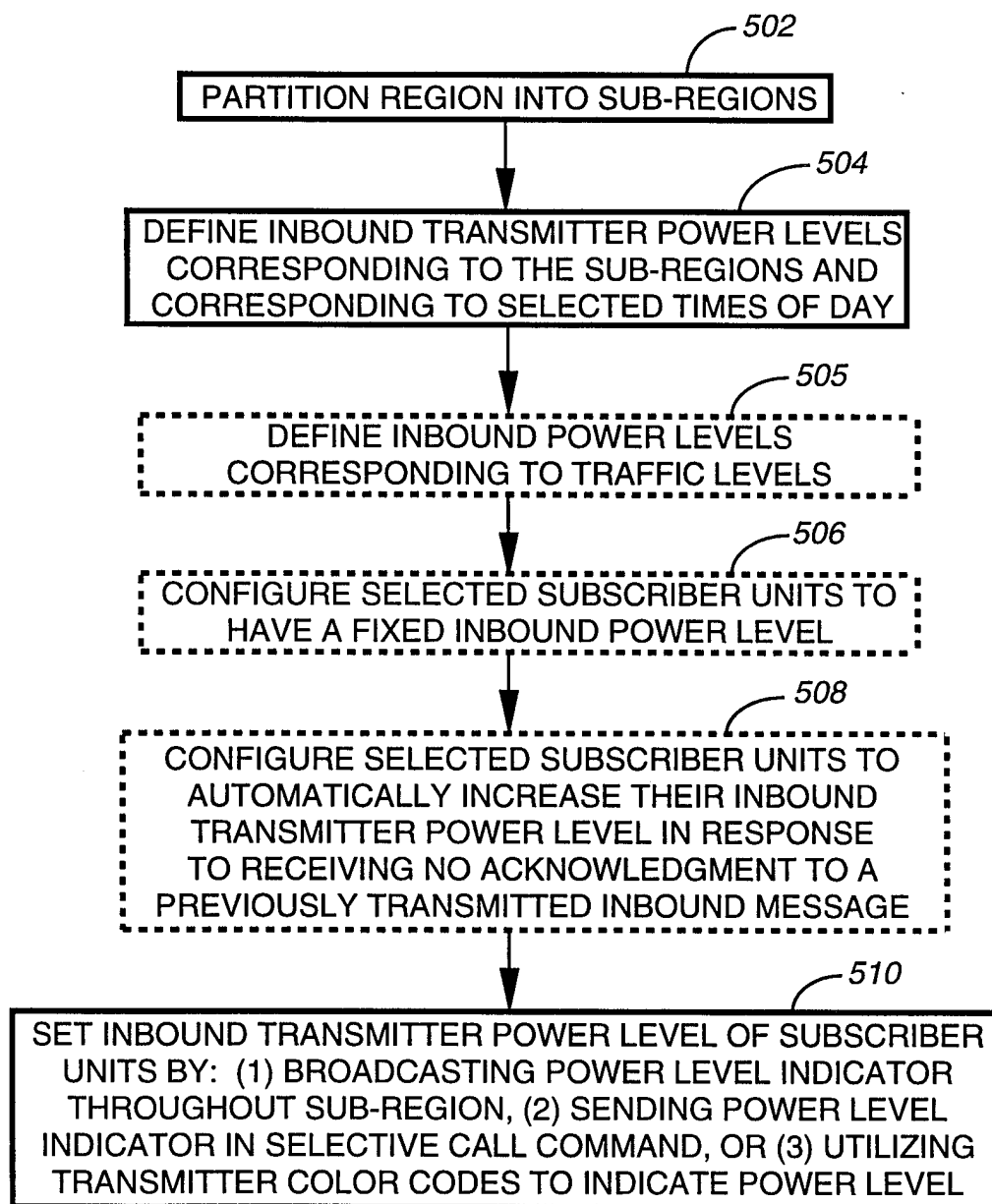
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20. The subscriber unit of claim 15, wherein the setter comprises an
increaser for automatically increasing the inbound transmitter power
level in response to the subscriber unit receiving no acknowledgment to
a previously transmitted inbound message.





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500**FIG. 5**

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US98/03315**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(6) : H04Q 7/00

US CL : 455/422

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)

U.S. : 455/422, 126, 127, 517

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 practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5,475,709 A (FUTAGAMI ET AL.) 12 DECEMBER 1995, SEE ABSTRACT	1-20
A	US 5,265,119 A (GILHOUSEN ET AL.) 23 NOVEMBER 1993, SEE ABSTRACT	1-20
A	US 5,369,786 A (HULSEBOSCH) 29 NOVEMBER 1994, SEE ABSTRACT	1-20
A	US 5,465,399 A (OBERHOLZER ET AL.) 07 NOVEMBER 1995, SEE ABSTRACT	1-20
A	US 5,267,262 (WHEATLEY, III) 30 NOVEMBER 1993, SEE ABSTRACT	1-20
A	US 5,469,471 A (WHEATLEY, III) 21 NOVEMBER 1995, SEE ABSTRACT	1-20

☐ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"A" document defining the general state of the art which is not considered to be of particular relevance	"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search 30 MARCH 1998	Date of mailing of the international search report 25 AUG 1998
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