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(54) **Method for transmitting an uplink sounding reference signal for an LTE system**

Verfahren zur Übertragung eines Referenzsignals in Aufwärtsrichtung eines LTE-Systems

Procédé de transmission de signal de référence de liaison montante pour un système de type LTE

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- **HUAWEI, NTT DOCOMO, PANASONIC, NOKIA SIEMENS NETWORKS, NOKIA: "Remaining issues on SRS hopping" 3GPP DRAFT; R1-082675, 3RD GENERATION PARTNERSHIP PROJECT (3GPP) TSG RAN WG1 53BIS, CHANGE REQUEST., vol. RAN WG1, no. Warsaw, Poland, June 30- July 4, 2008, 4 July 2008 (2008-07-04), XP002566975 [retrieved on 2010-02-01]**
- **SAMSUNG: "SRS indication for TDD" 3GPP DRAFT; R1-081211, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX ; FRANCE, vol. RAN WG1, no. Shenzhen, China; 20080326, 26 March 2008 (2008-03-26), XP050109655 [retrieved on 2008-03-26]**

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EP 2 154 811 B9

Description**BACKGROUND OF THE INVENTION****1. Field of the Invention**

[0001] The present invention relates generally to a wireless communication system, and more particularly, to a device and method for transmitting uplink sounding reference signals for a wireless communication system.

2. Description of the Related Art

[0002] An objective of the Third Generation Partnership Project (3GPP) standardization organization is to establish a new generation of communication standard, known as the Long Term Evolution (LTE) standard. The downlink transmission technique of LTE is based on Orthogonal Frequency Division Multiplexing (OFDM), while the uplink transmission technique is based on a Single Carrier Frequency Division Multiple Access (SCFDMA) scheme. There are two types of frame structures in the LTE system, wherein type 1 applies Frequency Division Duplex (FDD) and type 2 applies Time Division Duplex (TDD).

[0003] Figure 2 illustrates a frame structure in the LTE FDD system where time duration of a radio frame is $307200 \times T_s = 10\text{ms}$ and each frame is divided into 20 time slots $15360T_s = 0.5\text{ ms}$ long which cover the index ranging from 0 to 19. Each time slot includes several OFDM symbols and use a Cyclic Prefix (CP) of one of two types, i.e., normal CP and extended CP. Time slots using normal CP include seven OFDM symbols while the time slots using extended CP have six OFDM symbols. Each sub-frame consists of two continuous time slots, i.e., the k^{th} sub-frame includes the $2k^{\text{th}}$ and $(2k+1)^{\text{th}}$ time slots.

[0004] Figure 3 illustrates a frame structure in the LTE TDD system. A radio frame having a length of $307200 \times T_s = 10\text{ms}$ is divided into two equal half-frames $153600 \times T_s = 5\text{ ms}$ long. Each half-frame includes eight $15360T_s = 0.5\text{ ms}$ long slots and three special domains, i.e., a Downlink Pilot Time Slot (DwPTS), a Guard Period (GP) and an Uplink Pilot Time Slot (UpPTS), and has a total length of $30720T_s = 1\text{ ms}$. Each time slot includes several OFDM symbols and use either the normal CP or the extended CP. Time slots using normal CP include 7 OFDM symbols while the time slots using extended CP have 6 OFDM symbols.

[0005] Each sub-frame consists of two continuous time slots, i.e., the k^{th} sub-frame includes the $2k^{\text{th}}$ and $(2k+1)^{\text{th}}$ time slots. Sub-frame 1 and 6 include the aforementioned three domains. To this point, sub-frames 0, 5 and DwPTS are constantly assigned for downlink transmission. If the conversion period is 5ms, UpPTS, sub-frames two and seven are constantly assigned for uplink transmission. If the conversion period is 10ms, UpPTS and sub-frame 2 are constantly assigned for uplink transmission.

[0006] Figure 4 illustrates a configuration diagram of an LTE TDD frame structure. In Figure 4, it can be clearly seen that in configuration 0, each radio frame contains ten radio sub-frames that are circularly indexed from 0. Both sub-frames 0 and 5 are adopted to transmit downlink data, i.e., both sub-frames 0 and 5 are adopted by evolved Node B (eNB) to transmit information to UEs, Sub-frames 2, 3, 7, 8 and 9 are adopted by UEs to transmit uplink data, i.e., to transmit information to the eNB, and Sub-frames 1 and 6, also known as special sub-frames, are composed of three special time slots defined as DwPTS, GP and UpPTS respectively. Here, the time length of DwPTS, GP and UpPTS is variable depending on the system configuration.

[0007] Figure 5 illustrates a distribution diagram of the time-frequency grid of a single uplink sub-frame and a possible location of the time-frequency resource for the Sounding Reference Signal (SRS) transmission under the condition that the normal CP and the extended CP are configured in an LTE system. When the system is configured with normal CPs, each uplink sub-frame within a Resource Block (RB) contains two time slots with each containing 7 Single Carrier Frequency Division Multiple Access (SC-FDMA) symbols (the time domain) and 12 sub-carriers (the frequency domain). When the system is configured with extended CPs, each uplink sub-frame within each RB contains two continuous time slots containing 6 SC-FDMA symbols and 12 sub-carriers. The minimum uplink sub-frame resource is called the Resource Element (RE).

[0008] According to present discussion on LTE, in each radio frame, the last symbol in some sub-frame is adopted to transmit the SRS.

[0009] An objective of LTE on an uplink SRS is for the SRS frequency-hop scheme to guarantee that the SRS signal from the UE for the entire system bandwidth is as loudly as possible. At present, with the provision of SRS for four different system bandwidth configurations, eNB adopts 8-bit Radio Resource Control (RRC) signaling to assign the UE with different frequency-hop schemes. Among the 8-bit RRC signaling, four bits are adopted to indicate the configuration of SRS bandwidth, two bits are adopted to indicate the UE's SRS bandwidth in current configuration, and the remaining two bits are adopted to indicate SRS frequency-hop bandwidth.

[0010] To avoid collision among SRSs of different UEs within the same frequency-hop period (T), the same transmission

sub-frame offset and the same Comb location, when a UE configures the SRS frequency hop, the SRS's logic Identifier (ID) (n_{SRS}) is calculated according to a current radio frame number (n_f), an index (n_s) of the time slot for transmitting the SRS and the SRS period (T), by Equation (1) as follows:

$$n_{SRS} = \left\lfloor (n_f \times 10 + \left\lfloor \frac{n_s}{2} \right\rfloor) / T \right\rfloor \quad (1)$$

[0011] The physical resource for each transmission of SRS is then determined based on n_{SRS} . When n_{SRS} is a continuous value, according to the present SRS frequency-hop scheme, the UE can be guaranteed to sound the entire system bandwidth as loudly as possible. In an FDD system, since frequency division multiplex is applied in both uplink and downlink, it can be guaranteed that in each SRS period at least one uplink sub-frame is allocated by eNB. Therefore, n_{SRS} obtained by Equation (1) is a continuous value. This guarantees that the SRS could sound the entire system bandwidth.

[0012] However, in a TDD system's frame structure, it cannot be guaranteed that at least one uplink sub-frame is allocated in every two continuous sub-frames. Thus, when a UE is configured with a 2ms period, n_{SRS} obtained by Equation (1) is not continuous in a TDD system, which results in that the UE is not able to sound the entire system bandwidth or that the frequency-hop pattern is not uniform within the sounding frequency-hop bandwidth.

[0013] Figures 9A and 9B illustrate the values of n_{SRS} obtained by Equation (1) when $T = 2$ (in Figure 9A) and 5 respectively. Figure 10 illustrates the problems in the current system when the system bandwidth = 25RB, the SRS frequency-hop index = 3, the SRS bandwidth = 4 and the SRS frequency-hop bandwidth = 20. Since seven different uplink and downlink configurations can be applied in a TDD system, the new frequency-hop scheme should guarantee that within any SRS configuration period in either TDD or FDD system, the UE could periodically sound the entire SRS frequency-hop bandwidth with a fixed period, and the frequency-hop pattern should be uniformly distributed over the frequency-hop bandwidth, i.e., the sounding frequency for each SRS bandwidth should be as consistent as possible. As indicated in Figures 9A and 9B, the SRS only sounds a part of the bandwidth or the numbers of sounding for the bandwidths are not equal, regardless of the value of T .

[0014] HUAWEI, NTT DOCOMO, PANASONIC, NOKIA SIEMENS NETWORKS, NOKIA: "Remaining issues on SRS hopping", 3GPP DRAFT; RI-082675, 3RD GENERATION PARTNERSHIP PROJECT (3GPP) TSG RAN UG 53BIS, CHANGE REQUEST, vol. RAN WG1, no. Warsaw, Poland, June 30-July 4, 2008, 4 July 2008, XP002566975, discloses a redefinition of n_{SKS} and to define the number of Hopping ON/OFF bit and inclusion of frequency position description.

[0015] SAMSUNG: "SRS indication for TDD", 3GPP DRAFT; RI-081211, 3RD GENERATION PARTNERSHIP PROJECT (3GPP), MOBILE COMPETENCE CENTRE ; 650, ROUTE DES LUCIOLES ; F-06921 SOPHIA-ANTIPOLIS CEDEX; FRANCE, vol. RAN WG1, no. Shenzhen, China; 20080326, 26 March 2008, XP050109655, discloses the 2ms and 5ms parameters for the SRS transmission period in EUTRA TDD. The following description for EUTRA TDD is proposed. For 2ms SRS period, it indicates assigned uplink resources in each half frame are used for SRS transmission in configuration 0-2 and 6. For 2ms SRS period, it indicates 2 assigned uplink SRS resources in the first half frame are used for SRS transmission in configure 3-5. For 5ms SRS period, it is suggested to neglect this parameter in configuration 3-5. For all other situations, keep the same descriptions between FDD and TDD.

[0016] At present, there is no LTE discussion underway on how to solve the complicated problem of all-around consideration on the seven different uplink and downlink configurations.

SUMMARY OF THE INVENTION

[0017] An object of the invention is to provide a frequency-hop method for transmitting uplink signal, particularly for transmitting an uplink sounding signal.

[0018] Aspects of the invention are defined in the independent claims. The dependent claims define advantageous embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019]

Figure 1 illustrates a block diagram of a structure according to the present invention;
 Figure 2 illustrates a conventional LTE FDD frame structure;
 Figure 3 illustrates a conventional LTE TDD frame structure;
 Figure 4 illustrates conventional uplink and downlink configurations for the LTE TDD system;

Figure 5 illustrates a conventional structure of an LTE uplink sub-frame for transmitting the SRS;
 Figure 6 illustrates a UE SRS configuration table in an FDD system;
 Figure 7 illustrates a first embodiment of a UE SRS configuration table in a TDD system;
 Figure 8 illustrates a second embodiment of a UE SRS configuration table in a TDD system;
 Figures 9A and 9B illustrate a problem to be solved;
 Figure 10 illustrates an ideal SRS frequency-hop pattern;
 Figure 11 illustrates an SRS frequency-hop pattern when $T=2$;
 Figure 12 illustrates an SRS frequency-hop pattern when $T=5$;
 Figures 13A through 13D illustrate an SRS bandwidth configuration for different uplink bandwidths;
 Figures 14A and 14B illustrate a frequency-hop method applied in a TDD system when the UE's SRS configuration table of Figure 7 is adopted;
 Figures 15A and 15B illustrate a frequency-hop method applied in a TDD system when the UE's SRS configuration table of Figure 8 is adopted;
 Figures 16A and 16B illustrate a frequency-hop method when using an RRC incremental indication;
 Figure 17 illustrates an SRS signal resource mapping diagram; and
 Figure 18 illustrates a mapping relationship between SRS index k when different uplink and downlink configurations are applied in a TDD system.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0020] Hereinafter, preferred embodiments of the present invention are described in detail with reference to the accompanying drawings. The same reference numbers are used throughout the drawings to refer to the same or similar parts. Detailed descriptions of well-known functions and structures incorporated herein may be omitted for the sake of clarity and conciseness.

[0021] Figure 1 illustrates a system block diagram according to the present invention. The system includes an SRS sequence generator 101 which generates a Zadoff-chu sequence to be transmitted according to the SRS bandwidth indicator transmitted with RRC signaling from an eNB, a physical resource mapper 102 which determines the SRS frequency-hop pattern according to the SRS parameters (transmitted with the 11-bit RRC signaling from eNB) such as an SRS period T , a sub-frame offset (as shown in Figures 7 and 8) and an index number n_f of the current radio frame, and maps the SRS sequence to corresponding physical Resource Elements (REs) according to the generated frequency-hop pattern, and generates SC-FDMA symbols to be transmitted through Inverse Fast Fourier Transform (IFFT). Further included in the system are antennas which transmits the RF (Radio Frequency) signal output from the radio transmitter in a form of electro-magnetic waves.

[0022] The system according to the present invention relates to the physical resource mapper 102 shown in Figure 1.

[0023] Figures 14A and 14D illustrate an SRS frequency-hopping method according to present invention, which is suitable for the UE SRS configuration table for the TDD system shown in Figure 7. According to this method, in step 1400 the UE generates the SRS reference symbol sequence according to the SRS bandwidth parameter (allocated by the eNB through RRC signaling) and the cyclic shift parameter.

[0024] In step 1401 the UE determines whether the SRS period (allocated by eNB for UE) is 2, i.e., the UE reads out a value of I_{SRS} (the SRS period, which is transmitted from the eNB through RRC signaling). If $0 \leq I_{SRS} \leq 9$, the method proceeds to step 1402; otherwise, the method proceeds to step 1403.

[0025] In step 1402 the UE determines the frequency-hop pattern parameter n_{SRS} according to the index number n_f of the radio frame for transmitting the SRS signal, and the index number k of the SRS in the SRS sequence within the radio frame. The requirements for determining the parameter are to avoid collision between SRSs from different UEs but with the same SRS period, the same sub-frame offset and the same Comb index number, and for n_{SRS} to be continuous with the index number k of the SRS in the SRS sequence within the radio frame and the different uplink and downlink sub-frame configurations (as shown in Figure 4) in a TDD system so that the UE can sound the entire SRS frequency-hop bandwidth allocated by the eNB.

[0026] By these requirements, it can be concluded that $n_{SRS} = f(n_f, k)$. Here, the implementation mode cannot be confined within the mapping method of Equation (2):

$$n_{SRS} = n_f \times L + k \quad (2)$$

[0027] By Equation 2, if the configurations for the uplink and downlink in the TDD system are 0, 1, 2 and 6, then $k=0, 1, 2$ and 3 , $L = 4$, and if the configurations for the uplink and downlink in the TDD system are 3, 4 and 5, then $k = 0, 1$; $L = 2$. k is indexed in ascending order, i.e., the first SC-FDMA symbol in each radio frame for transmitting the SRS

corresponds to $k = 0$, the second SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 1$, the third SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 2$, the fourth SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 3$, and n_f denotes the index number of radio frame and $n_f > 0$.

[0028] Other methods for deriving a continuous n_{SRS} according to different values of k may be used as long as the same principles as the foregoing are applied.

[0029] In step 1403 the UE determines the frequency-hop parameter n_{SRS} according to the index number n_f of the radio frame for transmitting the SRS, and the index number n_s of time slot in the radio frame for transmitting the SRS, i.e., by Equation (3) as follows:

$$n_{SRS} = \left\lfloor (n_f \times 10 + \left\lfloor \frac{n_s}{2} \right\rfloor) / T \right\rfloor \quad (3)$$

[0030] In Equation (3), $n_f \geq 0$ denotes the index number of radio frame, n_s denotes the index number of the time slot in the radio frame for transmitting the SRS, $0 \leq n_s \leq 19$, and according to the RRC signaling from the eNB, the UE determines T and n_s based on the contents in Figure 7, and $5 \leq T \leq 320$.

[0031] In step 1404 the frequency-domain increment is calculated and updated by the SRS within the frame according to the obtained n_{SRS} , i.e., by Equation (4) as follows:

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \left\lfloor N_b / 2 \right\rfloor \left\lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \right\rfloor & \text{if } N_b \text{ odd} \end{cases} \quad (4)$$

In Equation (4), N_b is obtained according to the RRC signaling from the eNB and with reference to Figures 13A through 13D, and b_{hop} denotes SRS frequency-hop bandwidth parameter, $0 \leq b_{hop} \leq 3$, which the UE obtains by reading the RRC signaling from the eNB.

[0032] In step 1405, the index number n_b frequency-domain location is calculated for transmitting the SRS according to the obtained $F_b(n_{SRS})$, by Equation (5) as follows:

$$n_b = \begin{cases} \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor & b \leq b_{hop} \\ \left\{ F_b(n_{SRS}) + \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor \right\} \bmod N_b & \text{else} \end{cases} \quad (5)$$

[0033] In Equation (5), $m_{SRS,b}$, b_{hop} , n_{RRC} are the parameters that the UE obtains by reading the RRC signaling from the eNB.

[0034] In step 1406 the start frequency-domain position k_0 is calculated for transmitting the SRS, by Equation (6) as follows:

$$\begin{aligned} k'_0 &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC} \\ k_0 &= k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b \\ M_{sc,b}^{RS} &= m_{SRS,b} N_{sc}^{RB} / 2 \end{aligned} \quad (6)$$

[0035] In Equation (6), $m_{SRS,0}$ is obtained from the 3-bit cell-specific SRS parameter broadcast by the eNB, $m_{SRS,b}$

is allocated by the eNB through RRC signaling and with reference to the lookup table in Figures 13A through 13D,

$N_{sc}^{RB} = 12$ denotes the number of sub-carriers in each RB), $k_{TC} \in \{0,1\}$ denotes the Comb number, and N_{RB}^{UL} denotes the number of frequency-domain RBs in the uplink sub-frame.

[0036] In step 1407 the SRS sequence is mapped to sub-carriers numbered starting from k_0 . The detailed mapping approach is shown in Figure 17.

[0037] In step 1408 the frequency-domain symbols obtained by using IFFT are mapped to time-domain symbols, and then are transmitted through antennas.

[0038] Figures 15A and 15B illustrate another SRS frequency-hop method of the present invention, which is suitable for the UE SRS configuration table for the TDD system in Figure 8. In the method, in step 1500 the UE generates the SRS reference symbol sequence according to the SRS bandwidth parameter (allocated by the eNB through RRC signaling) and the cyclic shift parameter.

[0039] In step 1501 the UE determines whether the SRS period (allocated by eNB for UE) is 5, i.e., the UE reads out the value of l_{SRS} (the SRS period, which is transmitted from the eNB through RRC signaling). If $0 \leq l_{SRS} \leq 14$, the method proceeds to step 1502; otherwise, the method proceeds to step 1504.

[0040] In step 1502 the UE reads out the parameter l_{SRS} on SRS period that is transmitted from the eNB through RRC signaling. If $0 \leq l_{SRS} \leq 9$, the method proceeds to step 1503; otherwise, the method proceeds to step 1504;

[0041] In step 1503 the UE determines the frequency-hop pattern parameter n_{SRS} according to the index number n_f of the radio frame for transmitting the SRS signal, the index number n_s of the time slot in the radio frame for transmitting the SRS, and the index number k of the SRS in the SRS sequence within the radio frame (refer to Figure 18). The requirements for determining the parameter are to avoid a collision between SRSs from different UEs but with the same SRS period, the same sub-frame offset and the same Comb index number, and to guarantee that n_{SRS} is continuous with the index number k of the SRS in the SRS sequence within the radio frame and the different uplink and downlink sub-frame configurations in a TDD system so that the UE can sound the entire SRS frequency-hop bandwidth allocated by the eNB.

[0042] By these requirements, it can be concluded that $n_{SRS} = f(n_f, k)$. Here, the implementation mode cannot be confined within the mapping method of Equation (7) as follows:

$$n_{SRS} = \left\lfloor (n_f \times 10 + \left\lfloor \frac{n_s}{2} \right\rfloor) / T \right\rfloor + \Delta_k \quad (7)$$

(a) For the TDD uplink and downlink configurations 0, 1, 2 and 6:

$$\Delta_k = \begin{cases} 2 \times n_f + k & (k = 0, 1) \\ 2 \times n_f + k - 1 & (k = 2, 3) \end{cases}$$

(b) For the TDD uplink and downlink configurations 3, 4 and 5

$$\Delta_k = k \quad (k = 0, 1)$$

Where $k = 0, 1, 2$ and 3 (if the configurations for the uplink and downlink in TDD system are $0, 1, 2$ and 6), $k = 0$ and 1 (if the configurations for the uplink and downlink in TDD system are $3, 4$ and 5), k is indexed in ascending order, i.e., the first SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 0$, the second SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 1$, the third SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 2$, the fourth SC-FDMA symbol in each radio frame for transmitting the SRS corresponds to $k = 3$, and $n_f \geq 0$ denotes the index number of radio frame. Here $T=5$.

[0043] Other methods for deriving continuous n_{SRS} according to different values of k may be used as long as the same requirements are applied.

[0044] In step 1504 the UE determines the frequency-hop parameter n_{SRS} according to the index number n_f of the radio frame for transmitting the SRS, and the index number n_s of time slot in the radio frame for transmitting the SRS, in Equation (8) as follows:

$$n_{SRS} = \left\lfloor (n_f \times 10 + \left\lfloor \frac{n_s}{2} \right\rfloor) / T \right\rfloor \quad (8)$$

[0045] In Equation (8), $n_f \geq 0$ denotes the index number of radio frame, $0 \leq n_s \leq 19$ denotes the index number of the time slot in the radio frame for transmitting the SRS, and according to the RRC signaling from the eNB, the UE determines T and n_s with reference to Figure 8, $5 \leq T \leq 320$.

[0046] In step 1505 the frequency-domain increment that the SRS needs to be updated within the frame is calculated according to the obtained n_{SRS} , by Equation (9) as

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \lfloor N_b / 2 \rfloor \lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases} \quad (9)$$

[0047] In Equation (9), N_b is obtained according to the RRC signaling from the eNB and with reference to Figures 13A through 13D, b_{hop} denote SRS frequency-hop bandwidth parameter, $0 \leq b_{hop} \leq 3$, which the UE obtains by reading the RRC signaling from the eNB.

[0048] In step 1506 the index number n_b frequency-domain location for transmitting the SRS is calculated according to the obtained $F_b(n_{SRS})$, by Equation (10) as follows:

$$n_b = \begin{cases} \lfloor 4n_{RRC} / m_{SRS,b} \rfloor & b \leq b_{hop} \\ \{F_b(n_{SRS}) + \lfloor 4n_{RRC} / m_{SRS,b} \rfloor\} \bmod N_b & \text{else} \end{cases} \quad (10)$$

[0049] In Equation (10), $m_{SRS,b}$, b_{hop} , n_{RRC} are the parameters that the UE obtains by reading the RRC signaling from the eNB.

[0050] In step 1507 the start frequency-domain position k_0 is calculated for transmitting the SRS by Equation (11), as follows:

$$\begin{aligned} k'_0 &= \left(\lfloor N_{RB}^{UL} / 2 \rfloor - m_{SRS,0} / 2 \right) N_{SC}^{RB} + k_{TC} \\ k_0 &= k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b \\ M_{sc,b}^{RS} &= m_{SRS,b} N_{sc}^{RB} / 2 \end{aligned} \quad (11)$$

[0051] In Equation (11), $m_{SRS,0}$ is obtained from the 3-bit cell-specific SRS parameter broadcast by the eNB, $m_{SRS,b}$ is allocated by the eNB through RRC signaling and obtained with reference to the lookup table in Figures 13A through 13D, $N_{sc}^{RB} = 12$ denotes the number of sub-carrier in each RB, $k_{TC} \in \{0,1\}$ denotes the Comb number, and N_{RB}^{UL} denotes the number of frequency-domain RB in the uplink sub-frame.

[0052] In step 1508 the SRS sequence is mapped to sub-carriers numbered beginning with k_0 . The detailed mapping technique is shown in Figure 17.

[0053] In step 1509 the frequency-domain symbols obtained by using IFFT are mapped to time-domain symbols, and

then transmitted through antennas.

[0054] In addition, another SRS frequency-hop method according to the present invention is shown in Figures 16A and 16B. In the method, in step 1600 the UE generates the SRS reference symbol sequence according to the SRS bandwidth parameter (allocated by the eNB through RRC signaling) and the cyclic shift parameter.

[0055] In step 1601 the UE reads out the SRS period index I_{SRS} transmitted from the eNB. If $0 \leq I_{SRS} \leq 9$, the method proceeds to step 1602; otherwise, the method proceeds to step 1603.

[0056] In step 1602 the parameter n_{SRS} is calculated according to different configurations in a TDD system. For the TDD uplink and downlink configurations 0, 1, 2 and 6 as shown in Figure 4, Equation (12) is used as follows:

$$n_{SRS} = n_f \times 2 + \lfloor n_s / 10 \rfloor \quad (12)$$

For the TDD uplink and downlink configurations 3, 4 and 5 as shown in Figure 4, Equation (13) is used as follows:

$$n_{SRS} = n_f \quad (13)$$

[0057] In Equations (12) and (13), n_f denotes the index number of radio frame, $n_f \geq 0$; n_s denotes the index number of the time slot in the radio frame for transmitting the SRS, and $0 \leq n_s \leq 19$.

[0058] In step 1603 the UE determines the frequency-hop parameter n_{SRS} according to the index number n_f of the radio frame for transmitting the SRS, and the index number n_s of time slot in the radio frame for transmitting the SRS, by Equation (14) as follows:

$$n_{SRS} = \left\lfloor (n_f \times 10 + \lfloor n_s / 2 \rfloor) / T \right\rfloor \quad (14)$$

[0059] In Equation (14), n_f denotes the index number of radio frame, $n_f \geq 0$, n_s denotes the index number of the time slot in the radio frame for transmitting the SRS, $0 \leq n_s \leq 19$, and according to the RRC signaling from the eNB, the UE determines T and n_s .

[0060] In step 1604 the frequency-domain increment that the SRS needs to be updated within the frame is calculated according to the obtained n_{SRS} , by Equation (15) as follows:

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \lfloor N_b / 2 \rfloor \lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases} \quad (15)$$

[0061] In Equation (15), N_b is obtained according to the RRC signaling from the eNB and with reference to Figures 13A through 13D, b_{hop} denotes the SRS frequency-hop bandwidth parameter, which the UE obtains by reading the RRC signaling from the eNB, and $0 \leq b_{hop} \leq 3$.

[0062] In step 1605 the UE reads out the SRS period index I_{SRS} transmitted from eNB. If $0 \leq I_{SRS} \leq 9$, the method proceeds to step 1606; otherwise, the method proceeds to step 1607.

[0063] In step 1606 the UE determines whether the SRS to be transmitted is the first one in a current time slot. If yes, the method proceeds to step 1607; otherwise, the method proceeds to step 1608.

[0064] In step 1607 the index number n_b frequency-domain location for transmitting the SRS is calculated according to the obtained $F_b(n_{SRS})$, by Equation (16) as follows:

$$n_b = \begin{cases} \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor & b \leq b_{\text{hop}} \\ \{F_b(n_{\text{SRS}}) + \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor\} \bmod N_b & \text{else} \end{cases} \quad (16)$$

[0065] In Equation (16), $m_{\text{SRS},b}$, b_{hop} , n_{RRC} are the parameters that the UE obtains by reading the RRC signaling from the eNB.

[0066] In step 1608 the index number n_b frequency-domain location for transmitting the SRS is calculated according to the obtained $F_b(n_{\text{SRS}})$, by Equation (17) as follows:

$$n_b = \begin{cases} \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor & b \leq b_{\text{hop}} \\ \{F_b(n_{\text{SRS}}) + f(n_{\text{RRC}})\} \bmod N_b & \text{else} \end{cases} \quad (17)$$

[0067] In Equation (17), $m_{\text{SRS},b}$, b_{hop} , n_{RRC} are the parameters that the UE obtains by reading the RRC signaling from the eNB.

[0068] Different variations to the foregoing method can be applied. For example, in Equation (18),

$$n_b = \begin{cases} \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor & b \leq b_{\text{hop}} \\ \{F_b(n_{\text{SRS}}) + \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor + \Delta_b\} \bmod N_b & \text{else} \end{cases} \quad (18)$$

Where: $\Delta_b = 0, 1, 2, \dots, N_b - 1$.

[0069] The approach in Equation (19) can also be adopted to calculate n_b , as follows:

$$n_b = \begin{cases} \lfloor 4n_{\text{RRC}}/m_{\text{SRS},b} \rfloor & b \leq b_{\text{hop}} \\ \{F_b(n_{\text{SRS}}) + \lfloor 4(n_{\text{RRC}} + \Delta)/m_{\text{SRS},b} \rfloor\} \bmod N_b & \text{else} \end{cases} \quad (19)$$

Where: $\Delta \geq 0$.

[0070] In step 1609 the start frequency-domain position k_0 for transmitting the SRS is calculated by Equation (20), as follows:

$$\begin{aligned} k'_0 &= \left(\lfloor N_{\text{RB}}^{\text{UL}} / 2 \rfloor - m_{\text{SRS},0} / 2 \right) N_{\text{SC}}^{\text{RB}} + k_{\text{TC}} \\ k_0 &= k'_0 + \sum_{b=0}^{B_{\text{SRS}}} 2M_{\text{sc},b}^{\text{RS}} n_b \\ M_{\text{sc},b}^{\text{RS}} &= m_{\text{SRS},b} N_{\text{sc}}^{\text{RB}} / 2 \end{aligned} \quad (20)$$

[0071] In Equation (20), $m_{\text{SRS},0}$ is obtained from the 3-bit cell-specific SRS parameter broadcast by the eNB, $m_{\text{SRS},b}$ is allocated by the eNB through RRC signaling and obtained with reference to the lookup table in Figures 13A through

13D, $N_{sc}^{RB} = 12$ denotes the number of sub-carrier in each RB, $k_{TC} \in \{0,1\}$ denotes the Comb number, and N_{RB}^{UL} denotes the number of the frequency-domain RB in the uplink sub-frame.

[0072] In step 1610 the SRS sequence is mapped to sub-carriers numbered starting from k_0 . The detailed mapping technique is shown in Figure 17.

[0073] In step 1611 the frequency-domain symbols obtained by IFFT are mapped to time-domain symbols and are then transmitted through antennas.

[0074] In the following example of the present invention, it is assumed that the uplink of the TDD system occupies N RBs, where N = 25.

[0075] The index number of the SRS bandwidth configuration broadcast by the eNB is k, where k = 3.

[0076] The SRS period parameter configured by the eNB for the UE through the RRC signaling is l_{SRS} , where $l_{SRS} = 0$ in this example.

[0077] The SRS bandwidth parameter configured by the eNB for the UE through the RRC signaling is $m_{SRS,b}$, and the frequency-hop bandwidth is b_{hop} , the index of number of Comb for transmitting the SRS is k_{TC} , where $b=3$, and $m_{SRS,b} = 4$, $b_{hop} = 0$, $k_{TC} = 0$.

[0078] The start frequency-hop position configured by the eNB for the UE through the RRC signaling is $L4n_{RRC}/m_{SRS,b}$ where $n_{RRC} = 0$.

[0079] In a TDD system, the uplink and downlink are configured with the configuration l , where $l=1$ in the examples 1, 2 and 3, and $l=4$ in the examples 4, 5 and 6.

[0080] A first example is suitable for the TDD system for which Figure 7 illustrates the UE SRS configuration table. The processing flow is illustrated in Figures 14A and 14B. In step 1, the UE generates the Zadoff-chu sequence with the length of $H = m_{SRS,b} \times 12/2 = 4 \times 12/2 = 24$ according to the SRS bandwidth parameter $m_{SRS,b} = 4$ configured by the eNB through RRC signaling.

[0081] In step 2, the UE deduces the SRS period $T = 2$ according to the SRS period index $l_{SRS} = 0$ and with the information in Figure 7. Moreover, the UE learns about in each radio frame the SRS index $k = 0, 1, 2$ and 3 and the corresponding time slot index, as shown in Figure 18(a);

[0082] In step 3, before transmitting the SRS signal each time, the UE calculates the key frequency-hop parameter n_{SRS} according to current SRS index k and the radio frame index n_f . In this example, it is assumed that current frame's index number $n_f = 0$, and for the second transmission of SRS, $k=1$, $L=4$, and $n_{SRS} = n_f \times 4 + k = 0 \times 4 + 1 = 1$.

[0083] In subsequent steps, the frequency-domain increment is calculated by Equation (21) as follows:

$$F_3(1) = \left\lfloor \frac{5}{2} \right\rfloor \left\lfloor \frac{1}{\prod_{b=0}^2 N_b} \right\rfloor = 2$$

(21)

[0084] The frequency-domain location for transmitting the SRS is calculated according to Equation (22) as follows:

$$F_3(1) \quad \text{as} \quad n_3 = \{F_3(1) + 0\} \bmod 5 = 2;$$

(22)

[0085] The frequency-domain sub-carrier's start position for transmitting the SRS is calculated by Equation (23) as

$$k_0' = \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) \times N_{SC}^{RB} + k_{TC} = \left(\left\lfloor 25 / 2 \right\rfloor - 20 / 2 \right) \times 12 + 0 = 24;$$

$$k_0 = k_0' + \sum_{b=0}^3 2 \times m_{SRS,b} \times n_b = 24 + (20 \times 12 \times 0 + 4 \times 12 \times 2) = 120;$$

(23)

[0086] The UE maps the generated SRS symbols to the sub-carriers numbered starting from k_0 , as shown in Figure 17, and then adopts IFFT to translate the frequency-domain symbols to time-domain symbols and transmit the symbols

through an antenna.

[0087] A second example is suitable for the TDD system for which Figure 8 shows the UE SRS configuration table.

[0088] The processing flow is illustrated in Figures 15A and 15B:

[0089] In step 1, the UE generates the Zadoff-chu sequence with the length of $H = m_{SRS,b} \times 12/2 = 4 \times 12/2 = 24$ according to the SRS bandwidth parameter $m_{SRS,b} = 4$ configured by eNB through RRC signaling.

[0090] In step 2, the UE deduces the SRS period $T = 5$ according to the SRS period index $I_{SRS} = 0$ and with the information in Figure 8. Moreover, the UE learns about in each radio frame the SRS index $k = 0, 1, 2$ and 3 and the corresponding time slot index, as shown in Figure 18(a).

[0091] In step 3, before transmitting the SRS signal each time, the UE calculates the key frequency-hop parameter n_{SRS} according to the current SRS index k and the radio frame index n_f . In this example, it is assumed that the current frame's index number $n_f = 0$, and for the third transmission of the SRS, $k=2$. Thus

$$n_{SRS} = \left\lfloor (n_f \times 10 + \left\lfloor \frac{n_s}{2} \right\rfloor) / T \right\rfloor + 2 \times n_f + k = \left\lfloor (0 \times 10 + \left\lfloor 3/2 \right\rfloor) / 5 \right\rfloor + 2 \times 0 + 2 = 2;$$

[0092] In subsequent steps, the frequency-domain increment is calculated by Equation (24) as follows:

$$F_3(1) = \left\lfloor \frac{5}{2} \right\rfloor \left\lfloor \frac{2}{\prod_{b'=0}^2 N_{b'}} \right\rfloor = 4$$

(24)

[0093] The frequency-domain location for transmitting the SRS is calculated according to Equation (25) as follows:

$$F_3(1) \quad \text{as} \quad n_3 = \{F_3(1) + 0\} \bmod 5 = 4$$

(25)

[0094] The frequency-domain sub-carrier's start position for transmitting the SRS is calculated by Equation (26) as follows:

$$\begin{aligned} k_0' &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) \times N_{SC}^{RB} + k_{TC} = \left(\left\lfloor 25/2 \right\rfloor - 20/2 \right) \times 12 + 0 = 24; \\ k_0 &= k_0' + \sum_{b=0}^3 2 \times m_{SRS,b} \times n_b = 24 + (20 \times 12 \times 0 + 4 \times 12 \times 4) = 192; \end{aligned}$$

(26)

[0095] The UE maps the generated SRS symbols to the sub-carriers numbered starting from $k_0 = 192$, as shown in Figure 17, and then adopts IFFT to translate the frequency-domain symbols to time-domain symbols and transmit the signals through an antenna.

[0096] A third example corresponds to the RRC indicated frequency-hop method illustrated in Figures 16A and 16B. In step 1, the UE generates the Zadoff-chu sequence with the length of $H = m_{SRS,b} \times 12/2 = 4 \times 12/2 = 24$ according to the SRS bandwidth parameter $m_{SRS,b} = 4$ configured by the eNB through RRC signaling.

[0097] In step 2, the UE deduces the index number n_s of the time slot where the SC-FDMA symbol for transmitting the SRS locates in each radio frame according to the SRS period index $I_{SRS} = 0$. The UE calculates the key frequency-hop parameter n_{SRS} according to the radio frame index n_f and the obtained time slot index n_s . In this example, it is assumed that current frame's index number $n_f = 0$, and for the second transmission of the SRS, $n_{SRS} = 2 \times n_f + \lfloor n_s / 10 \rfloor = \lfloor (0 \times 2 + \lfloor 3/10 \rfloor) \rfloor = 0$;

[0098] In subsequent steps, the frequency-domain increment is calculated by Equation (27) as follows:

$$F_3(1) = \left\lfloor \frac{5}{2} \right\rfloor \left\lfloor \frac{0}{\prod_{b'=0}^2 N_{b'}} \right\rfloor = 0.$$

(27)

[0099] It is assumed that $f(n_{RRC})=4n_{RRC}/m_{SRS,3}+2=2$ in this example. The frequency-domain location for transmitting the SRS is calculated according to Equation (28) as follows:

$$F_3(1) \quad \text{as} \quad n_3 = \{F_3(1) + 0 + 2\} \bmod 5 = 2; \quad (28)$$

[0100] The frequency-domain sub-carrier's start position for transmitting the SRS is calculated by Equation (29) as

$$\begin{aligned} k_0' &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) \times N_{SC}^{RB} + k_{TC} = \left(\left\lfloor 25 / 2 \right\rfloor - 20 / 2 \right) \times 12 + 0 = 24 \\ k_0 &= k_0' + \sum_{b=0}^3 2 \times m_{SRS,b} \times n_b = 24 + (20 \times 12 \times 0 + 4 \times 12 \times 2) = 120 \end{aligned} \quad (29)$$

[0101] The UE maps the generated SRS symbols to the sub-carriers numbered starting from $k_0=120$, as shown in Figure 17, and then adopts IFFT to translate the frequency-domain symbols to time-domain symbols and transmit the symbols through an antenna.

[0102] A fourth example is suitable for the TDD system for which Figure 7 shows the UE SRS configuration table.

[0103] The processing flow is illustrated in Figures 14A and 14B.

[0104] In step 1, the UE generates the Zadoff-chu sequence with the length of $H = m_{SRS,b} \times 12 / 2 = 4 \times 12 / 2 = 24$ according to the SRS bandwidth parameter $M_{SPS,b} = 4$ configured by the eNB through RRC signaling.

[0105] In step 2, the UE deduces the SRS period $T = 2$ according to the SRS period index $I_{SRS} = 0$ and with the information in Figure 7. Moreover, the UE learns about in each radio frame the SRS index $k = 0, 1$ and the corresponding time slot index, as shown in Figure 18(b).

[0106] In step 3, before transmitting the SRS signal each time, the UE calculates the key frequency-hop parameter n_{SRS} according to a current SRS index k and the radio frame index n_f . In this example, it is assumed that the current frame's index number $n_f = 1$, and for the second transmission of the SRS, $k=1$, and $L=2$. Thus $n_{SRS} = n_f \times 2 + k = 1 \times 2 + 1 = 3$.

[0107] In subsequent steps, the frequency-domain increment is calculated by Equation (30) as follows:

$$F_3(1) = \left\lfloor \frac{5}{2} \right\rfloor \left\lfloor \frac{3}{\prod_{b=0}^3 N_b} \right\rfloor = 6 \quad (30)$$

[0108] The frequency-domain location for transmitting the SRS is calculated by Equation (31) according to $F_3(1)$ as

$$n_3 = \{F_3(1) + 0\} \bmod 5 = 1. \quad (31)$$

[0109] The frequency-domain sub-carrier's start position for transmitting the SRS is calculated by Equation (32) as

$$\begin{aligned} k_0' &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) \times N_{SC}^{RB} + k_{TC} = \left(\left\lfloor 25 / 2 \right\rfloor - 20 / 2 \right) \times 12 + 0 = 24 \\ k_0 &= k_0' + \sum_{b=0}^3 2 \times m_{SRS,b} \times n_b = 24 + (20 \times 12 \times 0 + 4 \times 12 \times 1) = 72 \end{aligned} \quad (32)$$

[0110] The UE maps the generated SRS symbols to the sub-carriers numbered starting from k_0 , as shown in Figure 17, and then adopts IFFT to translate the frequency-domain symbols to time-domain symbols and transmit the symbols

through an antenna.

[0111] A fifth example is suitable for the TDD system for which Figure 8 shows the UE SRS configuration table. The processing flow is illustrated in Figures 15A and 15B:

In step 1, the UE generates the Zadoff-chu sequence with the length of $H = m_{SRS,b} \times 12/2 = 4 \times 12/2 = 24$ according to the SRS bandwidth parameter $m_{SRS,b} = 4$ configured by the eNB through RRC signaling.

In step 2, the UE deduces the SRS period $T = 5$ according to the SRS period index $l_{SRS} = 0$ and with the information in Figure 8. Moreover, the UE learns about in each radio frame the SRS index $k = 0$ and 1 and the corresponding time slot index, as shown in Figure 18(b).

In step 3, before transmitting the SRS signal each time, the UE calculates the key frequency-hop parameter n_{SRS} according to a current SRS index k and the radio frame index n_f . In this example, it is assumed that current frame's index number $n_f = 2$, and for the 0th transmission of SRS,

$$n_{SRS} = \left\lfloor (n_f \times 10 + \left\lfloor \frac{n_s}{2} \right\rfloor) / T \right\rfloor + 2 \times n_f + k = \left\lfloor (2 \times 10 + \left\lfloor 3/2 \right\rfloor) / 5 \right\rfloor + 2 \times 2 + 0 = 8$$

[0112] In subsequent steps, the frequency-domain increment is calculated by Equation (33) as follows:

$$F_3(1) = \left\lfloor \frac{5}{2} \right\rfloor \left\lfloor \frac{8}{\prod_{b'=0}^2 N_{b'}} \right\rfloor = 16 \quad (33)$$

[0113] The frequency-domain location for transmitting the SRS is calculated according to Equation (34) as follows:

$$F_3(1) \quad \text{as} \quad n_3 = \{F_3(1) + 0\} \bmod 5 = 1. \quad (34)$$

[0114] The frequency-domain sub-carrier's start position for transmitting the SRS is calculated by Equation (35) as follows:

$$\begin{aligned} k_0' &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) \times N_{SC}^{RB} + k_{TC} = \left(\left\lfloor 25 / 2 \right\rfloor - 20 / 2 \right) \times 12 + 0 = 24; \\ k_0 &= k_0' + \sum_{b=0}^3 2 \times m_{SRS,b} \times n_b = 24 + (20 \times 12 \times 0 + 4 \times 12 \times 1) = 72; \end{aligned} \quad (35)$$

[0115] The UE maps the generated SRS symbols to the sub-carriers numbered starting from $k_0=72$, as shown in Figure 17, and then adopts IFFT to translate the frequency-domain symbols to time-domain symbols and transmit the symbols through an antenna.

[0116] A sixth example corresponds to the RRC indicated frequency-hop method illustrated in Figures 16A and 16B. In step 1, the UE generates the Zadoff-chu sequence with the length of $H = m_{SRS,b} \times 12/2 = 4 \times 12/2 = 24$ according to the SRS bandwidth parameter $m_{SRS,b} = 4$ configured by the eNB through RRC signaling.

[0117] In step 2, the UE deduces the index number n_s of the time slot where the SC-FDMA symbol for transmitting the SRS locates in each radio frame according to SRS period index $l_{SRS}=0$. The UE calculates the key frequency-hop parameter n_{SRS} according to the radio frame index n_f and the obtained time slot index n_s . In this example, it is assumed that current frame's index number $n_f=8$, and for the second transmission of the SRS, $n_{SRS} = n_f = 8$.

[0118] In subsequent steps, the frequency-domain increment is calculated by Equation (36) as follows:

$$F_3(1) = \left\lfloor \frac{5}{2} \right\rfloor \left\lfloor \frac{8}{\prod_{b'=0}^2 N_{b'}} \right\rfloor = 16 \quad (36)$$

[0119] It is assumed that $f(n_{RRC}) = \lfloor 4n_{RRC} / m_{SRS,3} \rfloor + 2 = 2$ in this example. The frequency-domain location for transmitting the SRS is calculated according to $F_3(1)$ as by Equation (37):

$$n_3 = \{F_3(1) + 0 + 2\} \bmod 5 = 3 \quad (37)$$

[0120] The frequency-domain sub-carrier's start position for transmitting the SRS is calculated by Equation (38) as follows:

$$\begin{aligned} k_0' &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) \times N_{SC}^{RB} + k_{TC} = \left(\left\lfloor 25 / 2 \right\rfloor - 20 / 2 \right) \times 12 + 0 = 24; \\ k_0 &= k_0' + \sum_{b=0}^3 2 \times m_{SRS,b} \times n_b = 24 + (20 \times 12 \times 0 + 4 \times 12 \times 3) = 168; \end{aligned} \quad (38)$$

[0121] The UE maps the generated SRS symbols to the sub-carriers numbered starting from $k_0 = 168$, as shown in Figure 17, and then adopts IFFT to translate the frequency-domain symbols to time-domain symbols and transmit the symbols through an antenna.

Claims

1. A method for transmitting an uplink Sounding Reference Signal, SRS, for 2 ms SRS periodicity in a TDD system for LTE comprising the steps of:

- a. calculating a value of n_{SRS} for transmitting the SRS;
- b. determining a frequency-domain starting position of the SRS with n_{SRS} (1406), and
- c. transmitting the SRS at the determined frequency-domain starting position (1408),

characterized in that,

n_{SRS} is calculated by $n_{SRS} = n_f \times L + k$ for 2ms SRS periodicity in a TDD system,

where n_f is the system frame number, where L is 4 for a TDD system configuration 0, 1, 2, or 6, and L is 2 for a TDD system configuration 3, 4, or 5, and

k is a parameter used to index the Single-Carrier Frequency Division Multiple Access, SC-FDMA, symbol transmitting the SRS in a radio frame, said k taking values from 0 to 3 for a TDD system configuration 0, 1, 2, and 6, and values from 0 to 1 for a TDD system configuration 3, 4, or 5,

wherein the value k=0 corresponds to the first SC-FDMA symbol for transmitting the SRS in the radio frame, the value k=1 corresponds to the second SC-FDMA symbol for transmitting the SRS in the radio frame, the value k=2 corresponds to the third SC-FDMA symbol for transmitting the SRS in the radio frame, and the value k=3 corresponds to the fourth SC-FDMA symbol for transmitting the SRS in the radio frame.

2. The method according to Claim 1, further comprising:

- calculating a frequency-domain increment to be updated for the SRS according to the obtained n_{SRS} , and
- calculating a frequency position index for transmitting the SRS according to the obtained frequency-domain increment.

3. The method according to Claim 2, wherein the frequency-domain increment is calculated by

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \lfloor N_b / 2 \rfloor \lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases}$$

where N_b is obtained according to an RRC(Radio Resource Control) signaling and b_{hop} denotes SRS frequency-hopping parameter, $0 \leq b_{hop} \leq 3$, which is provided by a higher-layer parameter (1404).

4. The method according to Claim 3, wherein the frequency position index is calculated by

$$n_b = \begin{cases} \lfloor 4n_{RRC} / m_{SRS,b} \rfloor & b \leq b_{hop} \\ \{F_b(n_{SRS}) + \lfloor 4n_{RRC} / m_{SRS,b} \rfloor\} \bmod N_b & \text{else} \end{cases}$$

where $m_{SRS,b}$ is obtained by reading the RRC signaling and n_{RRC} is given by a higher-layer parameter(1405).

5. The method according to Claim 4, wherein, the frequency-domain starting position k_0 is calculated by

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\lfloor N_{RB}^{UL} / 2 \rfloor - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

where $m_{SRS,0}$ obtained from a cell-specific SRS parameter, N_{sc}^{RB} denotes resource block size in the frequency domain, expressed as a number of subcarriers, $k_{TC} \in \{0,1\}$ denotes the Comb parameter, and N_{RB}^{UL} denotes uplink bandwidth configuration, expressed in multiples of N_{sc}^{RB} (1406).

6. A UE, User Equipment, for transmitting an uplink Sounding Reference Signal, SRS, for 2 ms SRS periodicity in a TDD system for LTE, comprising:

an SRS sequence generator for generating SRS sequence;
a physical resource mapper for transmitting the SRS; and
a transmitter for transmitting the SRS at the determined frequency-domain starting position (1408),
wherein the physical resource mapper is adapted to perform the following steps in sequence;

- a) calculating a value of n_{SRS} based on a number L , and the system frame number n_f for transmitting the SRS;
b) determining a frequency-domain starting position of the SRS with n_{SRS} (1406),

wherein n_{SRS} is calculated by $n_{SRS} = n_f \times L + k$ for 2ms SRS periodicity in a TDD system, where L is 4 for a TDD system configuration 0, 1, 2, or 6, and L is 2 for a TDD system configuration 3, 4, or 5,

wherein k is a parameter used to index the Single-Carrier Frequency Division Multiple Access, SC-FDMA, symbol transmitting the SRS in a radio frame, said k taking values from 0 to 3 for a TDD system configuration 0, 1, 2, or 6, and values from 0 to 1 for a TDD system configuration 3, 4, or 5,

wherein the value $k=0$ corresponds to the first SC-FDMA symbol for transmitting the SRS in the radio frame

the value, k=1 corresponds to the second SC-FDMA symbol for transmitting the SRS in the radio frame, the value k=2 corresponds to the third SC-FDMA symbol for transmitting the SRS in the radio frame, and the value k=3 corresponds to the fourth SC-FDMA symbol for transmitting the SRS in the radio frame.

7. The UE according to Claim 6, the physical resource mapper further performing:

calculating a frequency-domain increment to be updated for the SRS according to the obtained n_{SRS} , and calculating a frequency position index for transmitting the SRS according to the obtained frequency-domain increment.

8. The UE according to Claim 7, wherein the frequency-domain increment is calculated by

$$F_b(n_{SRS}) = \begin{cases} (N_b/2) \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{if } N_b \text{ even} \\ \lfloor N_b/2 \rfloor \lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases}$$

where N_b is obtained according to an RRC(Radio Resource Control) signaling and b_{hop} denotes SRS frequency-hopping parameter, $0 \leq b_{hop} \leq 3$, which is provided by a higher-layer parameter (1404).

9. The UE according to Claim 8, wherein the frequency position index is calculated by

$$n_b = \begin{cases} \lfloor 4n_{RRC}/m_{SRS,b} \rfloor & b \leq b_{hop} \\ \left\{ F_b(n_{SRS}) + \lfloor 4n_{RRC}/m_{SRS,b} \rfloor \right\} \bmod N_b & \text{else} \end{cases}$$

where $m_{SRS,b}$ is obtained by reading the RRC signaling and n_{RRC} is given by a higher-layer parameter(1405).

10. The UE according to Claim 9, wherein, the frequency-domain starting position k_0 is calculated by

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\lfloor N_{RB}^{UL}/2 \rfloor - m_{SRS,0}/2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

where $m_{SRS,0}$ obtained from a cell-specific SRS parameter, N_{sc}^{RB} denotes resource block size in the frequency domain, expressed as a number of subcarriers, $k_{TC} \in \{0,1\}$ denotes the Comb parameter, and N_{RB}^{UL} denotes uplink bandwidth configuration, expressed in multiples of N_{sc}^{RB} (1406).

11. A method for receiving an uplink Sounding Reference Signal (SRS) for 2 ms SRS periodicity in a TDD system for LTE, comprising the steps of:

- calculating a value of n_{SRS} for receiving the SRS;
- determining a frequency-domain starting position of the SRS with n_{SRS} (1406), and

c. receiving the SRS at the determined frequency-domain starting position (1408),

characterized in that,

n_{SRS} is calculated by $n_{SRS} = n_f \times L + k$ for 2ms SRS periodicity in a TDD system, where n_f is the system frame number, where L is 4 for a TDD system configuration 0, 1, 2, or 6, and L is 2 for a TDD system configuration 3, 4, or 5, and k is a parameter used to index the Single-Carrier Frequency Division Multiple Access, SC-FDMA, symbol transmitting the SRS in a radio frame, said k taking values from 0 to 3 for a TDD system configuration 0, 1, 2, and 6, and values from 0 to 1 for a TDD system configuration 3, 4, or 5,

wherein the value $k=0$ corresponds to the first SC-FDMA symbol for transmitting the SRS in the radio frame, the value $k=1$ corresponds to the second SC-FDMA symbol for transmitting the SRS in the radio frame, the value $k=2$ corresponds to the third SC-FDMA symbol for transmitting the SRS in the radio frame, and the value $k=3$ corresponds to the fourth SC-FDMA symbol for transmitting the SRS in the radio frame.

12. The method according to Claim 11, further comprising step of:

calculating a frequency-domain increment to be updated for the SRS according to the obtained n_{SRS} , and calculating a frequency position index for transmitting the SRS according to the obtained frequency-domain increment.

13. The method according to Claim 12, wherein the frequency-domain increment is calculated by

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{if } N_b \text{ even} \\ \lfloor N_b / 2 \rfloor \lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases}$$

where N_b is obtained according to an RRC(Radio Resource Control) signaling and b_{hop} denotes SRS frequency-hopping parameter, $0 \leq b_{hop} \leq 3$, which is provided by a higher-layer parameter (1404).

14. The method according to Claim 13, wherein the frequency position index is calculated by

$$n_b = \begin{cases} \lfloor 4n_{RRC} / m_{SRS,b} \rfloor & b \leq b_{hop} \\ \{F_b(n_{SRS}) + \lfloor 4n_{RRC} / m_{SRS,b} \rfloor\} \bmod N_b & \text{else} \end{cases}$$

where $m_{SRS,b}$ is obtained by reading the RRC signaling and n_{RRC} is given by a higher-layer parameter(1405).

15. The method according to Claim 14, wherein the frequency-domain starting position k_0 is calculated by

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\lfloor N_{RB}^{UL} / 2 \rfloor - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

where $m_{SRS,0}$ obtained from a cell-specific SRS parameter, N_{sc}^{RB} denotes resource block size in the frequency

domain, expressed as a number of subcarriers, $k_{TC} \in \{0,1\}$ denotes the Comb parameter, and N_{RB}^{UL} denotes uplink bandwidth configuration, expressed in multiples of N_{sc}^{RB} (1406).

16. A Base station for receiving an uplink Sounding Reference Signal, SRS, for 2 ms SRS periodicity in a TDD system for LTE, comprising:

an SRS sequence generator for generating SRS sequence;

a physical resource mapper for receiving the SRS; and

a receiver for receiving the SRS at the determined frequency-domain starting position (1408), wherein the physical resource mapper is adapted to perform the following steps in sequence;

- a) calculating a value of n_{SRS} based on a number L, and the system frame number n_f for transmitting the SRS;
- b) determining a frequency-domain starting position of the SRS with n_{SRS} (1406),

wherein n_{SRS} is calculated by $n_{SRS} = n_f \times L + k$ for 2ms SRS periodicity in a TDD system, where L is 4 for a TDD system configuration 0, 1, 2, or 6, and L is 2 for a TDD system configuration 3, 4, or 5, wherein k is a parameter used to index the Single-Carrier Frequency Division Multiple Access, SC-FDMA, symbol transmitting the SRS in a radio frame, said k taking values from 0 to 3 for a TDD system configuration 0, 1, 2, and 6, and values from 0 to 1 for a TDD system configuration 3, 4, and 5, wherein the value k=0 corresponds to the first SC-FDMA symbol for transmitting the SRS in the radio frame, the value k=1 corresponds to the second SC-FDMA symbol for transmitting the SRS in the radio frame, the value k=2 corresponds to the third SC-FDMA symbol for transmitting the SRS in the radio frame, and the value k=3 corresponds to the fourth SC-FDMA symbol for transmitting the SRS in the radio frame.

17. The Base station according to Claim 16, the physical resource mapper further performing; calculating a frequency-domain increment to be updated for the SRS according to the obtained n_{SRS} , and calculating a frequency position index for transmitting the SRS according to the obtained frequency-domain increment.

18. The Base station according to Claim 17, wherein the frequency-domain increment is calculated by

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor & \text{if } N_b \text{ even} \\ \lfloor N_b / 2 \rfloor \lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \rfloor & \text{if } N_b \text{ odd} \end{cases}$$

where N_b is obtained according to an RRC(Radio Resource Control) signaling and b_{hop} denotes SRS frequency-hopping parameter, $0 \leq b_{hop} \leq 3$, which is provided by a higher-Layer parameter (1404).

19. The Base station according to Claim 18, wherein the frequency position index is calculated by

$$n_b = \begin{cases} \lfloor 4n_{RRC} / m_{SRS,b} \rfloor & b \leq b_{hop} \\ \{F_b(n_{SRS}) + \lfloor 4n_{RRC} / m_{SRS,b} \rfloor\} \bmod N_b & \text{else} \end{cases}$$

where $m_{SRS,b}$ is obtained by reading the RRC signaling and n_{RRC} is given by a higher-layer parameter(1405).

20. The Base station according to Claim 19, wherein, the frequency-domain starting position k_0 is calculated by

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

where $m_{SRS,0}$ obtained from a cell-specific SRS parameter, N_{sc}^{RB} denotes resource block size in the frequency domain, expressed as a number of subcarriers, $k_{TC} \in \{0,1\}$ denotes the Comb parameter, and N_{RB}^{UL} denotes uplink bandwidth configuration, expressed in multiples of N_{sc}^{RB} (1406).

Patentansprüche

1. Verfahren zum Senden eines Uplink-Tonreferenzsignales, -SRS, für 2 ms SRS-Periodizität in einem Zeitduplexsystem für LTE, das die folgenden Schritte umfasst:

- Berechnen eines Wertes von n_{SRS} zum Senden des SRS;
- Bestimmen einer Frequenzbereichs-Anfangsposition des SRS mit n_{SRS} (1406) und
- Senden des SRS bei der bestimmten Frequenzbereichs-Anfangsposition (1408),

dadurch gekennzeichnet, dass n_{SRS} über $n_{SRS} = n_f \times L + k$ für 2 ms SRS-Periodizität in einem Zeitduplexsystem berechnet wird, wobei n_f die Systemrahmenzahl ist, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 oder 6 L gleich 4 ist und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 L gleich 2 ist, und k ein Parameter ist, der verwendet wird, um das Einfachträger-Frequenzmultiplex-Symbol, SC-FDMA-Symbol zu indizieren, das das SRS in einem Funksignalrahmen sendet, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 und 6 das k Werte von 0 bis 3 und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 Werte von 0 bis 1 annimmt, wobei der Wert k=0 dem ersten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=1 dem zweiten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=2 dem dritten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht und der Wert k=3 dem vierten SC-FDMA-Symbol zum senden des SRS im Funksignalrahmen entspricht.

2. Verfahren nach Anspruch 1, das ferner Folgendes umfasst:

Berechnen eines zu aktualisierenden Frequenzbereichs-Inkrementes für das SRS gemäß dem erlangten n_{SRS} und
Berechnen eines Frequenzpositionsindex zum Senden des SRS gemäß dem erlangten Frequenzbereichs-Inkrement.

3. Verfahren nach Anspruch 2, wobei das Frequenzbereichs-Inkrement berechnet wird über

$$F_b(n_{SRS}) = \begin{cases} (N_b / 2) \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{\prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{2 \prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{wenn } N_b \text{ gerade} \\ \left[N_b / 2 \right] \left[n_{SRS} / \prod_{b'=b_{hop}}^{b-1} N_{b'} \right] & \text{wenn } N_b \text{ ungerade} \end{cases}$$

wobei N_b gemäß einer RRC-Signalisierung (Funkressourcensteuerungs-Signalisierung) erlangt wird und b_{hop} einen

SRS-Frequenzsprung-Parameter, $0 \leq b_{hop} \leq 3$, bezeichnet, der durch einen Parameter höherer Schicht bereitgestellt wird (1404).

4. Verfahren nach Anspruch 3, wobei der Frequenzpositionsindex berechnet wird über

$$n_b = \begin{cases} \lfloor 4n_{RRC} / m_{SRS,b} \rfloor & b \leq b_{hop} \\ \{F_b(n_{SRS}) + \lfloor 4n_{RRC} / m_{SRS,b} \rfloor\} \bmod N_b & \text{andernfalls} \end{cases}$$

wobei $m_{SRS,b}$ durch Auslesen der RRC-Signalisierung erlangt wird und n_{RRC} durch einen Parameter höherer Schicht gegeben ist (1405).

5. Verfahren nach Anspruch 4, wobei die Frequenzbereichs-Anfangsposition k_0 berechnet wird über

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

wobei $m_{SRS,0}$ aus einem zellenspezifischen SRS-Parameter erlangt wird, N_{sc}^{RB} eine Ressourcenblockgröße im Frequenzbereich bezeichnet, die als Anzahl Hilfsträger ausgedrückt wird, $k_{TC} \in \{0, 1\}$ den Kammparameter bezeichnet und N_{RB}^{UL} eine Uplink-Bandbreiten-Konfiguration bezeichnet, die in Vielfachen von N_{sc}^{RB} ausgedrückt wird (1406).

6. UE, Benutzereinrichtung, zum Senden eines Uplink-Tonreferenzsignales, -SRS, für 2 ms SRS-Periodizität in einem Zeitduplexsystem für LTE, die Folgendes umfasst:

einen SRS-Sequenz-Generator zum Generieren einer SRS-Sequenz;
einen Mapper physikalischer Ressourcen zum Senden des SRS; und
einen Sender zum Senden des SRS bei der bestimmten Frequenzbereichs-Anfangsposition (1408),
wobei der Mapper physikalischer Ressourcen ausgelegt ist, die folgenden Schritte in der Sequenz durchzuführen;

- a) Berechnen eines Wertes von n_{SRS} basierend auf einer Zahl L und der Systemrahmenzahl n_f zum Senden des SRS;
b) Bestimmen einer Frequenzbereichs-Anfangsposition des SRS mit n_{SRS} (1406),

wobei n_{SRS} über $n_{SRS} = n_f \times L + k$ für 2 ms SRS-Periodizität in einem Zeitduplexsystem berechnet wird, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 oder 6 L gleich 4 ist und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 L gleich 2 ist,
wobei k ein Parameter ist, der verwendet wird, um das Einfachträger-Frequenzmultiplex-Symbol, SC-FDMA-Symbol zu indizieren, das das SRS in einem Funksignalrahmen sendet, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 oder 6 das k Werte von 0 bis 3 und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 Werte von 0 bis 1 annimmt, wobei der Wert k=0 dem ersten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=1 dem zweiten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=2 dem dritten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht und der Wert k=3 dem vierten SC-FDMA-Symbol zum senden des SRS im Funksignalrahmen entspricht.

7. UE nach Anspruch 6, wobei der Mapper physikalischer Ressourcen ferner Folgendes durchführt:

Berechnen eines zu aktualisierenden Frequenzbereichs-Inkrementes für das SRS gemäß dem erlangten n_{SRS} und
Berechnen eines Frequenzpositionsindex zum Senden des SRS gemäß dem erlangten Frequenzbereichs-Inkrement.

8. UE nach Anspruch 7, wobei das Frequenzbereichs-Inkrement berechnet wird über

$$F_b(n_{SRS}) = \begin{cases} (N_b/2) \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{\prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{2 \prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{wenn } N_b \text{ gerade} \\ \left[N_b/2 \right] \left[n_{SRS} / \prod_{b'=b_{hop}}^{b-1} N_{b'} \right] & \text{wenn } N_b \text{ ungerade} \end{cases}$$

wobei N_b gemäß einer RRC-Signalisierung (Funkressourcensteuerungs-Signalisierung) erlangt wird und b_{hop} einen SRS-Frequenzsprung-Parameter, $0 \leq b_{hop} \leq 3$, bezeichnet, der durch einen Parameter höherer Schicht bereitgestellt wird (1404).

9. UE nach Anspruch 8, wobei der Frequenzpositionsindex berechnet wird über

$$n_b = \begin{cases} \left[4n_{RRC} / m_{SRS,b} \right] & b \leq b_{hop} \\ \{F_b(n_{SRS}) + [4n_{RRC} / m_{SRS,b}]\} \bmod N_b & \text{andernfalls} \end{cases}$$

wobei $m_{SRS,b}$ durch Auslesen der RRC-Signalisierung erlangt wird und n_{RRC} durch einen Parameter höherer Schicht gegeben ist (1405).

10. UE nach Anspruch 9, wobei die Frequenzbereichs-Anfangsposition k_0 berechnet wird über

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\left[N_{RB}^{UL} / 2 \right] - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

wobei $m_{SRS,0}$ aus einem zellenspezifischen SRS-Parameter erlangt wird, N_{sc}^{RB} eine Ressourcenblockgröße im Frequenzbereich bezeichnet, die als Anzahl Hilfssträger ausgedrückt wird, $k_{TC} \in \{0, 1\}$ den Kammparameter bezeichnet und N_{RB}^{UL} eine Uplink-Bandbreiten-Konfiguration bezeichnet, die in Vielfachen von N_{sc}^{RB} ausgedrückt wird (1406).

11. Verfahren zum Empfangen eines Uplink-Tonreferenzsignales (-SRS) für 2 ms SRS-Periodizität in einem Zeitduplexsystem für LTE, das die folgenden Schritte umfasst:

- Berechnen eines Wertes von n_{SRS} zum Empfangen des SRS;
- Bestimmen einer Frequenzbereichs-Anfangsposition des SRS mit n_{SRS} (1406) und
- Empfangen des SRS bei der bestimmten Frequenzbereichs-Anfangsposition (1408),

dadurch gekennzeichnet, dass n_{SRS} über $n_{SPS} = n_f \times L + k$ für 2 ms SRS-Periodizität in einem Zeitduplexsystem berechnet wird, wobei n_f die Systemrahmenzahl ist, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 oder 6 L gleich 4 ist und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 L gleich 2 ist, und

k ein Parameter ist, der verwendet wird, um das Einfachträger-Frequenzmultiplex-Symbol, SC-FDMA-Symbol zu indizieren, das das SRS in einem Funksignalrahmen sendet, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 und 6 das k Werte von 0 bis 3 und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 Werte von 0 bis 1 annimmt, wobei der Wert k=0 dem ersten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=1 dem zweiten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=2 dem dritten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht und der Wert k=3 dem vierten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht.

12. Verfahren nach Anspruch 11, das ferner folgenden Schritt umfasst:

Berechnen eines zu aktualisierenden Frequenzbereichs-Inkrementes für das SRS gemäß dem erlangten n_{SRS} und
Berechnen eines Frequenzpositionsindex zum Senden des SRS gemäß dem erlangten Frequenzbereichs-Inkrement.

13. Verfahren nach Anspruch 12, wobei das Frequenzbereichs-Inkrement berechnet wird über

$$F_b(n_{SRS}) = \begin{cases} (N_b/2) \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{\prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{2 \prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{wenn } N_b \text{ gerade} \\ [N_b/2] \left[n_{SRS} / \prod_{b'=b_{hop}}^{b-1} N_{b'} \right] & \text{wenn } N_b \text{ ungerade} \end{cases}$$

wobei N_b gemäß einer RRC-Signalisierung (Funkressourcensteuerungs-Signalisierung) erlangt wird und b_{hop} einen SRS-Frequenzsprung-Parameter, $0 \leq b_{hop} \leq 3$, bezeichnet, der durch einen Parameter höherer Schicht bereitgestellt wird (1404).

14. Verfahren nach Anspruch 13, wobei der Frequenzpositionsindex berechnet wird über

$$n_b = \begin{cases} [4n_{RRC} / m_{SRS,b}] & b \leq b_{hop} \\ \{F_b(n_{SRS}) + [4n_{RRC} / m_{SRS,b}]\} \bmod N_b & \text{andernfalls} \end{cases}$$

wobei $m_{SRS,b}$ durch Auslesen der RRC-Signalisierung erlangt wird und n_{RRC} durch einen Parameter höherer Schicht gegeben ist (1405).

15. Verfahren nach Anspruch 14, wobei die Frequenzbereichs-Anfangsposition k_0 berechnet wird über

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\left[N_{RB}^{UL} / 2 \right] - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

wobei $m_{SRS,0}$ aus einem zellenspezifischen SRS-Parameter erlangt wird, N_{sc}^{RB} eine Ressourcenblockgröße im Frequenzbereich bezeichnet, die als Anzahl Hilfsträger ausgedrückt wird, $k_{TC} \in \{0, 1\}$ den Kammparameter bezeichnet und N_{RB}^{UL} eine Uplink-Bandbreiten-Konfiguration bezeichnet, die in Vielfachen von N_{sc}^{RB} ausgedrückt wird (1406).

16. Basisstation zum Empfangen eines Uplink-Tonreferenzsignales, -SRS, für 2 ms SRS-Periodizität in einem Zeitduplexsystem für LTE, die Folgendes umfasst:

einen SRS-Sequenz-Generator zum Generieren einer SRS-Sequenz;
einen Mapper physikalischer Ressourcen zum Empfangen des SRS; und
einen Empfänger zum Empfangen des SRS bei der bestimmten Frequenzbereichs-Anfangsposition (1408), wobei der Mapper physikalischer Ressourcen ausgelegt ist, die folgenden Schritte in der Sequenz durchzuführen;

- a) Berechnen eines Wertes von n_{SRS} basierend auf einer Zahl L und der Systemrahmenzahl n_f zum Senden des SRS;
b) Bestimmen einer Frequenzbereichs-Anfangsposition des SRS mit n_{SRS} (1406),

wobei n_{SRS} über $n_{SRS} = n_f \times L + k$ für 2 ms SRS-Periodizität in einem Zeitduplexsystem berechnet wird, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 oder 6 L gleich 4 ist und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 L gleich 2 ist,

wobei k ein Parameter ist, der verwendet wird, um das Einfachträger-Frequenzmultiplex-Symbol, SC-FDMA-Symbol zu indizieren, das das SRS in einem Funksignalrahmen sendet, wobei für eine Zeitduplexsystem-Konfiguration 0, 1, 2 und 6 das k Werte von 0 bis 3 und für eine Zeitduplexsystem-Konfiguration 3, 4 oder 5 Werte von 0 bis 1 annimmt, wobei der Wert k=0 dem ersten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=1 dem zweiten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht, der Wert k=2 dem dritten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht und der Wert k=3 dem vierten SC-FDMA-Symbol zum Senden des SRS im Funksignalrahmen entspricht.

17. Basisstation nach Anspruch 16, wobei der Mapper physikalischer Ressourcen ferner Folgendes durchführt; Berechnen eines zu aktualisierenden Frequenzbereichs-Inkrementes für das SRS gemäß dem erlangten n_{SRS} und Berechnen eines Frequenzpositionsindex zum Senden des SRS gemäß dem erlangten Frequenzbereichs-Inkrement.

18. Basisstation nach Anspruch 17, wobei das Frequenzbereichs-Inkrement berechnet wird über

$$F_b(n_{SRS}) = \begin{cases} (N_b/2) \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{\prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \prod_{b'=b_{hop}}^b N_{b'}}{2 \prod_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{wenn } N_b \text{ gerade} \\ [N_b/2] \left[n_{SRS} / \prod_{b'=b_{hop}}^{b-1} N_{b'} \right] & \text{wenn } N_b \text{ ungerade} \end{cases}$$

wobei N_b gemäß einer RRC-Signalisierung (Funkressourcensteuerungs-Signalisierung) erlangt wird und b_{hop} einen SRS-Frequenzsprung-Parameter, $0 \leq b_{hop} \leq 3$, bezeichnet, der durch einen Parameter höherer Schicht bereitgestellt wird (1404).

19. Basisstation nach Anspruch 18, wobei der Frequenzpositionsindex berechnet wird über

$$n_b = \begin{cases} [4n_{RRC} / m_{SRS,b}] & b \leq b_{hop} \\ \{F_b(n_{SRS}) + [4n_{RRC} / m_{SRS,b}]\} \bmod N_b & \text{andernfalls} \end{cases}$$

wobei $m_{SRS,b}$ durch Auslesen der RRC-Signalisierung erlangt wird und n_{RRC} durch einen Parameter höherer Schicht gegeben ist (1405).

20. Basisstation nach Anspruch 19, wobei die Frequenzbereichs-Anfangsposition k_0 berechnet wird über

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) N_{SC}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

wobei $m_{SRS,0}$ aus einem zellenspezifischen SRS-Parameter erlangt wird, N_{sc}^{RB} eine Ressourcenblockgröße im Frequenzbereich bezeichnet, die als Anzahl Hilfssträger ausgedrückt wird, $k_{TC} \in \{0, 1\}$ den Kammparameter bezeichnet und N_{RB}^{UL} eine Uplink-Bandbreiten-Konfiguration bezeichnet, die in Vielfachen von N_{sc}^{RB} ausgedrückt wird (1406).

Revendications

1. Procédé de transmission d'un signal de référence de sondage, SRS, de liaison montante pour une périodicité de SRS de 2 ms dans un système TDD pour LTE, comprenant les étapes de :

- le calcul d'une valeur de n_{SRS} pour transmettre le SRS ;
- la détermination d'une position de début dans le domaine de fréquence du SRS avec n_{SRS} (1406), et
- la transmission du SRS à la position de début dans le domaine de fréquence déterminée (1408),

caractérisé en ce que n_{SRS} est calculé par $n_{SRS} = n_f \times L + k$ pour une périodicité de SRS de 2 ms dans un système TDD, où n_f est le numéro de trame de système, L est égal à 4 pour une configuration de système TDD 0, 1, 2 ou 6 et L est égal à 2 pour une configuration de système TDD 3, 4 ou 5, et

k est un paramètre utilisé pour indexer un symbole d'accès multiples par répartition de fréquences à porteuse unique, SC-FDMA, transmettant le SRS dans une trame radio, ledit k prenant des valeurs de 0 à 3 pour une configuration de système TDD 0, 1, 2 et 6, et des valeurs de 0 à 1 pour une configuration de système TDD 3, 4 ou 5, dans lequel la valeur $k = 0$ correspond au premier symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur $k = 1$ correspond au deuxième symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur $k = 2$ correspond au troisième symbole SC-FDMA pour transmettre le SRS dans la trame radio, et la valeur $k = 3$ correspond au quatrième symbole SC-FDMA pour transmettre le SRS dans la trame radio.

2. Procédé selon la revendication 1, comprenant en outre :

le calcul d'un incrément de domaine de fréquence à mettre à jour pour le SRS en fonction du n_{SRS} obtenu, et le calcul d'un indice de position de fréquence pour transmettre le SRS en fonction de l'incrément de domaine de fréquence obtenu.

3. Procédé selon la revendication 2, dans lequel l'incrément de domaine de fréquence est calculé par :

$$F_b(n_{SRS}) = \begin{cases} \left(\left\lfloor N_b / 2 \right\rfloor \right) \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b'} N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b'} N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{si } N_b \text{ est pair} \\ \left\lfloor N_b / 2 \right\rfloor \left[\frac{n_{SRS}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{si } N_b \text{ est impair} \end{cases}$$

où N_b est obtenu en fonction d'une signalisation de commande de ressources radio, RRC, et b_{hop} indique un paramètre de saut de fréquence de SRS, $0 \leq b_{hop} \leq 3$, qui est fourni par un paramètre de couche supérieure (1404).

4. Procédé selon la revendication 3, dans lequel l'indice de position de fréquence est calculé par :

$$n_b = \begin{cases} \left\lfloor 4n_{RRC}/m_{SRS,b} \right\rfloor & \text{si } b < b_{hop} \\ \left\{ F_b(n_{SRS}) + \left\lfloor 4n_{RRC}/m_{SRS,b} \right\rfloor \right\} \bmod N_b & \text{sinon} \end{cases}$$

où $m_{SRS,b}$ est obtenu par la lecture de la signalisation RRC et n_{RRC} est donné par un paramètre de couche supérieure (1405).

5. Procédé selon la revendication 4, dans lequel la position de début de domaine de fréquence k_0 est calculée par :

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{SC,b}^{RS} n_b$$

$$k'_0 = \left(\left\lfloor N_{RB}^{UL}/2 \right\rfloor - m_{SRS,0}/2 \right) N_{SC}^{RB} + k_{TC}$$

$$M_{SC,b}^{RS} = m_{SRS,b} N_{SC}^{RB} / 2$$

où $m_{SRS,0}$ est obtenu à partir d'un paramètre de SRS spécifique à la cellule, N_{SC}^{RB} indique une taille de bloc de ressources dans le domaine de fréquence exprimée sous la forme d'un nombre de sous-porteuses, $k_{TC} \in \{0,1\}$ indique le paramètre de Comb, et N_{RB}^{UL} indique une configuration de largeur de bande de liaison montante exprimée en multiples de N_{SC}^{RB} (1406).

6. Equipement d'utilisateur, UE, destiné à transmettre un signal de référence de sondage, SRS, de liaison montante pour une périodicité de SRS de 2 ms dans un système TDD pour LTE, comprenant :

un générateur de séquence de SRS pour générer une séquence de SRS ;

un mappeur de ressources physiques pour transmettre le SRS ; et

un émetteur pour transmettre le SRS à la position de début de domaine de fréquence déterminée (1408), dans lequel le mappeur de ressources physiques est apte à effectuer les étapes suivantes dans l'ordre :

a) le calcul d'une valeur de n_{SRS} sur la base d'un nombre L, et du numéro de trame de système n_f pour transmettre le SRS ;

b) la détermination d'une position de début dans le domaine de fréquence du SRS avec n_{SRS} (1406),

dans lequel n_{SRS} est calculé par $n_{SRS} = n_f \times L + k$ pour une périodicité de SRS de 2 ms dans un système TDD, où L est égal à 4 pour une configuration de système TDD 0, 1, 2 ou 6 et L est égal à 2 pour une configuration de système TDD 3, 4 ou 5, et

k est un paramètre utilisé pour indexer un symbole d'accès multiples par répartition de fréquences à porteuse unique, SC-FDMA, transmettant le SRS dans une trame radio, ledit k prenant des valeurs de 0 à 3 pour une configuration de système TDD 0, 1, 2 et 6, et des valeurs de 0 à 1 pour une configuration de système TDD 3, 4 ou 5, dans lequel la valeur k = 0 correspond au premier symbole SC-FDMA pour transmettre le SRS dans la

trame radio, la valeur $k = 1$ correspond au deuxième symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur $k = 2$ correspond au troisième symbole SC-FDMA pour transmettre le SRS dans la trame radio, et la valeur $k = 3$ correspond au quatrième symbole SC-FDMA pour transmettre le SRS dans la trame radio.

7. UE selon la revendication 6, dans lequel le mappeur de ressources physiques effectue en outre :

le calcul d'un incrément de domaine de fréquence à mettre à jour pour le SRS en fonction du n_{SRS} obtenu, et le calcul d'un indice de position de fréquence pour transmettre le SRS en fonction de l'incrément de domaine de fréquence obtenu.

8. UE selon la revendication 7, dans lequel l'incrément de domaine de fréquence est calculé par :

$$F_b(n_{SRS}) = \begin{cases} \left(\left(N_b / 2 \right) \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] \right) & \text{si } N_b \text{ est pair} \\ \left\lfloor N_b / 2 \right\rfloor \left\lceil n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \right\rceil & \text{si } N_b \text{ est impair} \end{cases}$$

où N_b est obtenu en fonction d'une signalisation de commande de ressources radio, RRC, et b_{hop} indique un paramètre de saut de fréquence de SRS, $0 \leq b_{hop} \leq 3$, qui est fourni par un paramètre de couche supérieure (1404).

9. UE selon la revendication 8, dans lequel l'indice de position de fréquence est calculé par :

$$n_b = \begin{cases} \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor & \text{si } b < b_{hop} \\ \left\{ F_b(n_{SRS}) + \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor \right\} \bmod N_b & \text{sinon} \end{cases}$$

où $m_{SRS,b}$ est obtenu par la lecture de la signalisation RRC et n_{RRC} est donné par un paramètre de couche supérieure (1405).

10. UE selon la revendication 9, dans lequel la position de début de domaine de fréquence k_0 est calculée par :

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{SC,b}^{RS} n_b$$

$$k'_0 = \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) N_{SC}^{RB} + k_{TC}$$

$$M_{SC,b}^{RS} = m_{SRS,b} N_{SC}^{RB} / 2$$

où $m_{SRS,0}$ est obtenu à partir d'un paramètre de SRS spécifique à la cellule, N_{SC}^{RB} indique une taille de bloc de ressources dans le domaine de fréquence exprimée sous la forme d'un nombre de sous-porteuses, $k_{TC} \in \{0,1\}$ indique le paramètre de Comb, et N_{RB}^{UL} indique une configuration de largeur de bande de liaison montante exprimée

en multiples de N_{SC}^{RB} (1406).

11. Procédé de réception d'un signal de référence de sondage, SRS, de liaison montante pour une périodicité de SRS de 2 ms dans un système TDD pour LTE, comprenant les étapes de :

- le calcul d'une valeur de n_{SRS} pour recevoir le SRS ;
- la détermination d'une position de début dans le domaine de fréquence du SRS avec n_{SRS} (1406), et
- la réception du SRS à la position de début dans le domaine de fréquence déterminée (1408),

caractérisé en ce que n_{SRS} est calculé par $n_{SRS} = n_f \times L + k$ pour une périodicité de SRS de 2 ms dans un système TDD, où n_f est le numéro de trame de système, L est égal à 4 pour une configuration de système TDD 0, 1, 2 ou 6 et L est égal à 2 pour une configuration de système TDD 3, 4 ou 5, et

k est un paramètre utilisé pour indexer un symbole d'accès multiples par répartition de fréquences à porteuse unique, SC-FDMA, transmettant le SRS dans une trame radio, ledit k prenant des valeurs de 0 à 3 pour une configuration de système TDD 0, 1, 2 et 6, et des valeurs de 0 à 1 pour une configuration de système TDD 3, 4 ou 5, dans lequel la valeur k = 0 correspond au premier symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur k = 1 correspond au deuxième symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur k = 2 correspond au troisième symbole SC-FDMA pour transmettre le SRS dans la trame radio, et la valeur k = 3 correspond au quatrième symbole SC-FDMA pour transmettre le SRS dans la trame radio.

12. Procédé selon la revendication 11, comprenant en outre les étapes de :

le calcul d'un incrément de domaine de fréquence à mettre à jour pour le SRS en fonction du n_{SRS} obtenu, et le calcul d'un indice de position de fréquence pour transmettre le SRS en fonction de l'incrément de domaine de fréquence obtenu.

13. Procédé selon la revendication 12, dans lequel l'incrément de domaine de fréquence est calculé par :

$$F_b(n_{SRS}) = \begin{cases} \left(\left(N_b / 2 \right) \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] + \left[\frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^b N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] \right) & \text{si } N_b \text{ est pair} \\ \left\lfloor N_b / 2 \right\rfloor \left[\frac{n_{SRS}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right] & \text{si } N_b \text{ est impair} \end{cases}$$

où N_b est obtenu en fonction d'une signalisation de commande de ressources radio, RRC, et b_{hop} indique un paramètre de saut de fréquence de SRS, $0 \leq b_{hop} \leq 3$, qui est fourni par un paramètre de couche supérieure (1404).

14. Procédé selon la revendication 13, dans lequel l'indice de position de fréquence est calculé par :

$$n_b = \begin{cases} \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor & \text{si } b \leq b_{hop} \\ \left\{ F_b(n_{SRS}) + \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor \right\} \bmod N_b & \text{sinon} \end{cases}$$

où $m_{SRS,b}$ est obtenu par la lecture de la signalisation RRC et n_{RRC} est donné par un paramètre de couche supérieure (1405).

15. Procédé selon la revendication 14, dans lequel la position de début de domaine de fréquence k_0 est calculée par :

$$k_0 = k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b$$

$$k'_0 = \left(\left\lfloor \frac{N_{RB}^{UL}}{2} \right\rfloor - \frac{m_{SRS,0}}{2} \right) N_{sc}^{RB} + k_{TC}$$

$$M_{sc,b}^{RS} = m_{SRS,b} N_{sc}^{RB} / 2$$

où $m_{SRS,0}$ est obtenu à partir d'un paramètre de SRS spécifique à la cellule, N_{sc}^{RB} indique une taille de bloc de ressources dans le domaine de fréquence exprimée sous la forme d'un nombre de sous-porteuses, $k_{TC}(\cdot, 1)$ indique le paramètre de Comb, et N_{RB}^{UL} indique une configuration de largeur de bande de liaison montante exprimée en multiples de N_{sc}^{RB} (1406).

16. Station de base destinée à recevoir un signal de référence de sondage, SRS, de liaison montante pour une périodicité de SRS de 2 ms dans un système TDD pour LTE, comprenant :

un générateur de séquence de SRS pour générer une séquence de SRS ;

un mappeur de ressources physiques pour recevoir le SRS ; et

un récepteur pour recevoir le SRS à la position de début de domaine de fréquence déterminée (1408), dans laquelle le mappeur de ressources physiques est apte à effectuer les étapes suivantes dans l'ordre :

a) le calcul d'une valeur de n_{SRS} sur la base d'un nombre L , et du numéro de trame de système n_f pour transmettre le SRS ;

b) la détermination d'une position de début dans le domaine de fréquence du SRS avec n_{SRS} (1406),

dans laquelle n_{SRS} est calculé par $n_{SRS} = n_f \times L + k$ pour une périodicité de SRS de 2 ms dans un système TDD, où L est égal à 4 pour une configuration de système TDD 0, 1, 2 ou 6 et L est égal à 2 pour une configuration de système TDD 3, 4 ou 5, et

k est un paramètre utilisé pour indexer un symbole d'accès multiples par répartition de fréquences à porteuse unique, SC-FDMA, transmettant le SRS dans une trame radio, ledit k prenant des valeurs de 0 à 3 pour une configuration de système TDD 0, 1, 2 et 6, et des valeurs de 0 à 1 pour une configuration de système TDD 3, 4 ou 5, dans lequel la valeur $k = 0$ correspond au premier symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur $k = 1$ correspond au deuxième symbole SC-FDMA pour transmettre le SRS dans la trame radio, la valeur $k = 2$ correspond au troisième symbole SC-FDMA pour transmettre le SRS dans la trame radio, et la valeur $k = 3$ correspond au quatrième symbole SC-FDMA pour transmettre le SRS dans la trame radio.

17. Station de base selon la revendication 16, dans laquelle le mappeur de ressources physiques effectue en outre :

le calcul d'un incrément de domaine de fréquence à mettre à jour pour le SRS en fonction du n_{SRS} obtenu, et le calcul d'un indice de position de fréquence pour transmettre le SRS en fonction de l'incrément de domaine de fréquence obtenu.

18. Station de base selon la revendication 17, dans laquelle l'incrément de domaine de fréquence est calculé par :

$$\begin{aligned}
& F_b(n_{SRS}) \\
& = \begin{cases} \left(\left(N_b / 2 \right) \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b'} N_{b'}}{\Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor + \left\lfloor \frac{n_{SRS} \bmod \Pi_{b'=b_{hop}}^{b'} N_{b'}}{2 \Pi_{b'=b_{hop}}^{b-1} N_{b'}} \right\rfloor \right) & \text{si } N_b \text{ est pair} \\ \left\lfloor N_b / 2 \right\rfloor \left\lfloor n_{SRS} / \Pi_{b'=b_{hop}}^{b-1} N_{b'} \right\rfloor & \text{si } N_b \text{ est impair} \end{cases}
\end{aligned}$$

où N_b est obtenu en fonction d'une signalisation de commande de ressources radio, RRC, et b_{hop} indique un paramètre de saut de fréquence de SRS, $0 \leq b_{hop} \leq 3$, qui est fourni par un paramètre de couche supérieure (1404).

19. Station de base selon la revendication 18, dans laquelle l'indice de position de fréquence est calculé par :

$$n_b = \begin{cases} \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor & \text{si } b \leq b_{hop} \\ \left\{ F_b(n_{SRS}) + \left\lfloor 4n_{RRC} / m_{SRS,b} \right\rfloor \right\} \bmod N_b & \text{sinon} \end{cases}$$

où $m_{SRS,b}$ est obtenu par la lecture de la signalisation RRC et n_{RRC} est donné par un paramètre de couche supérieure (1405).

20. Station de base selon la revendication 19, dans laquelle la position de début de domaine de fréquence k_0 est calculée par :

$$\begin{aligned}
k_0 &= k'_0 + \sum_{b=0}^{B_{SRS}} 2M_{sc,b}^{RS} n_b \\
k'_0 &= \left(\left\lfloor N_{RB}^{UL} / 2 \right\rfloor - m_{SRS,0} / 2 \right) N_{sc}^{RB} + k_{TC} \\
M_{sc,b}^{RS} &= m_{SRS,b} N_{sc}^{RB} / 2
\end{aligned}$$

où $m_{SRS,0}$ est obtenu à partir d'un paramètre de SRS spécifique à la cellule, N_{sc}^{RB} indique une taille de bloc de ressources dans le domaine de fréquence exprimée sous la forme d'un nombre de sous-porteuses, $k_{TC} \in \{0,1\}$ indique le paramètre de Comb, et N_{RB}^{UL} indique une configuration de largeur de bande de liaison montante exprimée en multiples de N_{sc}^{RB} (1406).

FIG . 1

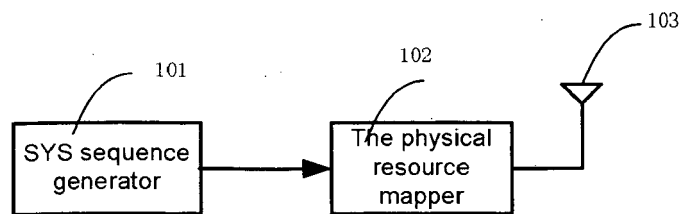


FIG . 2
PRIOR ART

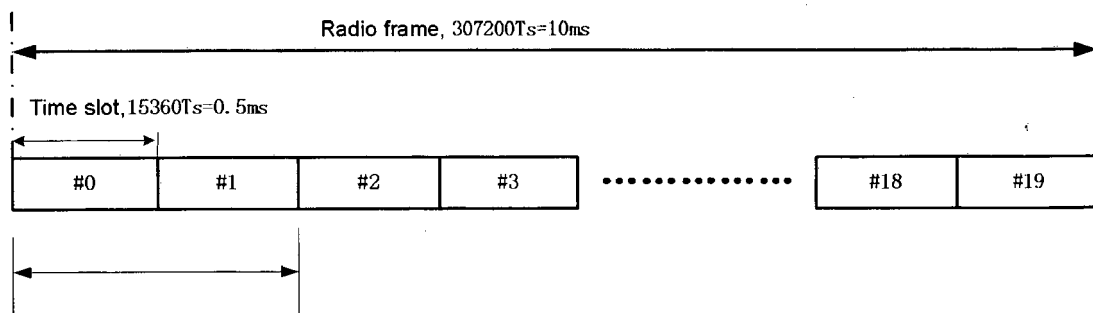


FIG . 3
PRIOR ART

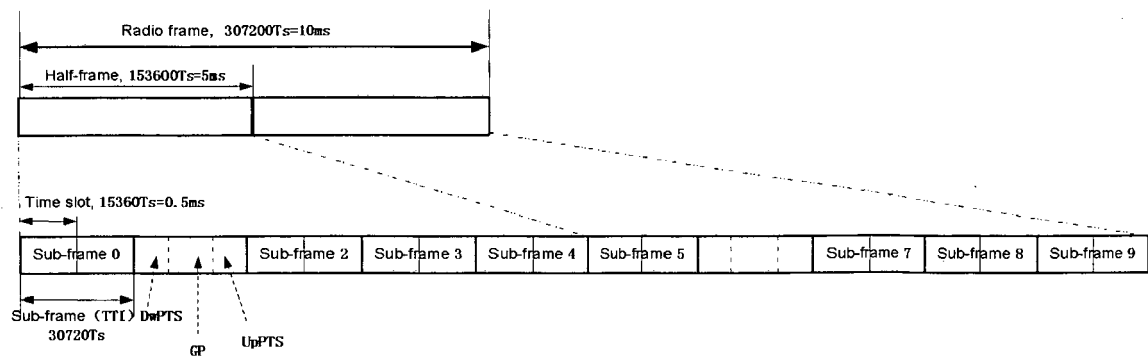


FIG . 4
PRIOR ART

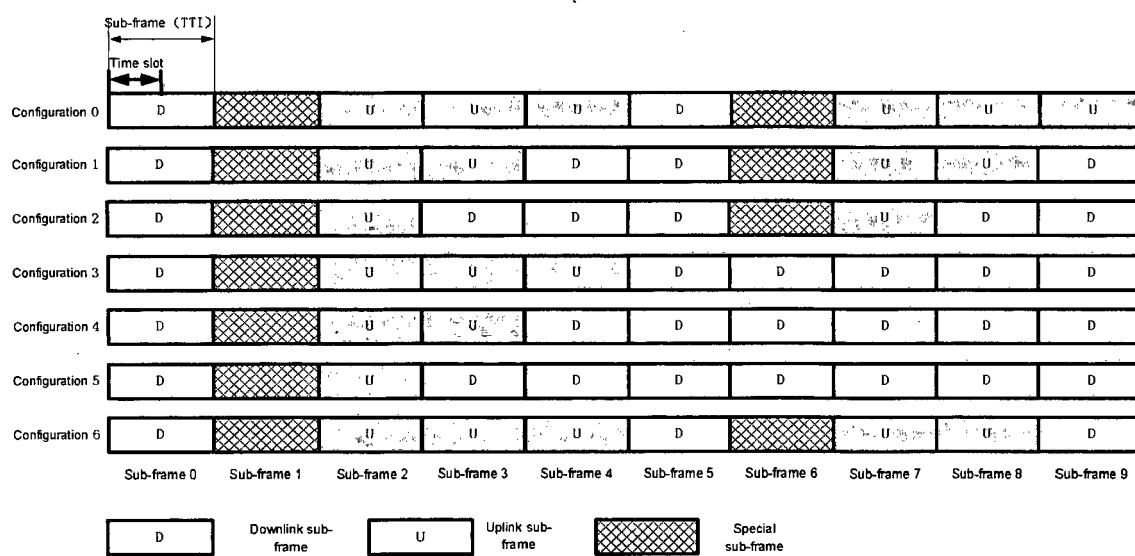
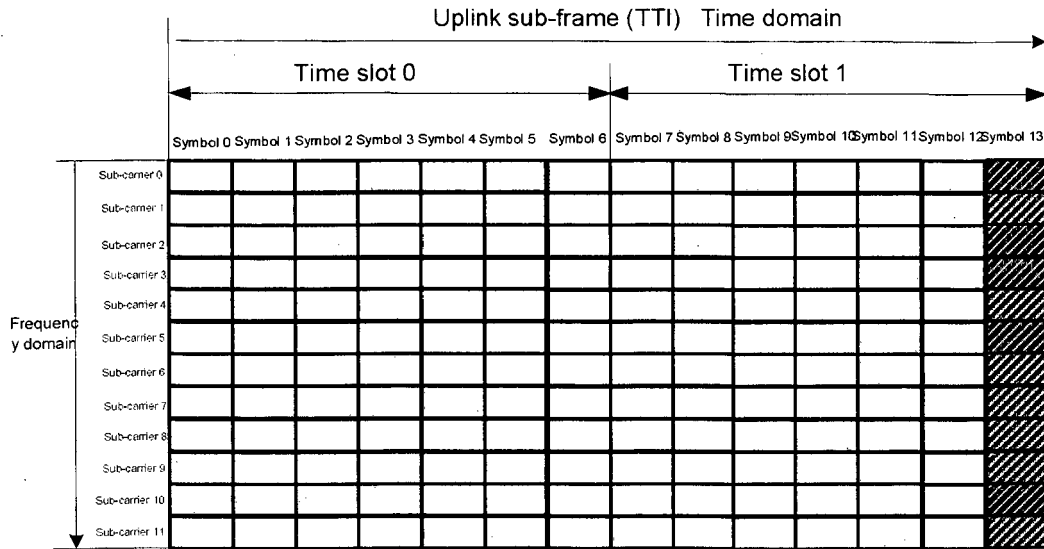
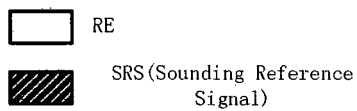
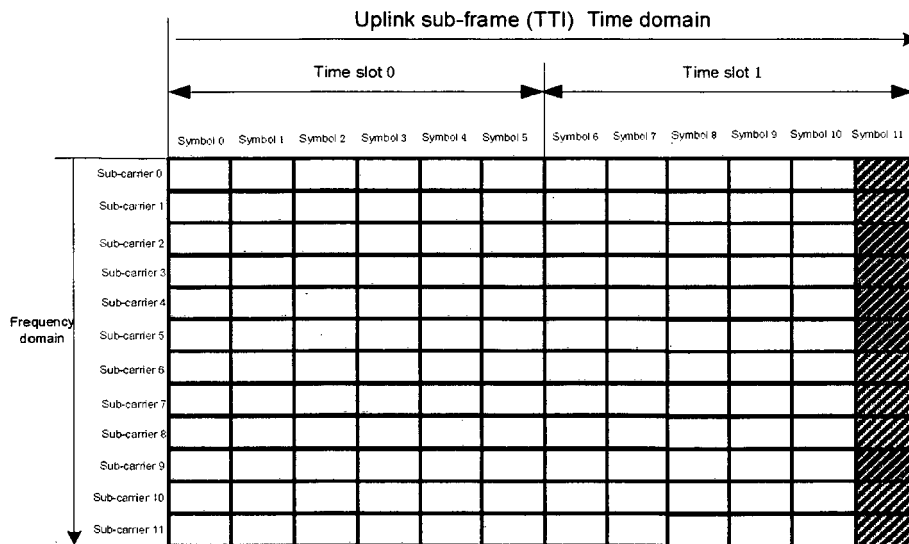


FIG . 5
PRIOR ART



(a)



(b)

FIG . 6

Configuration index I_{SRS}	SRS period (T ms)	SRS sub-frame offset
0 – 1	2	I_{SRS}
2 – 6	5	$I_{\text{SRS}} - 2$
7 – 16	10	$I_{\text{SRS}} - 7$
17 – 36	20	$I_{\text{SRS}} - 17$
37 – 76	40	$I_{\text{SRS}} - 37$
77 – 156	80	$I_{\text{SRS}} - 77$
157 – 316	160	$I_{\text{SRS}} - 157$
317 – 636	320	$I_{\text{SRS}} - 317$
637 – 1023	Reserved	Reserved

FIG . 7

Configuration index I_{SRS}	SRS period (T ms)	SRS sub-frame offset
0	2	0, 1
1	2	0, 2
2	2	1, 2
3	2	0, 3
4	2	1, 3
5	2	0, 4
6	2	1, 4
7	2	2, 3
8	2	2, 4
9	2	3, 4
10 – 14	5	$I_{\text{SRS}} - 10$
15 – 24	10	$I_{\text{SRS}} - 15$
25 – 44	20	$I_{\text{SRS}} - 25$
45 – 84	40	$I_{\text{SRS}} - 45$
85 – 164	80	$I_{\text{SRS}} - 85$
165 – 324	160	$I_{\text{SRS}} - 165$
325 – 644	320	$I_{\text{SRS}} - 325$
645 – 1023	Reserved	Reserved

FIG . 8

Configuration index I_{SRS}	SRS period (T ms)	SRS sub-frame offset
0	5	0, 1
1	5	0, 2
2	5	1, 2
3	5	0, 3
4	5	1, 3
5	5	0, 4
6	5	1, 4
7	5	2, 3
8	5	2, 4
9	5	3, 4
10 – 14	5	$I_{\text{SRS}} - 10$
15 – 24	10	$I_{\text{SRS}} - 15$
25 – 44	20	$I_{\text{SRS}} - 25$
45 – 84	40	$I_{\text{SRS}} - 45$
85 – 164	80	$I_{\text{SRS}} - 85$
165 – 324	160	$I_{\text{SRS}} - 165$
325 – 644	320	$I_{\text{SRS}} - 325$
645 – 1023	Reserved	Reserved

FIG . 9a
PRIOR ART

Configuration index l_{SRS}	n_s (in a single radio frame)	n_{SRS}
0	3,3,13,13	0,0,3,3,5,5,8,8,10,10,13,13,15,15,18,18...
1	3,5,13,15	0,1,3,3,5,6,8,8,10,11,13,13,15,16,18,18...
2		
3	3,7,13,17	0,1,3,4,5,6,8,9,10,11,13,14,15,16,18,19...
4		
5	3,9,13,19	0,2,3,4,5,7,8,9,10,12,13,14,15,17,18,19...
6		
7	5,7,15,17	1,1,3,4,6,6,8,9,11,11,13,14,16,16,18,19...
8	5,9,15,19	1,2,3,4,6,7,8,9,11,12,13,14,16,17,18,19...
9	7,9,17,19	1,2,4,4,6,7,9,9,11,12,14,14,16,17,19,19...

(a) T=2

FIG . 9b
PRIOR ART

Configuration n index l_{SRS}	n_s (in a single radio frame)	n_{SRS}
0	3,3,13,13	0,0,1,1,2,2,3,3,4,4,5,5,6,6,7,7.....
1	3,5,13,15	
2		
3	3,7,13,17	
4		
5	3,9,13,19	
6		
7	5,7,15,17	
8	5,9,15,19	
9	7,9,17,19	

(b) T=5

FIG . 10
PRIOR ART

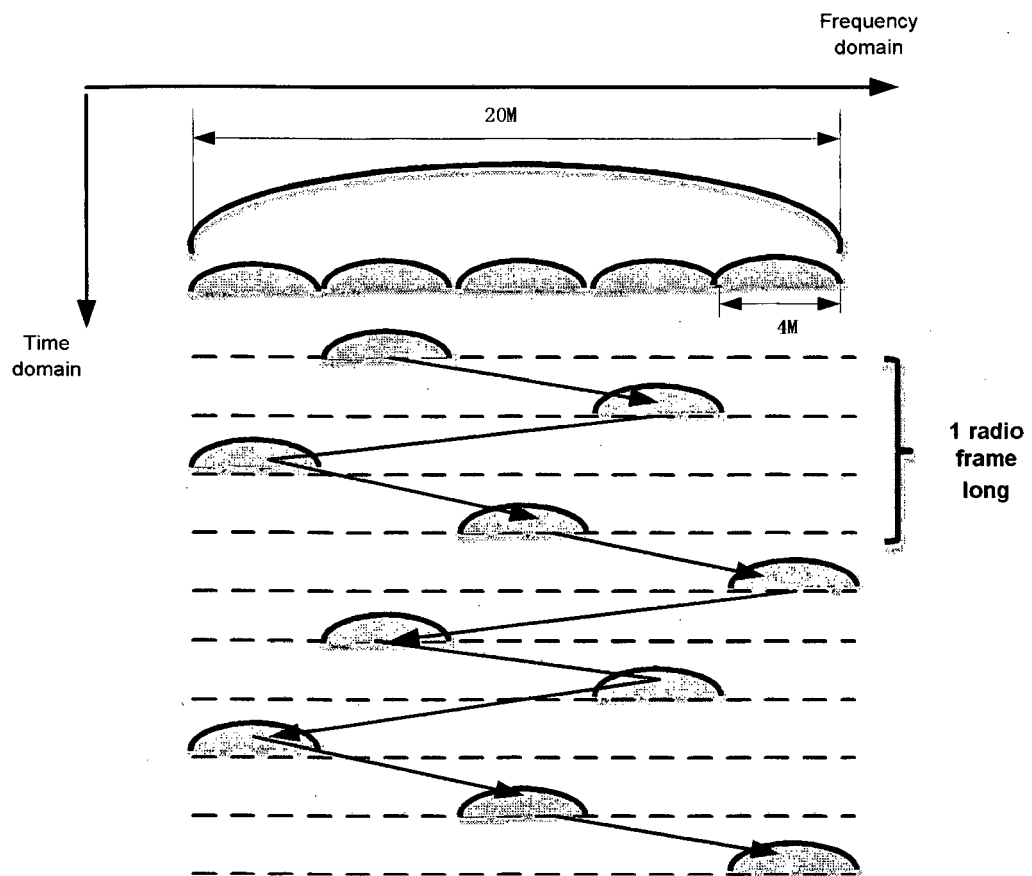


FIG . 11

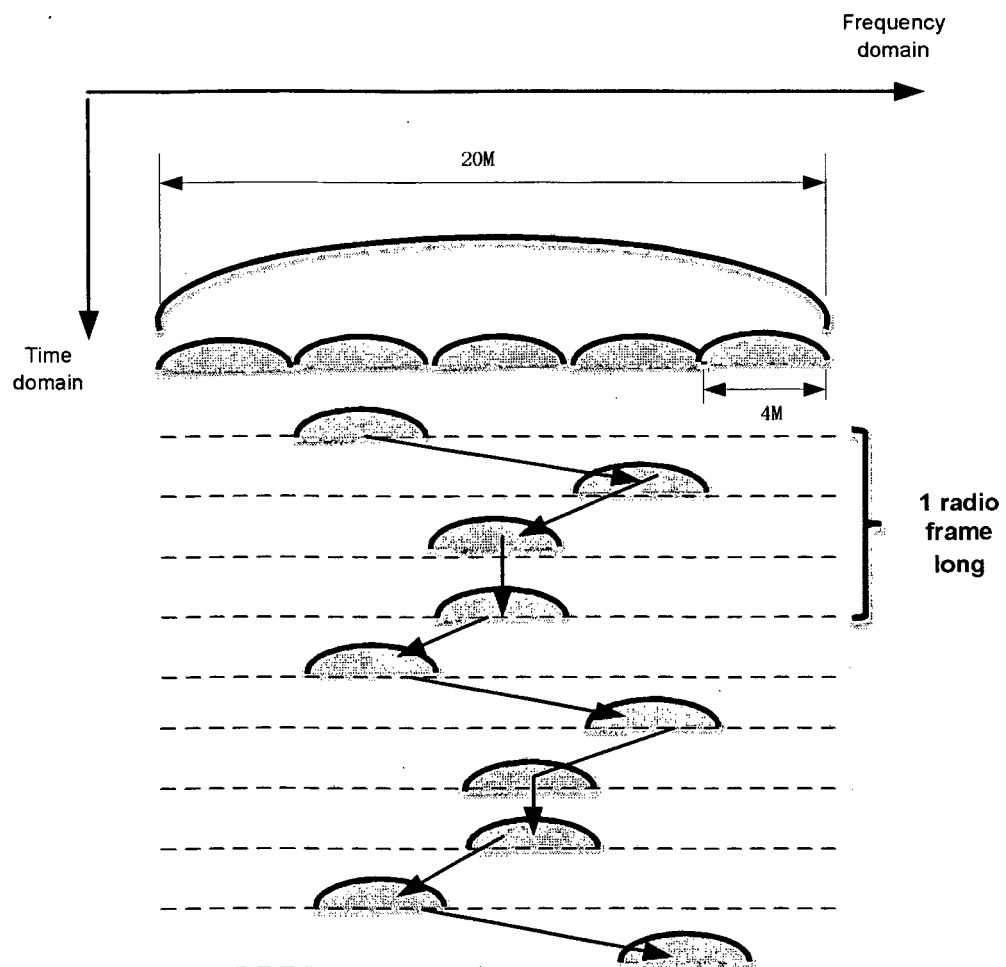


FIG . 12

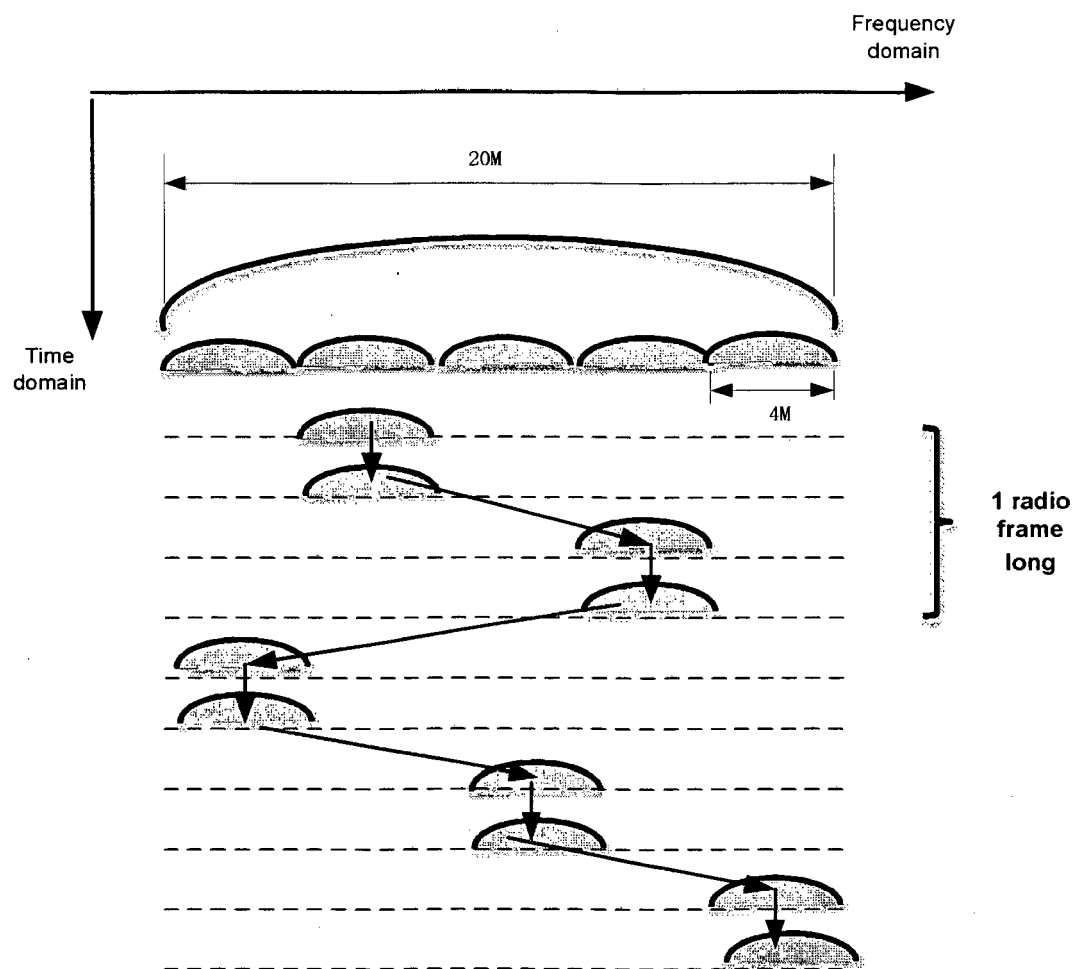


FIG . 13a

SRS bandwidth configuratio n	SRS-bandwidth h b = 0		SRS-bandwidth h b = 1		SRS-bandwidth h b = 2		SRS-bandwidth h b = 3		
	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	
	0	36	1	12	3	N/A	1	4	3
	1	32	1	16	2	8	2	4	2
2	24	1	N/A	1	N/A	1	4	6	
3	20	1	N/A	1	N/A	1	4	5	
4	16	1	N/A	1	N/A	1	4	4	
5	12	1	N/A	1	N/A	1	4	3	
6	8	1	N/A	1	N/A	1	4	2	
7	4	1	N/A	N/A	N/A	N/A	N/A	N/A	

(a) Uplink bandwidth $6 \leq N_{\text{RB}}^{\text{UL}} \leq 40$

FIG . 13b

SRS bandwidth configuratio n	SRS- bandwidth $b = 0$		SRS- bandwidth $b = 1$		SRS- bandwidth $b = 2$		SRS- bandwidth $b = 3$	
	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b
0	48	1	24	2	12	2	4	3
1	48	1	16	3	8	2	4	2
2	40	1	20	2	N/A	1	4	5
3	36	1	12	3	N/A	1	4	3
4	32	1	16	2	8	2	4	2
5	24	1	N/A	1	N/A	1	4	6
6	20	1	N/A	1	N/A	1	4	5
7	16	1	N/A	1	N/A	1	4	4

(b) Uplink bandwidth $40 \leq N_{\text{RB}}^{\text{UL}} \leq 60$

FIG . 13c

SRS bandwidth configuratio	SRS- bandwidth $b = 0$		SRS- bandwidth $b = 1$		SRS- bandwidth $b = 2$		SRS- bandwidth $b = 3$	
n	$m_{\text{SRS}, b}$	N_b	$m_{\text{SRS}, b}$	N_b	$m_{\text{SRS}, b}$	N_b	$m_{\text{SRS}, b}$	N_b
0	72	1	24	3	12	2	4	3
1	64	1	32	2	16	2	4	4
2	60	1	20	3	N/A	1	4	5
3	48	1	24	2	12	2	4	3
4	48	1	16	3	8	2	4	2
5	40	1	20	2	N/A	1	4	5
6	36	1	12	3	N/A	1	4	3
7	32	1	16	2	8	2	4	2

(c) Uplink bandwidth $60 \leq N_{\text{RB}}^{\text{UL}} \leq 80$

FIG . 13d

SRS bandwidth configuratio n	SRS- bandwidth $b = 0$		SRS- bandwidth $b = 1$		SRS- bandwidth $b = 2$		SRS- bandwidth $b = 3$	
	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b	$m_{\text{SRS},b}$	N_b
0	72	1	24	3	12	2	4	3
1	64	1	32	2	16	2	4	4
2	60	1	20	3	N/A	1	4	5
3	48	1	24	2	12	2	4	3
4	48	1	16	3	8	2	4	2
5	40	1	20	2	N/A	1	4	5
6	36	1	12	3	N/A	1	4	3
7	32	1	16	2	8	2	4	2

(c) Uplink bandwidth $60 \leq N_{\text{RB}}^{\text{UL}} \leq 80$

FIG . 14a

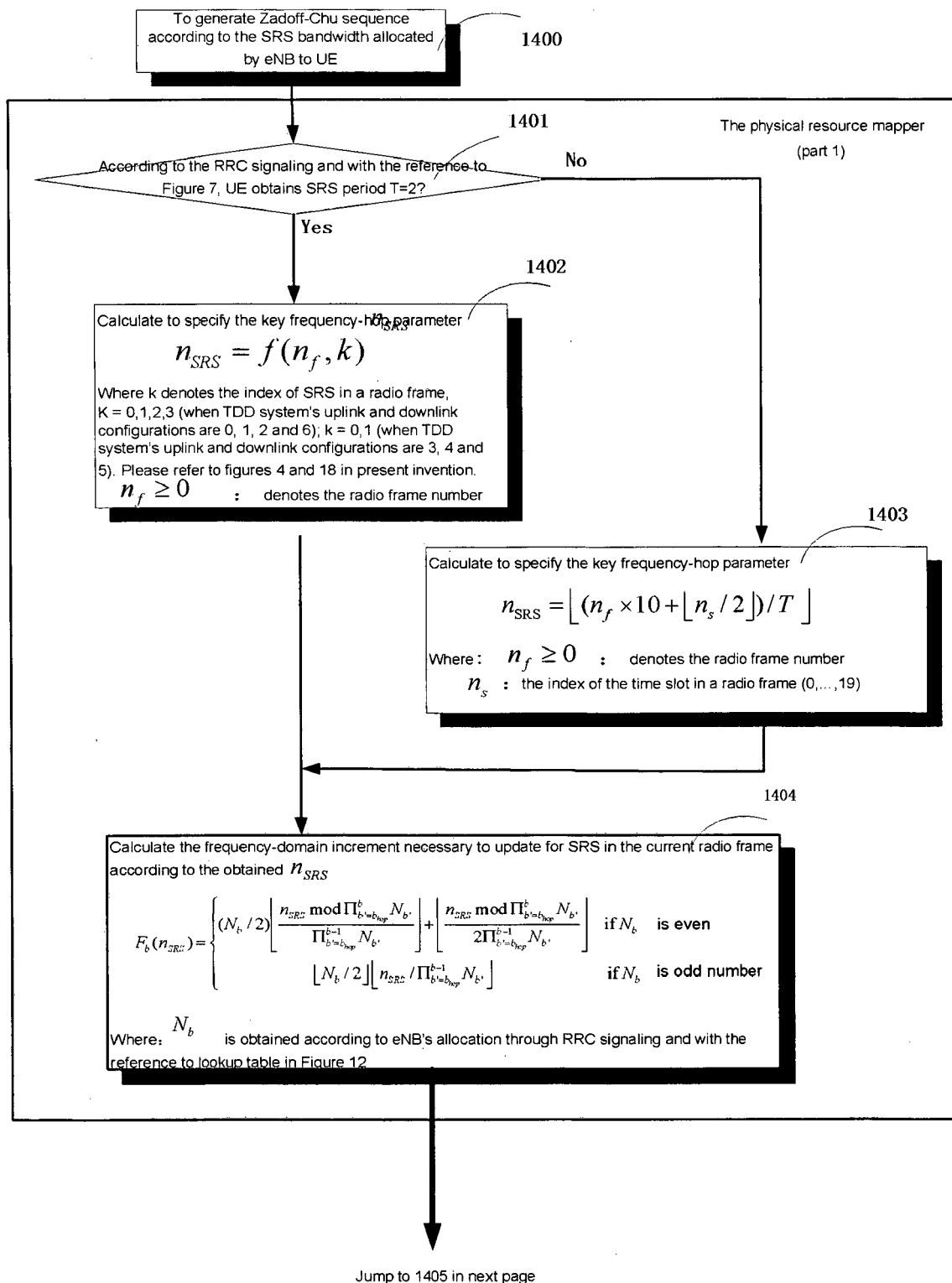


FIG . 14b

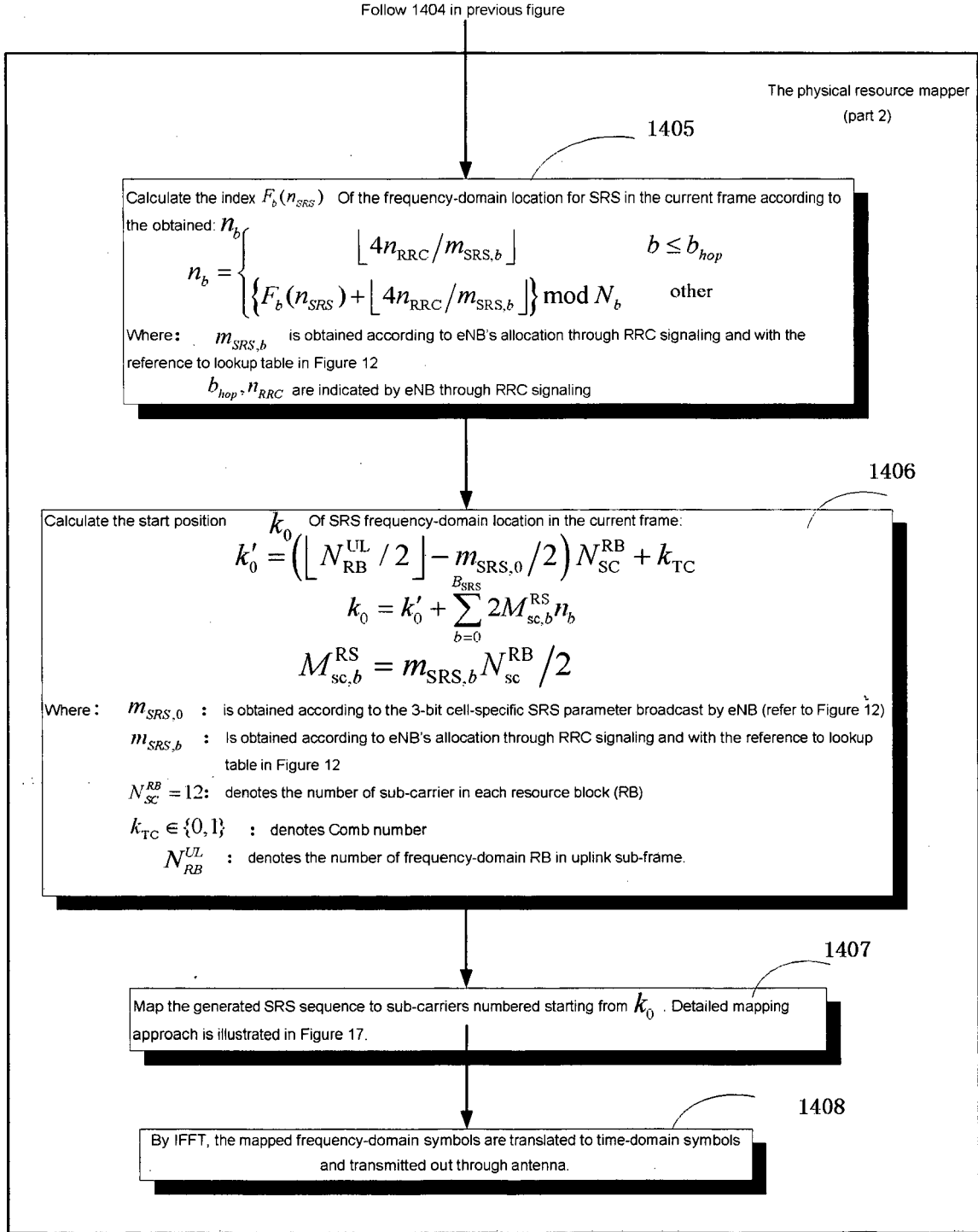


FIG . 15a

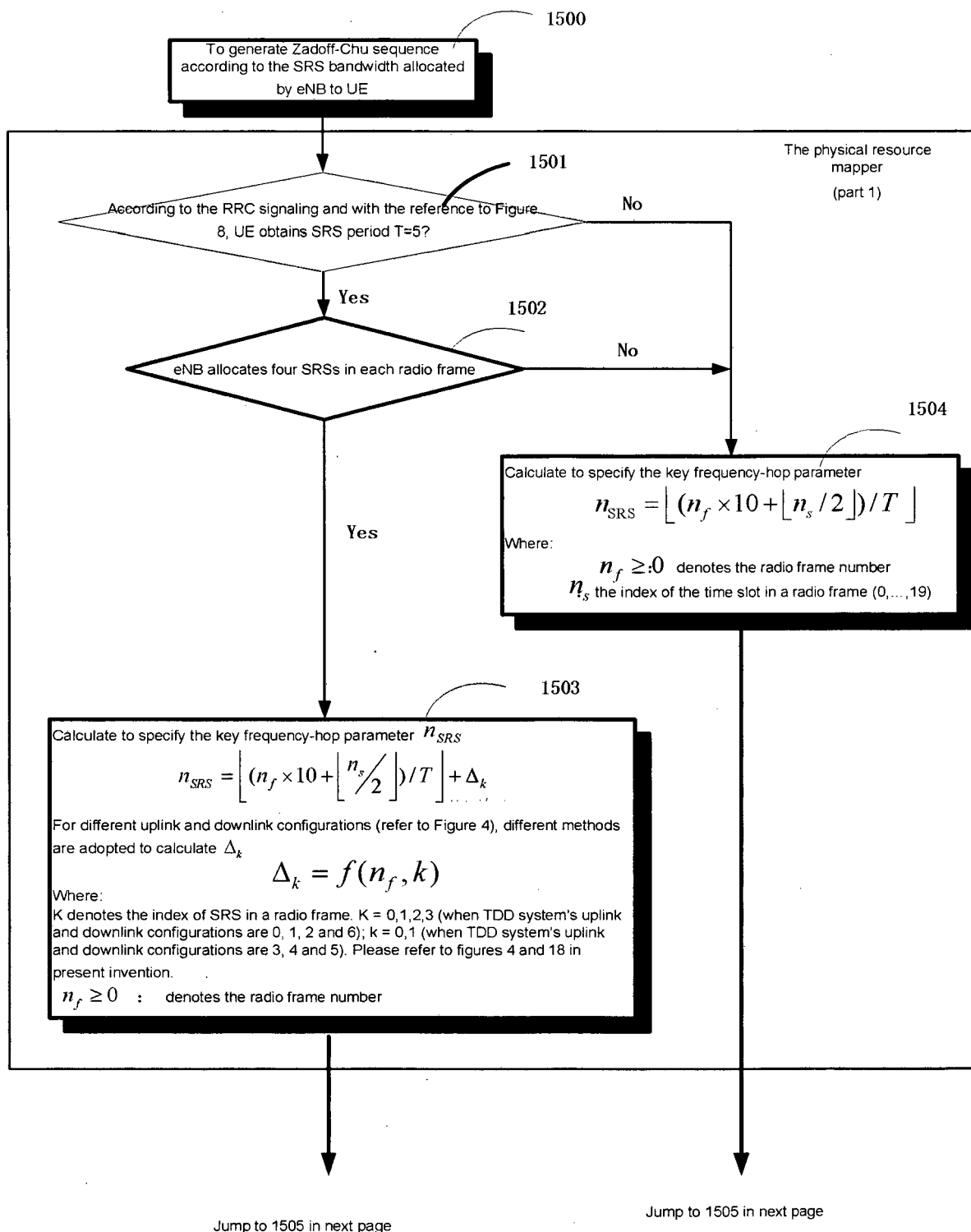


FIG . 15b

Follow 1503 and 1504 in previous figure

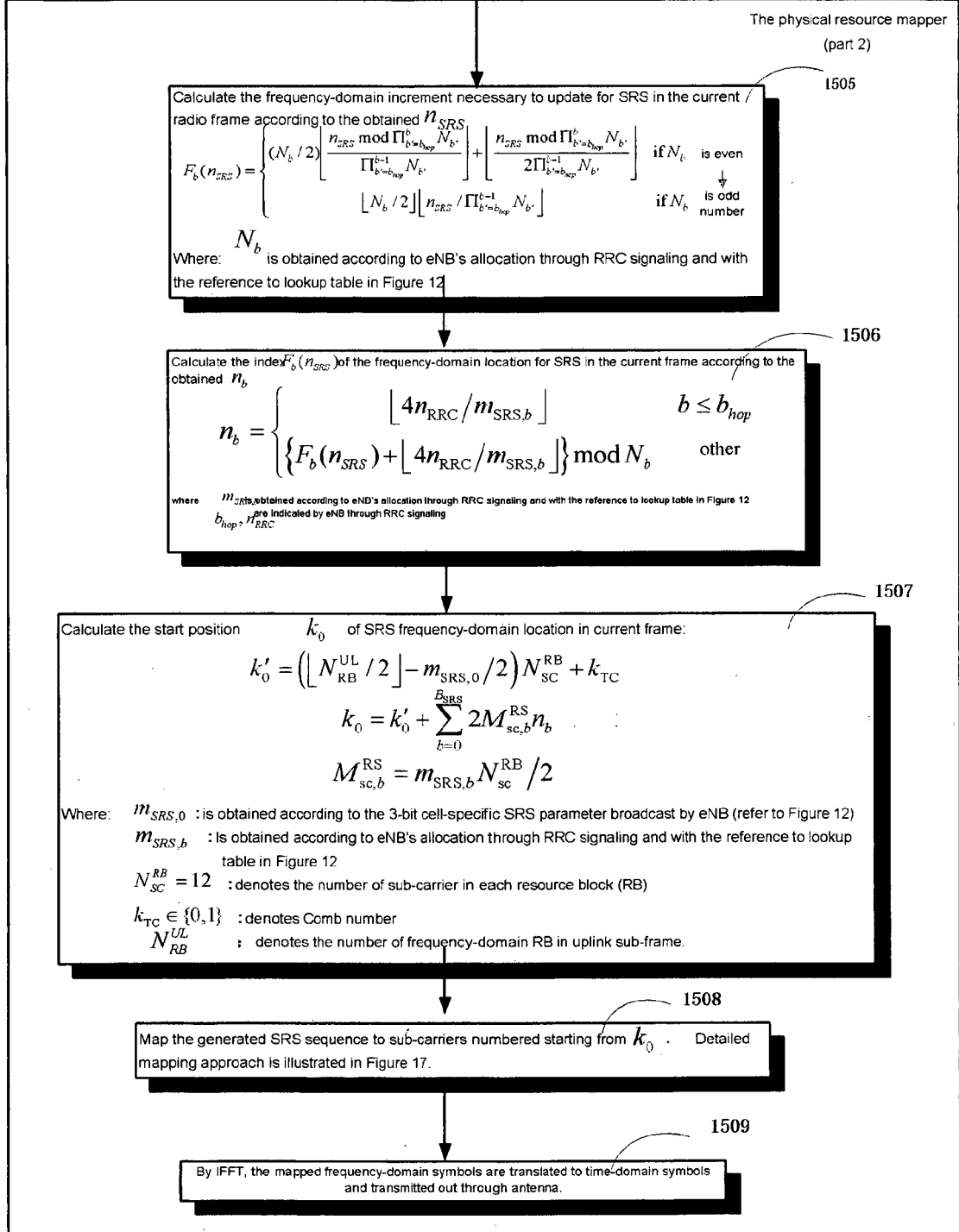


FIG . 16a

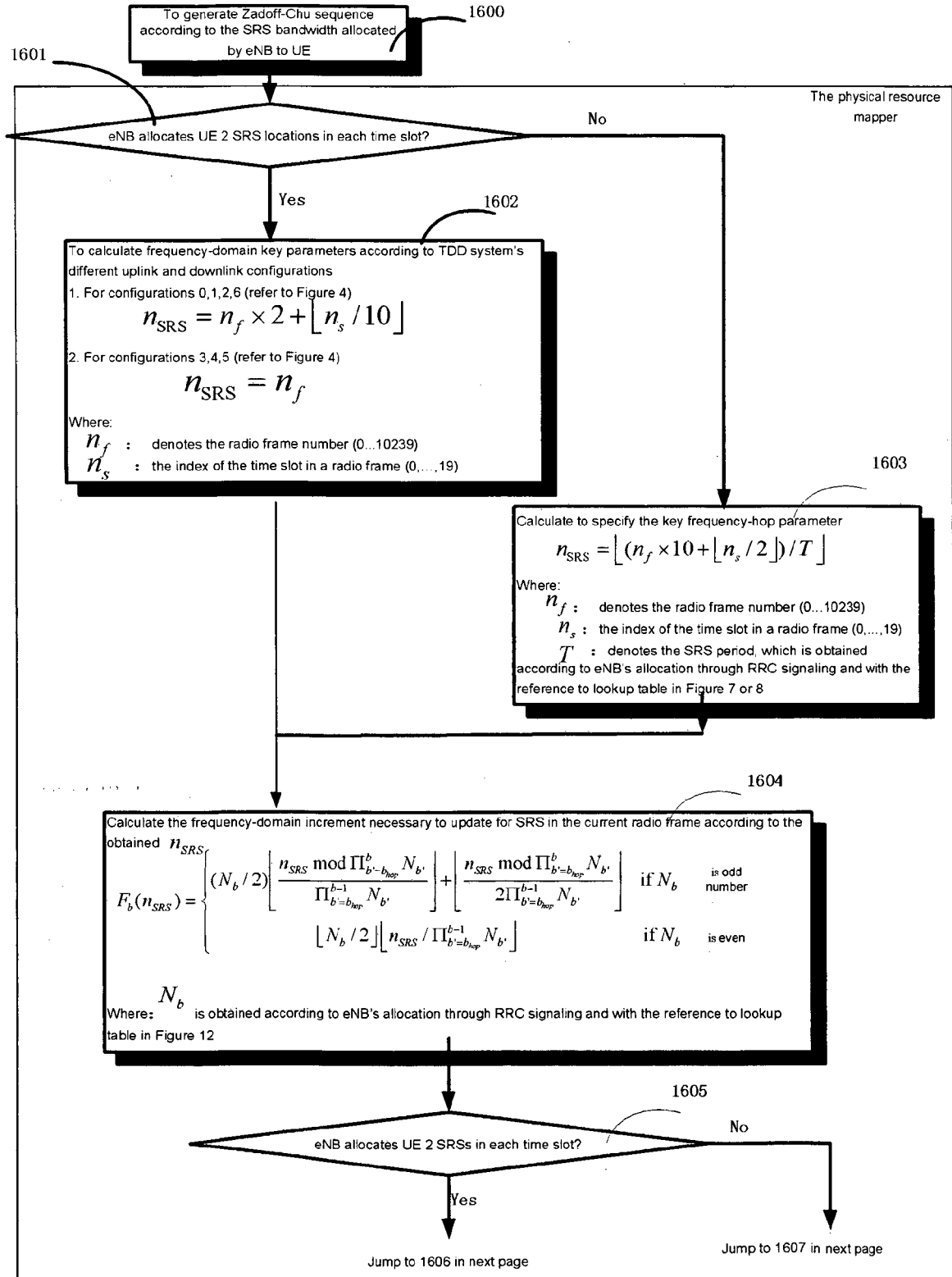


FIG . 16b

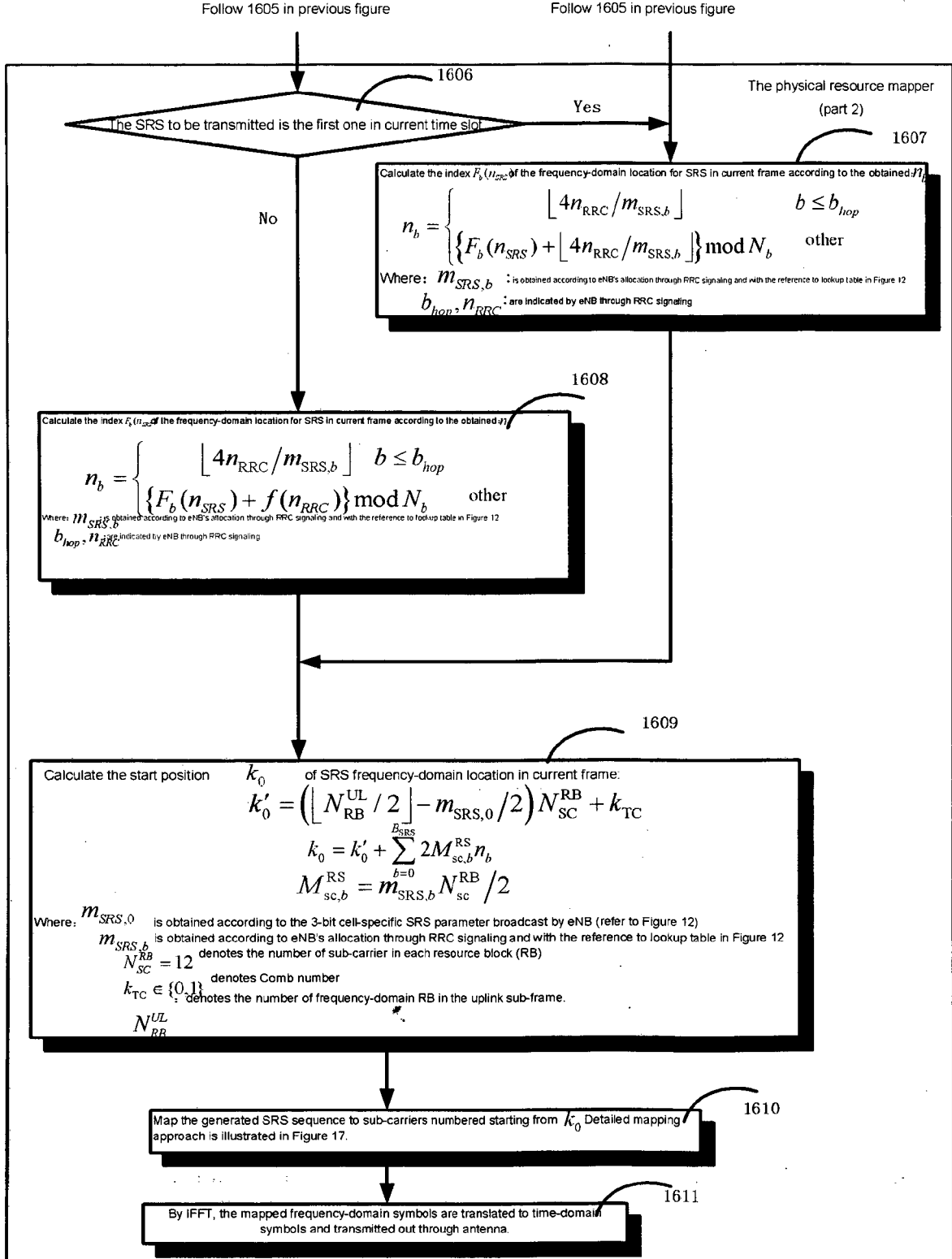


FIG . 17

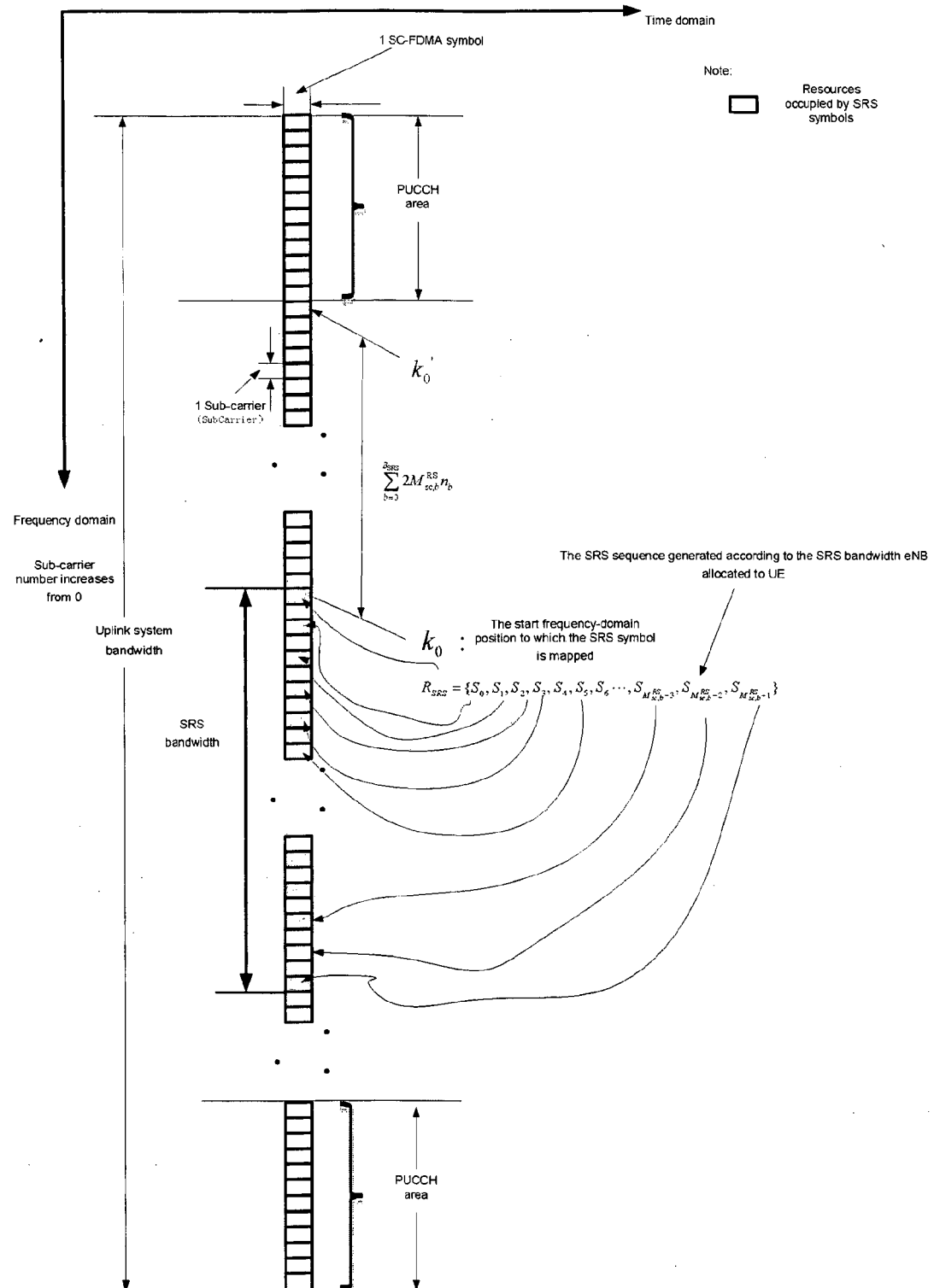
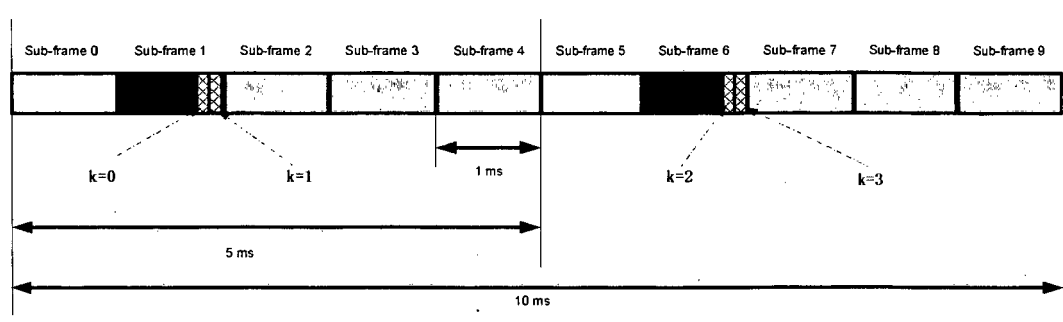
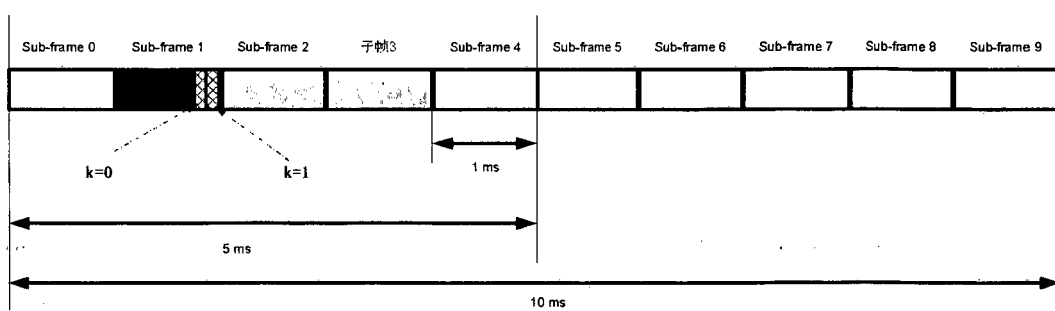


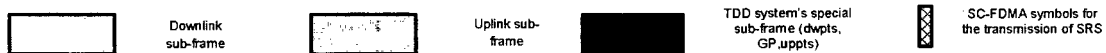
FIG . 18



(a) The corresponding relationship between SRS index k and time slot when configuration 0 is applied in TDD system's uplink and downlink



(b) The corresponding relationship between SRS index k and time slot when configuration 4 is applied in TDD system's uplink and downlink



REFERENCES CITED IN THE DESCRIPTION

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Non-patent literature cited in the description

- **HUAWEI ; NTT DOCOMO ; PANASONIC ; NOKIA SIEMENES NETWORKS ; NOKIA.** Remaining issues on SRS hopping. 3GPP DRAFT; RI-082675, 3RD GENERATION PARTNERSHIP PROJECT (3GPP) TSG RAN UG 53BIS, CHANGE REQUEST, 30 June 2008 [0014]
- SRS indication for TDD. **SAMSUNG.** 3GPP DRAFT; RI-081211, 3RD GENERATION PARTNERSHIP PROJECT (3GPP). MOBILE COMPETENCE CENTRE, 26 March 2008 [0015]