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(72) KOCKMANN, JURGEN, DE
(72) SYDON, UWE, DE
(71) SIEMENS AKTIENGESELLSCHAFT, DE

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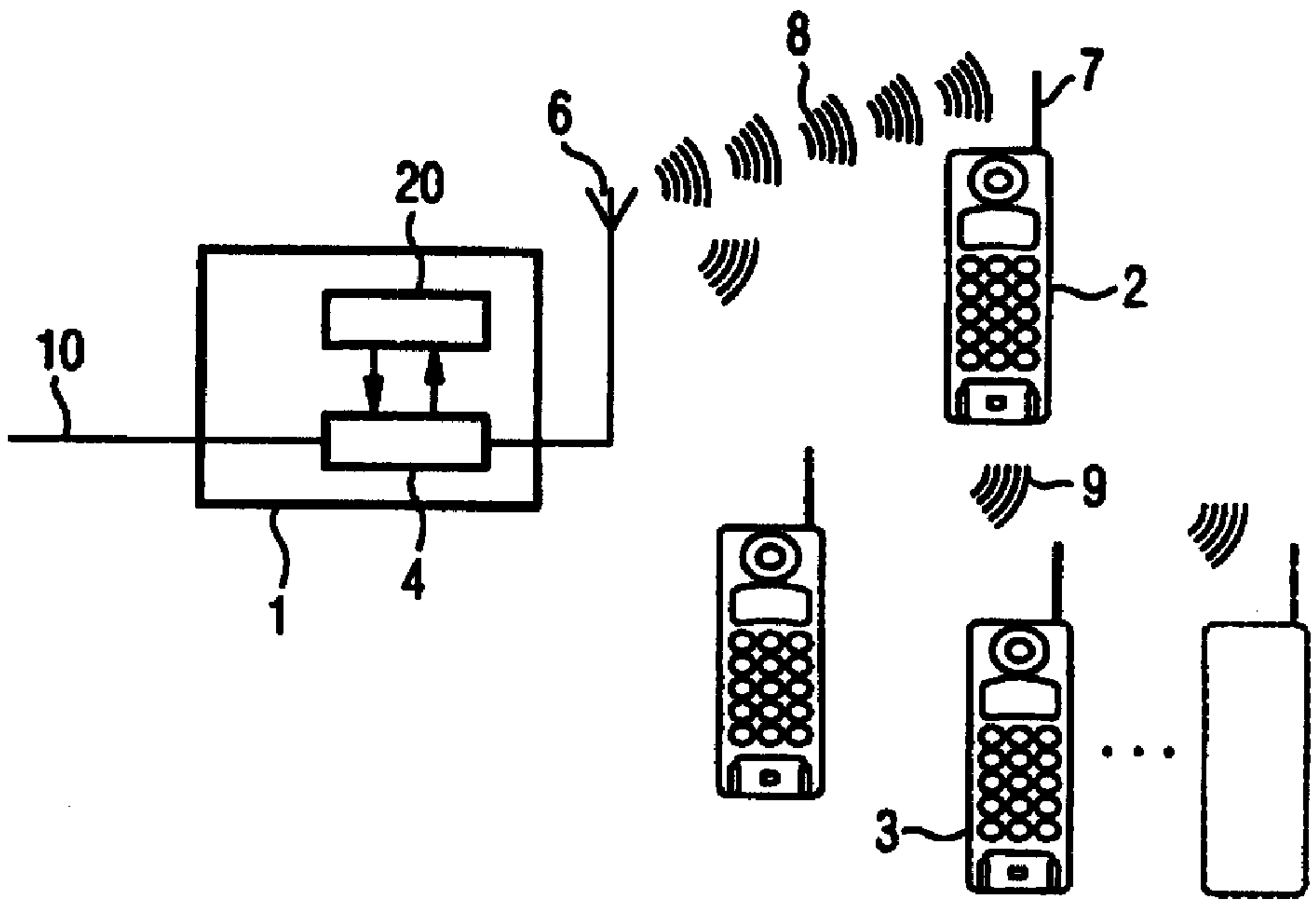
(54) **PROCEDE ET SYSTEME DE TRANSMISSION POUR LA SIGNALISATION D'UNE FREQUENCE PORTEUSE**

(54) **METHOD AND SYSTEM FOR SIGNALLING A CARRIER FREQUENCY**




(57) La présente invention offre la possibilité de signaler numériquement une fréquence porteuse qui est utilisée à un moment prédéterminé après la signalisation. L'invention est mise en oeuvre en particulier selon ce que l'on appelle un mode multitrame d'une partie mobile (2) d'un système de transmission numérique, mode selon lequel la station mobile (2) ne reçoit des données en provenance d'une station fixe (1) que

(57) The invention offers the possibility of digitally signalling a carrier frequency which is used at a predetermined time after the signalling. The invention operates according to the so-called multiframe mode of a mobile part (2) of a digital transmission system, mode whereby the mobile station (2) receives data coming from the fixed station (1) only during what are known as multiframe intervals, to be synchronised on the fixed

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pendant ce que l'on appelle des intervalles multitrames, pour pouvoir se synchroniser sur la station fixe (1) en économisant de l'énergie. Un intervalle multitrame est prévu après chaque (m-1) intervalle de la transmission. La fréquence porteuse (fx) utilisée dans l'intervalle multitrame suivant par la station fixe (1) est signalée à la station mobile (2) par les bits qui correspondent aux bits de l'en-tête du champ A de la norme DECT. Selon l'invention, à partir de la signalisation et de la synchronisation des fréquences porteuses (fx) des intervalles multitrames qui ont été effectuées une fois en tant que première étape, la synchronisation des fréquences porteuses, en ce qui concerne les intervalles, peut être effectuée entre deux intervalles multitrames successifs.

station (1), thus saving energy. A multiframe interval is provided after each (m-1) transmission interval. The carrier frequency (fx) used in the following multiframe interval by the fixed station (1) is signalled to the mobile station (2) by the bits corresponding to the A field header of the DECT standard . On the basis of the signalling and the synchronisation of the carrier frequencies (fx) of the multiframe intervals which have been carried out once as a first step, the carrier frequency synchronisation, concerning the intervals, can be carried out between two successive multiframe intervals.

GR 97 P 2146 P

Abstract

Method and transmission system for the signalling of a carrier frequency

The present invention provides a possible way of signalling digitally a carrier frequency which is used at a predetermined instant after the signalling. The invention can be used in particular in a so-called multiframe mode of a mobile part (2) of a digital transmission system, in a multiframe mode the mobile station (2) receiving data from a fixed station (1) only during so-called multiframe frames in order to be able to resynchronized with the fixed station (1) in an energy-saving manner. A multiframe frame is in this case provided after every (m-1) frames of the transmission. The carrier frequency (fx) used by the fixed station (1) in the next multiframe frame is in this case signalled to the mobile station (2) by means of the bits which correspond to bits of the header of the A field of the DECT standard.

According to the invention, as a result of the initially effected signalling and synchronization of the carrier frequencies (fx) of the multiframe frames as the first step, it is then possible for the carrier frequency synchronization with regard to the frames between two successive multiframe frames to be carried out.

Figure 1

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Description

# Method and transmission system for the signalling of a carrier frequency

The present invention relates to a method and a transmission system which permits signalling of a carrier frequency which is used at a predetermined instant after the signalling. The invention in this case relates in particular to a method and a transmission system which permits the signalling of the frequencies of a so-called multiframe mode of a frequency hopping spread spectrum interface based on the DECT standard.

The so-called frequency hopping spread spectrum system is a known method for transmitting data on a plurality of carrier frequencies. A frequency hopping spread spectrum system is in this case to be understood as meaning a system in which, for the purpose of radio transmission of data, a multiplicity of carrier frequencies are provided and the currently used carrier frequency is periodically changed. In a time division multiplex (TDMA) system, in particular, the carrier frequency may be changed after each time slot or time frame of the time division multiplex transmission or an integral multiple thereof. Such a frequency hopping spread spectrum system has advantages to the extent that the energy of the entire radiotransmission is distributed over all the carrier frequencies. This is important particularly when a generally available frequency band, such as the 2.4 GHz ISM (Industrial, Scientific, Medical) band, for example, is used. For the use of this frequency band, an upper limit for the maximum energy occurring per carrier frequency is defined in accordance with the relevant specifications (in the USA, the specification "FCC part 15" defined by the Federal Communications Commission), in order to minimize interference of other subscribers. Furthermore, it is prescribed by the specification "FCC part 15" that 75 different carrier frequencies must be used.

A further advantage of the frequency hopping spread spectrum system that may be mentioned is that the system becomes more insensitive to interference as a result of the provision of a large number of carrier frequencies. Furthermore, the security of the system against eavesdropping by third parties is increased since the third party generally does not know the carrier frequency to which a change is made after a certain period of time.

The sequence of carrier frequencies which are used one after the other for transmission is determined by an algorithm. Such an algorithm is implemented in an identical manner in the fixed station and also in each mobile station of the mobile radio transmission. Consequently, if a mobile part is synchronized with the associated fixed station with regard to the carrier frequencies, the mobile part and the fixed station will perform the carrier frequency change predetermined by the sequence of the algorithm in synchronism with one another.

The idle locked mode or multiframe mode is an operating mode in which a mobile part, although ready to receive, is, however, connected to the fixed station without any active communication. For the purpose of saving energy, in particular, a mobile part, which in other words is ready to receive in a type of standby state in the idle locked mode, resynchronizes its carrier frequencies only after m carrier frequencies since, after all, each resynchronization requires a connection to the fixed station in order to receive at least one time slot and, consequently, consumes energy. The mobile part in the idle locked mode, which is therefore resynchronized with the base station only in every mth frame (multiframe frame), therefore does not exchange any information with the base station during the remaining frames between two successive multiframe frames, i.e. during the first to (m-1)-th frame.

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~~The present invention is concerned with the problem of how signalling of carrier frequencies can be~~

A radio system according to the frequency hopping method is known from EP 0 650 304 A2 in which special synchronization bursts are inserted into the frequency hopping sequence of the control channels to improve the initial synchronization of control channels of the mobile stations of the radio system.

A radio system with error-tolerant frequency hopping synchronization is known from EP 0 650 274 A2 in which header bits are used for the signalling of carrier frequencies that takes place from a fixed station to a mobile station and/or vice versa.

A method for connecting transmitters/receivers of a wireless telecommunications system to a communication unit is known from US 5,625,888 in which messages are transmitted in a booking and registration phase according to the DECT standard.

The present invention is concerned with the problem of how signalling of carrier frequencies can be effected while maintaining structures of the DECT standard to the greatest possible extent.

According to the invetion, a method for the digital signalling of a carrier frequency is provided which is used at a predetermined instant after the signalling, whereby the signalling takes place from a fixed station to a mobile station and/or vice versa and the signalling of the frequency is transmitted in header bits and in which a so-called multiframe mode is used, in which a mobile station receives data from a fixed station only during so-called multiframe frames, in order to be able to be resynchronized with the fixed station. A multiframe frame is in this case provided after every (m-1) frames of the transmission. "m" is in this case a whole number greater than 1. The carrier frequency used by the fixed station in the next multiframe frame is signalled to the mobile station during all of the frames of the transmission that precede the multiframe frames, by means of bits which correspond to bits of the header of the A field of the DECT standard. In the sense of the present description, "correspond" should be understood to mean that in the case of the invention, although it is not necessary to use all the features of the DECT standard, the structure of the A field and of the D field of the DECT standard will always be maintained. In contrast, for example, the time slot structure and frame structure of the DECT standard can be modified in terms of the number and duration. Of course, the carrier frequencies used can also be altered as desired. For example, a different frequency band can be used.

Moreover, according to the invention, a method for the digital signalling of a carrier frequency is provided which is used at a predetermined instant after the signalling, whereby the signalling takes place from a fixed station to a mobile station and/or vice versa and the signalling of the frequency is transmitted in header bits and in which the signalling of the carrier frequency takes place in the Q1, the 3BA and/or in the Q2 bit of the header of the A field.

If the signalling of the carrier frequency is effected in all of the aforementioned bits of the header of the A field, it is consequently possible to signal one of 32 different carrier frequencies.

A multiframe frame may follow after every 15 frames of the transmisson. The carrier frequency which is used in the multiframe frame is consequently signalled to the mobile station during 15 frames of the transmission.

The carrier frequencies which are signalled can be stored in the fixed station and in the mobile station, in each case in a table provided there.

The invention furthermore provides a digital wire-free transmission system having a fixed station and at least one mobile station. The fixed station and the mobile station in this case have devices for signalling from the fixed station to the mobile station and/or vice versa a carrier frequency which is intended to be used at a predetermined instant after the signalling. Header bits are provided here for the signalling. A multiframe mode is provided in the digital wire-free transmission system in which the mobile station receives the data from the fixed station only during multiframe frames, in order to be able to be resynchronized with the fixed station. A multiframe frame is in this case provided after every (m-1) frames of the transmission, wherein m is a predetermined number > 1. The carrier frequency used by the fixed station in the next multiframe frame is in this case signalled to the mobile station in the bits which correspond to bits of the header of the A field of the DECT standard. In the sense of the present description, "correspond" should be understood to mean that in the case of the invention, although it is not necessary to use all the features of the DECT standard, the structure of the A field and of the D field of the DECT standard will always be maintained. In contrast, for example, the time slot structure and frame structure of the DECT standard can be modified in terms of the number and duration. Of course, the carrier frequencies used can also be altered as desired. For example, a different frequency band can be used.

The invention furthermore provides a digital wire-free transmission system having a fixed station and at least one mobile station. The fixed station and the mobile station in this case again have devices for signalling from the fixed station to the mobile station and/or vice versa a carrier frequency which is intended to be used at a predetermined instant after the signalling. Header bits are again provided for the signalling. The Q1, the 3BA and/or the Q2 bit of the header of the A field of the DECT standard are provided for the signalling of the carrier frequency.

If all of the aforementioned bits of the header of the A field are provided for the signalling of the carrier frequency, 32 possible different carrier frequencies can be signalled.

A multiframe frame may be provided after every 15 frames of the transmission.

A table in which the possible carrier frequencies are stored can be provided in each case in the fixed station and in the mobile station.

The invention will now be explained in greater detail with reference to an embodiment and to the accompanying drawings, in which:

Figure 1 shows a mobile radio transmission system having a fixed station according to the invention,

Figure 2 shows a time frame of a data transmission standard of the kind that can be employed in the case of the present invention,

Figure 3 shows, in detail, the internal structure of a fixed station (base station) according to the invention.

Figure 4 shows a diagrammatic illustration of a frequency hopping spread spectrum system, in particular also for the case of an interference-source evasive mode, and frames of the transmission.

A table in which the possible carrier frequencies are stored can be provided in each case in the fixed station and in the mobile station.

The invention will now be explained in more detail using an exemplary embodiment and with reference to the accompanying drawings, in which:

Figure 1 shows a mobile radio transmission system having a fixed station according to the invention,

Figure 2 shows a time frame of a data transmission standard of the kind that can be employed in the case of the present invention,

Figure 3 shows, in detail, the internal structure of a fixed station (base station) according to the invention,

Figure 4 shows a diagrammatic illustration of a frequency hopping spread spectrum system, in particular also for the case of an interference-source evasive mode, and

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Figure 5a to Figure 5e show the structure of the DECT standard and, particularly in Figure 5e, the content of the so-called header of the A field.

Referring to Figure 1, it is intended first of all to give an explanation of the general structure of a mobile radio transmission. As is generally customary, the arrangement for the radio transmission of data has a fixed station 1 and a plurality of mobile parts (mobile stations, cordless telephones) 2, 3 ... The fixed station 1 is connected by a terminal line 10 to the fixed network. For the purpose of communication, it is possible to provide an interface device (not illustrated) between the fixed station 1 and the terminal line 10. The fixed station 1 has an antenna 6 by means of which, for example, a communication with the mobile part 2 takes place via a first radio transmission path 8 or a communication with the mobile part 3 takes place via a second radio transmission path 9. The mobile parts 2, 3 ... each have an antenna 7 for receiving and/or for transmitting data. Figure 1 diagrammatically illustrates the state in which the fixed station 1 is actively communicating with the mobile part 2 and, consequently, is exchanging data. The mobile part 3, on the other hand, is in the so-called idle locked mode, in which it waits in standby-like fashion for a call from the fixed station 1. In this state, the mobile part 3 is not communicating continually with the fixed station 1, but rather receives the data for example of a time slot only at periodic intervals, which data are necessary for resynchronization of the carrier frequencies fx.

The internal structure of the fixed station 1 is illustrated diagrammatically in Figure 1. The voice information data are fed to an RF module 4, which is driven by a carrier frequency sequence unit. The exact structure of a fixed station 1 according to the invention will be described later.

Referring to Figure 2, it is now intended to give an explanation of a transmission standard of the kind that can be used in the case of the present invention. As is evident from Figure 2, data are transmitted chronologically successively on a plurality of carrier frequencies fx, ten of which are illustrated, in a plurality of time slots, 24 time slots Zx in the case illustrated, using a time division multiplex method TDMA (Time Division Multiple Access). In the case illustrated, operation is in the duplex mode, that is to say after the first twelve time slots Zx have been transmitted, a switch is made to reception, and the second twelve time slots (Z13 to Z24) are received by the fixed station in the opposite direction.

If the so-called DECT standard is used for the transmission, the time duration of a time frame is 10 ms, and 24 time slots Zx are provided, namely twelve time slots for transmission from the fixed station to mobile parts and a further twelve time slots Zx for transmission from the mobile parts to the fixed station. According to the DECT standard, ten carrier frequencies fx between 1.88 GHz and 1.90 GHz are provided.

Of course, other frame structures, for example with half the number of time slots compared with the DECT standard, are just as suitable for the present invention.

The present invention is used particularly for transmissions in the so-called 2.4 GHz ISM (Industrial, Scientific, Medical) frequency band. The generally accessible ISM frequency band has a bandwidth of 83.5 MHz. In accordance with the specification "FCC part 15", at least 75 carrier frequencies fx must be distributed over these 83.5 MHz. What is particularly advantageous is a division of the bandwidth of 83.5 MHz between 96 carrier frequencies, i.e. a channel spacing of 864 kHz. The abovementioned frequency bands and standards are cited purely as an example. The only fundamental precondition for applicability of the present invention is that a so-called frequency hopping spread spectrum is used, i.e. that a plurality of carrier frequencies are available, and that the carrier frequency selected for transmission is periodically changed. For such a change, it is advantageous if the data are transmitted in time slots Zx (time division multiplex method). The DECT standard is therefore suitable, for example, as well as any other modified standard based on this DECT standard.

Referring to Figure 3, it is now intended to give a more detailed explanation of the internal structure of a fixed station 1 according to the invention. As can be seen in Figure 3, information data are fed to the RF module 4 when transmission is to be effected from the fixed station 1 to a mobile part 2, 3 ... by means of the antenna 6, and information data are output from the RF module 4 when data from mobile parts are received. The RF module 4 modulates the digital encoded information data onto a carrier frequency fx. The carrier frequency fx that is currently to be used is in this case predetermined by a carrier frequency sequence unit, which is designated in general by 20.

As illustrated in Figure 3, the main components of the carrier frequency sequency unit 20 are a first calculation device, which is designated in general by 25, and also a second calculation device 26. A switching device 27 is furthermore provided. This switching device 27 is driven by the processor 23 in the manner shown and selects whether the first calculation device 25 or the second calculation device 26 is to predetermine the current value for the carrier frequency fx.

Provided in the first calculation device 25 is a detection device 24, to which the demodulated signal from the RF module 4 is fed. Interference in this context means that either interference in the actual sense or seizure by another transmitter is present. Interference in the sense of the present description can therefore be detected by demodulating a received signal on a carrier frequency and detecting whether or not a signal level is present on this carrier frequency.

Interference in the actual sense can be detected using CRC errors or burst losses.

The detection device 24 therefore uses the demodulated signal from the RF module 4 to determine how high the signal component modulated onto a specific carrier frequency fx is or whether a burst or CRC error has occurred. If the signal component detected lies above a predetermined limit value or if one of the above-mentioned errors has occurred, the detection device 24 passes an interference detection signal to an inhibit/enable unit 21. Depending on the interference-source detection signal from the detection device 24, the inhibit/enable unit 21 passes an inhibit/enable information item to a processor 23. This inhibit/enable information item indicates which of the carrier frequencies fx are inhibited or enabled again on account of the detection of interference by the detection device 24, as will be explained later.

In other words, the detection device 24 and the inhibit/enable device 21 provide an independent procedure by means of which frequencies subjected to interference can be inhibited and enabled again. In addition to the inhibit/enable information items from the inhibit/enable unit 21, a sequence from a random number generator 22 is fed to the processor 23. On the basis of a random algorithm implicit in it, the random number generator 22 generates a randomly distributed sequence of carrier frequency values within the predetermined frequency band. The random number generator 22 consequently carries out a procedure which is independent of the procedure of frequency inhibiting for the case of interference.

The second calculation device 26 is provided for the purpose of implementing a second algorithm, which is independent of the first algorithm realized in the first calculation device 25. As is evident, there is no possibility for frequency inhibiting in the case of the second algorithm realized in the second calculation device 26. The second algorithm can be determined by the base station 1 for example when a mobile part logs onto the base station 1, with the result that after the logging on, there is no need for any further information exchange between the base station and the mobile part with regard to this second algorithm.

The second calculation device 26 can generate the second algorithm by means of a random number generator contained in it, for example. As an alternative or in addition, a frequency table may also be provided in the second calculation device 26, which table is processed sequentially by the second calculation device 26. The frequency table therefore contains the carrier frequency values to be used for the carrier frequencies with the operating parameter nxm, that is to say in the event that the carrier frequency is changed after the duration of a frame, for every mth frame. The frequency table may, for example, be derived from the PIN code number of the mobile part 2 that has logged on, as a result of which mutually independent mobile radio systems each comprising a base station and at least one mobile part use different tables.

As is indicated in Figure 3 by arrows from the processor 23 to the random number generator 22 and to the second calculation device 26, the processor 23 outputs different information items to these components. The random number generator 22, for example, receives the information item regarding how many different values it is supposed to generate.

In a mobile part, in particular, the processor 23 can furthermore predetermine for the random number generator 22 a start value for the algorithm thereof. This start value is communicated to the mobile part during synchronization, which can be achieved by the mobile part and fixed station using the same start value and the same algorithm.

The second calculation device 26 receives from the processor 23 information items regarding the periodicity of the idle locked mode, that is to say the value of m.

Referring to Figure 4, it is now intended to give a more detailed explanation of the method of operation of a fixed station 1 according to the invention and of the method according to the invention. As is illustrated in Figure 4, a carrier frequency f1 is used during a frame Rx of a mobile radio transmission, as is illustrated in hatched fashion in Figure 4. This frequency f1 is therefore the first value of the sequence which is generated by the random number generator 22 and is fed to the processor 23, which, in turn, drives the RF module 4 accordingly. For the frame R2, let it be assumed that the random number generator 22 prescribes, on the basis of its calculated frequency, a frequency hop P1 to a carrier frequency f3.

Let it now be assumed that the detection device 24 has detected for example during a previous transmission that the carrier frequency $f_2$ is subjected to interference, in other words the detection device 24 has passed a corresponding interference signal to the inhibit/enable unit 21 which, in turn, has indicated inhibition of the frequency f2 to the processor 23. Let it furthermore be assumed that the random number generator 22, using its determined sequence, prescribes for the frame R3 the carrier frequency f2 which was previously detected as being subjected to interference. Proceeding from the coincidence between the prescribed carrier frequency f2 according to the sequence of the random number generator 22 and, at the same time, the inhibit signal from the inhibit/enable unit 21 for the same carrier frequency f2, the processor 23 now replaces the carrier frequency f2, which was actually prescribed but has been detected as being subjected to interference, for the frame R3 by a carrier frequency that has not been detected as being subjected to interference by the detection device 24, for example the carrier frequency f4, as is indicated by the frequency hop arrow P3. Therefore, instead of the carrier frequency f2 actually prescribed by the sequence, the RF module 4 is driven to the backup carrier frequency f4. Replacing the carrier frequency which was detected as being subjected to interference therefore creates a modified sequence of carrier frequencies. The modified sequence has only carrier frequencies that are not subjected to interference. By virtue of the fact that a carrier frequency which has been detected as being subjected to interference is replaced, and not skipped, as a result of the transition to the following carrier frequency, the positions of the carrier frequencies that are not subjected to interference in the modified sequence are not altered in comparison with the original sequence.

The basis of this modified sequence comprising only carrier frequencies fx that are not subjected to interference is, therefore, two superposed, mutually independent procedures (random number generator 22 and inhibit/enable unit 21). The first procedure comprises the random number generator 22, which generates values between 0 and N, where N is the number of possible carrier frequencies. The second procedure inhibits frequencies that are subjected to interference as explained above. This inhibiting can be cancelled again by the inhibit/enable unit 21 as soon as a recent detection by the detection device 24 indicates that the carrier frequency that was formerly subjected to interference is now no longer subjected to interference. For this case, the inhibit/enable unit 21 passes to the processor 23 an enable signal, which indicates that the processor 23 now no longer has to replace the carrier frequency that was formerly subjected to interference by a different carrier frequency.

As an alternative, the inhibit/enable unit 21 can automatically output an enable signal to the processor 23, without recent detection by the detection device 24, as soon as a predetermined period of time has elapsed. Each of the said procedures therefore ensures per se that the entire predetermined frequency spectrum is utilized with uniform distribution. Consequently, by adapting the times in the procedure for the inhibiting of frequencies, it is possible to comply with standards such as, for example, the US specification "FCC part 15", which impose upper limits on energy transmitted on a carrier frequency.

The random number generator 22 is constructed in a known manner and is therefore not explained any further in the course of the present description. It is important, however, that the random number generator be operated independently of the inhibit/enable procedure. An identical random number generator is, moreover, implemented in each mobile part 2, 3.

The fixed station 1 is the master during frequency allocation, i.e. at the beginning of a connection set-up, the random number generator in a mobile part is initialized with the state of the random number generator 22 of the fixed station 1. The random number generators in the mobile part 2, 3 ... and in the fixed station 1 then generate the same carrier frequency values synchronously in timing and autonomously of one another.

The procedure for frequency inhibition which is carried out by the detection device 24 and the inhibit/enable unit 21 uses a unidirectional protocol on the radio interface during the entire connection time between the fixed station 1 and a mobile part 2, 3 ... If the detection device 24 finds one of the n possible frequencies fx from the fixed station 1 to be subjected to interference, then the fixed station 1 therefore communicates to all mobile parts with which it is operating connections that this frequency which is subjected to interference, if it is generated by the sequence of the random number generator, must be replaced by a different carrier frequency that is not detected as being subjected to interference. The random number generator 22 is not influenced by the frequency inhibition. This frequency inhibition is cancelled again by the inhibit/enable unit 21 when the inhibited carrier frequency is again suitable for transmission, or when it has been inhibited for longer than a previously defined time.

In the idle locked mode, mobile parts cannot acknowledge frequency inhibition to the fixed station 1 since, after all, they can only receive, but not transmit, in this special operating mode. However, if the frame with an information item regarding the frequency inhibition is subjected to such interference during the transmission from the fixed station 1 to the mobile part (unidirectional protocol) that the mobile part does not actually receive this information item regarding the frequency inhibition, the synchronously running random number generators in the fixed station 1 and in the mobile parts 2, 3 ensure that in the case of the non-inhibited carrier frequencies in the frames after the frames of an inhibited carrier frequency, the fixed station 1 and all of the active mobile parts use the same carrier frequency.

According to the invention, a so-called multi-frame mode can be realized in a particularly favourable and simple manner. A multiframe has a length of m frames. m may be 16, for example. According to the invention, the value for the carrier frequency fx which is output by the algorithm of the second calculation device 26 and is completely independent of the first algorithm realized by the first calculation device 25 is used in every mth frame (multiframe frame). In other words, the first algorithm in the first calculation device 25 is used for the carrier frequencies having the frame number $(n-1)\times m+1$ to $(n\times m)-1$, where n is an operating parameter $\geq 1$ and m is a predetermined whole number $> 1$. The value of the second algorithm of the second calculation device 26 is then used for the carrier frequencies having the frame number $n\times m$, which is illustrated symbolically in Figure 3 by a changeover device 27. If, for example, the multiframe has a length of 16 frames, the carrier frequencies are determined by the first algorithm of the first calculation device 25 in the frames having the numbers 1 to 15, while the carrier frequency is determined by the second algorithm in the multiframe frame having the number 16. Consequently, a mobile part which is in the multiframe mode can always remain synchronized with the base station since the second algorithm used for the multiframe mode never changes. In the case of an actual connection set-up, an information exchange regarding the first algorithm is carried out between the base station and the mobile part to be connected. After the information exchange regarding the first algorithm, the frames between two successive multiframe frames can then also be utilized after a communication regarding the remaining carrier frequencies (first algorithm).

According to the invention, it is therefore ensured that mobile parts which are in the so-called multiframe mode and are resynchronized only every m frames, i.e. in the multiframe frames, and therefore cannot receive the signalling of a frequency inhibition in the idle locked mode are not adversely affected by frequency inhibitions of the fixed station 1 in the sense that their overall synchronization with the fixed station 1 is lost.

Figure 4 illustrates the example of a multiframe comprising 5 frames. As illustrated, the carrier frequencies for the frames having the numbers 1 to 4 are in this case predetermined by the first algorithm. For the frame having the number 5 (multiframe frame), the value on the basis of the second algorithm of the second calculation device 26 is used. As illustrated in Figure 4 this value may be for example a value (carrier frequency $f_2$) which was actually detected as being subjected to interference by the first calculation device. The second calculation unit 26, however, never carries out inhibitions of carrier frequency values and therefore uses completely independently of the detection in the first calculation device 25, even carrier frequencies which are subjected to interference.

As already mentioned in the introduction, the invention relates in particular to a solution for the problem of how the fixed station can communicate (signal) to the mobile station the carrier frequency which the fixed station will use in the next multiframe frame. The solution according to the invention will now be explained, in which case, first of all, referring to Figure 5a to Figure 5e, it is intended to give an exact explanation of the structure of the DECT standard and, in particular, the structure of the A field and of the header of the A field.

Figure 5a again illustrates the time slot structure of a frame in accordance with the DECT standard. As already mentioned, a DECT frame has 24 time slots, of which the first 12 are used for transmission from the fixed station to a mobile part (down-link) and the following 12 are used for transmission from one or more mobile parts to the fixed station (up-link). However, it should once again be expressly emphasized that the time slot structure and frame structure of the DECT standard as well as the carrier frequencies used can, according to the invention, be modified in any desired way from the DECT standard. For example, the number of time slots per frame can be reduced from 24 to 12. The 2.4 GHz ISM band can be used as the frequency band. Any other time slot and frame structures are possible.

Figure 5b illustrates in detail the structure of a time slot (full slot), a time slot comprising 480 bits and, according to the DECT standard, having a duration of 416.7 μs. As can be seen in Figure 5b, a time slot of the DECT standard has 32 bits of the synchronization field S, 388 bits of the so-called D field, 4 bits of the Z field and 56 bits of the guard field.

Figure 5c illustrates the structure of the D field. As is evident in Figure 5c, the D field has 388 bits, where 64 bits are allotted to the so-called A field, 320 bits are allotted to the B field and 4 bits are allotted to the so-called X field.

Figure 5d, in turn, illustrates the exact structure of the A field. As is evident in Figure 5d, the A field has 64 bits, of which 8 bits are allotted to the so-called header, 40 bits are allotted to the so-called tail and 16 bits are allotted to the so-called R-CRC field.

Figure 5e illustrates the 8 bits of the header of the A field. The 3 TA bits describe which of the total of 8 possible messages of the A field is transmitted in the so-called tail (40 bits). The Q bits are utilized for an information exchange between base and mobile part with regard to the channel quality, and the 3 BA bits describe whether a so-called dummy bearer or a traffic bearer is involved. In order to be able to set up a connection between base station and mobile station in the DECT system, at least one so-called dummy bearer is continually transmitted by each base station.

As already mentioned, the Q1 bit and the Q2 bit are used for quality monitoring. With the Q1 bit and the Q2 bit, the receiver can communicate to the transmitter information concerning the reception quality of the transmitted data. If, for example, CRC errors occur during the data transmission, the receiver informs the transmitter about the interference in the channel by setting the Q1 and Q2 bits. The receiver then carries out a handover in the event of an accumulation of CRC errors.

Since, as already mentioned, the fixed station is the master for the frequency hopping algorithm, information transmission in the Q bits from the base station to the mobile part is not necessary. If the dummy or traffic bearer information is not transmitted via the three BA bits (but rather, for example, in one of the messages in the tail area), 5 free bits are available in the header in the so-called down-link (connection from base to mobile part), namely the 3 BA bits and the 2 Q bits. The Q bits are available, furthermore, in the up-link, that is to say in the transmission direction from mobile part to base station, as a result of which the mobile part can communicate to the base station the quality of the received time slot.

32 different values (carrier frequencies) can be described by these 5 bits. If, for example, identical tables having 32 carrier frequencies are created for the multiframe hopping algorithm in the base station and in the mobile part, then the carrier frequency information with regard to the following multiframe frame can be transmitted (signalled) in each time slot transmitted by the base station to a mobile station.

As an alternative, instead of the tables, it is also possible to implement identical algorithms in the base station and in the mobile part.

During the synchronization of a mobile part, it is consequently possible for the mobile part to be synchronized with a fixed station without any frequency information. If the mobile part would like to be synchronized with the base station for the first time, although it cannot determine the carrier frequency of the next time slot, the carrier frequency of the next multiframe frame is communicated to it by the signalling information which is transmitted in the bits of the header of the A field. Given a multiframe mode periodicity of 16, this frame is a maximum of 15 frames away, with the result that the synchronization in the time domain is not lost in the time period of these 15 frames. Consequently, after multiframe synchronization has been achieved, the information exchange between the base station and the mobile part with regard to the first hopping algorithm can then take place, as a result of which carrier frequency synchronization with regard to the frames between two successive multiframe frames also takes place. The synchronization is therefore effective in two steps. Firstly, the carrier frequencies of the multi-frame frames are synchronized. In a second step, the carrier frequencies of the frames between two successive multiframe frames are then synchronized.

It should be pointed out that an alteration of the 40 tail bits of the A field with regard to a signalling of carrier frequencies is disadvantageous compared with the inventive modification of the header bits since modification of the 40 tail bits of the A field constitutes an alteration of the DECT MAC layer A field mapping.

It should be pointed out that the application of the present invention to the signalling of the carrier frequencies of the multiframe mode constitutes only a preferred embodiment of the invention. According to the invention, any desired future frequencies can be signalled in advance digitally in a wire-free manner.

Consequently, according to the invention, carrier frequency signalling is carried out in a particularly advantageous manner using the structure of the A field of the DECT standard. It should once again be pointed out that, according to the invention, the time slot structure and frame structure of the DECT standard can be modified as desired.

List of reference symbols

1: Fixed station
2: Mobile part
3: Mobile part
4: RF module
6: Antenna fixed station
7: Antenna mobile part
8: First radio transmission path
9: Second radio transmission path
10: Terminal line
20: Carrier frequency sequence unit
21: Inhibit/enable unit
22: Random number generator
23: Processor
24: Detection device
25: First calculation device
26: Second calculation device
27: Switching device
fx: Carrier frequency
Rx: Frame
Zx: Time slot

Patent Claims

1. Method for the digital signalling of a carrier frequency which is used at a predetermined instant after the signalling, the signalling being effected from a fixed statoin (1) to a mobile station (2) and/or vice versa, and the signalling of the frequency (fx) being transmitted in header bits, characterized in that a multiframe mode is used in which the mobile station (2) receives data from a fixed station (1) only during multiframe frames, in order to be able to be resynchronized with the fixed station (1),
a multiframe frame being provided after every (m-1) frames of the transmission,
m is a predetermined number > 1,
and the carrier frequency of the mobile station (2) used by the fixed station (1) in the next multiframe frame is signalled by means of the bits which correspond to bits of the header of the A field of the DECT standard.

2. Method for the digital signalling of a carrier frequency which is used at a predetermined instant after the signalling, the signalling being effected from a fixed station (1) to a mobile station (2) and/or vice versa, and the signalling of the frequency (fx) being transmitted in header bits, characterized in that the signalling of the carrier frequency (fx) is effected in the Q1 bit, the three BA bits and/or in the Q2 bit of the header of the A field of the DECT standard.

3. Method according to claim 2, characterized in that the signalling of the carrier frequency (fx) is effected in the Q1, the three BA bits and the Q2 bit of the header of the A field and one of 32 carrier frequencies (fx) is signalled.

4. Method according to one of claims 1 to 3, characterized in that a multiframe frame follows after every 15 frames of the transmission.

5. Method according to one of the preceding claims, characterized in that the carrier frequencies (fx) are signalled which are stored in a respective table in the fixed station (1) and in the mobile station (2).

6. Method for the frequency synchronization of a mobile station, having the following steps:

- signalling of the carrier frequencies from the fixed station to the mobile station in accordance with a method according to one of the preceding claims,
- synchronization of the carrier frequencies of the multiframe frames, and
- synchronization of the carrier frequencies of the frames between two successive multiframe frames.

7. Digital wire-free transmission system, having a fixed station (1) and at least one mobile station (2), the fixed station (1) and the mobile station (2) having devices for signalling from the fixed station (1) to the mobile station (2) and/or vice versa a carrier frequency (fx) which is used at a predetermined instant after the signalling,
header bits being provided for the signalling, characterized in that a multiframe mode is used in which the mobile station (2) receives data from a fixed station (1) only during multiframe frames, in order to be able to be resynchronized with the fixed station (1),
a multiframe frame being provided after every (m-1) frames of the transmission,
m is a predetermined number > 1,

and the carrier frequency (fx) of the mobile station (2) used by the fixed station (1) in the next multiframe frame is signalled by means of the bits which correspond to bits of the header of the A field of the DECT standard.

8. Digital wire-free transmission system, having a fixed station (1) and at least one mobile station (2), the fixed station (1) and the mobile station (2) having devices for signalling from the fixed station (1) to the mobile station (2) and/or vice versa a carrier frequency (fx) which is used at a predetermined instant after the signalling,
header bits being provided for the signalling, characterized in that the Q1 bit, the 3BA bits and/or the Q2 bit of the header of the A field are provided for signalling the carrier frequency (fx).

9. Transmission system according to claim 8, characterized in that the Q1 bit, the three BA bits and the Q2 bit of the header of the A field are provided for the signalling of the carrier frequency (fx), and 32 possible carrier frequencies (fx) are provided, one of which can be signalled.

10. Transmission system according to one of claims 7 to 9, characterized in that a multiframe frame is provided after every 15 frames of the transmission.

11. Transmission system according to one of claims 7 to 10, characterized in that a respective table in which the possible carrier frequencies (fx) are stored is provided in the fixed station (1) and in the mobile station (2).

Fetherstonhaugh & Co.
Ottawa, Canada
Patent Agents

FIG 1

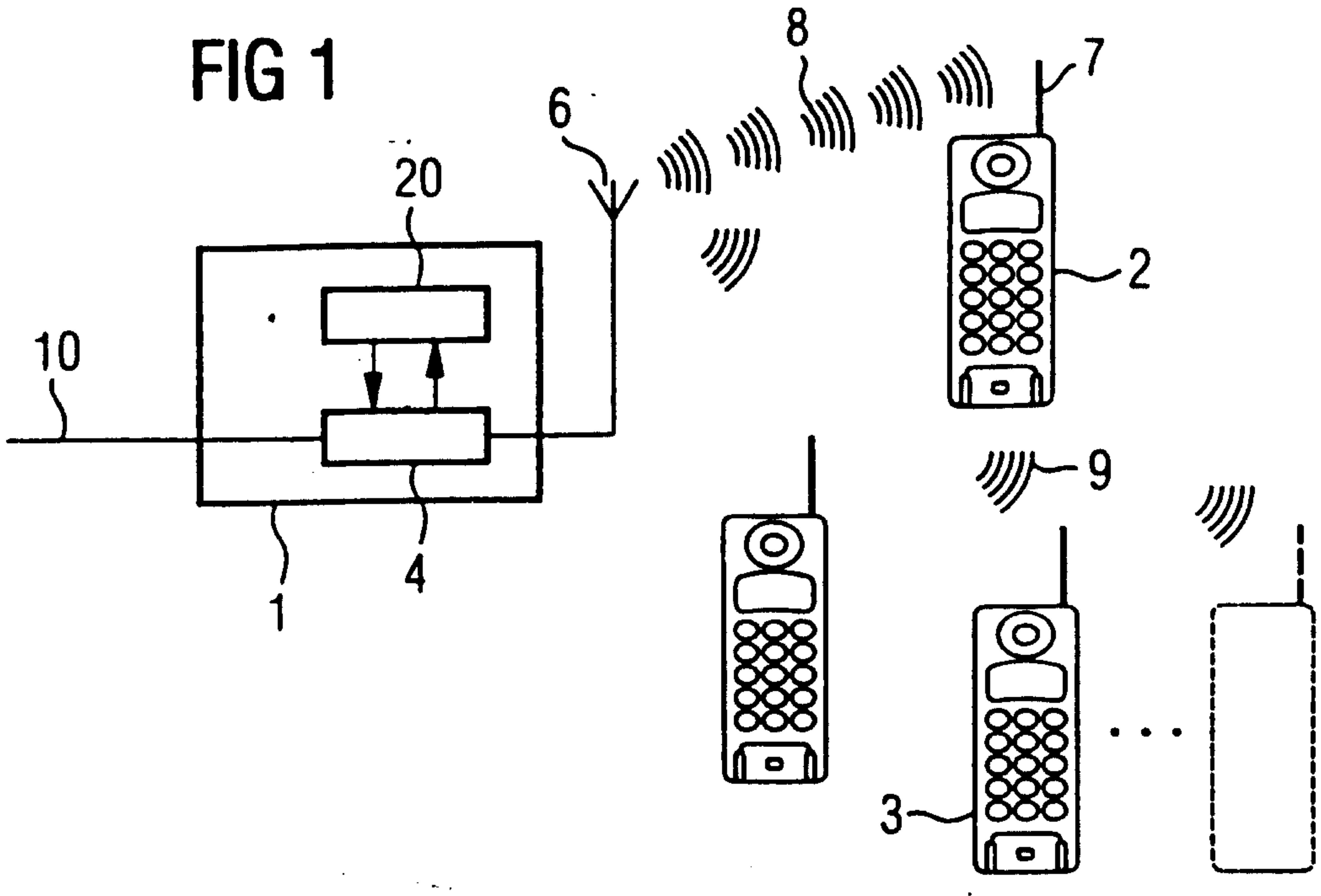

8
7
6
20
2
10
9
4
1
3

FIG 2

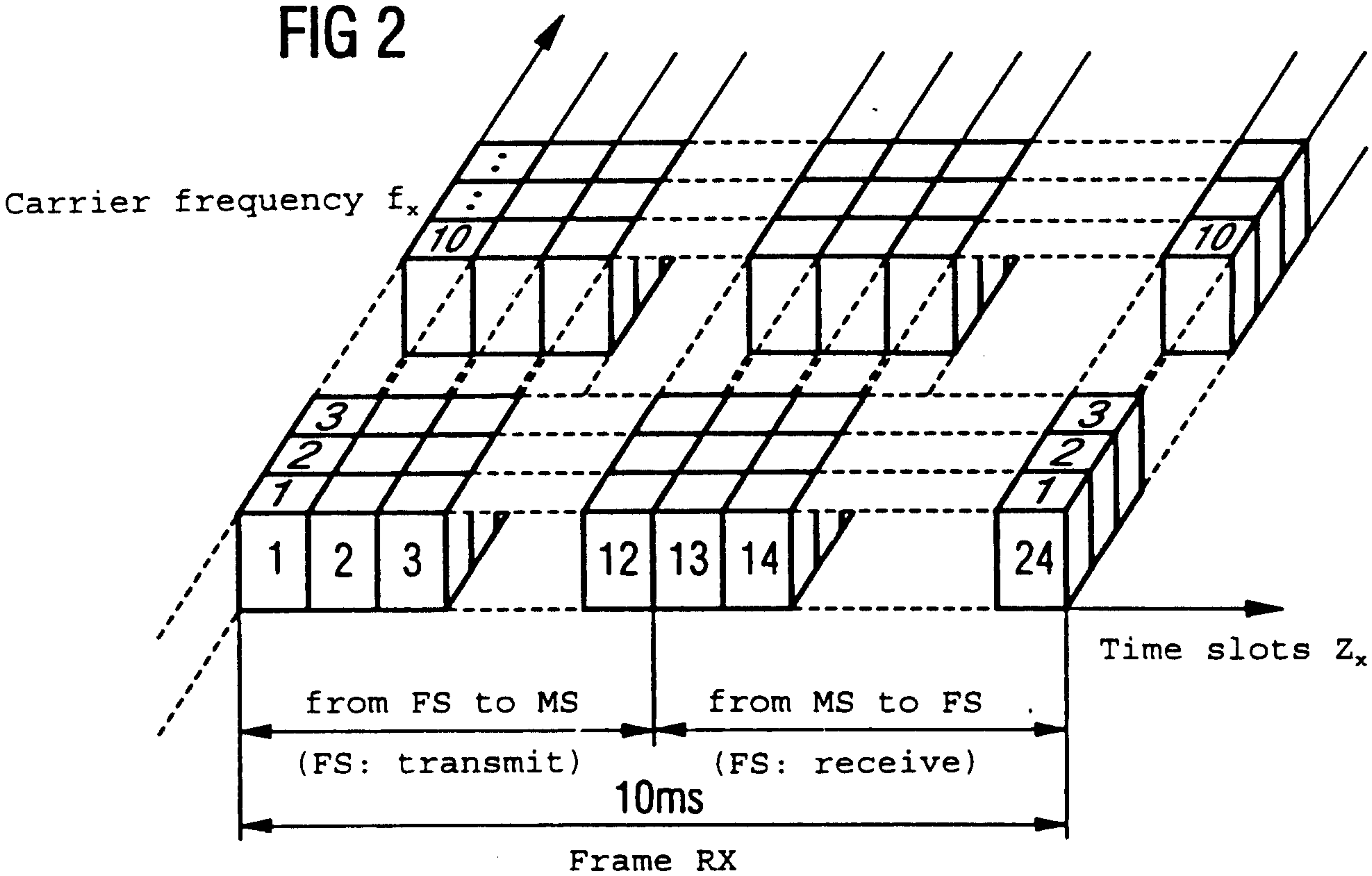

Carrier frequency $f_x$
10
3
2
1
1
2
3
12
13
14
24
Time slots $Z_x$
from FS to MS
(FS: transmit)
from MS to FS
(FS: receive)
10ms
Frame RX

FIG 3

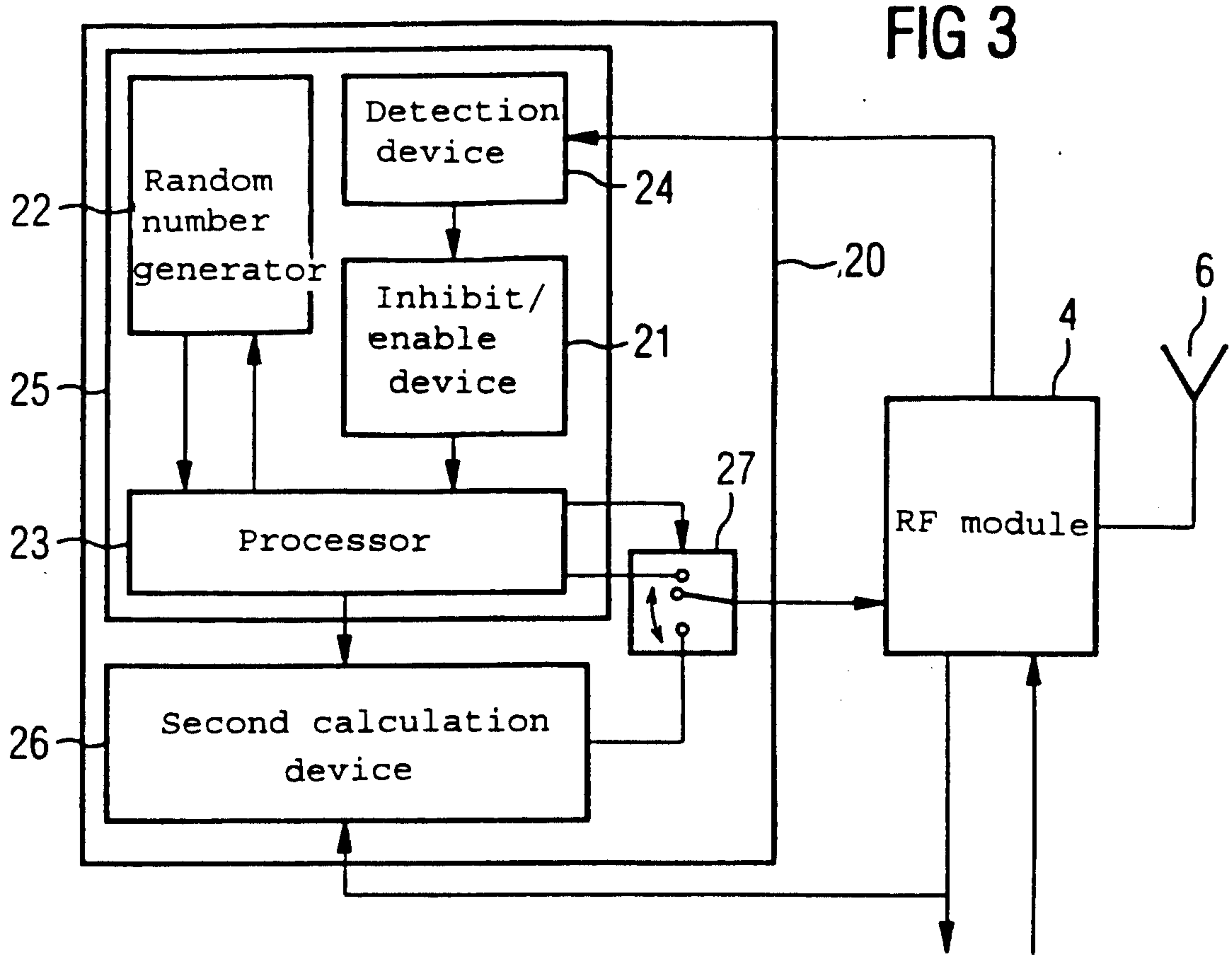
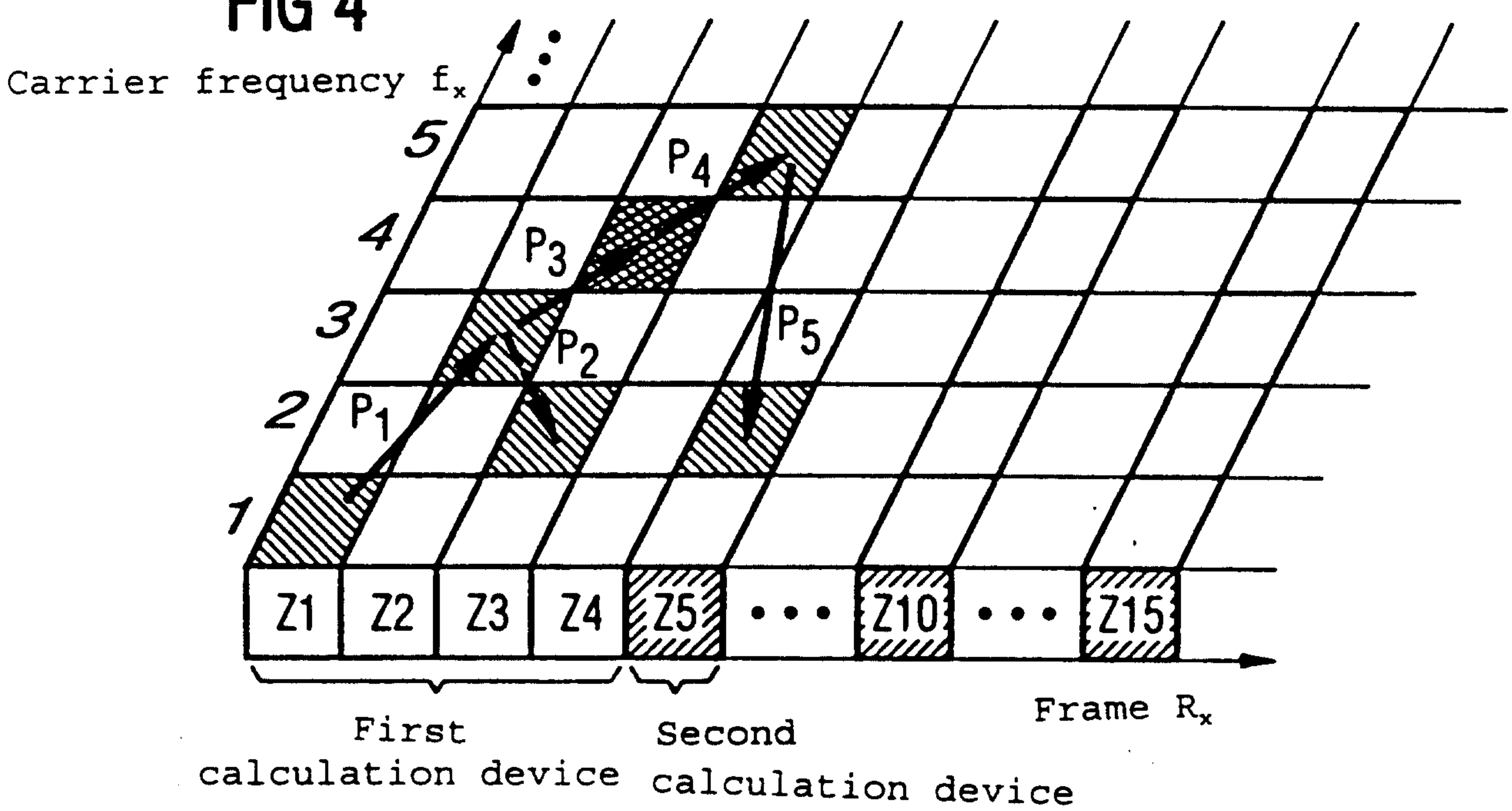

Detection device
Random number generator
Inhibit/ enable device
Processor
Second calculation device
RF module
22
24
20
6
4
21
25
27
23
26

FIG 4


Carrier frequency $f_x$
5
4
3
2
1
$P_1$
$P_2$
$P_3$
$P_4$
$P_5$
Z1
Z2
Z3
Z4
Z5
Z10
Z15
Frame $R_x$
First calculation device
Second calculation device

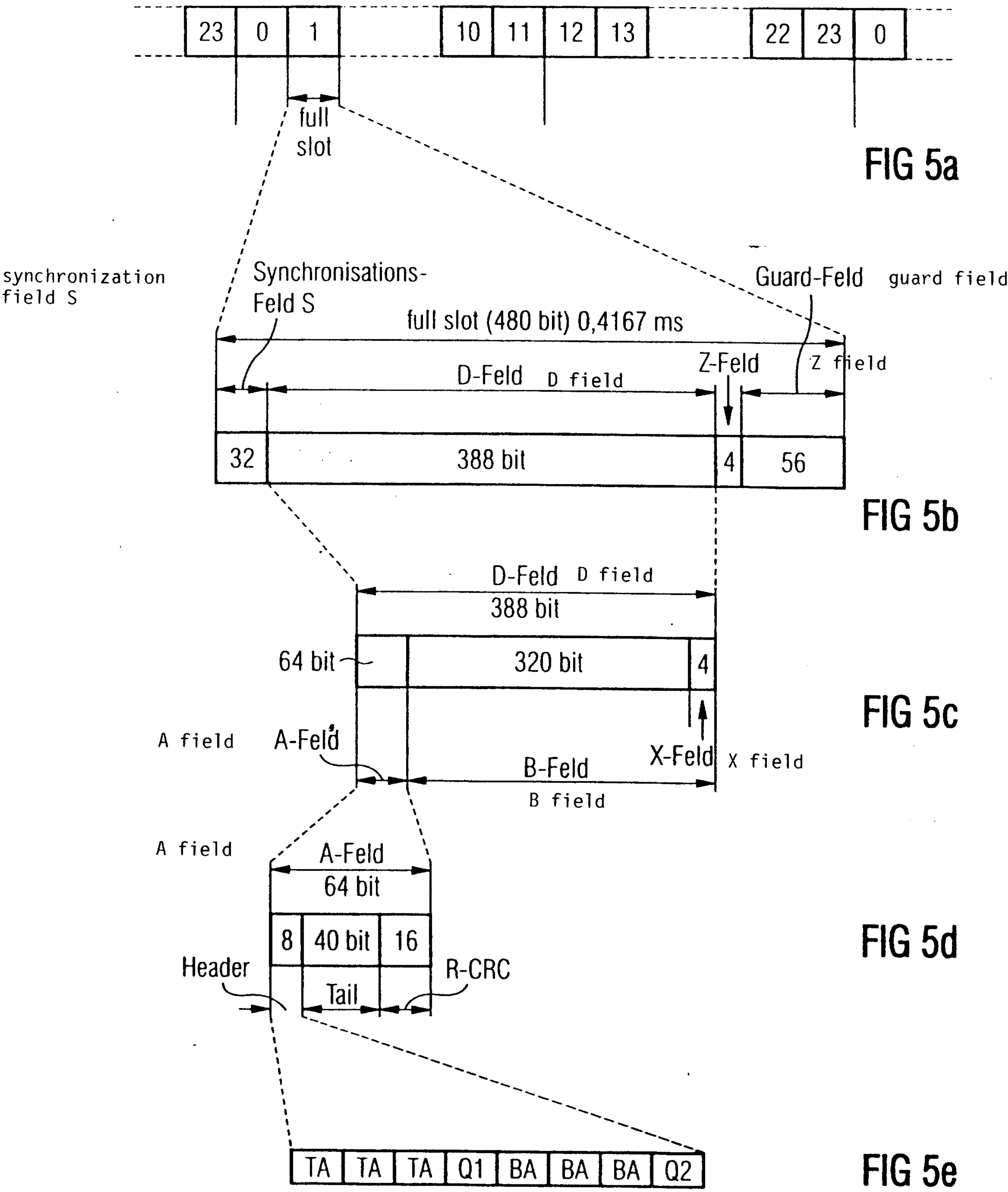



FIG 5a

FIG 5b

FIG 5c

FIG 5d

FIG 5e