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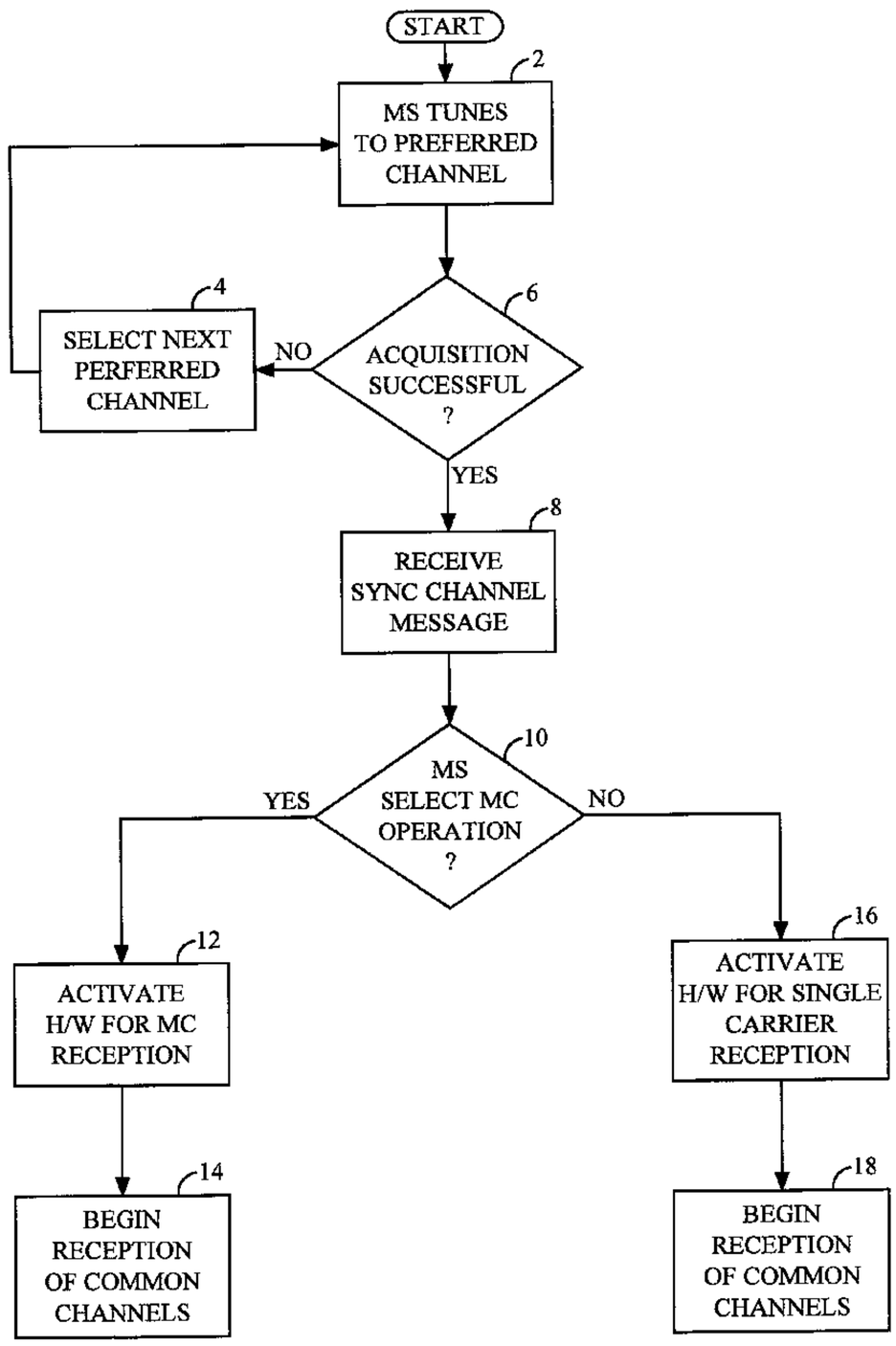
(54) Titre : PROCEDE ET APPAREIL DE TRANSMISSION DE MESSAGE D'UN CANAL DE SYNCHRONISATION DANS UN SYSTEME DE COMMUNICATION A PORTEUSE MULTIPLE

(54) Title: METHOD AND APPARATUS FOR TRANSMITTING THE SYNC CHANNEL MESSAGE IN A MULTI-CARRIER COMMUNICATION SYSTEM



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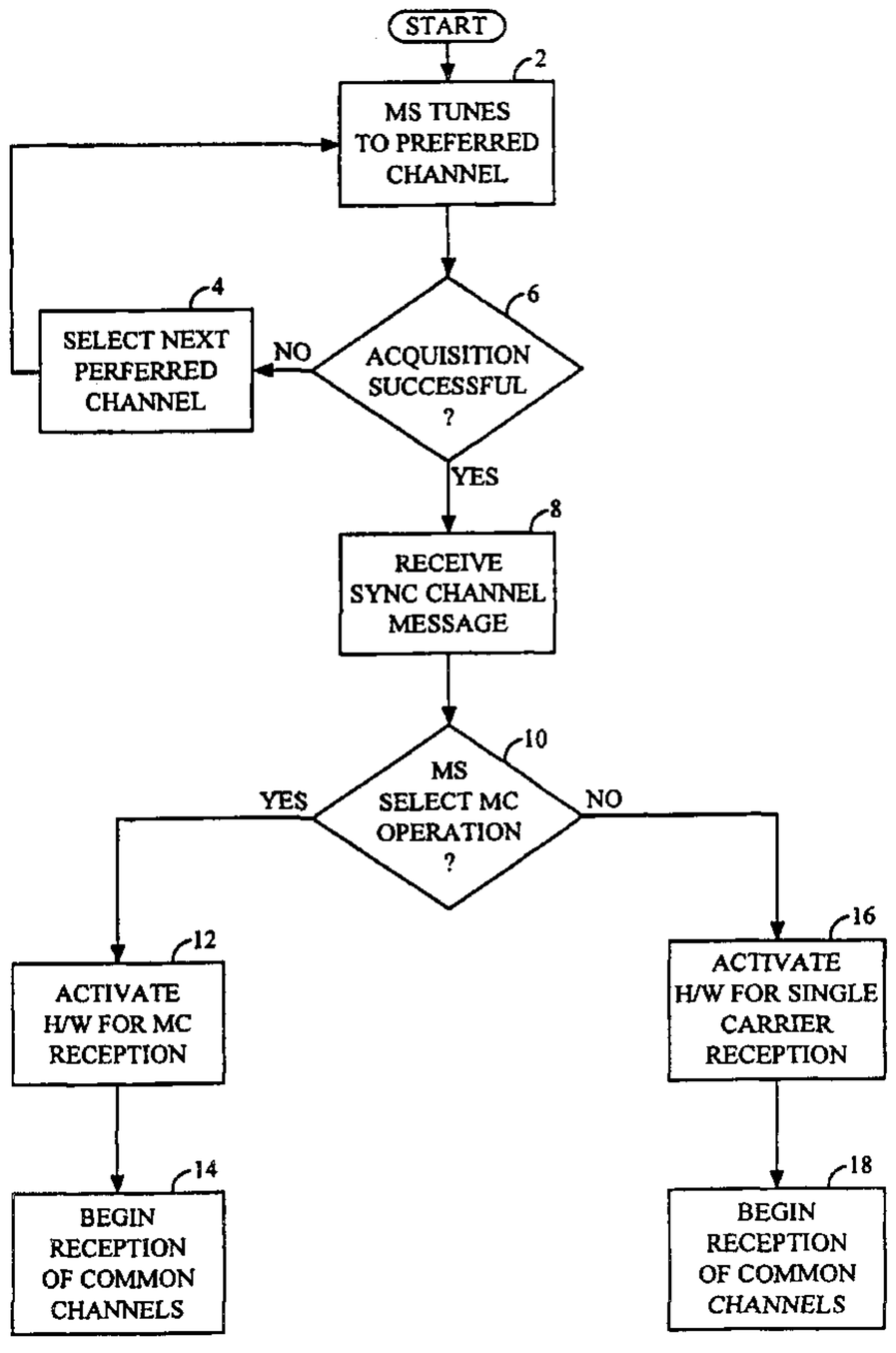
(54) Title: METHOD AND APPARATUS FOR TRANSMITTING THE SYNC CHANNEL MESSAGE IN A MULTI–CARRIER COMMUNICATION SYSTEM

(57) Abstract

A method and apparatus for transmitting broadcast information in a multi–carrier communication system. The Sync Channel of the multi–carrier system is transmitted a 1.25 MHz channel bandwidth (i.e., over a single carrier), and to specify the preferred channels for the Sync Channel transmission instead of the preferred channels for the entire multi–carrier system. The Sync Channel Message will carry the additional information to indicating the center frequency of a multi–carrier system within a reserved set of frequency bands and indicating the frequency of a single carrier system in the reserved set of frequency bands. Considering the A block of the PCS band again, the preferred channels for Sync Channel transmission can be selected as channels 75, 150 and 225. This selection ensures that one of the preferred channels will always be used by any multi–carrier system regardless of the location of its center channel.



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METHOD AND APPARATUS FOR TRANSMITTING THE SYNC CHANNEL MESSAGE IN A MULTI-CARRIER COMMUNICATION SYSTEM

BACKGROUND OF THE INVENTION

I. Field of the Invention

The present invention relates to communications. More particularly, the present invention relates to a novel and improved method and apparatus for transmitting and receiving broadcast information in a multi-carrier CDMA communication system.

II. Description of the Related Art

The use of code division multiple access (CDMA) modulation techniques is one of several techniques for facilitating communications in which a large number of system users are present. Other multiple access communication system techniques, such as time division multiple access (TDMA) and frequency division multiple access (FDMA) are known in the art. However, the spread spectrum modulation technique of CDMA has significant advantages over these modulation techniques for multiple access communication systems. The use of CDMA techniques in a multiple access communication system is disclosed in U.S. Patent No. 4,901,307, entitled "SPREAD SPECTRUM MULTIPLE ACCESS COMMUNICATION SYSTEM USING SATELLITE OR TERRESTRIAL REPEATERS", assigned to the assignee of the present invention. The use of CDMA techniques in a

multiple access communication system is further disclosed in U.S. Patent No. 5,103,459, entitled "SYSTEM AND METHOD FOR GENERATING SIGNAL WAVEFORMS IN A CDMA CELLULAR TELEPHONE SYSTEM", assigned to the assignee of the present invention. CDMA has been standardized by the Telecommunications Industry Association in Interim Standards IS-95A and IS-95B, entitled "Mobile Station-Base Station Compatibility Standard for Dual Mode Spread Spectrum Systems" (referred to hereafter collectively as IS-95).

In IS-95 communications systems channels of information transmitted from a common base station are distinguished from one another by orthogonal spreading codes. Each channel is spread by a unique

orthogonal spreading sequence. The channels that are transmitted by an IS-95 base station include, a pilot channel, a sync channel, at least one paging channel and dedicated traffic channels. The pilot channels is used to provide a phase reference for coherent demodulation of the other channels by mobile stations within the coverage area of the base station. The sync channel carriers overhead information such as timing information, pilot PN offset information and other information that allows the reception of the other overhead channels. The paging channel notifies mobile stations of mobile terminated calls directed to the mobile station in the area. Dedicated traffic channels provide information directed to the user of a specific mobile station in the coverage area of the base station.

In IS-95, when the base station sends a *Sync Channel Message*, it shall uses the fixed-length message format of Table 1 below:

TABLE 1

Field	Length (bits)
MSG_TYPE ('00000001')	8
P_REV	8
MIN_P_REV	8
SID	15
NID	16
PILOT_PN	9
LC_STATE	42
SYS_TIME	36
LP_SEC	8
LTM_OFF	6
DAYLT	1
PRAT	2
CDMA_FREQ	11

MSG_TYPE Message type.

P_REV Protocol revision level.

MIN_P_REV Minimum protocol revision level. The base station sets this field to prevent mobile stations which cannot be supported by the base station from accessing the system.

SID — System identification. The base station shall set this field to the system identification number for this system.

NID — Network identification. This field serves as a sub-identifier of a system as defined by the owner of the SID.

PILOT_PN — Pilot PN sequence offset index. The base station shall set this field to the pilot PN sequence offset for this base station, in units of 64 PN chips.

LC_STATE — Long code state. The base station shall set this field to the long code state at the time given by the SYS_TIME field of this message.

SYS_TIME — System time. The base station shall set this field to the System Time as of four Sync Channel super frames (320 ms) after the end of the last super frame containing any part of this *Sync Channel Message*, minus the pilot PN sequence offset, in units of 80 ms.

LP_SEC — The number of leap seconds that have occurred since the start of System Time.

LTM_OFF — Offset of local time from System Time. The base station shall set this field to the two's complement offset of local time from System Time, in units of 30 minutes.

DAYLT — Daylight savings time indicator. If daylight savings time is in effect, the base station shall set this field to '1'; otherwise, the base station shall set this field to '0'.

PRAT — Paging Channel data rate. The base station shall set this field to the PRAT field value shown in Table 2 corresponding to the data rate used by the Paging Channels in the system.

TABLE 2. Paging Channel Data Rate

PRAT Field (binary)	Paging Channel data rate
00	9600 bps
01	4800 bps
10	Reserved
11	Reserved

CDMA_FREQ — Frequency assignment. The base station shall set this field to the CDMA Channel number corresponding to the CDMA frequency assignment for the CDMA Channel containing a Primary Paging Channel.

In IS-95 systems, each base station transmits a pilot channel that is covered only by a short PN sequence. In IS-95 systems, the short PN sequence repeats once every 26ms. The pilot signal transmissions from each base station are distinguished from one another by a phase offset with respect to one another. In particular, there each base station associated with a single base station controller differs in phase by at least 64 PN chips.

Under normal operation, the mobile station acquires the pilot signal first. The pilot signal carries no data and is simply the all ones sequence spread by the common short code, which also spreads all of the other channels transmitted by the base station. After acquiring the pilot channel, the mobile station receives the information described above from the sync channel. The frame and interleaver timing on the sync channel are aligned with the pilot PN sequence. The zero state of the short PN sequence marks the starting point of the sync channel frame and interleaver.

In the U.S. Personal Communication System (PCS) spectrum, the CDMA channel number N specifies the carrier frequencies of the forward and reverse link channels . In particular, channel number N corresponds to a reverse link carrier frequency of (1850 + 0.05N) MHz and a forward link carrier frequency of (1930 + 0.05N) MHz, where N ranges from 0 to 1199. The bandwidth of each CDMA channel is 1.25 MHz. Therefore, the channel numbers of adjacent CDMA channels are different by at least 25 (25×0.05 MHz = 1.25 MHz). To facilitate mobile stations' initial acquisition, certain carrier frequencies are designated as the preferred frequency assignments. Referring to FIG. 1, for an IS-95B CDMA system in the A block of PCS band, the channel numbers of the preferred frequency assignments are 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, and 275. Mobile stations will search the preferred frequency assignments first upon powering up.

The International Telecommunications Union recently requested the submission of proposed methods for providing high rate data and high-quality speech services over wireless communication channels. A first of these proposals was issued by the Telecommunications Industry Association, entitled "The cdma2000 ITU-R RTT Candidate Submission" (hereafter cdma2000). cdma2000 proposes increasing the throughput of the forward link signals by transmitting portions of the information on three bands, each of 1.2288 MHz. This method is described as the "multi-carrier" approach.

A multi-carrier CDMA system, that uses three adjacent 1.25 MHz RF channels with channel spacing also equal to 1.25 MHz is defined in

cdma2000. Referring to FIG. 2, a multi-carrier CDMA system in the A block of the PCS band can be deployed with the center channel on channel 50, 75, 100, 125,150, 175, 200, 225, or 250. Channels 50 and 250 are usually avoided to avoid interference to adjacent bands on the reverse link. In the proposed cdma2000 description, the reverse link may be direct-spread with a chip rate of 3.6864 Mcps, which makes the emission limit requirements more difficult to meet than for a chip rate of 1.2288 Mcps.

A mobile station, upon powering up, searches for pilot signal on a preferred frequency. If no pilot is found in the current channel, it changes its channel and searches again. Once a pilot is acquired, the mobile station demodulates the Sync Channel associated with that pilot to receive timing information, pilot PN offset, and other information enabling its reception of the other overhead channels.

In a multi-carrier approach, one method for providing Sync Channel data would be to tri-partition the Sync Channel message and place one third of the message on each of the three portions of the multi-carrier signal. If the Sync Channel of a multi-carrier system is spread over three channels, the mobile station will have to know the exact channels used by the system in order to demodulate the Sync Channel reliably. Since the exact channels are not known in advance, the mobile station has to try numerous combinations to receive the Sync Channel message. Given the number of preferred channels, the time spent on such trials could be excessive and therefore degrade the mobile station's initial acquisition time. Therefore, there is a need felt in the art for a method that minimizes the mobile station's search time.

According to one aspect of the present invention, there is provided a multi-frequency channel base station operating within a predetermined set of frequency channels wherein data components of forward link data are transmitted simultaneously on a plurality of frequency bands each band representing a frequency channel and having a carrier frequency, comprising: a first transmission subsystem for transmitting a sync channel message on a single frequency channel of said predetermined set of frequency channels, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system, wherein the center frequency channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; and at least one additional transmission subsystem for transmitting remaining components of said forward link data on another frequency channel of said predetermined set of frequency channels.

According to another aspect of the present invention, there is provided a multi-frequency channel mobile station comprising: a control processor for controlling the operation of a plurality of receiver subsystems in accordance with frequency information indicated in a received sync channel message, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system, wherein the center frequency channel is used for reception of signals by the mobile station and is one of a set of a preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any

combination of three adjacent bands includes the center frequency channel; a first receiver subsystem for receiving said sync channel message on a single frequency channel and for providing said sync channel message to said control processor and for receiving a first portion of a multi-channel signal; and at least one additional receiver subsystem for receiving additional portions of said multi-channel signal.

According to still another aspect of the present invention, there is provided a method of transmitting data components of forward link data in a communication system, comprising: transmitting a sync channel message on a single frequency channel within a predetermined set of frequency channels, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system, wherein the center frequency channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; and transmitting remaining components of said forward link data on another frequency channel within said predetermined set of frequency channels.

According to yet another aspect of the present invention, there is provided a method of receiving data components of forward link data in a communication system, comprising: receiving a sync channel message and a first portion of a multi-channel signal on a single frequency channel, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system, wherein the center frequency channel is used for reception of signals and is one of a set of

preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; controlling operation of a plurality of receiver subsystems in accordance with frequency information indicated in said received sync channel message; and receiving additional portions of said multi-frequency channel signal on another frequency channel.

According to a further aspect of the present invention, there is provided a multi-frequency channel base station operating within a predetermined set of frequency channels wherein data components of forward link data are transmitted simultaneously on a plurality of frequency bands each band representing a frequency channel and having a carrier frequency, said base station comprising: means for transmitting a sync channel message on a single frequency channel within a predetermined set of frequency channels, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system, wherein the center frequency channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; and means transmitting remaining components of said forward link data on another frequency channel within said predetermined set of frequency channels.

According to yet a further aspect of the present invention, there is provided a multi-frequency channel mobile station comprising: means for controlling the operation of a plurality of receiver subsystems in accordance with frequency information indicated in a

received sync carrier message, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system, wherein the center frequency channel is used for reception of signals and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; means for receiving said sync channel message on single frequency channel and for providing said sync carrier message to said means for controlling and for receiving a first portion of a multi-channel signal; and means for receiving additional portions of said multi-frequency channel signal on another frequency channel.

According to still a further aspect of the present invention, there is provided an apparatus operable in at least one of a single carrier system and a multi-carrier system, comprising: a demultiplexer that demultiplexes a forward link signal into a forward link data stream comprising broadcast channel data including a sync channel message; a first transmission subsystem, coupled to the demultiplexer, that transmits a first portion of the forward link data stream on a first carrier frequency; a second transmission subsystem, coupled to the demultiplexer, that transmits a second portion of the forward link data stream on a second carrier frequency; and a third transmission subsystem, coupled to the demultiplexer, that transmits a third portion of the forward link data stream on a third carrier frequency, wherein the sync channel message is transmitted on a preferred channel by a selected one of the first, second and third transmission subsystems for transmission at a selected one of the first, second and third carrier frequencies, and wherein the preferred channel

is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands arranged such that any combination of three adjacent bands includes the preferred frequency channel.

SUMMARY OF THE INVENTION

Embodiments of the present invention provide a method and apparatus for transmitting broadcast information in a multi-carrier communication system. Embodiments of the invention send the Sync Channel of the multi-carrier system in a 1.25 MHz channel bandwidth (i.e., over a single carrier), and specify the preferred channels for the Sync Channel transmission instead of the preferred channels for the entire multi-carrier system. The Sync Channel Message will indicate the center frequency for a multi-carrier system in the band if one exists and the frequency of a single band system if one exists.

Considering the A block of the PCS band again, the preferred channels for Sync Channel transmission can be selected as channels 75, 150 and 225. This selection ensures that one of the preferred channels will always be used by any multi-carrier system regardless the location of its center channel. The mobile station, upon powering up, searches on the preferred channels for Sync Channel first. Once the pilot signal is acquired on any of these channels, the mobile station demodulates the Sync Channel on the channel as well. The mobile station learns from the Sync Channel Message the location of a multic arrier and a single carrier system in the band if either exists. It can be easily observed that the number of channels to search and the number of hypotheses to try are significantly reduced by using the proposal in this disclosure. As a result, it improves the mobile station's initial acquisition time.

BRIEF DESCRIPTION OF THE DRAWINGS

The features, objects, and advantages of the present invention will become more apparent from the detailed description set forth below when taken in conjunction with the drawings in which like reference characters identify correspondingly throughout and wherein:

FIG. 1 is an illustrative band diagram for a PCS system for 1x communications systems;

FIG. 2 is an illustrative band diagram for a PCS system for 3x communications systems;

FIG. 3 is a flowchart illustrating the acquisition method of the present invention;

FIG. 4 is a block diagram illustrating the major elements in a wireless communications system;

FIG. 5 is a simplified block diagram of a multi-carrier transmission system;

FIG. 6 is a block diagram of CDMA modulation system;

FIG. 7 is a simplified block diagram of a multi-carrier receiver system; and

FIG. 8 is a block diagram of a CDMA demodulation system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. 1 illustrates a typical band diagram for a multi-band communications system. In currently contemplated wireless communications systems, mobile station that is attempting to begin service will tune to each possible frequency in a preferred set of frequencies and determine whether a system is available at that frequency. In FIG. 1, the channel numbers of the preferred frequency assignments are 25, 50, 75, 100, 125, 150, 175, 200, 225, 250, and 275, which corresponds to bands **200a**, **200b**, **200c**, **200d**, **200e**, **200f**, **200g**, **200h**, **200i**, **200j** and **200k**. In the exemplary embodiment, each of these bands is 1.25Mhz wide and is used to carry an IS-95 CDMA transmissions.

FIG. 2 illustrates the possible center bands of a three component multi-carrier communication system as is contemplated in cdma2000 (also referred to as IS-2000). In the multi-carrier communication system, the mobile station tunes to each possible grouping of three adjacent channels and attempts to receive the Sync Channel message. In the current designs for multi-carrier systems the Sync Channel message will be divided into three component parts with each component part transmitted separately and simultaneously on a different carrier of the multi-carrier band. The mobile station first attempts to receive the Sync Channel message on a multi carrier system comprising bands **300b**, **300c**, **300d**. If unsuccessful, the mobile station then attempts to acquire the Sync Channel on a multi-carrier system consisting of bands **300c**, **300d**, and **300e**. This continues for each possible three band system until the mobile station checks for a multi-carrier system consisting of bands **300h**, **300i** and **300j**. For reasons described above, in the exemplary embodiment, bands **300a** and **300k** will not be used in a multi carrier system.

This method of receiving the Sync Channel message is very inefficient and time consuming. If a mobile station is capable of operating in a multi-carrier or single carrier mode, the mobile station will potentially have to conduct eleven 1x searches or bands **200a-200k** and seven multi-carrier searches using center frequencies **300c-300i**. In a CDMA communication system, each band searched requires the mobile station to test a large number of PN offsets to detect the presence of the pilot signal. Thus, this method of acquisition requires a substantial time period.

The present invention provides a significantly more efficient method for acquiring the necessary system parameters in a potentially mixed bandwidth communication system. In the present invention, the Sync Channel is always transmitted in a 1x band. In the preferred embodiment, the preferred channels are channels 75, 150 and 225. Thus, a mobile station need only conduct at most three searches to receive the Synch Channel message in 1x bandwidth in order to acquire the necessary information for acquisition of its preferred system. The present invention greatly reduces acquisition time in a mixed bandwidth communication system. In addition, by providing the Sync Channel message only on the preferred channels reduces the capacity impact of providing that overhead messaging on many more channels.

The reason for the allocation of the preferred channels of the present invention is that it provides the greatest flexibility in the provision of a multi-carrier system. With the allocation of the preferred channels to channel numbers 75, 150 and 220 (**300c**, **300f** and **300j**), a multi-carrier system provided anywhere in the band consisting of bands **300a-300k** will include one of the preferred channels. A multi-carrier system comprising the bands **300a**, **300b** and **300c** will include the preferred channel **300c**. A multi-carrier system comprising the bands **300b**, **300c** and **300d** will include the preferred channel of **300c**. A multi-carrier system comprising the bands of **300c**, **300d** and **300e** will include the preferred channel of **300c**. A multi-carrier system comprising the bands of **300d**, **300e** and **300f** will include the preferred channel of **300f**. Any combinations of three adjacent bands will include a preferred channel upon which the mobile station will be able to receive the necessary system parameters for operation.

In the present invention, the mobile station tunes to a preferred channel (**300c**, **300f** or **300i**) and attempts to detect a pilot signal on that frequency band. If a pilot signal is detected the mobile station, receives demodulates and decodes the Sync Channel message. In the present invention, the Sync Channel message will provide information that identifies the center frequency of a multi-carrier system in the current set of frequency bands (if one exists) and the frequency of a 1x band in the current set of frequency bands (if one exists).

The mobile station in response to the information received in the Sync Channel selects the system that is appropriate for its needs or capabilities. If the mobile station prefers to use a multi-carrier system, the mobile station uses the center frequency of the multi-carrier system

indicated in the Sync Channel message to tune to the multi-carrier system and receive the broadcast channel (BCH) message. The broadcast channel message will indicate to the mobile station the number of common control channels (CCCHs) that are employed by the current system. The mobile station takes the number of common control channels and using a predetermined hashing algorithm determines what code channel it will use to receive page messages from the transmitting base station.

If the mobile station selects to operate in a single band system, the mobile station uses the information received in the Sync Channel message to tune to the appropriate frequency of the single band system. The mobile station then receives the general paging channel message on the primary paging channel. The general paging channel message provides the number of paging channels used by the single band system. The mobile station uses a predetermine hashing function to determine the code channel upon which the mobile station will receive paging message for the transmitting base station.

The present invention is equally applicable to systems that may include 3X direct spread communications systems. In this embodiment, the Sync Channel message would include the addition information whether the 3X system is a direct spread system or a multi-carrier system. In addition, the Sync Channel message may also provide information respect whether the system uses a form of diversity transmission such as orthogonal transmit diversity (OTD). If methods of transmission diversity are possible in the multiple bandwidth communication system, specification of the means of transmit diversity greatly reduces the number of hypotheses that must be tested to acquire a system.

These changes to the Sync Channel messages can be accommodated without necessitating the extension of the Sync Channel message used in IS-95B and illustrated above. In the current Sync Channel message there a large number of reserved bits that can be used to provide the additional information.

FIG. 3 is a flowchart illustrating the acquisition operation of the present invention. In block **2**, the mobile station tunes to a preferred channel (**300c**, **300f** or **300i**). It will be understood that the present invention is disclosed in context of the PCS band of freqeuncies and can easily be extended to other bands such as the cellular band. Moreover, the selected set of preferred channels though preferred for three carrier, multi-carrier

communications systems would be different for multi-carrier systems with a different number of carriers.

In block 6, the mobile station determines whether the search operation was successful. In the exemplary embodiment, the present invention is incorporated into a CDMA communications system, though the present invention would be equally applicable to other mixed bandwidth communications systems. In the exemplary embodiment, the mobile station tunes its RF receiver to a preferred channel (300c, 300f, or 300i) and attempts to detect the presence of a pilot signal. In the exemplary embodiment of an IS-95 based CDMA communications system, each base station transmits its pilot signal using a unique pilot signal offset. Thus, the mobile station after tuning to a preferred channel (300c, 300f, or 300i), searches the possible PN offset hypotheses.

The method and apparatus for detecting a pilot signal in a CDMA communication system are well known in the art and are described in detail in U.S. Patent No. 5,644,591, entitled "Method And Apparatus For Performing Search Acquisition In A CDMA Communication System", which is assigned to the assignee of the present invention. The mobile station tests each PN offset hypothesis by computing the correlation between the received signal within the preferred frequency band with the PN hypothesis being tested. If the correlation energy for all PN hypotheses is less than a threshold value, then the acquisition at the preferred frequency is not successful and the operation moves to block 4. In block 4, the next preferred channel (300c, 300f, or 300i) to be tested by the mobile station is selected and the flow moves to block 2 and continues as described.

When the mobile station detects sufficient correlation energy between the received signal at the preferred channel frequency and a PN offset hypothesis, a successful acquisition is declared. At this point the operation moves to block 8. In block 8, the mobile station receives the Sync Channel message. In the present invention, the Sync Channel message is transmitted in a single 1x band (300c, 300f, or 300i). In the exemplary embodiment of an IS-95 based CDMA communication system, the Sync Channel frame boundary and the interleaver boundary are aligned with the short PN sequence used to spread the pilot channel signal. Thus, upon successful acquisition of the pilot channel signal, the mobile station has enough information to de-interleave and decode the Sync Channel message.

After receiving the Sync Channel message, the operation moves to block **10**. The mobile station determines from the Sync Channel message the center frequency of a multi-carrier system in the current set of bands (if one exists) and the location of a single carrier band in the current set of bands (if one exists). The mobile station decides whether to operate in a multi-carrier mode or a single channel mode based on its capabilities and needs.

The operation moves to control block **10**. If the mobile station capable of operating in a multi-carrier mode decides to operate in multi-carrier mode, then the flow moves to block **12**. In block **12**, the mobile station initiates its RF hardware for multi-carrier reception. The mobile station will know from the received Sync Channel message the center frequency of a multi-carrier system in the current set of frequency bands if one exists. The operation then moves to block **14**, where the mobile station receives the broadcast channel (BCH) signal and from that channel learn among other information the number of common control channels used by the communication system. The mobile station hashes the number of common control channels to determine the code channel that it should use to receive pages.

If, back in block **10**, the mobile station decides to use a single channel system because of limitations in its capability or other preference with respect to its service needs, the operation moves to block **16**. In block **16**, the mobile station initiates its RF hardware for single-carrier reception. The operation then moves to block **18**, where the mobile station receives the general page message on a predetermined code channel. The general page message will state the number of paging channels used by the system. The mobile station hashes the number of paging channels used to determine the code channel that it will use to receive directed pages from the serving base station.

FIG. 4 introduces the elements and nomenclature of an very simplified wireless communications system. Base station **30** transmits forward link signal **32** to mobile station **40**. Mobile station **40** transmits reverse link signal **34** to base station **30**.

FIG. 5 is simplified block diagram illustrating the exemplary embodiment of base **30** as multi-carrier CDMA transmission system with three forward link channels. Each of transmission subsystems **48** transmits a portion of forward link signal **32** on a different carrier frequency. Transmission subsystem **48a** transmits a portion of forward link signal **32** on

frequency f_1, transmission subsystem **48b** transmits a portion of forward link signal **32** on frequency f_2, and transmission subsystem **48c** transmits a portion of forward link signal **32** on frequency f_3.

The data for transmission on forward link signal **32** is provided to de-multiplexer **50**. De-multiplexer **50** provides the data to one of the three transmission subsystems **48**. The present invention is described in term of a three carrier multi-carrier communication system because three IS-95 carriers each occupying 1.2288 MHz can fit into a 5MHz band. However, it will be understood by one skilled in the art that the teachings of the present invention can easily be extended to an arbitrary number of channels in a multi-carrier system.

The de-multiplexed data streams are provided to modulators **52**. In the exemplary embodiment, modulators **52** modulate the forward link data in accordance with a CDMA modulation format such as that described in the IS-95 standard and described in detail in the aforementioned U.S. Patent No. 5,103,459. The forward link data includes dedicated channel data that is for provision to a specific mobile station and broadcast channel data that is for provision to all mobile stations in the coverage area of base station **30** or a subset of mobile stations **30** in the coverage area of base station **30**. The Sync Channel message is an example of broadcast data that is transmitted to all mobile stations in the coverage area of base station **30**. In the present invention, the Synch Channel message is provided to a designated one of transmission subsystems **48** for transmission on a designated one of the three carriers.

The modulated forward link data from modulators **52** is provided to up converter **54**. Up converter **54** up coverts the modulated signal to a carrier frequency (f_1, f_2, or f_3) that is generated by a local oscillator (not shown). The up converted signals are then combined for transmission through antenna **56**.

FIG. 6 illustrates the exemplary embodiment of modulators **52** which modulate a portion of the forward link signal for transmission on a single carrier of forward link signal **32**. In the exemplary embodiment, a pilot signal is transmitted to allow for coherent demodulation of the signal by the receivers, which improves the performance of the receiver by providing a phase reference for demodulation. A set of pilot symbols known to both base station **30** and mobile station **40** are provided to Walsh spreader **60**. Walsh spreader **60** spreads the pilot symbols by a Walsh sequence W_{pilot}. In the exemplary embodiment, Walsh sequences are used to distinguish the

channels of the data transmitted on a single CDMA carrier. The Walsh function can be either of a fixed number of symbols as is described in the IS-95 specification or it can be an orthogonal function that varies in length in accordance with the rate of the data to be transmitted on the channel as is described in the cdma2000 proposal and in U.S. Patent No. 5,751,761, entitled "System and Method for Orthogonal Spread Spectrum Sequence Generation in Variable Data Rate Systems", which is assigned to the assignee of the present invention.

The Walsh spread pilot symbols are provided to complex PN spreader 62. Complex PN spreader 62 spreads the Walsh spread pilot symbols in accordance with two separately generated pseudonoise (PN) sequences, PN_I and PN_Q. If the two inputs to complex PN spreader 62 are designated as I and Q, the result of the complex spreading operation are two channels I′ and Q′ given by the equations:

$$I' = PN_I\, I - PN_Q\, Q \quad (1)$$

$$Q' = PN_Q\, I + PN_I\, Q. \quad (2)$$

The purpose of the complex PN spreading is to more evenly distribute the loading on the in-phase and quadrature channels of the QPSK modulator, which results in a reduction of the peak to average ratio on the power amplifier (not shown) of base station 30 which in turn increases the capacity of base station 30. Complex PN spreading is described in the cdma2000 RTT proposal and is described in detail in U.S. Patent Serial No. 6,396,804, entitled "High Data Rate CDMA Wireless Communication System", which is assigned to the assignee of the present invention. The complex PN spread pilot symbols are provided to transmitter (TMTR) 94, which up converts, filters and amplifies the signal for transmission through antenna 56.

In the exemplary embodiment, the Sync Channel message is distinguished from other channels of information by being spread by a unique orthogonal spreading sequence W_{sync}. In the preferred embodiment of the present invention, the sync channel message is only transmitted by a selected one of modulators 48a, 48b or 48c. The selected modulator 48 transmits the Sync Channel message on a preferred channel. In the exemplary embodiment, the Sync Channel message indicates the center frequency of a multi-carrier system in the current band of frequencies, in

one exists and the frequency of a single carrier system in the current set of frequency bands if one exists.

The Sync Channel message is provided to message formatter **64**. In the exemplary embodiment, message formatter **64** generates a set of cyclic redundancy check (CRC) bits and an optional set of tail bits and appends those bits to the Sync Channel message. IS-95 systems do not append tail bits to the Synch Channel message. cdma2000 (also referred to as IS-2000) systems append eight tail bits to the Sync Channel message. The Sync channel message with the CRC bits and tails bits appended are provided to encoder **66**. Encoder **66** encodes the sync channel message, CRC bits and tail bits in accordance with a predetermined forward error correction coding algorithm such as convolutional coding.

The encoded symbols are then provided to interleaver (INT) **68** which reorders the encoded symbols in accordance with a predetermined interleaving format. The interleaver is provided to provide time diversity in the transmitted stream of encoded symbols. Decoders have better error correction performance when the errors in the received stream are not burst errors.

The reordered symbols are provided to Walsh spreader **70** which spreads the reordered symbols in accordance with a predetermined code sequence W_{sync}. In the exemplary embodiment, W_{sync} is a code sequence that is orthogonal to all other code sequences used to channelized the channels of forward link signal **32**. The Walsh spread signal is then provided to complex PN spreader **62** and is spread as described above.

Common channel messages are transmitted to all subscriber stations or sets of subscriber stations within the coverage area of base station **30**. Examples of common channel messages include paging messages that alert mobile station of incoming calls and control channel messages that provide necessary control information to mobile stations in the coverage area of base station **30**. For illustration purposes a single control channel is shown. It will be understood by one skilled in the art that in practical implementations a plurality of control channels will be transmitted a base station **30**.

The Common Channel message is provided to message formatter **74**. In the exemplary embodiment, message formatter **74** generates a set of cyclic redundancy check (CRC) bits and a set of tail bits and appends those bits to the Common Channel message. The Common Channel message with the CRC bits and tails bits appended are provided to encoder **76**. Encoder **76**

encodes the Common Channel message, CRC bits and tail bits in accordance with a predetermined forward error correction coding algorithm such as convolutional coding.

The encoded symbols are then provided to interleaver (INT) **78** which reorders the encoded symbols in accordance with a predetermined interleaving format. The interleaver is provided to provide time diversity in the transmitted stream of encoded symbols. Decoders have better error correction performance when the errors in the received stream are not burst errors.

The reordered symbols are provided to Walsh spreader **82** which spreads the reordered symbols in accordance with a predetermined code sequence W_{cc}. In the exemplary embodiment, W_{cc} is a code sequence that is orthogonal to all other code sequences used to channelized the channels of forward link signal **32**. The Walsh spread signal is then provided to complex PN spreader **62** and is spread as described above.

Dedicated Channel data is transmitted to a particular subscriber station within the coverage area of base station **30**. The Dedicated Channel data is provided to message formatter **84**. In the exemplary embodiment, message formatter **84** generates a set of cyclic redundancy check (CRC) bits and a set of tail bits and appends those bits to the frame of dedicated channel data. The frame of Dedicated Channel data with the CRC bits and tails bits appended is provided to encoder **86**. Encoder **86** encodes the frame of Dedicated Channel data, CRC bits and tail bits in accordance with a predetermined forward error correction coding algorithm such as turbo coding or convolutional coding.

The encoded symbols are then provided to interleaver (INT) **88** which reorders the encoded symbols in accordance with a predetermined interleaving format. The interleaver is provided to provide time diversity in the transmitted stream of encoded symbols. Decoders have better error correction performance when the errors in the received stream are not burst errors.

The reordered symbols are provided to Walsh spreader **90**, which spreads the reordered symbols in accordance with a predetermined code sequence W_T. In the exemplary embodiment, W_T is a code sequence that is orthogonal to all other code sequences used to channelized the channels of forward link signal **32**. The Walsh spread signal is then provided to complex PN spreader **62** and is spread as described above.

The complex PN spread data is provided to transmitter (TMTR) **94** and up converted, filtered and amplified for transmission through antenna **56**.

Turning to FIG. 7, a simplified multi-carrier receiver which in the exemplary embodiment is provided in mobile station **40** is illustrated. In the exemplary embodiment, mobile station **40** is capable of simultaneously receiving forward link signals **32** transmitted on up to three carrier channels. It will be understood by one skilled in the art that the present invention can be extended to multi-carrier reception of an arbitrary number of channels. The received signal is provided to each of receive subsystems **105** which down convert and demodulate a different component of forward link signal **32** in accordance with a unique carrier frequency.

The forward link signal **32** is received at antenna **100** and provided to receivers **102**. Each of receivers **102a**, **102b** and **102c** down convert, filter and amplify the received signal in accordance with a different frequency f_1, f_2, or f_3, respectively. The down converted signals are provided to demodulators **104**. In the exemplary embodiment, demodulators **104** demodulated each of the down converted signals in accordance with a code division multiple access (CDMA) modulation format. The implementation of demodulators **104** are described in detail in the aforementioned U.S. Patent No. 5,103,459. The demodulated components of forward link signal **32** are provided to multiplexer (MUX) **106** which re-assembles the transmitted data stream.

In the present invention, mobile station **40** initially only uses a single receiver **102** and demodulator **104**. Mobile station **40** tunes a selected receivers **102** to a preferred channel (**300c**, **300f** or **300i**) and attempts to acquire the pilot signal at the preferred channel frequency using a corresponding one of demodulators **104**. If sufficient correlation energy is detected, the acquisition is declared to be successful. The mobile station then still only down converting at the single frequency, demodulates, de-interleaves and decodes the Sync Channel message. From the Sync Channel message, mobile station **40** determines the center frequency of a multi-carrier system in the current frequency bands, if one exists, and the frequency of a single carrier system in the current frequency bands, if one exists.

Mobile station **40** decides whether, it will operate in a multi-carrier mode or a single carrier mode. If mobile station **40** decides to operate in a multi-carrier mode, then mobile station **40** activates the RF circuitry additional receivers **102**, tuning to the appropriate set of frequencies

indicated in the Sync Channel message and begins to receive the forward link signal on a plurality of carrier frequencies. If mobile station **40** decides to operate in a single-carrier mode, then mobile station **40** tunes to the appropriate frequency indicated in the Sync Channel message and begins to receive the forward link signal on a single carrier frequency band.

FIG. 8 illustrates the apparatus to receive forward link signal **32** in the exemplary embodiment of a CDMA communication system. Initially, mobile station 40 must tune to a preferred channel and attempt to acquire the pilot signal of that channel in the following manner.

The forward link signals **32** are received at antenna **100** and provided to receiver **102**. Receiver **102** tunes to a preferred channel frequency and down converts, filters and amplifies the received signal. In the exemplary embodiment, receiver **102** is a quaternary phase shift keyed receiver and outputs an in-phase (I) and Quadrature (Q) component of the received signal.

The two components of the received signal are provided to complex PN despreader **112**. Complex PN despreader **112** despreads the received signal in accordance with two pseudonoise sequences PN_I and PN_Q. In the exemplary embodiment, the PN despreading is a complex PN despreading as is described in detail in the aforementioned U.S. Patent Serial No. 6,396,804. In the exemplary embodiment, the PN sequences used to spread forward link signals **32** are generated using a generator polynomial that is common to all base stations **30**. The spreading from base stations is distinguished from one another by the offset of the sequence.

Control processor **128** provides offset hypotheses to complex PN despreader **112**. Complex PN despreader **112** despreads the received signals in accordance with the PN offset hypotheses provided by control processor **128** as well as W_{pilot}. The received signal is despread in accordance with the PN offset hypothesis and the resultant signal is provided to pilot filter **114**. Pilot filter **114** despreads the signal from complex PN despreader **112** in accordance with an orthogonal sequence W_{pilot} and low pass filters the result of complex despreader **112** In the exemplary embodiment, the Walsh sequence comprising of all 1's is used to channel the pilot signal.

The resultant signals from pilot filter **114** are provided to energy detector **118** which sums the squares of the resultant samples from pilot filter **114** to provide a received pilot energy value. The received pilot energy value is provided to control processor **128**, where it is compared to a

predetermined threshold value. If the computed energy exceeds the threshold acquisition is declared to be successful and the mobile station begins to receive the Sync Channel message. If the energy falls below the threshold value, then the acquisition is declared unsuccessful and the next PN hypothesis is provided by control processor **128** to complex PN despreader **112**. The method and apparatus for searching PN offsets in a CDMA communication system is described in detail in U.S. Patent No. 5,644,591, entitled "Method And Apparatus For Performing Search Acquisition In A CDMA Communication System", which is assigned to the assignee of the present invention. If
exhausting the possible PN offset hypotheses, the received pilot energy fails to exceed the threshold value, then control processor sends message to receiver **102** to begin down converting the received signal at a different preferred frequency channel.

Upon successful acquisition of a pilot channel on a preferred channel frequency, mobile station **40** demodulates and decodes the Sync Channel message. The received signal from receiver **102** is despread using the PN offset determined in the pilot search algorithm. The pilot signal is processed by pilot filter **114** as described above.

The PN despread signal is also provided to Walsh despreader **116**. Walsh despreader **116** despreads the received signal in accordance with a Walsh code sequence W_{chan}. When demodulating the Sync Channel, the W_{chan} is Walsh sequence allocated for the transmission of the Sync Channel message. Walsh despreader **116** despreads the signal components in accordance with the orthogonal sequence W_{chan} and provides the result to dot product circuit **120**.

As forward link signal **32** traverse the propagation path to mobile station **40**, an unknown phase component is introduced into the received signal. Dot product circuit **120** computes the projection of the received signal onto the received pilot signal to provides a scalar result without the phase errors. The implementation of dot product circuits for coherent demodulation are well known in the art and a method and apparatus for performing the dot product procedure is described in detail in U.S. Patent No. 5,506,865, entitled "Pilot Carrier Dot Product Circuit" which is assigned to the assignee of the present invention.

The scalar outputs from dot product circuit **120** are provided to multiplexer **122** which combines the two received streams into a signal data stream. The data stream from multiplexer **122** is provided to de-interleaver

124 which reorders the received symbols in accordance with a predetermined de-interleaving format. The reordered symbols are provided to decoder **126** which decodes the symbols of the Sync Channel message to provide the received Sync Channel message.

The received Sync Channel message is provided to control processor **128**. In the present invention, control processor **128** determines from the Sync Channel message the channel frequency for the primary overhead channel of the single carrier system or the center frequency of the multi-carrier system. In response to the Sync Channel message, control processor **128** initiates the correct number of receive subsystems **105** and tunes them to the appropriate channels to receive forward link signal **32**.

The previous description of the preferred embodiments is provided to enable any person skilled in the art to make or use the present invention. The various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles defined herein may be applied to other embodiments without the use of the inventive faculty. Thus, the present invention is not intended to be limited to the embodiments shown herein but is to be accorded the widest scope consistent with the principles and novel features disclosed herein.

CLAIMS:

1. A multi-frequency channel base station operating within a predetermined set of frequency channels wherein data components of forward link data are transmitted simultaneously on a plurality of frequency bands each band representing a frequency channel and having a carrier frequency, comprising:

a first transmission subsystem for transmitting a sync channel message on a single frequency channel of said predetermined set of frequency channels, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system,

wherein the center frequency channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; and

at least one additional transmission subsystem for transmitting remaining components of said forward link data on another frequency channel of said predetermined set of frequency channels.

2. The base station of claim 1 wherein said sync channel message indicates the frequency channel of a single channel system in said predetermined set of frequency channels.

3. The base station of claim 1 wherein said sync channel message is transmitted on one of the set of preferred frequency channels wherein the number of channels is less than the number of channels in said predetermined set of frequency channels.

4. The base station of claim 3 wherein said set of predetermined frequency channels are the set of frequency channels in a personal communications system block of frequency channels.

5. The base station of claim 4 wherein the channel numbers of the set of preferred frequency channels are 75, 150 and 225.

6. A multi-frequency channel mobile station comprising:

a control processor for controlling the operation of a plurality of receiver subsystems in accordance with frequency information indicated in a received sync channel message, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system,

wherein the center frequency channel is used for reception of signals by the mobile station and is one of a set of a preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel;

a first receiver subsystem for receiving said sync channel message on a single frequency channel and for providing said sync channel message to said control processor and for receiving a first portion of a multi-channel signal; and

at least one additional receiver subsystem for receiving additional portions of said multi-channel signal.

7. The mobile station of claim 6 wherein said control processor decides whether to operate in a single frequency channel mode or a multi-frequency channel mode and directs

said first receiver subsystem to tune to a frequency channel indicated in said sync channel message for the reception of a single channel system when said mobile station decides to operate in a single frequency channel mode and directs said at least one additional receiver subsystem to tune to at least one additional frequency channel when said mobile station decides to operate in a multi-frequency channel mode.

8. The mobile station of claim 6 wherein said control processor directs said first receiver subsystem to tune to one of a predetermined set of preferred frequency channels.

9. The mobile station of claim 8 wherein said mobile station is operating within a personal communication system (PCS) set of frequency channels and wherein said predetermined set of preferred frequency channels consist of the frequency channel numbers 75, 150 and 225.

10. A method of transmitting data components of forward link data in a communication system, comprising:

transmitting a sync channel message on a single frequency channel within a predetermined set of frequency channels, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system,

wherein the center frequency channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; and

transmitting remaining components of said forward link data on another frequency channel within said predetermined set of frequency channels.

11. The method of claim 10 wherein said sync channel message is transmitted on one of a set of preferred frequency channels wherein the number of channels is less than the number of channels in said predetermined set of frequency channels.

12. The method of claim 11 wherein said set of predetermined frequency channels are the set of frequency channels in a personal communications system block of frequency channels.

13. The method of claim 12 wherein the channel numbers of the set of preferred frequency channels are 75, 150 and 225.

14. A method of receiving data components of forward link data in a communication system, comprising:

receiving a sync channel message and a first portion of a multi-channel signal on a single frequency channel, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system,

wherein the center frequency channel is used for reception of signals and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel;

controlling operation of a plurality of receiver subsystems in accordance with frequency information indicated in said received sync channel message; and

receiving additional portions of said multi-frequency channel signal on another frequency channel.

15. The method of claim 14 further comprising deciding whether to operate in a single frequency channel mode or a multi-frequency channel mode and tuning to a frequency channel indicated in said sync channel message for the reception of a single frequency channel signal when deciding to operate in a single frequency channel mode and tuning to at least one additional frequency channel when deciding to operate in a multi-frequency channel mode.

16. A multi-frequency channel base station operating within a predetermined set of frequency channels wherein data components of forward link data are transmitted simultaneously on a plurality of frequency bands each band representing a frequency channel and having a carrier frequency, said base station comprising:

means for transmitting a sync channel message on a single frequency channel within a predetermined set of frequency channels, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system,

wherein the center frequency channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel; and

means transmitting remaining components of said forward link data on another frequency channel within said predetermined set of frequency channels.

17. The base station of claim 16 wherein said sync channel message is transmitted on one of a set of preferred frequency channels wherein the number of channels is less than the number of channels in said predetermined set of frequency channels.

18. The base station of claim 17 wherein said set of predetermined frequency channels are the set of frequency channels in a personal communications system block of frequency channels.

19. The base station of claim 18 wherein the channel numbers of the set of preferred frequency channels are 75, 150 and 225.

20. A multi-frequency channel mobile station comprising:

means for controlling the operation of a plurality of receiver subsystems in accordance with frequency information indicated in a received sync carrier message, wherein said sync channel message indicates one of a center frequency channel of a multi-channel system and a single channel system,

wherein the center frequency channel is used for reception of signals and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands that are arranged such that any combination of three adjacent bands includes the center frequency channel;

means for receiving said sync channel message on single frequency channel and for providing said sync carrier message to said means for controlling and for receiving a first portion of a multi-channel signal; and

means for receiving additional portions of said multi-frequency channel signal on another frequency channel.

21. The mobile station of claim 20 wherein said means for controlling decides whether to operate in a single frequency channel mode or a multi-frequency channel mode and directs said first receiver subsystem to a frequency channel indicated in said sync channel message for the reception of a single frequency channel signal when said mobile station decides to operate in a single frequency channel mode and directs said at least one additional receiver subsystem to tune to at least one additional frequency channel when deciding to operate in a multi-frequency channel mode.

22. The mobile station of claim 20 wherein said means for controlling directs said first receiver subsystem to tune to one of a predetermined set of preferred frequency channels.

23. The mobile station of claim 20 wherein said mobile station is operating within a personal communication system (PCS) set of frequency channels and wherein said predetermined set of preferred frequency channels consist of the frequency channel numbers 75, 150 and 225.

24. An apparatus operable in at least one of a single carrier system and a multi-carrier system, comprising:

a demultiplexer that demultiplexes a forward link signal into a forward link data stream comprising broadcast channel data including a sync channel message;

a first transmission subsystem, coupled to the demultiplexer, that transmits a first portion of the forward link data stream on a first carrier frequency;

a second transmission subsystem, coupled to the demultiplexer, that transmits a second portion of the forward link data stream on a second carrier frequency; and

a third transmission subsystem, coupled to the demultiplexer, that transmits a third portion of the forward link data stream on a third carrier frequency,

wherein the sync channel message is transmitted on a preferred channel by a selected one of the first, second and third transmission subsystems for transmission at a selected one of the first, second and third carrier frequencies, and

wherein the preferred channel is used for reception of signals by a device receiving the sync channel message and is one of a set of preferred frequency channels that correspond to a plurality of frequency bands arranged such that any combination of three adjacent bands includes the preferred frequency channel.

25. The apparatus recited in claim 24, wherein the first transmission subsystem, comprises:

a first modulator that modulates the forward link data signal; and

a first up converter that receives modulated forward link data signal from the first modulator and up converts the modulated forward link data signal with the first carrier frequency to generate the first portion of time forward link data stream on the first carrier frequency.

26. The apparatus recited in claim 25, wherein the second transmission subsystem, comprises:

a second modulator that modulates the forward link data signal; and

a second up converter that receives modulated forward link data signal from the second modulator and up converts the modulated forward link data signal with the second carrier frequency to generate the second portion of the forward link data stream on the second carrier frequency.

27. The apparatus recited in claim 26, wherein the third transmission subsystem, comprises:

a third modulator that modulates the forward link data signal; and

a third up converter that receives modulated forward link data signal from the third modulator and up converts the modulated forward link data signal with the third carrier frequency to generate the third portion of the forward link data stream on the third carrier frequency.

28. The apparatus recited in claim 27, wherein the forward link data stream, further comprises:

a pilot symbol stream;

dedicated channel data for a specific mobile station; and

a common channel message.

29. The apparatus recited in claim 28, wherein the common channel message comprises a plurality of common channel messages transmitted to at least a set of subscriber stations within a coverage area of the apparatus.

30. The apparatus recited in claim 28, wherein the first modulator that modulates the forward link data signal, comprises:

a first Walsh spreader that receives the pilot symbol stream and spreads the pilot symbol stream using a Walsh sequence.

31. The apparatus recited in claim 30, wherein the first modulator that modulates the forward link data signal, further comprises:

a first message formatter that receives the sync channel message and generates a first act of cyclic redundancy check (CRC) bits and appends the first set of CRC bits to the sync channel message to produce a formatted sync channel message;

a first encoder that encodes the formatted sync channel message with a first predetermined forward error correction coding algorithm and generates first encoded symbols;

a first interleaver interleaves the first encoded symbols with a first predetermined interleaving format to generate first reordered symbols; and

a second Walsh spreader that receives the first reordered symbols and spreads the first reordered symbols in accordance with a first predetermined code sequence to generate a first Walsh spread signal.

32. The apparatus recited in claim 31, wherein the second modulator that modulates the forward link data signal, comprises:

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a second message formatter that receives the common channel message and generates a second set of cyclic redundancy check (CRC) bits end appends the second set of CRC bits to the common channel message to produce a formatted common channel message;

a second encoder that encodes the formatted common channel message with a second predetermined forward error correction coding algorithm and generates second encoded symbols;

a second interleaver interleaves the second encoded symbols with a second predetermined interleaving format to generate second reordered symbols; and

a third Walsh spreader that receives the second reordered symbols and spreads the second reordered symbols in accordance with a second predetermined code sequence to generate a second Walsh spread signal.

33. The apparatus recited in claim 32, wherein the third modulator that modulates the forward link data signal, comprises:

a third message formatter that receives the dedicated channel data and generates a third set of cyclic redundancy check (CRC) bits and appends the third set of CRC bits to the dedicated channel data to produce a frame of dedicated channel data;

a third encoder that encodes the frame of dedicated channel data with a third predetermined forward error correction coding algorithm and generates third encoded symbols;

a third interleaver interleaves the third encoded symbols with a third predetermined interleaving format to generate third reordered symbols; and

a fourth Walsh spreader that receives the third reordered symbols and spreads the third reordered symbols in accordance with a third predetermined code sequence to generate a third Walsh spread signal.

34. The apparatus recited in claim 32, further comprising:

a complex PN despreader that despreads the Walsh spread pilot symbol stream, the first Walsh spread signal, the second Walsh spread signal and the third Walsh spread signal, with two separately generated pseudonoise (PN) sequences to generate complex PN spread data; and

a transmitter that receives the complex PN spread data, and up converts, filters and amplifies the complex PN spread data.

35. The apparatus recited in claim 24, wherein channel numbers of the preferred channel comprise at least one of 75, 150 and 225.

36. The apparatus recited in claim 35, wherein the sync channel message is only transmitted by a selected one of first, second and third modulators.

37. The apparatus recited in claim 36, wherein the multicarrier system comprises a plurality of bands arranged such that any combination of three adjacent bands includes a preferred channel and wherein the sync channel message indicates the center frequency of a multi-carrier system in the current band of frequencies, if one exists.

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38. The apparatus recited in claim 37, wherein the sync channel message indicates the frequency of a single carrier system in the current set of frequency bands, if one exists.

39. The apparatus recited in claim 24, wherein the sync channel message is distinguished from other channels of information by being spread by a unique first predetermined code sequence.

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PATENT AGENTS

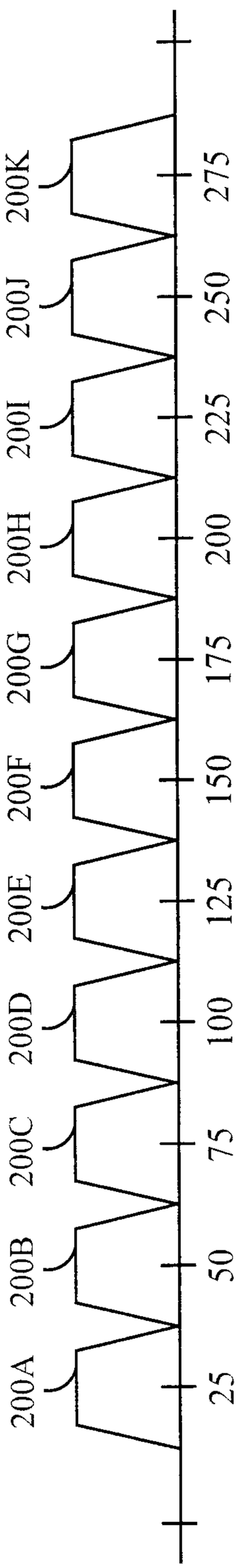
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FIG. 1

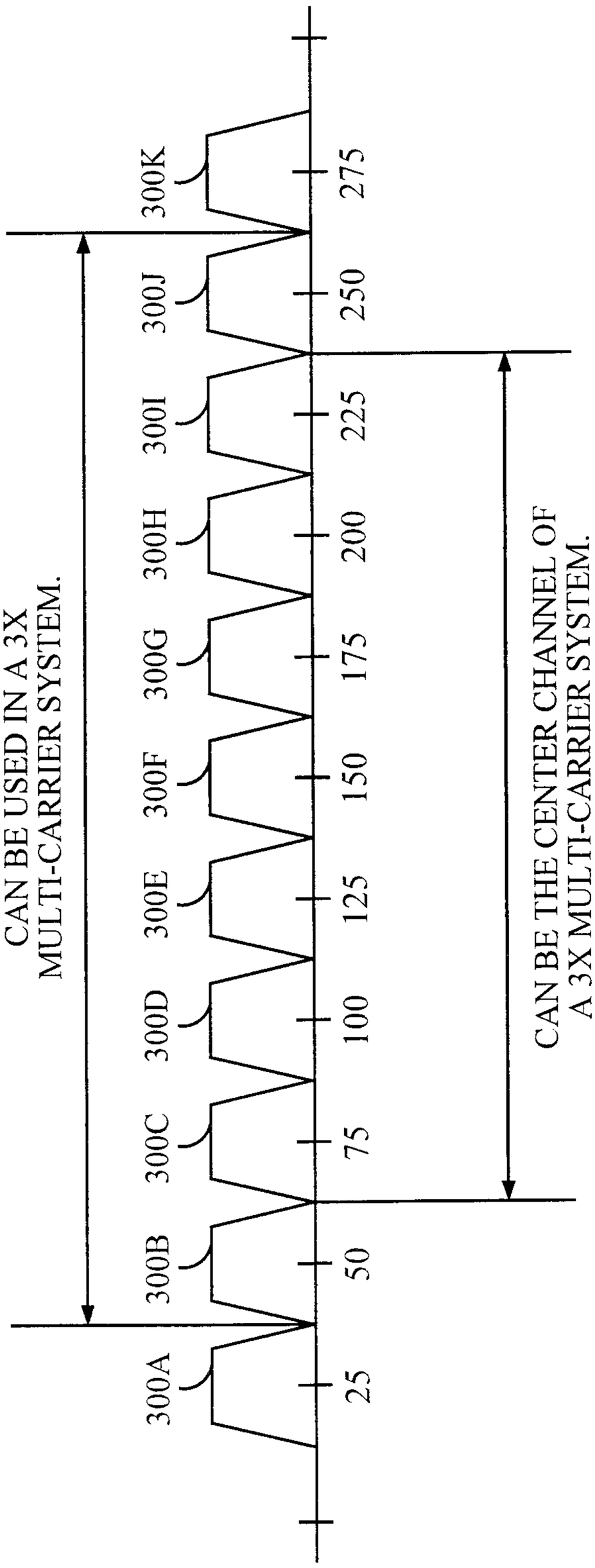

CAN BE USED IN A 3X MULTI-CARRIER SYSTEM.
CAN BE THE CENTER CHANNEL OF A 3X MULTI-CARRIER SYSTEM.
300A
300B
300C
300D
300E
300F
300G
300H
300I
300J
300K
25
50
75
100
125
150
175
200
225
250
275

FIG. 2

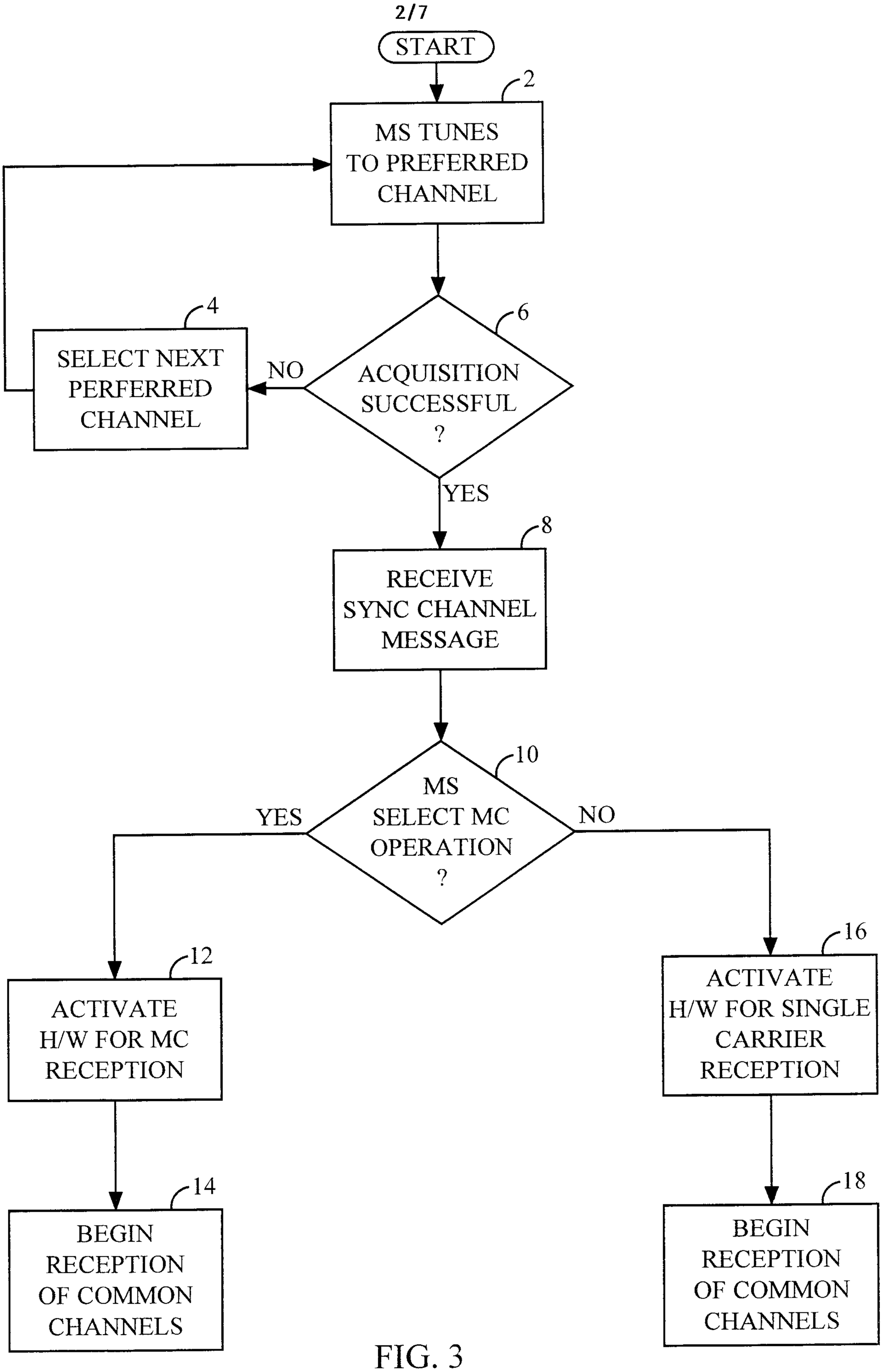

START
2
MS TUNES TO PREFERRED CHANNEL
6
ACQUISITION SUCCESSFUL ?
NO
4
SELECT NEXT PERFERRED CHANNEL
YES
8
RECEIVE SYNC CHANNEL MESSAGE
10
MS SELECT MC OPERATION ?
YES
12
ACTIVATE H/W FOR MC RECEPTION
14
BEGIN RECEPTION OF COMMON CHANNELS
NO
16
ACTIVATE H/W FOR SINGLE CARRIER RECEPTION
18
BEGIN RECEPTION OF COMMON CHANNELS

FIG. 3

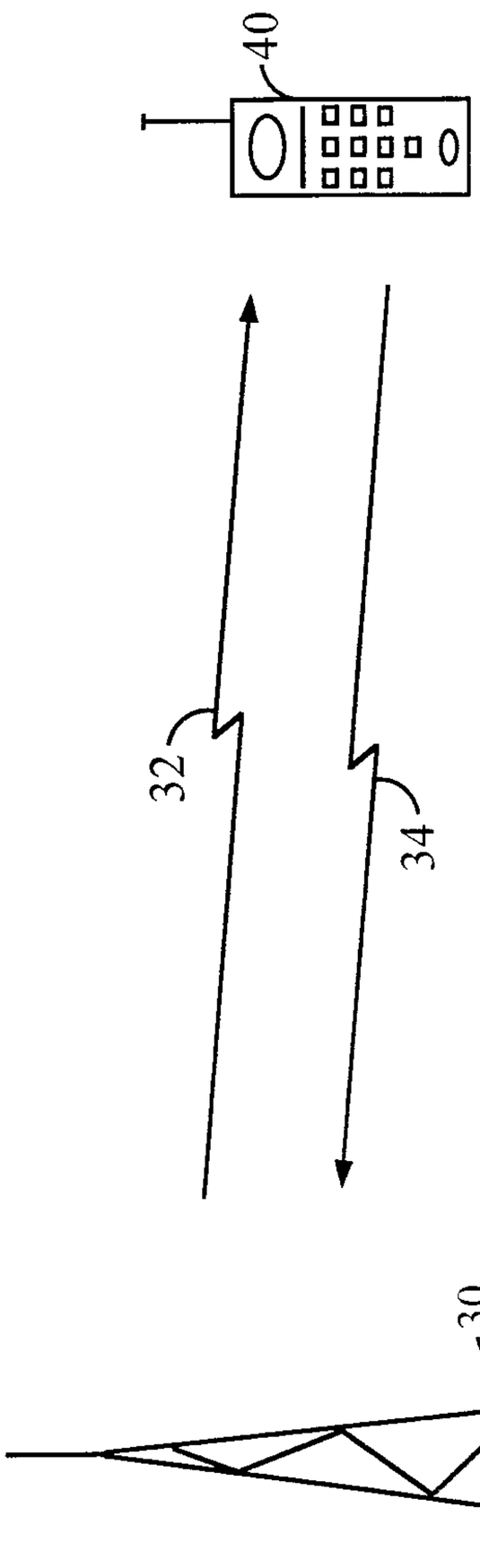


FIG. 4

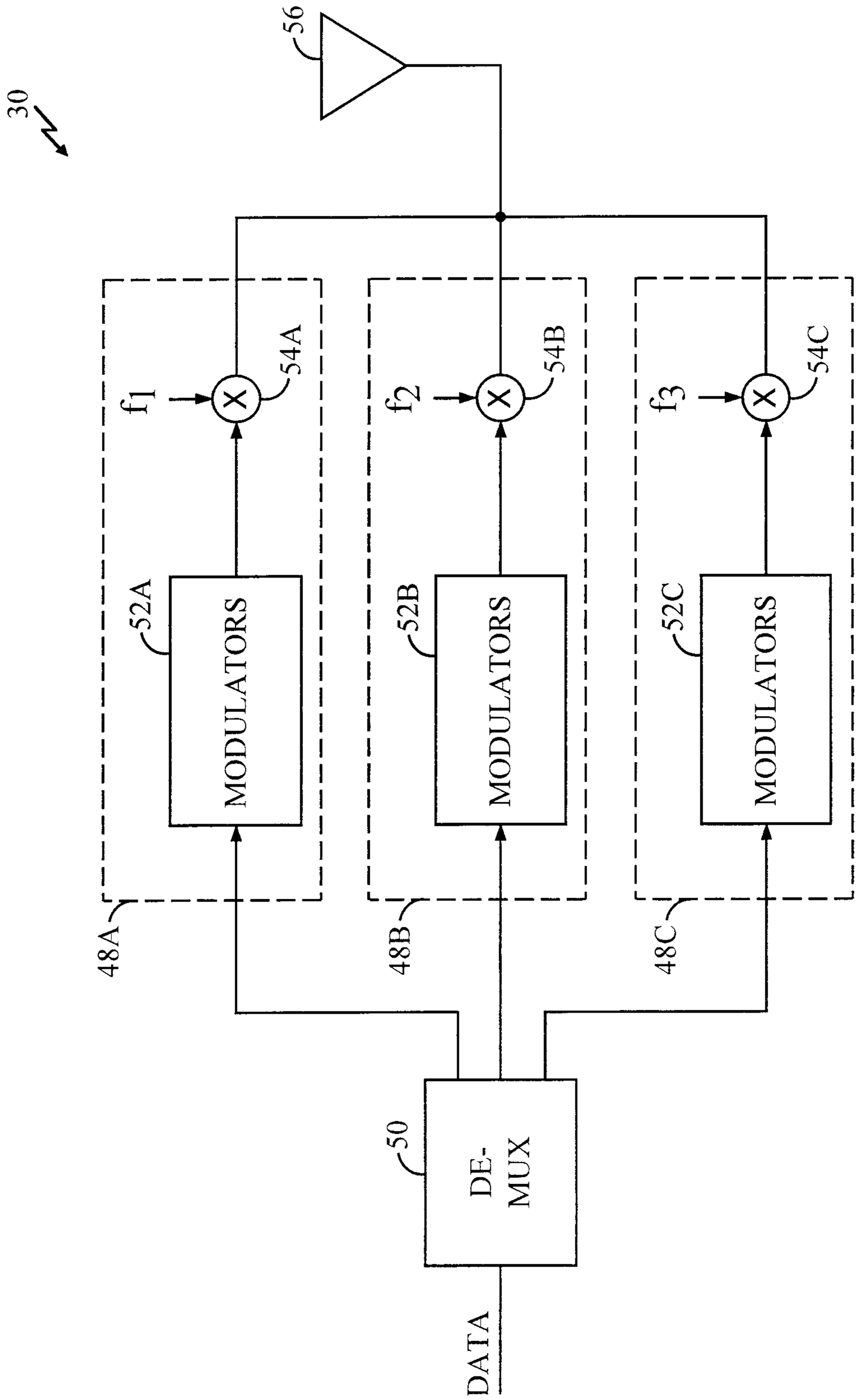

DATA
DE-MUX
50
MODULATORS
52A
MODULATORS
52B
MODULATORS
52C
48A
48B
48C
f1
f2
f3
54A
54B
54C
56
30

FIG. 5

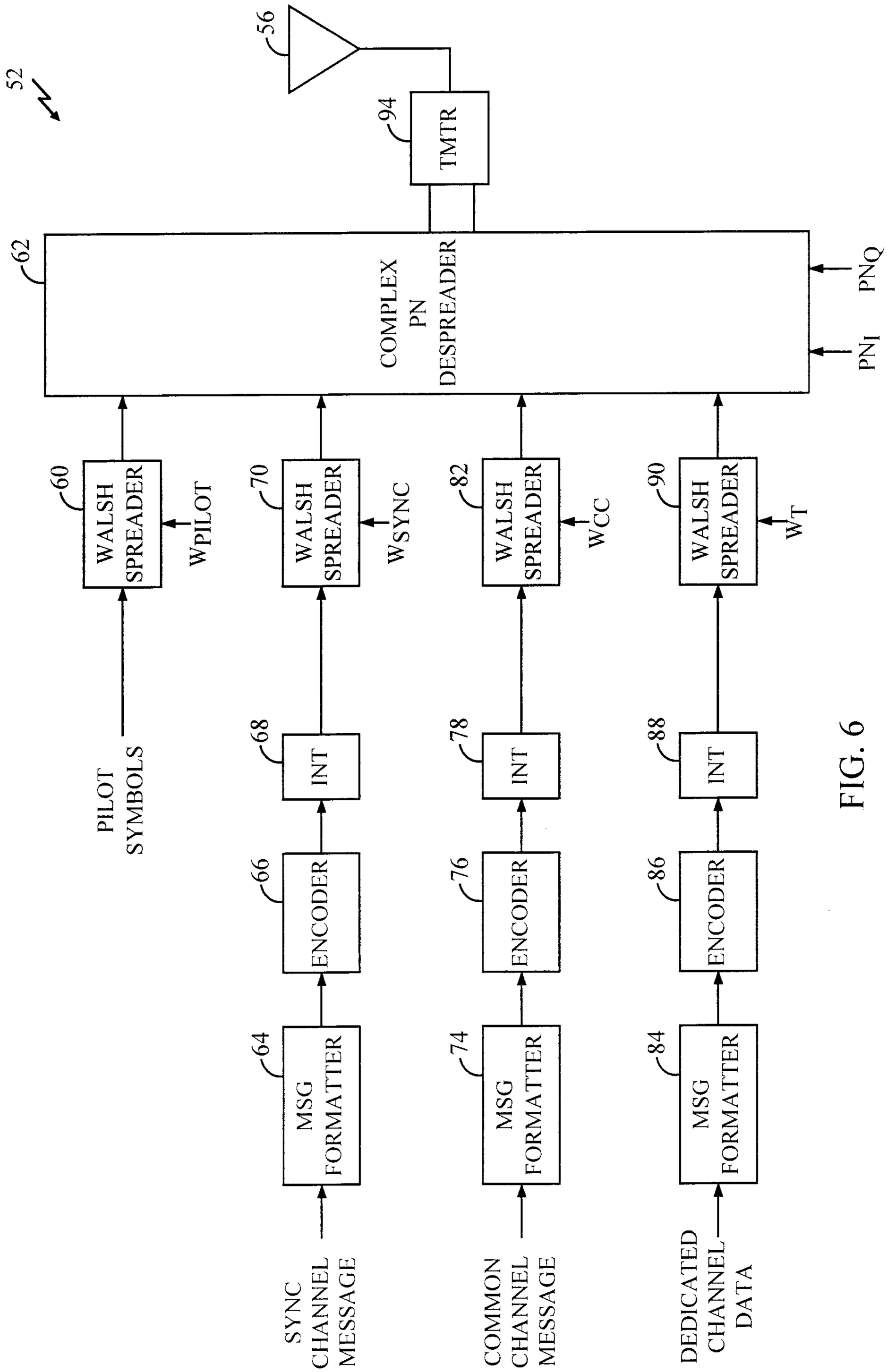

52
56
94
TMTR
62
COMPLEX PN DESPREADER
PNQ
PNI
60
WALSH SPREADER
WPILOT
70
WALSH SPREADER
WSYNC
82
WALSH SPREADER
WCC
90
WALSH SPREADER
WT
PILOT SYMBOLS
68
INT
66
ENCODER
64
MSG FORMATTER
SYNC CHANNEL MESSAGE
78
INT
76
ENCODER
74
MSG FORMATTER
COMMON CHANNEL MESSAGE
88
INT
86
ENCODER
84
MSG FORMATTER
DEDICATED CHANNEL DATA

FIG. 6

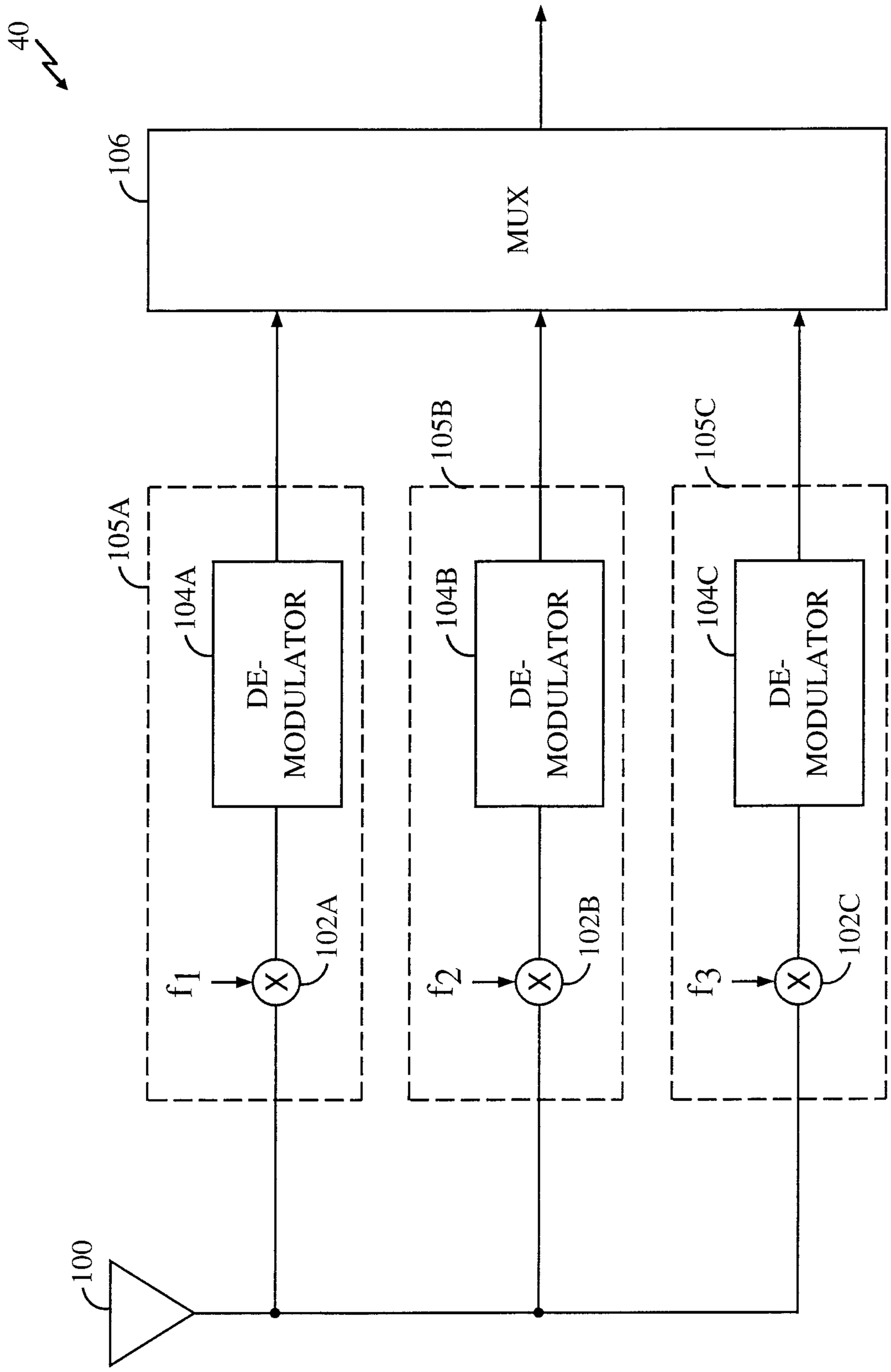

40
106
MUX
105A
104A
DE-MODULATOR
f_1
102A
105B
104B
DE-MODULATOR
f_2
102B
105C
104C
DE-MODULATOR
f_3
102C
100

FIG. 7

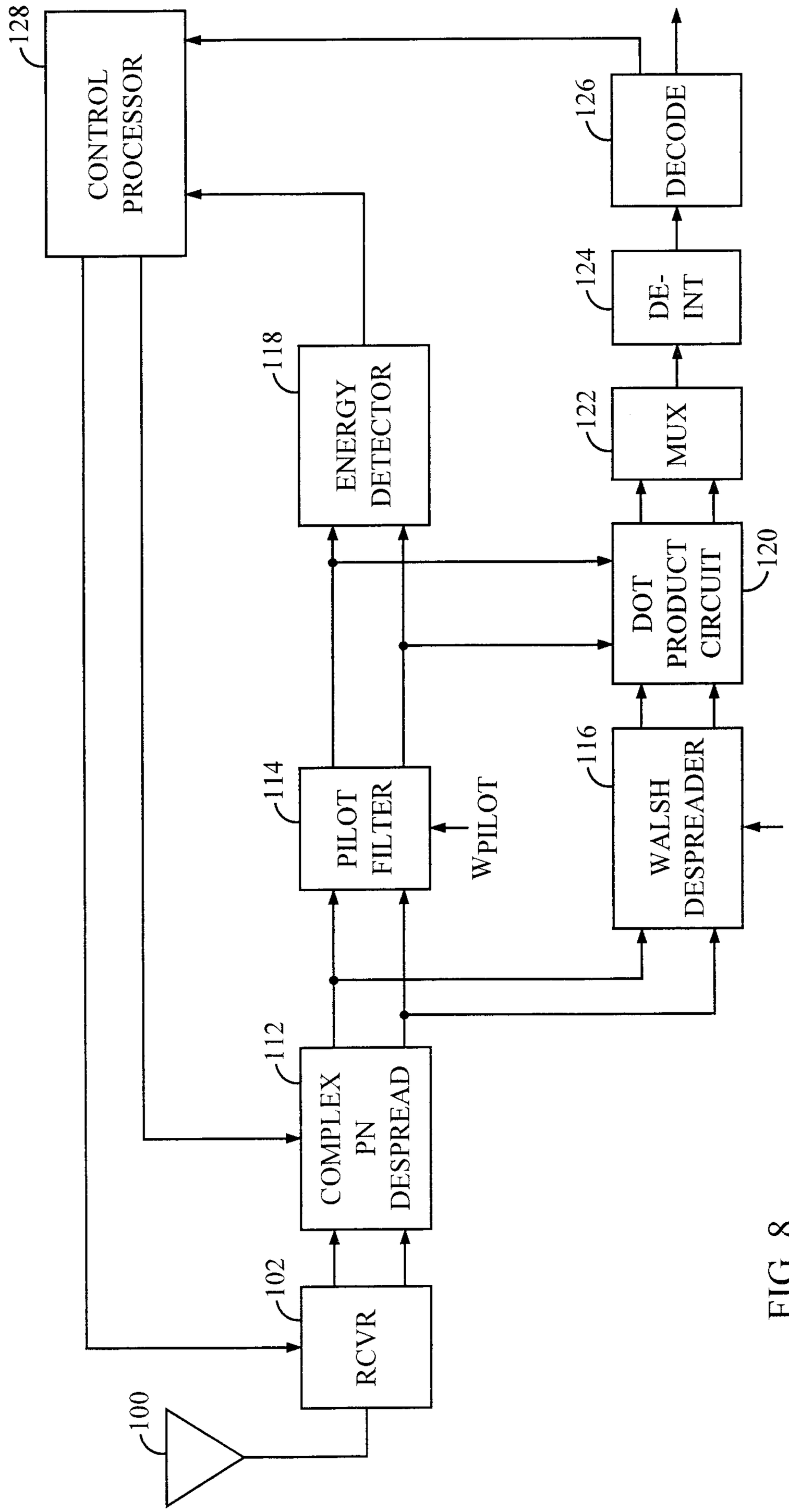
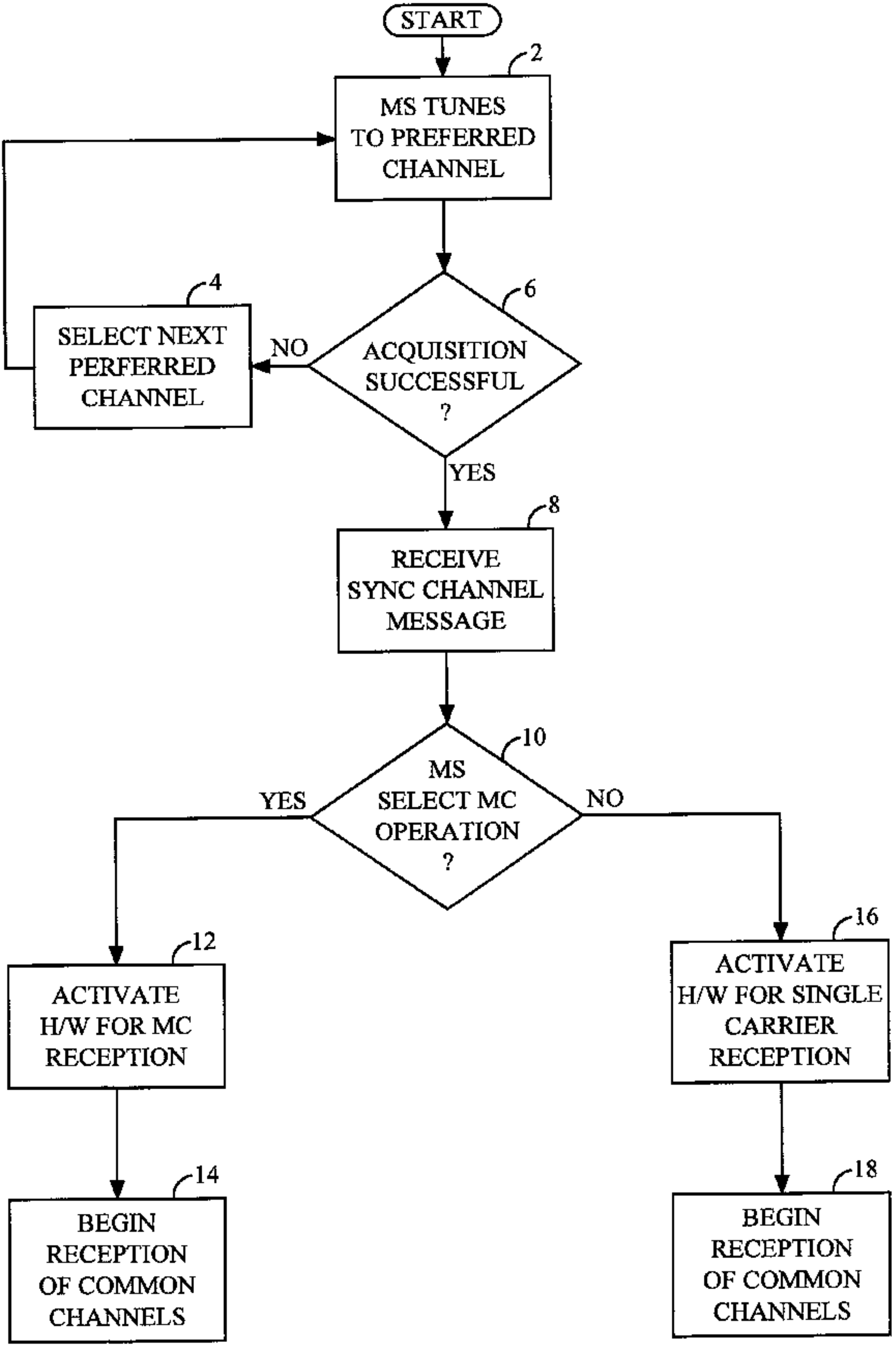

128
CONTROL PROCESSOR
126
DECODE
124
DE-INT
122
MUX
120
DOT PRODUCT CIRCUIT
118
ENERGY DETECTOR
116
WALSH DESPREADER
WCHAN
114
PILOT FILTER
WPILOT
112
COMPLEX PN DESPREAD
102
RCVR
100

FIG. 8


START
2
MS TUNES TO PREFERRED CHANNEL
4
SELECT NEXT PERFERRED CHANNEL
NO
6
ACQUISITION SUCCESSFUL ?
YES
8
RECEIVE SYNC CHANNEL MESSAGE
10
MS SELECT MC OPERATION ?
YES
NO
12
ACTIVATE H/W FOR MC RECEPTION
14
BEGIN RECEPTION OF COMMON CHANNELS
16
ACTIVATE H/W FOR SINGLE CARRIER RECEPTION
18
BEGIN RECEPTION OF COMMON CHANNELS