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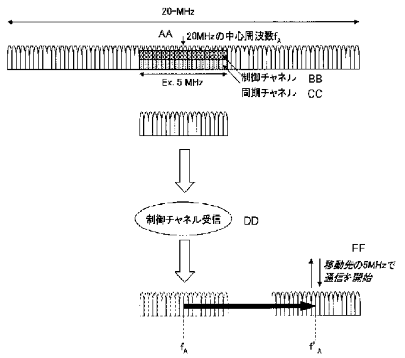

AA CENTER FREQUENCY f_A OF 20 MHz
BB CONTROL CHANNEL
CC SYNCHRONIZATION CHANNEL
DD RECEIVE CONTROL CHANNEL
EE START COMMUNICATION BY USING OF 5 MHz AFTER SHIFTING

(57) **Abstract:** A base station uses one of two or more frequency bands to perform communication of OFDM scheme with a mobile station. The base station has a means that transmits a synchronization channel and a control channel by use of a band which includes the center frequency (f_A), on the raster, of a first band (20 MHz) and the bandwidth of which is wider than the bandwidth of a second band (5 MHz at an end). The control channel includes center frequency information that determines the center frequency ($f_{A'}$) of the second band. After acquiring the center frequency information in the band including the center frequency on the raster, the mobile station shifts to a desired band. Thus, the mobile station can be connected to the desired band without searching for any frequencies that are not existent on the raster.

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(57) 要約:　基地局は、２以上の周波数帯域の何れかを用いて移動局とＯＦＤＭ方式の通信を行う。基地局は、第１の帯域（２０ＭＨｚ）のラスタ上の中心周波数 f_A を含み、第２の帯域（端の５ＭＨｚ）の帯域幅以上の帯域で同期チャネル及び制御チャネルを送信する手段を有する。制御チャネルは、前記第２の帯域の中心周波数 f_A' を特定する中心周波数情報を含む。移動局は、ラスタ上の中心周波数を含む帯域で中心周波数情報を得た後に、所望の帯域に移るので、ラスタ上にない周波数をサーチせずに所望の帯域に接続することができる。

SPECIFICATION

TITLE OF THE INVENTION

BASE STATION, MOBILE STATION AND METHOD

TECHNICAL FIELD

The present invention generally relates to a technical field of radio communication, and more particularly, relates to a base station, a mobile station and a method that can be used for a plurality of bands.

BACKGROUND ART

In existing communication systems related to a Wideband Code Division Multiple Access (W-CDMA) scheme and a GSM scheme and the like, a center frequency of a band used for communication is defined to agree with a predetermined frequency called a raster or a frequency raster. The frequency raster is arranged on a frequency axis at every 200 kHz, for example. Therefore, a mobile station searches frequency rasters on the frequency axis in series (searches for each 200kHz) so as to specify the center frequency of the operator so that the mobile station can connect to a downlink. Following non-patent documents 1 and 2 describe downlink cell search.

[non-patent document 1]3GPP, TS25.101, "User Equipment (UE) radio transmission and reception (FDD)", pp.12-14

[non-patent document 2]Keiji Tachikawa, "W-CDMA mobile communication scheme", MARUZEN, pp.35-45

SUMMARY

By the way, a wireless communication system supporting an orthogonal frequency division multiplexing (OFDM) scheme that uses a plurality of wide and narrow bands is being studied. The reason for adopting the OFDM scheme is that it has a merit that it can effectively suppress multipath propagation interference and intersymbol interference and the like. In this radio communication system, consideration is given such that various operators can provide services, in which a wide band such as 20 MHz and a part (5 MHz, for example) of the band can be chosen according to apparatus configuration of the mobile station, apparatus configuration of the base station, application and the like.

Fig.1 schematically shows spectrum on the radio communication system of the OFDM scheme having a plurality of bandwidths. In a cell A, communication of the OFDM scheme is performed in each of a wide bandwidth of 20 MHz and a narrow bandwidth of 5 MHz. The narrow bandwidth of 5 MHz is located at a right end of the wide bandwidth of 20 MHz on the frequency axis. Also in a cell B different from the cell A, communication of the OFDM scheme is performed using the bandwidth of 5 MHz. The band at the cell B is positioned apart from the band of 20 MHz of the cell A on the frequency axis. As mentioned above, frequency rasters are set at predetermined intervals on the frequency axis. In the example shown in the figure, the frequency rasters are set at every Δ_{raster} Hz starting from the point of X Mz on the left side. A center frequency f_A of the band of 20 MHz of the cell A is positioned on a frequency raster $X+2\Delta_{raster}$. A center frequency f_B of the band of 5 MHz of the cell B is positioned on a frequency raster $X+5\Delta_{raster}$.

On the other hand, a sub-carrier spacing is determined independently of the frequency raster, a spacing between frequency rasters is not necessarily an integral multiple of the sub-carrier spacing. Therefore, even when the center frequency f_A of the wide frequency band of 20 MHz is positioned on a raster, it can be predicted that a center frequency f_A' of a part of the band of 5 MHz is not always positioned on a raster. Therefore, it is feared that there is a problem in that a procedure for a mobile station that wants to use the frequency band of 5 MHz in the cell A to connect to a downlink and a process required for searching for a center frequency are complicated.

The aspects of the present invention provide a base station, a mobile station and a method that can make it easy to connect to a downlink signal in a mobile communication system in which communication of the OFDM scheme is performed using any one of more than one frequency band.

In an aspect of the present invention, a base station that performs communication of an OFDM scheme with a mobile station by using any one of equal to or greater than two frequency bands is used. The base station includes means that transmits a synchronization channel and a control channel using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band. The control channel includes center frequency information for specifying a center frequency of the second band.

According to aspects of the present invention, in a mobile communication system in which communication of an OFDM scheme is performed by using any one of equal to or greater than two frequency band, it becomes easy to connect to a downlink signal.

According to a further aspect of the present invention, there is provided a base station performing communication of an orthogonal frequency division multiplexing (OFDM) scheme with a mobile station by using any one of equal to or greater than two frequency

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bandwidths, comprising a unit that transmits a synchronization channel and a broadcast channel using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band, wherein the broadcast channel includes center frequency information for specifying a center frequency of the second band.

According to another aspect of the present invention, there is provided a method used in a base station performing communication of an orthogonal frequency division multiplexing (OFDM) scheme with a mobile station by using any one of equal to or greater than two frequency bandwidths, comprising transmitting a synchronization channel using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band and transmitting a broadcast channel that includes center frequency information for specifying the center frequency of the second band using the band that includes the center frequency on the raster of the first band and that has a bandwidth equal to or greater than that of the second band.

According to another aspect of the present invention, there is provided a mobile station comprising a unit that receives a downlink signal transmitted using any one of equal to or greater than two frequency bandwidths; a unit that detects a synchronization channel and detects a broadcast channel transmitted from a base station using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band; a unit that extracts center frequency information from the broadcast channel and a unit that changes a frequency band for receiving a signal according to the center frequency information, wherein the center frequency information specifies a center frequency of the second band which the base station instructs the mobile station to use for communication.

According to another aspect of the present invention, there is provided a method used by a mobile station, comprising receiving a downlink signal transmitted using any one of equal to or greater than two frequency bandwidths; detecting a synchronization channel and detecting a broadcast channel transmitted from a base station using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band; extracting center frequency information from the broadcast channel and changing a frequency band for receiving a signal according to the center frequency information, wherein the center frequency information specifies a center frequency of the second band which the base station instructs the mobile station to use for communication.

According to another aspect of the present invention, there is provided a base station used in a communication system of an orthogonal frequency division multiplexing (OFDM) scheme, comprising a determination unit configured to determine a transmission frequency band for transmitting a predetermined channel; a selection unit configured to select a transmission bandwidth of the transmission frequency band determined by the determination unit from among a plurality of candidates of transmission bandwidths; a generation unit configured to generate a synchronization channel and a broadcast channel; a setting unit for set information on a transmission bandwidth selected by the selection unit to the broadcast channel; a mapping unit configured to map the synchronization channel and the broadcast channel generated by the generation unit to a frequency band that is a center part of the transmission frequency band and a unit configured to transmit a downlink signal including the synchronization channel and the broadcast channel.

According to another aspect of the present invention, there is provided a user apparatus used in a communication system of an orthogonal frequency division multiplexing (OFDM) scheme, comprising a reception unit configured to tune to a frequency on a predetermined raster and receive a synchronization channel and a broadcast channel that are mapped to a frequency band of a center part of a transmission frequency band of a base station; a determination unit configured to determine, based on the broadcast channel, a transmission frequency bandwidth of the transmission frequency band of the base station from among a plurality of candidates of transmission bandwidths and a communication unit configured to communicate a data channel using a bandwidth of the transmission frequency band determined by the determination unit.

[THE NEXT PAGE IS PAGE 4]

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BRIEF DESCRIPTION OF THE DRAWINGS

Fig.1 schematically shows spectrum on a radio communication system of an OFDM scheme having a plurality of bandwidths;

Fig.2 shows a block diagram of a transmitter according to an embodiment of the present invention;

Fig.3 shows a block diagram of a receiver according to an embodiment of the present invention;

Fig.4 is a diagram showing a mapping example of a synchronization channel;

Fig.5 is a diagram showing principle for detecting a center of the band;

Fig.6 is a diagram showing a configuration example of a control channel;

Fig.7A is a diagram showing a flowchart of operation according to an embodiment of the present invention;

Fig.7B is a diagram showing operation on a frequency axis according to an embodiment of the present invention ;

Fig.8 is a block diagram of a transmitter according to an embodiment of the present invention;

Fig.9 is a block diagram of a receiver according to an embodiment of the present invention;

Fig.10 shows principle for detecting the center of the band;

Fig.11 is a diagram showing another mapping example of the synchronization channel;

Fig.12 is a diagram showing still another mapping example of the synchronization channel;

Fig.13 is a diagram showing still another mapping example of the synchronization channel;

Fig.14 is a diagram showing still another mapping example of the synchronization channel;

Fig.15 is a diagram showing another configuration example of the control channel;

Fig.16 is a diagram showing an example of scrambling code by which a control channel is multiplied;

Fig.17 is a diagram showing an example of scrambling code by which a control channel is multiplied;

Fig.18 is a diagram showing a configuration example of the control channel;

Fig.19 is a diagram showing another configuration example of the control channel;

Fig.20 is a diagram showing still another configuration example of the control channel.

Description of reference signs

MUX multiplexing unit
FFT fast Fourier transform unit
IFFT inverse fast Fourier transform unit
GI guard interval inserting unit or removing unit
RF radio unit

PREFERRED EMBODIMENTS FOR CARRYING OUT THE INVENTION

According to an embodiment of the present invention, a synchronization channel is transmitted from the base station to the mobile station using a band that includes a center frequency f_A on a raster of a first band (20MHz) and that has a bandwidth equal to or greater than that of a second band (5MHz of the end). Using a band near the center, a control channel that includes center frequency information for specifying a center frequency f_A' of the second band is transmitted from the base station to the mobile station. Since the mobile station moves to a desired band after obtaining center frequency information using a band including the center frequency on a raster, the mobile station can connect to the desired band without searching frequencies that are not on the raster.

The synchronization channel and the control channel may be transmitted using a band that includes the center frequency on the raster of the first band and that has a bandwidth same as that of the second band. Accordingly, the mobile station can fairly connect to a downlink irrespective of bandwidths to be used. The synchronization channel and/or the control channel may be transmitted using the whole of the first band. Accordingly, information that is different according to the bandwidth used for communication can be included in the control channel.

The synchronization channel may be mapped in the frequency direction at intervals each wider than a sub-carrier spacing. Since other information can be assigned to sub-carriers where the synchronization channel is not mapped, information transmission efficiency can be improved.

The control channel may be coded using two-dimensional scrambling code that is mapped to the band that includes the center frequency on the raster of the first band and that has a bandwidth equal to or greater than that of the second band in two-dimensional scrambling code that is mapped over the first band and equal to or greater than one transmission time interval. Accordingly, the mobile station can demodulate the control channel without switching scrambling code after synchronization is established.

Basic control information that is transmitted using the band that includes the center frequency on the raster of the first band and that has a bandwidth same as that of the second band may include control information common to any mobile station using any band, and control information that is transmitted using a third band other than the second band may include control information specific to a mobile station that uses the third band.

A mobile station according to an embodiment of the present invention includes: means that receives a downlink signal transmitted using any one of equal to or greater than two frequency bands; means that detects a synchronization channel and a control channel transmitted from a base station using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band; means that extracts center frequency information from the control channel; and means that changes a frequency band for receiving a signal according to the center frequency information.

[Embodiment 1]

Fig.2 schematically shows a transmitter according to an embodiment of the present invention. The transmitter is typically provided in a base station. The transmitter includes a multiplexing unit (MUX) for multiplexing transmission data and a synchronization pattern, an IFFT unit for performing inverse fast Fourier transform on the multiplexed data, a guard interval adding unit (GI) for adding a guard interval to a signal, on which the inverse Fourier transform has been performed, modulated by the OFDM scheme, and for outputting symbols to be transmitted, and a radio unit (RF) for converting a signal format of the symbols to be transmitted to a signal format for transmission using a radio frequency.

Fig.3 shows a block diagram of a receiver according to an embodiment of the present invention. The receiver is typically provided in a mobile station. The receiver includes a radio unit (RF) for converting a signal received by an antenna to a symbol of a digital format, a guard interval removing unit (GI) for removing the guard interval from the symbol to output an effective symbol, a FFT unit for performing fast Fourier conversion on the data of the effective symbol to perform modulation of the OFDM scheme, and a correlation detection unit for calculating correlation between the data modulated in the OFDM scheme and a predetermined synchronization pattern to detect a correlation peak.

Fig.4 shows mapping examples of a synchronization channel that is multiplexed in the multiplexing unit shown in Fig.2. The base station and the mobile station can perform communication in any of various wide and narrow frequency bands, and the example shown in the figure shows mapping examples of the synchronization channel when 20 MHz, 10 M Hz or 5 MHz is used for the communication. When the base station uses a bandwidth of 20 MHz, the transmitter of the base station maps the data of the synchronization channel onto entire sub-carriers. For simplicity, although 40 sub-carriers are shown for 20 MHz, more sub-carriers exist actually. In the figure, each number of 1 - 40 shows a phase of code. When the synchronization channel indicates a synchronization pattern using data sequence of d_1, d_2, ..., d_{40}, the data sequence is arranged in a frequency axis direction and is mapped to each sub-carrier. In the figure, the number "1", "2", ... correspond to d_1, d_2, ... respectively.

When the base station uses the band of 20 MHz and also the mobile station uses the same band of 20 MHz, the mobile station can easily find a center frequency of the band of 20 MHz by cell search so that the mobile station can connect to a downlink to perform communication after that. When the mobile station uses a band of 5 MHz whose center frequency is different from that of the band of 20 MHz, following operation is performed. The mobile station supplies a synchronization pattern of

$d_{16}, d_{17}, \ldots, d_{25}$ to the correlation detection unit shown in Fig.3. By doing so, as shown in Fig.5, the mobile station can detect the center frequency f_A of the band of 20 MHz. The correlation detection unit performs correlation calculation by shifting the phase between the received signal and a replica of the synchronization channel $d_{16}, d_{17}, \ldots, d_{25}$, so that a frequency by which the correlation value reaches its peak is detected. In the correlation calculation, even when they are displaced only by one sub-carrier, the correlation value becomes small. Accordingly, the center of the band can be detected accurately. As the synchronization pattern, PN code sequence, Gold code sequence and other various sequences can be used. This is because it is only necessary that a peak can be obtained and the position can be identified by performing correlation calculation.

In the present example, in a cell where a mobile station using a band of 5 MHz resides, bandwidths of 20 MHz, 10 MHz and 5 MHz are prepared so that the mobile station can use any of them. In addition to that the base station can perform transmission by mapping the synchronization channel onto entire sub-carriers as shown in Fig.4(1), the base station transmits control information for all users (common control channel) using a band of 5 MHz centered on the center frequency f_A as shown in Fig.6. As described being related to Fig.5, a mobile station using the band of 5 MHz can also detect the center frequency f_A, and the mobile station can properly demodulate the control channel transmitted using the band of 5 MHz centered on the frequency f_A. The common control channel includes center frequency information that can specify a position of a center frequency f_A' (that is not normally positioned on a raster) of the band of 5 MHz that uses a part of the band of 20 MHz. The center frequency information may include information indicating how far the frequency f_A' is apart from the frequency f_A on the raster, for example. The mobile station demodulates the common control channel, reads the center frequency information, adjusts a frequency synthesizer in the radio unit (such as the RF unit shown in Fig.3), so as to adjust the center of the band of 5 MHz received by the mobile station to the frequency f_A'. After that, the mobile station can communicate a data channel and the like using 5 MHz that is on the right end of the band of 20 MHz.

Fig.7A shows a flowchart of operation according to an embodiment of the present invention. Fig.7B schematically shows a situation in which the mobile station connects to a downlink according to the flow. An operation example is described by referring to both of the figures. A control channel and a synchronization channel are transmitted from the base station using the band (central band) of 5 MHz including the center frequency of the band of 20 MHz. The control channel and the synchronization channel are configured to have a pattern common to any mobile station regardless of bandwidths to be used for communication by the mobile station (regardless of bandwidths such as 5MHz, 10MHz, 20MHz and the like). In step 1, the synchronization channel and the control channel are transmitted from the base station, and the mobile station receives the synchronization channel by performing cell search to establish synchronization. In step 2, the mobile station receives the control channel and demodulates it so as to read frequency information. The frequency information includes information on frequency band assigned to the mobile station (such as shift amount between central band and band (use permitted band) permitted to use). The frequency information may include base station information indicating that the bandwidth of the cell is 20 MHz (this is not essential). In step 3, the mobile station adjusts a frequency for receiving signals to a band permitted to use reported by the control channel so as to change the band for communication. After that, the mobile station starts data communication using the use permitted band (having a bandwidth of 5 MHz, for example). As mentioned above, the center frequency f_A of the central band is positioned on the raster, but the center frequency f_A' of the use permitted band is not necessarily positioned on the raster. Therefore, it is not easy that the mobile station detects the center frequency of the use permitted band without the above-mentioned frequency information. Any mobile station can easily detect the center frequency on the raster of the central band and can demodulate the control channel. Thus, the mobile station can easily shift the center frequency of communication to a desired frequency that is not on the raster.

As shown in Fig.7, the mobile station that uses 5 MHz detects the center frequency f_A of the band of 20 MHz first, and receives the common control channel that is transmitted using the central band of 5 MHz. It is necessary that the base station prepares such a control channel as transmission data and adds it to the synchronization channel to transmit them to the mobile station under the base station. The mobile station moves to the band of 5 MHz on the right end that is permitted to use according to instruction information of the control channel. After that, communication is performed using the moved band.

By the way, in the examples of Figs.2 and 3, although the synchronization channel is multiplexed and demultiplexed in the frequency domain, multiplexing and demultiplexing may be performed in a time domain as shown in Figs.8 and 9. This is because it is only necessary that the mobile station can detect the center of the band of 20 MHz and can demodulate the control channel.

[Embodiment 2]

Fig.10 also shows a mapping example of the synchronization channel. But, in the example of Fig.10, although the base station can perform communication only in a band of 5 MHz, the mobile station has a capability that can use a band of 20 MHz. In this case, the mobile station cannot perform communication using the entire band of 20 MHz. As shown in Fig.4 (3), the base station transmits, to the mobile station under the base station, a data sequence having 10 pieces of data such as d_{16}, d_{17}, ..., d_{25} that are a part of the data sequence of 40 pieces of data as a pattern of the synchronization channel. The mobile station prepares the data sequence of 40 pieces of data such as d_1, d_2, ..., d_{40} shown in Fig.4 (1), calculates correlation between the sequence and the received signal to detect a peak position. As shown in Fig.10, the mobile station detects the center frequency f_A of the band of 5 MHz to establish synchronization, and receives the control channel transmitted using the band, and ascertains that the base station can perform communication only by 5 MHz.

Which band the base station uses for communication may be announced by the downlink control channel, or it may be determined in the mobile station as described in the following example. As an example, the mobile station derives three kinds of correlation values as shown in Fig.10. A first correlation value is a correlation value on a data sequence of d_{16} ~ d_{25} near the center. A second correlation value is a correlation value on a data sequence of $d_{11} \sim d_{30}$ in which both sides are added to the data sequence of $d_{16} \sim d_{25}$ near the center, and a third correlation value is a correlation value on the data sequence of $d_1 \sim d_{40}$ over the entire region. For example, when the base station transmits the synchronization channel only in the band of the 5 MHz like the above-mentioned example, each of the first, second and third correlation values indicates a same size of peak. However, when the base station transmits the synchronization channel using the band of 10 MHz as shown in Fig.4(2), the first correlation value is smaller than the second correlation value, and the size of the second correlation value is almost the same as the size of the third correlation value. The reason is that, the longer the data sequence is, the larger the peak of the correlation value is. In addition, when the base station transmits the synchronization channel using the entire band of 20 MHz, the first, the second and the third correlation values are obtained in order of increasing size. Therefore, by calculating the first to third correlation values and comparing them, the band of the base station can be specified.

[Embodiment 3]

Fig.11 shows another mapping example of the synchronization channel. As long as synchronization is maintained in the mobile station, the synchronization channel is not necessarily inserted into the entire region of the band that is used. In the example of the figure, the synchronization channel is intermittently inserted at every two sub-carriers in the frequency axis direction. In addition, the synchronization channel may be inserted not only in the frequency axis direction but also in the time axis direction as shown in Fig.12. Anyway, since another signal can be mapped onto sub-carriers to which the synchronization channel is not inserted, mapping amount of synchronization channel can be limited to a minimum amount so that information transmission rate can be improved.

As mentioned above, the mapping pattern of the synchronization channel may be different according to the bandwidth supported in the cell, or the synchronization channel may be transmitted using a same bandwidth near the center regardless of the band by which the mobile station performs communication as shown in Fig.13. In this case, as described in Fig.10, it may become difficult that the mobile station determines the band of the base station. However, from the viewpoint of equalizing cell detection accuracy irrespective of bandwidth that is used, it is desirable that the band to which the synchronization channel is inserted is common.

Fig.14 shows an example in which, the synchronization channel is transmitted using 5 MHz when a band equal to or greater than 5 MHz is used, and mapping of the synchronization channel is different according to bandwidths when a band narrower than 5 MHz is used. If fairness of cell detection accuracy is required even when there are significantly wide and narrow bands in bands that can be used, it is feared that enough cell detection accuracy cannot be adequately obtained when using a wideband. The reason is that the synchronization channel configuration of the case of wideband becomes largely different from optimum one. In this case, by adopting the configuration shown in Fig.14, both of the cell detection accuracy and fairness can be considered.

[Embodiment 4]

Fig.15 shows a configuration of a common control channel that is different from the common control channel shown in Fig.6. In the configuration example of Fig.15, a first band of 5 MHz that is the center includes control information for all users and control information for users using the band of 5 MHz. The latter control information includes center frequency information indicating relationship etc. between the center frequency f_A and the center frequency f_A' of the band to be used. In a second band that is both sides of the first band each being 2.5 MHz, redundant information of the control information for all users and control information for users using a band of 10 MHz are transmitted. The former redundant information is represented as redundant bits derived according to various algorithms of error correction coding that are performed on the control information. The latter control information includes center frequency information and the like for users using the band of 10 MHz. In a third band that is both sides of the second band, control information and redundant information for all users and control information for users using a band of 10 MHz are transmitted. By transmitting the control information and the like by dispersing it according to bands used by the user, transmission contents of the control channel can be changed according to classes of the mobile station, for example.

[Embodiment 5]

Scrambling code specific to a base station may be applied to a control channel and a data channel that are transmitted from the base station in addition to the synchronization channel. In this case, if scrambling code is set independently for each bandwidth used for communication, processes for the mobile station to decode a control channel after synchronization is established may become complicated. In the present embodiment, scrambling code is determined using an entire or a part of two-dimensional code defined in a predetermined period and in the entire region of the band of 20 MHz.

Fig.16 is a figure showing an example of scramble code by which a control channel and the like is multiplied. In the example shown in the figure, two-dimensional code covering 40 sub-carriers in the frequency direction and 8 symbols in the time direction is defined first. Adjacent symbols are shifted in phase by one sub-carrier with each other in the frequency axis direction. When the base station transmits the control channel and the like using the entire band of 20 MHz, the control channel is multiplied by the whole scrambling code, and is transmitted. When the base station uses only the band of 5 MHz, scrambling code mapped to the band of 5 MHz including the center frequency f_A is used. When the base station uses only the band of 10 MHz, scrambling code mapped to the band of 10 MHz including the center frequency f_A is used. Therefore, the mobile station can demodulate the control channel without switching scrambling code after synchronization is established so as to be able to connect to the downlink easily.

The two-dimensional code over the entire band of 20 MHz and 8 symbols may not be a repetition pattern shown in Fig.16. Fig.17 shows a case in which the two-dimensional code is prepared by a series of data sequences which is not the repetition pattern. Also by using such two-dimensional code, effect the same as those above-mentioned can be obtained.

[Embodiment 6]

In the first embodiment and the like, a minimum bandwidth of a use band of the mobile station is 5 MHz, and the synchronization channel and the control channel are transmitted using a central band of 5 MHz. However, the synchronization channel and the control channel may be transmitted using a bandwidth other than 5 MHz. In the example shown in Fig.18, a band usable for the mobile station is 1.25 MHz, and the central band is 1.25MHz. Fig.19 is similar to Fig.15 in the fourth embodiment, but is different in that the minimum bandwidth of the center is 1.25MHz. In addition, by combining the configuration examples shown in Figs.18 and 19, the control channel may be transmitted using a band of 1.25 MHz and a central band of 5 MHz. Accordingly, fairness among mobile stations can be considered while providing effect of wideband (improvement of quality of control channel and the like) for users using a bandwidth equal to or greater than 5 MHz.

As mentioned above, preferred embodiments of the present invention are described. But, the present invention is not limited to these embodiments. Variations and modifications can be made within the scope of the present invention. Although the present invention is described by classifying it into several embodiments for the sake of convenience of explanation, the classification into each embodiment is not essential, and one or more embodiment may be used as necessary.

The present application claims priority based on Japanese patent application No.2005-174399, filed in the JPO on June 14, 2005 and the entire contents of it are incorporated herein by reference.

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CLAIMS

The claims defining the invention are as follows:

1. A base station performing communication of an orthogonal frequency division multiplexing (OFDM) scheme with a mobile station by using any one of equal to or greater than two frequency bandwidths, comprising:

a unit that transmits a synchronization channel and a broadcast channel using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band,

wherein the broadcast channel includes center frequency information for specifying a center frequency of the second band.

2. The base station as claimed in claim 1, wherein the synchronization channel and the broadcast channel are transmitted using a band that includes the center frequency on the raster of the first band and that has a bandwidth sae as that of the second band.

3. The base station as claimed in claim 1, wherein the synchronization channel is transmitted using the whole of the first band.

4. The base station as claimed in claim 1, wherein the synchronization channel is mapped in the frequency direction at intervals each wider than a sub-carrier spacing.

5. The base station as claimed in claim 1, wherein the broadcast channel is coded using two-dimensional scrambling code that is mapped to the band that includes the center frequency on the raster of the first band and that

has a bandwidth equal to or greater than that of the second band in two-dimensional scrambling code that is mapped over the first band and equal to or greater than one transmission time interval.

6. The base station as claimed in claim 1, wherein basic control information that is transmitted using the band that includes the center frequency on the raster of the first band and that has a bandwidth same as that of the second band includes control information common to any mobile station using any band, and

control information that is transmitted using a third band other than the second band includes control information specific to a mobile station that uses the third band.

7. The base station as claimed in claim 1, wherein the synchronization channel and a scrambling code within a predetermined bandwidth including the center frequency band on the raster has a pattern common to mobile stations that perform communication using different bandwidths.

8. The base station as claimed in claim 1, wherein the synchronization channel is represented as a sequence having impulse-like correlation characteristics and is mapped in the frequency direction.

9. A method used in a base station performing communication of an orthogonal frequency division multiplexing (OFDM) scheme with a mobile station by using any one of equal to or greater than two frequency bandwidths, comprising:

transmitting a synchronization channel using a band that includes a center frequency on a raster of a first band

and that has a bandwidth equal to or greater than that of a second band; and

transmitting a broadcast channel that includes center frequency information for specifying the center frequency of the second band using the band that includes the center frequency on the raster of the first band and that has a bandwidth equal to or greater than that of the second band.

10. A mobile station, comprising:

a unit that receives a downlink signal transmitted using any one of equal to or greater than two frequency bandwidths;

a unit that detects a synchronization channel and detects a broadcast channel transmitted from a base station using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band;

a unit that extracts center frequency information from the broadcast channel; and

a unit that changes a frequency band for receiving a signal according to the center frequency information,

wherein the center frequency information specifies a center frequency of the second band which the base station instructs the mobile station to use for communication.

11. A method used by a mobile station, comprising:

receiving a downlink signal transmitted using any one of equal to or greater than two frequency bandwidths;

detecting a synchronization channel and detecting a broadcast channel transmitted from a base station using a band that includes a center frequency on a raster of a first band and that has a bandwidth equal to or greater than that of a second band;

extracting center frequency information from the broadcast channel; and

changing a frequency band for receiving a signal according to the center frequency information,

wherein the center frequency information specifies a center frequency of the second band which the base station instructs the mobile station to use for communication.

12. A base station used in a communication system of an orthogonal frequency division multiplexing (OFDM) scheme, comprising:

a determination unit configured to determine a transmission frequency band for transmitting a predetermined channel;

a selection unit configured to select a transmission bandwidth of the transmission frequency band determined by the determination unit from among a plurality of candidates of transmission bandwidths;

a generation unit configured to generate a synchronization channel and a broadcast channel;

a setting unit for set information on a transmission bandwidth selected by the selection unit to the broadcast channel;

a mapping unit configured to map the synchronization channel and the broadcast channel generated by the generation unit to a frequency band that is a center part of the transmission frequency band; and

a unit configured to transmit a downlink signal including the synchronization channel and the broadcast channel.

13. A user apparatus used in a communication system of an orthogonal frequency division multiplexing (OFDM) scheme, comprising:

[2895112_1]:wxb

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a reception unit configured to tune to a frequency on a predetermined raster and receive a synchronization channel and a broadcast channel that are mapped to a frequency band of a center part of a transmission frequency band of a base station;

a determination unit configured to determine, based on the broadcast channel, a transmission frequency bandwidth of the transmission frequency band of the base station from among a plurality of candidates of transmission bandwidths; and

a communication unit configured to communicate a data channel using a bandwidth of the transmission frequency band determined by the determination unit.

14. A base station, substantially as herein disclosed with reference to any one or more of Figs. 1-20 of the accompanying drawings.

15. A method used in a base station, substantially as herein disclosed with reference to any one or more of Figs. 1-20 of the accompanying drawings.

16. A mobile station, substantially as herein disclosed with reference to any one or more of Figs. 1-20 of the accompanying drawings.

17. A method used by a mobile station, substantially as herein disclosed with reference to any one or more of Figs. 1-20 of the accompanying drawings.

18. A base station used in a communication system of an orthogonal frequency division multiplexing (OFDM) scheme, substantially as herein disclosed with reference to any one or more of Figs. 1-20 of the accompanying drawings.

[2895112_1]:wxb

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19. A user apparatus used in a communication system of an orthogonal frequency division multiplexing (OFDM) scheme, substantially as herein disclosed with reference to any one or more of Figs. 1-20 of the accompanying drawings.

DATED this Eleventh Day of August, 2010
NTT DoCoMo, Inc.
Patent Attorneys for the Applicant
SPRUSON & FERGUSON

[2895112_1]:wxb

FIG.1

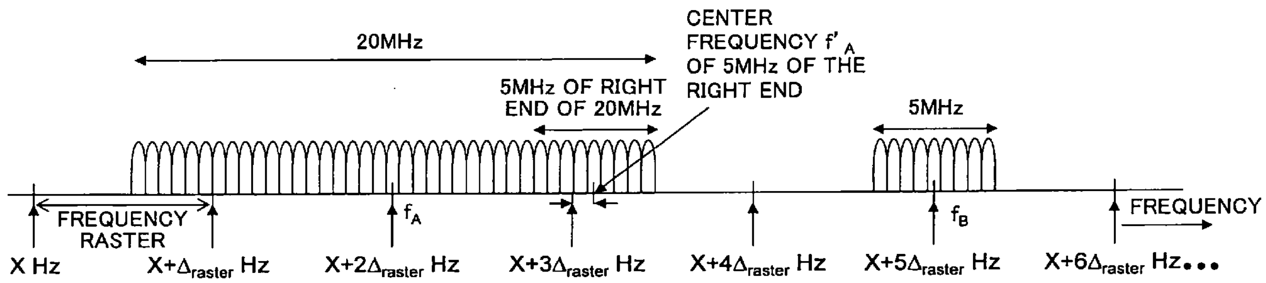

20MHz
5MHz OF RIGHT END OF 20MHz
CENTER FREQUENCY f'A OF 5MHz OF THE RIGHT END
5MHz
FREQUENCY RASTER
fA
fB
FREQUENCY
X Hz
X+Δraster Hz
X+2Δraster Hz
X+3Δraster Hz
X+4Δraster Hz
X+5Δraster Hz
X+6Δraster Hz...

FIG.2

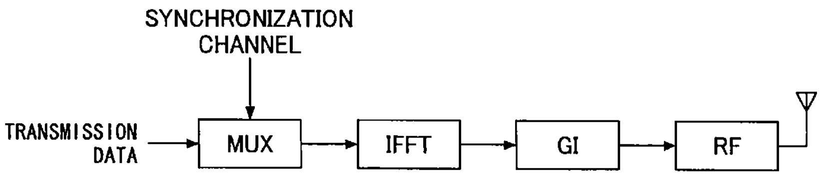

SYNCHRONIZATION
CHANNEL
TRANSMISSION
DATA
MUX
IFFT
GI
RF

FIG.3

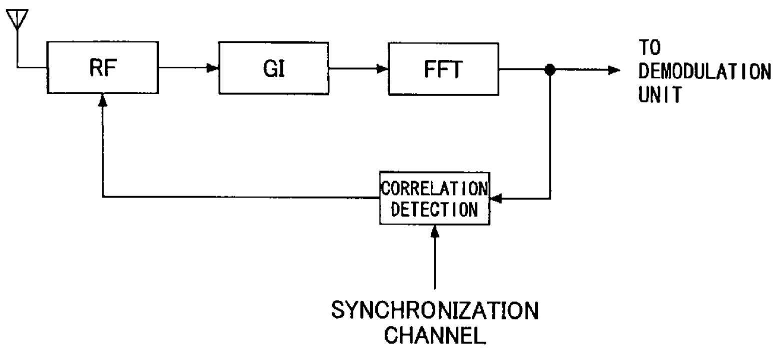

RF
GI
FFT
TO
DEMODULATION
UNIT
CORRELATION
DETECTION
SYNCHRONIZATION
CHANNEL

FIG.4

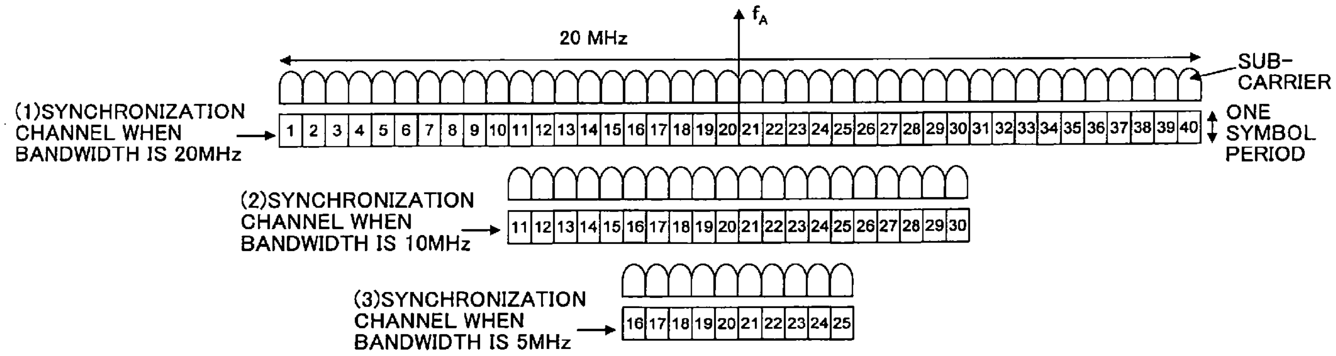

20 MHz
f_A
SUB-CARRIER
ONE SYMBOL PERIOD
(1)SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 20MHz
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
(2)SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 10MHz
11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
(3)SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 5MHz
16 17 18 19 20 21 22 23 24 25

FIG.5

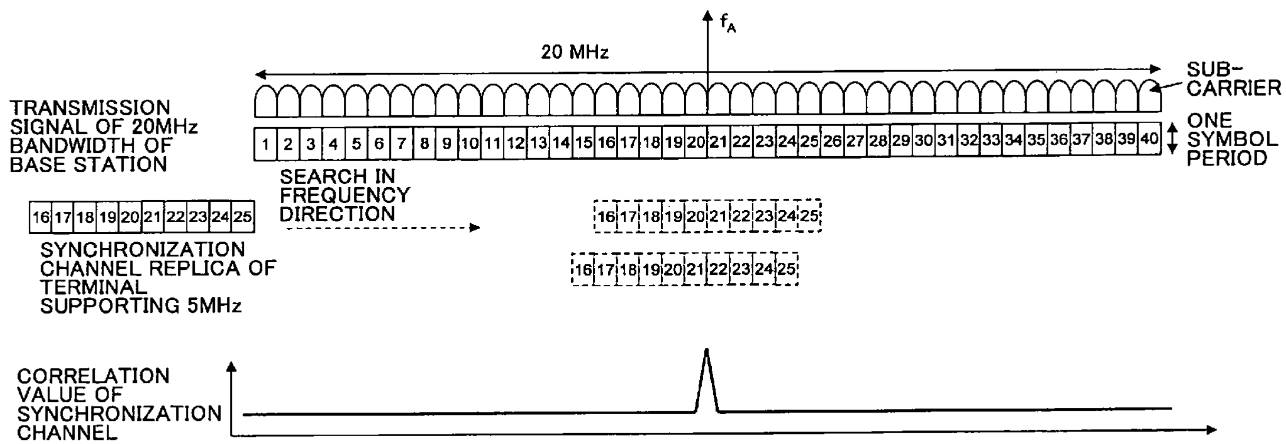
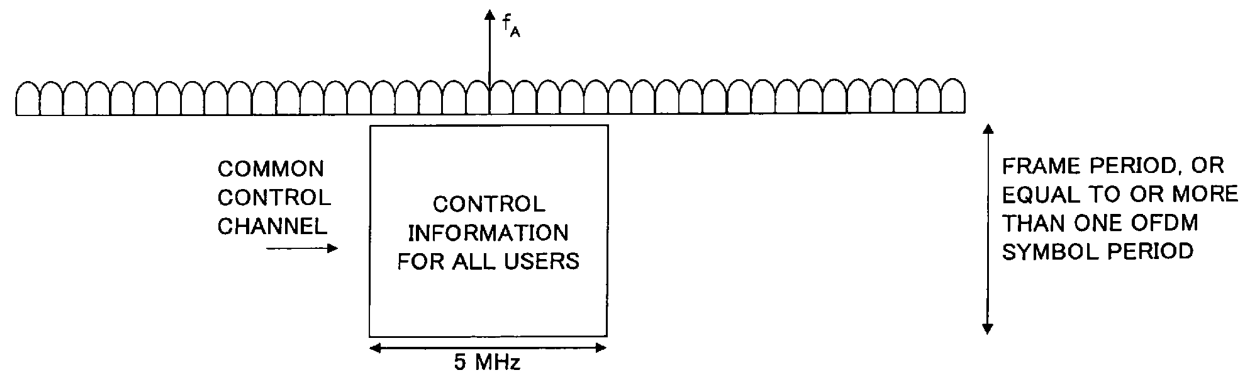

20 MHz
f_A
TRANSMISSION SIGNAL OF 20MHz BANDWIDTH OF BASE STATION
SUB-CARRIER
ONE SYMBOL PERIOD
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
16 17 18 19 20 21 22 23 24 25
SYNCHRONIZATION CHANNEL REPLICA OF TERMINAL SUPPORTING 5MHz
SEARCH IN FREQUENCY DIRECTION
16 17 18 19 20 21 22 23 24 25
16 17 18 19 20 21 22 23 24 25
CORRELATION VALUE OF SYNCHRONIZATION CHANNEL

FIG.6



f_A
COMMON CONTROL CHANNEL
CONTROL INFORMATION FOR ALL USERS
5 MHz
FRAME PERIOD, OR EQUAL TO OR MORE THAN ONE OFDM SYMBOL PERIOD

FIG.7A

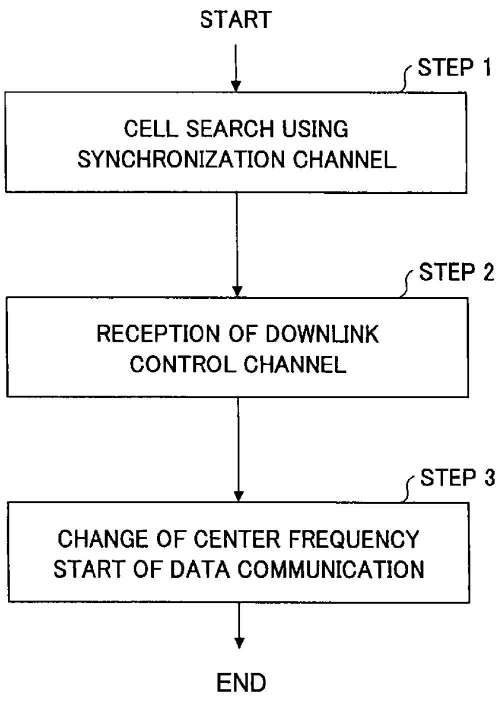

START
STEP 1
CELL SEARCH USING
SYNCHRONIZATION CHANNEL
STEP 2
RECEPTION OF DOWNLINK
CONTROL CHANNEL
STEP 3
CHANGE OF CENTER FREQUENCY
START OF DATA COMMUNICATION
END

FIG.7B

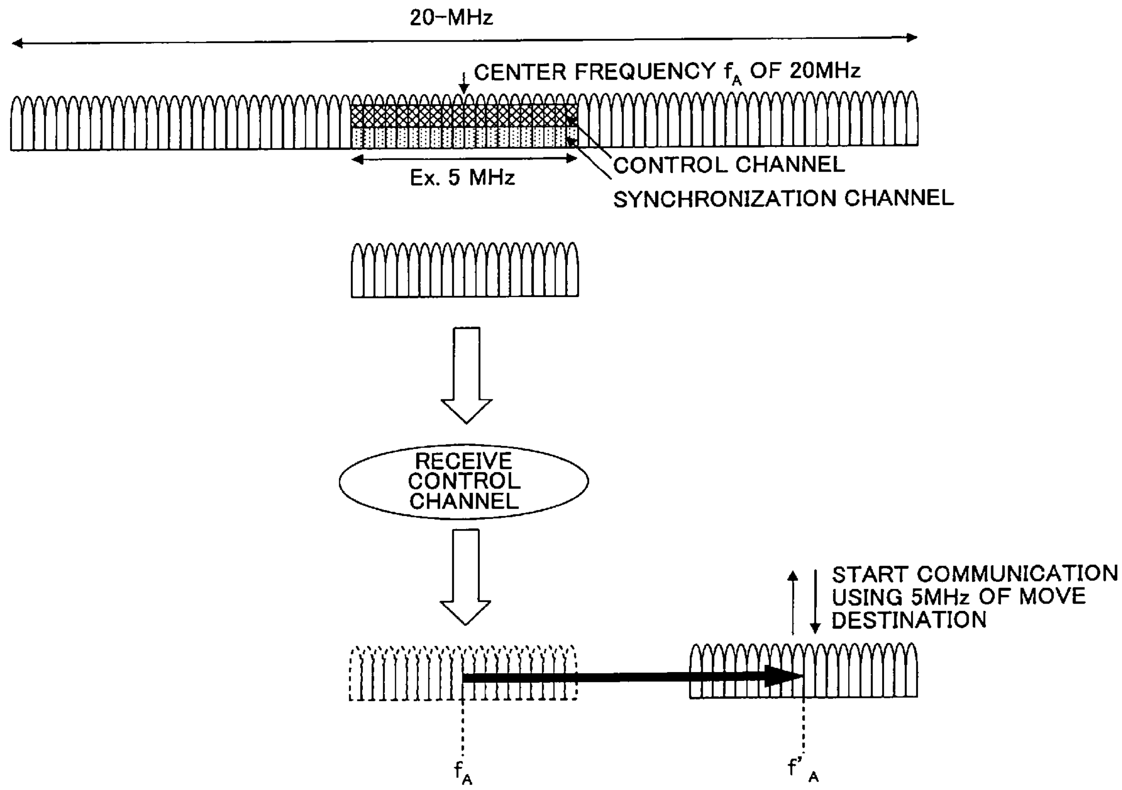

20-MHz
CENTER FREQUENCY f_A OF 20MHz
Ex. 5 MHz
CONTROL CHANNEL
SYNCHRONIZATION CHANNEL
RECEIVE CONTROL CHANNEL
START COMMUNICATION USING 5MHz OF MOVE DESTINATION
f_A
f'_A

FIG.8

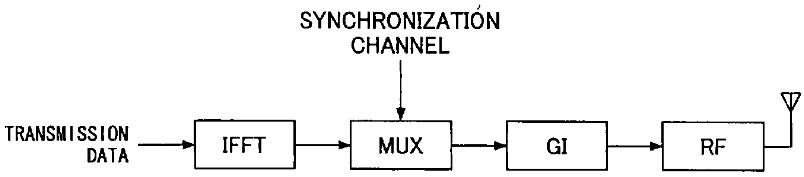

SYNCHRONIZATION
CHANNEL
TRANSMISSION
DATA
IFFT
MUX
GI
RF

FIG.9

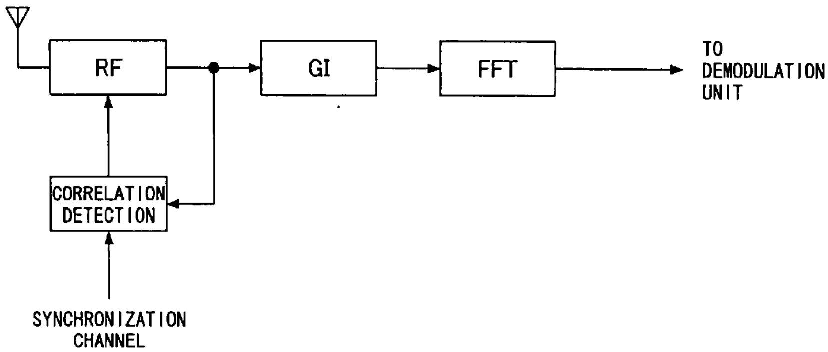

RF
GI
FFT
TO
DEMODULATION
UNIT
CORRELATION
DETECTION
SYNCHRONIZATION
CHANNEL

FIG.10

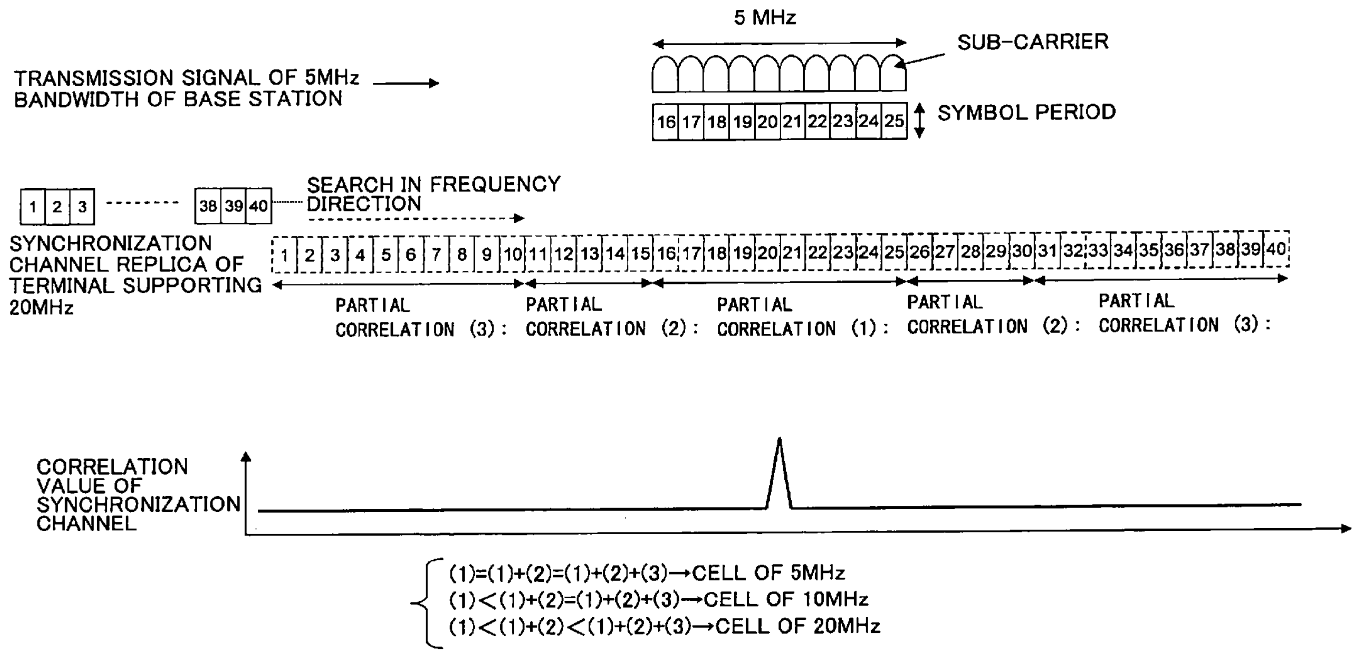
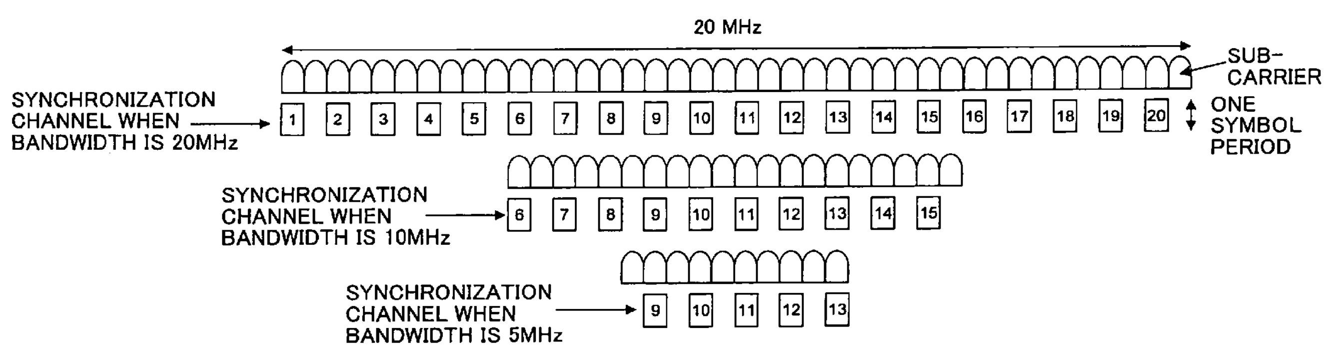
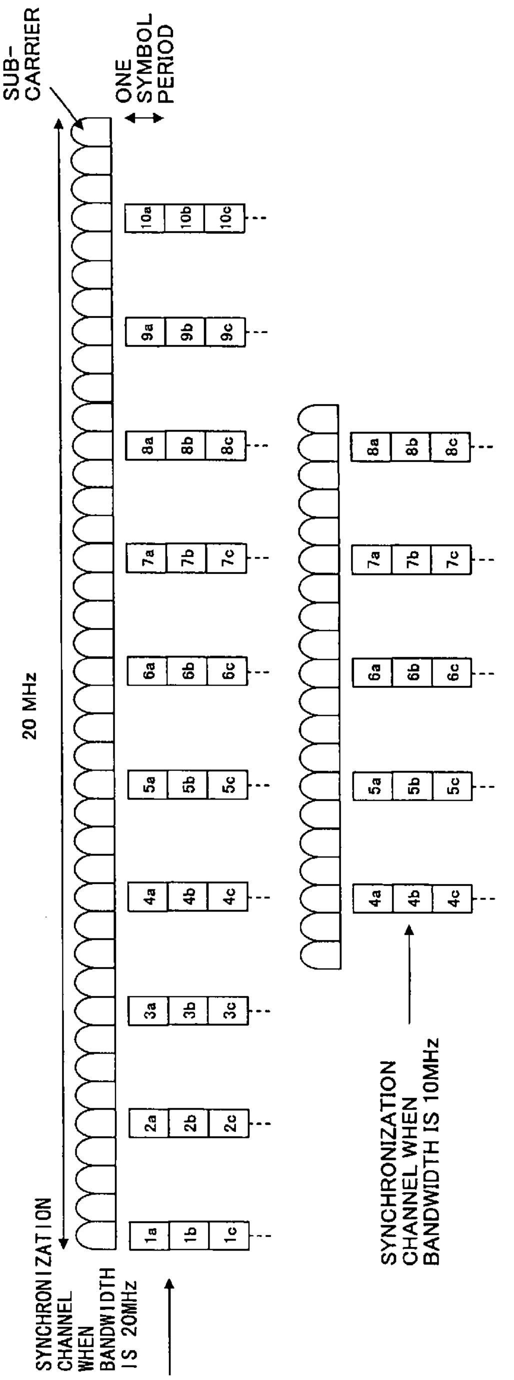

5 MHz
SUB-CARRIER
TRANSMISSION SIGNAL OF 5MHz BANDWIDTH OF BASE STATION
16 17 18 19 20 21 22 23 24 25
SYMBOL PERIOD
1 2 3 -------- 38 39 40
SEARCH IN FREQUENCY DIRECTION
SYNCHRONIZATION CHANNEL REPLICA OF TERMINAL SUPPORTING 20MHz
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
PARTIAL CORRELATION (3):
PARTIAL CORRELATION (2):
PARTIAL CORRELATION (1):
PARTIAL CORRELATION (2):
PARTIAL CORRELATION (3):
CORRELATION VALUE OF SYNCHRONIZATION CHANNEL
(1)=(1)+(2)=(1)+(2)+(3)→CELL OF 5MHz
(1)<(1)+(2)=(1)+(2)+(3)→CELL OF 10MHz
(1)<(1)+(2)<(1)+(2)+(3)→CELL OF 20MHz

FIG.11



20 MHz
SUB-CARRIER
ONE SYMBOL PERIOD
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 20MHz
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 10MHz
6
7
8
9
10
11
12
13
14
15
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 5MHz
9
10
11
12
13

FIG.12



SUB-CARRIER
ONE SYMBOL PERIOD
20 MHz
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 20MHz
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 10MHz
1a
1b
1c
2a
2b
2c
3a
3b
3c
4a
4b
4c
5a
5b
5c
6a
6b
6c
7a
7b
7c
8a
8b
8c
9a
9b
9c
10a
10b
10c

FIG.13

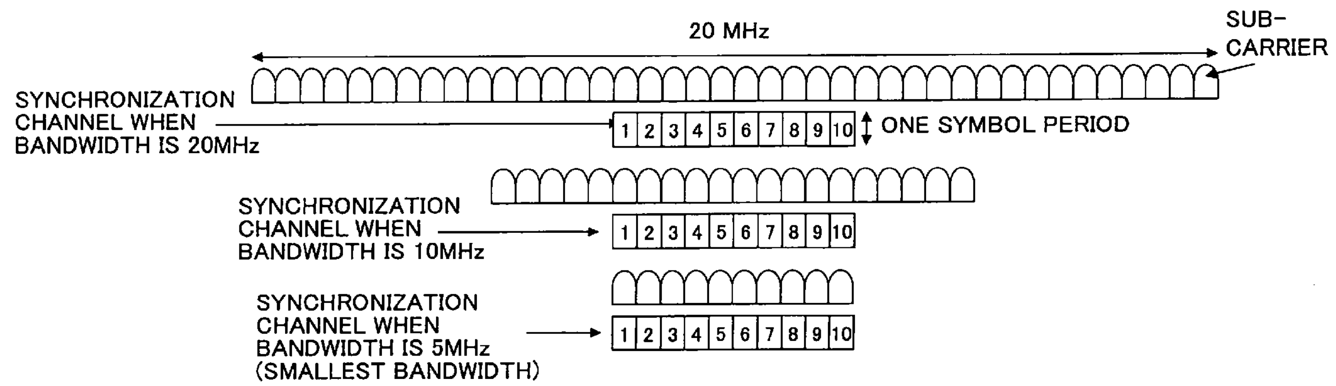

20 MHz
SUB-
CARRIER
SYNCHRONIZATION
CHANNEL WHEN
BANDWIDTH IS 20MHz
1 2 3 4 5 6 7 8 9 10
ONE SYMBOL PERIOD
SYNCHRONIZATION
CHANNEL WHEN
BANDWIDTH IS 10MHz
1 2 3 4 5 6 7 8 9 10
SYNCHRONIZATION
CHANNEL WHEN
BANDWIDTH IS 5MHz
(SMALLEST BANDWIDTH)
1 2 3 4 5 6 7 8 9 10

FIG.14

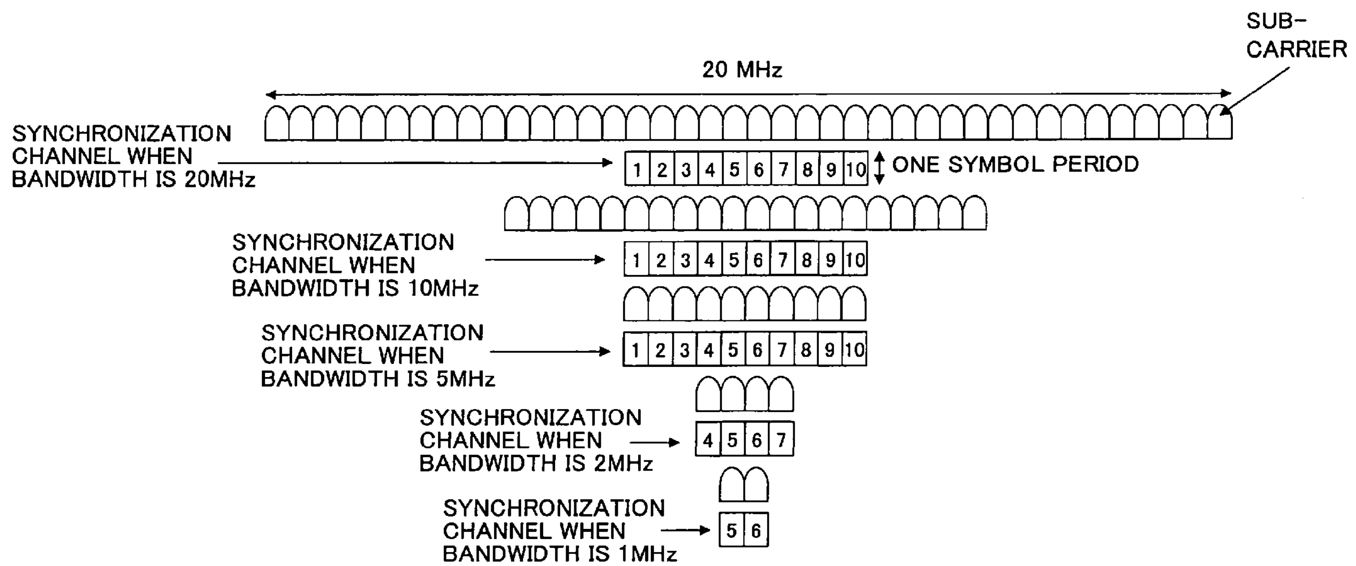

SUB-
CARRIER
20 MHz
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 20MHz
1 2 3 4 5 6 7 8 9 10
ONE SYMBOL PERIOD
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 10MHz
1 2 3 4 5 6 7 8 9 10
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 5MHz
1 2 3 4 5 6 7 8 9 10
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 2MHz
4 5 6 7
SYNCHRONIZATION CHANNEL WHEN BANDWIDTH IS 1MHz
5 6

FIG.15

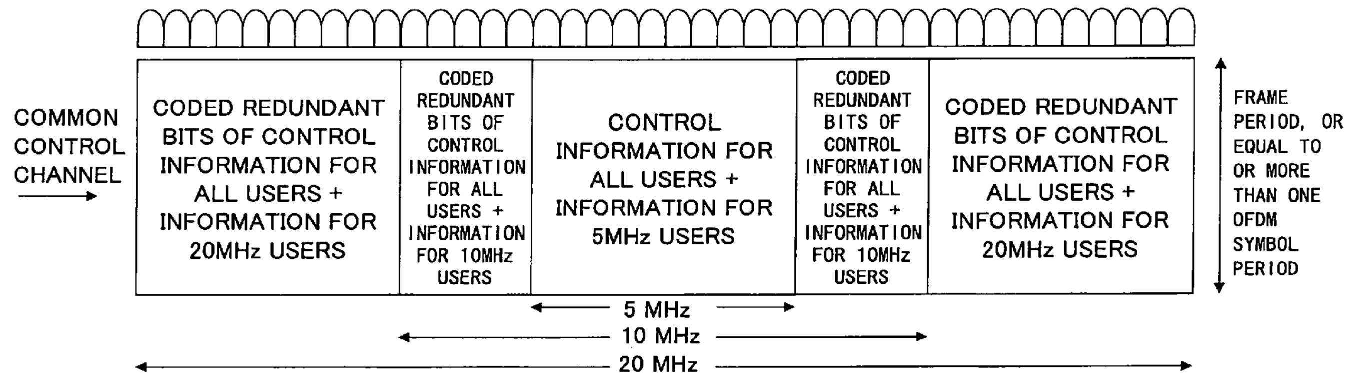
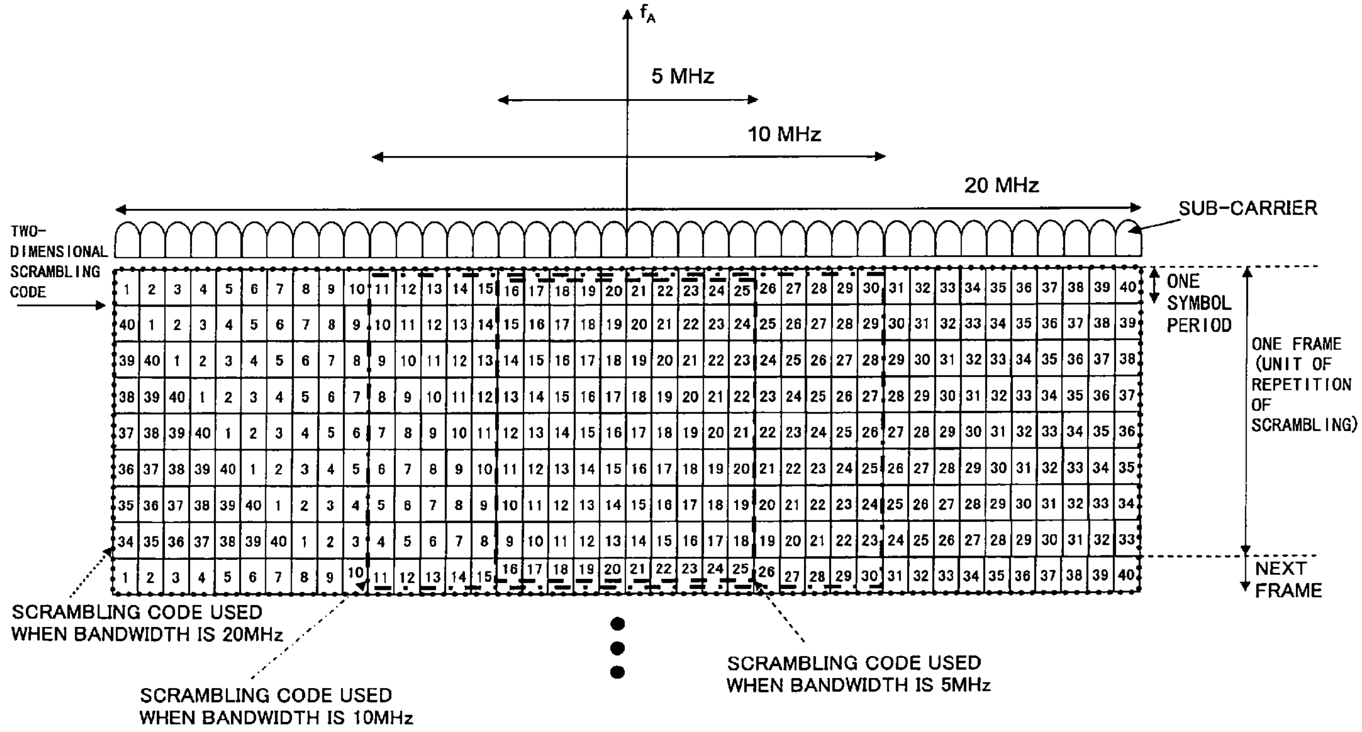
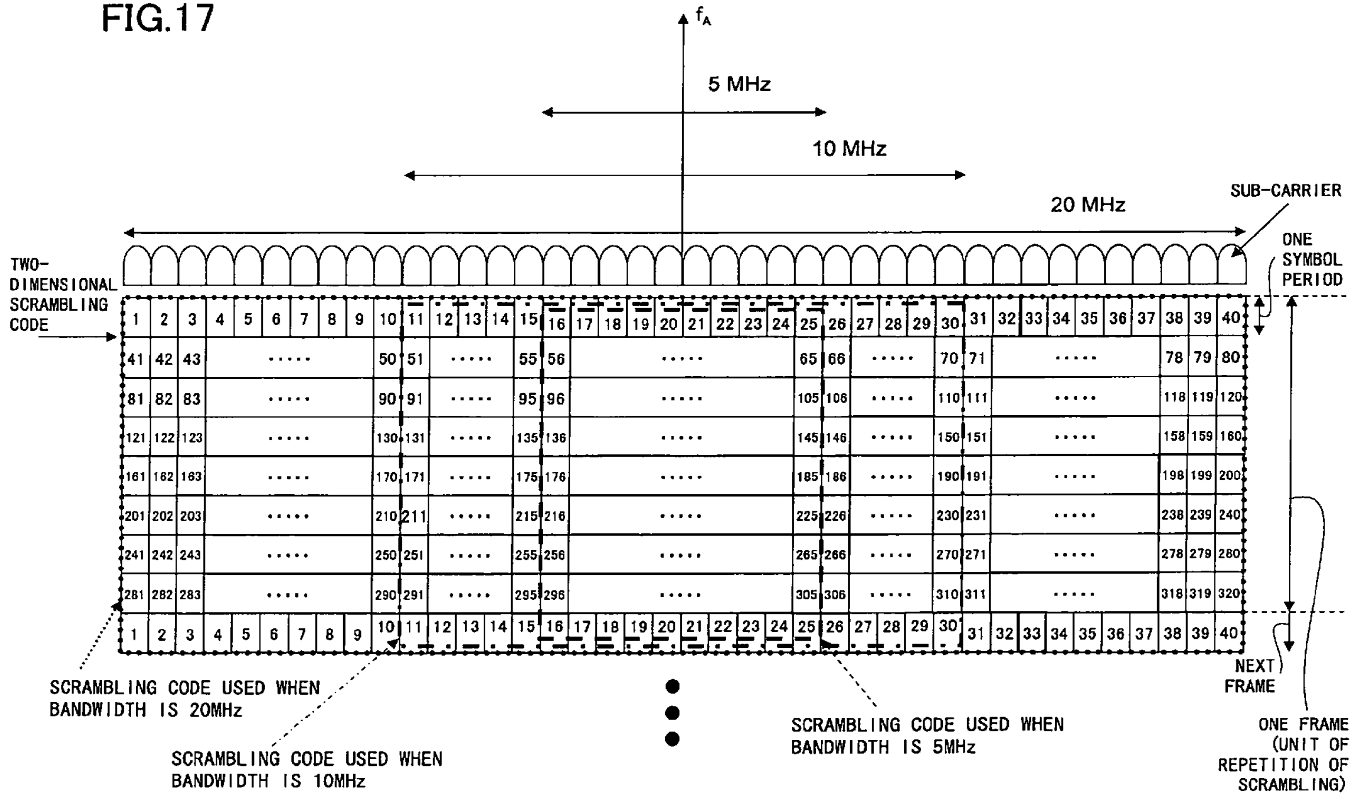

COMMON CONTROL CHANNEL
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 20MHz USERS
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 10MHz USERS
CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 5MHz USERS
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 10MHz USERS
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 20MHz USERS
FRAME PERIOD, OR EQUAL TO OR MORE THAN ONE OFDM SYMBOL PERIOD
5 MHz
10 MHz
20 MHz

FIG.16



f_A
5 MHz
10 MHz
20 MHz
SUB-CARRIER
TWO-DIMENSIONAL SCRAMBLING CODE
ONE SYMBOL PERIOD
ONE FRAME (UNIT OF REPETITION OF SCRAMBLING)
NEXT FRAME
SCRAMBLING CODE USED WHEN BANDWIDTH IS 20MHz
SCRAMBLING CODE USED WHEN BANDWIDTH IS 10MHz
SCRAMBLING CODE USED WHEN BANDWIDTH IS 5MHz

FIG.17



fA
5 MHz
10 MHz
20 MHz
SUB-CARRIER
ONE SYMBOL PERIOD
TWO-DIMENSIONAL SCRAMBLING CODE
NEXT FRAME
ONE FRAME (UNIT OF REPETITION OF SCRAMBLING)
SCRAMBLING CODE USED WHEN BANDWIDTH IS 20MHz
SCRAMBLING CODE USED WHEN BANDWIDTH IS 10MHz
SCRAMBLING CODE USED WHEN BANDWIDTH IS 5MHz

FIG.18

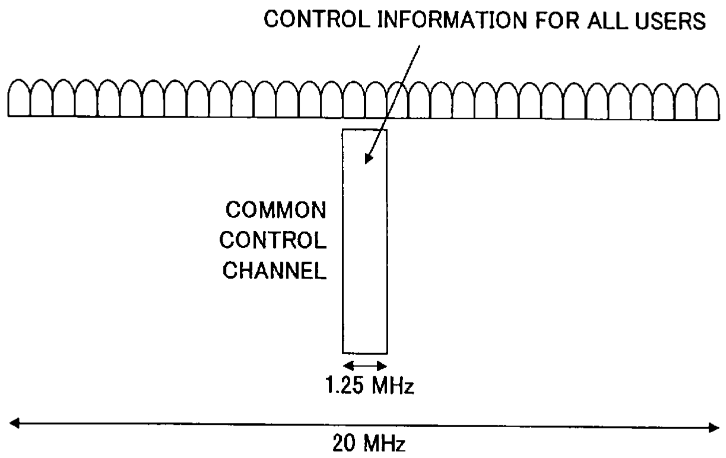

CONTROL INFORMATION FOR ALL USERS
COMMON
CONTROL
CHANNEL
1.25 MHz
20 MHz

FIG.19

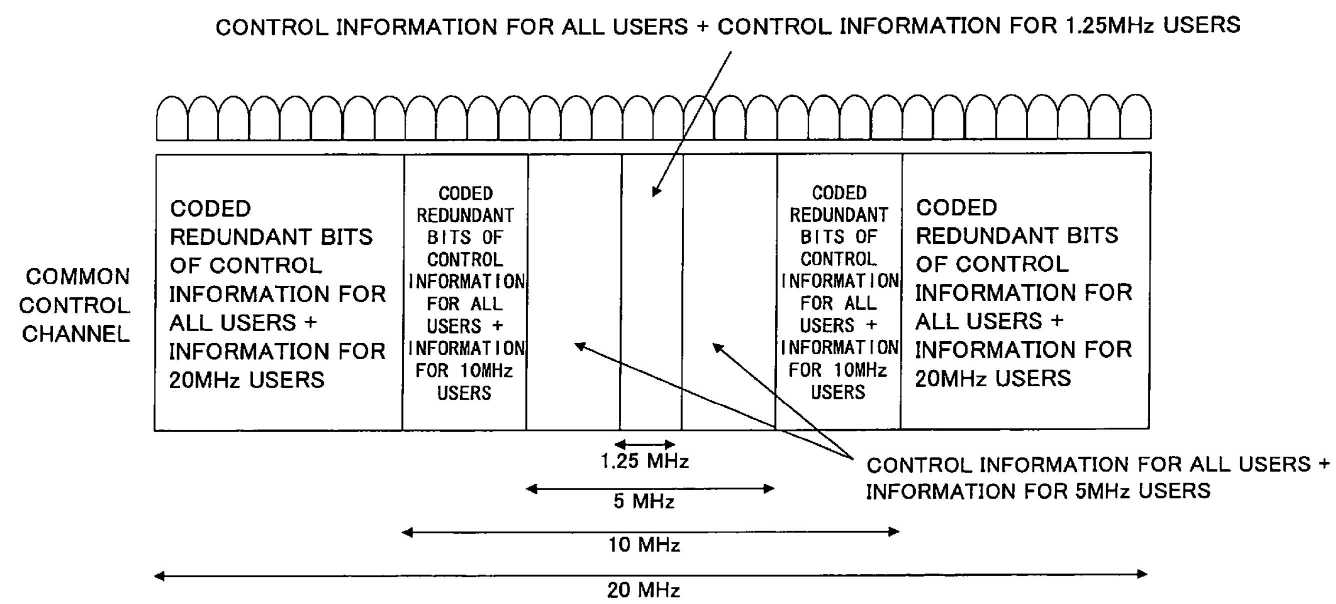
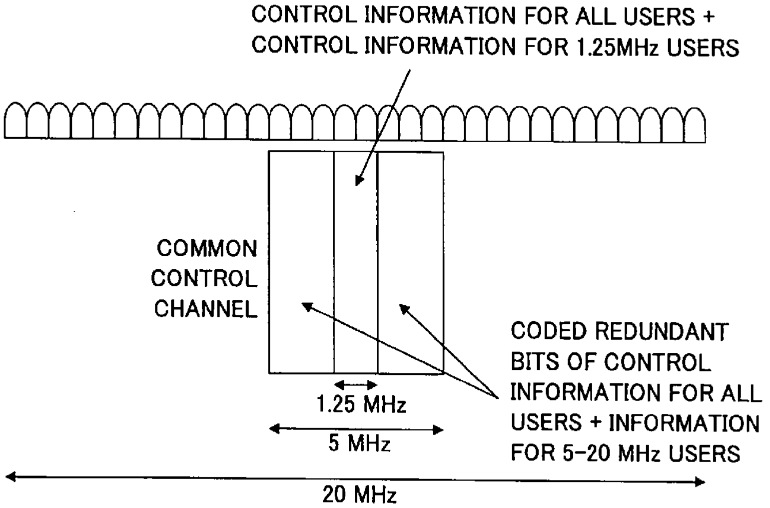

CONTROL INFORMATION FOR ALL USERS + CONTROL INFORMATION FOR 1.25MHz USERS
COMMON CONTROL CHANNEL
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 20MHz USERS
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 10MHz USERS
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 10MHz USERS
CODED REDUNDANT BITS OF CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 20MHz USERS
CONTROL INFORMATION FOR ALL USERS + INFORMATION FOR 5MHz USERS
1.25 MHz
5 MHz
10 MHz
20 MHz

FIG.20


CONTROL INFORMATION FOR ALL USERS +
CONTROL INFORMATION FOR 1.25MHz USERS
COMMON
CONTROL
CHANNEL
CODED REDUNDANT
BITS OF CONTROL
INFORMATION FOR ALL
USERS + INFORMATION
FOR 5-20 MHz USERS
1.25 MHz
5 MHz
20 MHz