(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) **World Intellectual Property Organization**
International Bureau

(43) **International Publication Date**
13 October 2011 (13.10.2011)

PCT

(10) **International Publication Number**
WO 2011/126320 A2

(51) **International Patent Classification**:
H04J 11/00 (2006.01) ***H04W 72/12*** (2009.01)
H04L 1/16 (2006.01) ***H04B 7/26*** (2006.01)

(21) **International Application Number**: PCT/KR2011/002449

(22) **International Filing Date**: 7 April 2011 (07.04.2011)

(25) **Filing Language**: English

(26) **Publication Language**: English

(30) **Priority Data**:
201010142068.5 7 April 2010 (07.04.2010) CN

(71) **Applicant** *(for all designated States except US)*: **SAMSUNG ELECTRONICS CO., LTD.** [KR/KR]; 416, Maetan-dong, Yeongtong-gu, Suwon-si, Gyeonggi-do 443-742 (KR).

(72) **Inventors; and**

(75) **Inventors/Applicants** *(for US only)*: **HE, Hong** [CN/CN]; Beijing Samsung Telecom R&D Center, 12/F Zhongdian Fazhan Building, No.9, Xiaguangli Chaoyang District, Beijing 100125 (CN). **LI, Yingyang** [CN/CN]; Room 402, Gate 5, Building 10, Qingshangyuan, Haidian District, Beijing 100085 (CN). **SUN, Chengjun** [CN/CN]; Beijing Samsung Telecom R&D Center, 12/F Zhongdian Fazhan Building, No.9, Xiaguangli Chaoyang District, Beijing 100125 (CN).

(74) **Agents**: **KWON, Hyuk-Rok** et al.; 2F. Seokwang Bldg., 1-96 Sinmun-ro 2ga, Jongro-ku, Seoul 110-062 (KR).

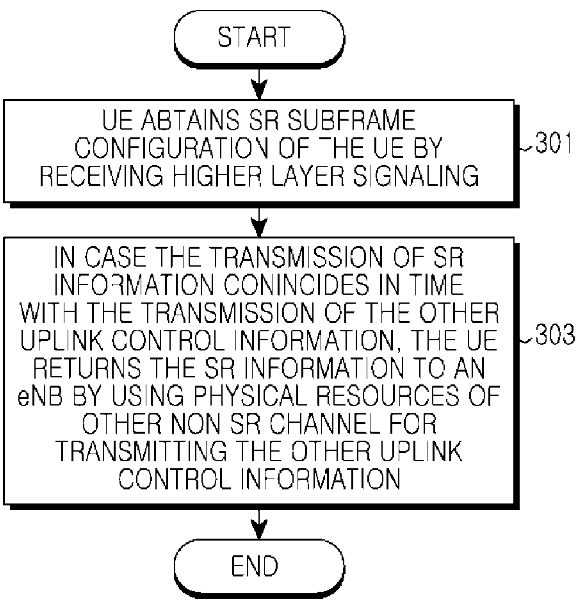
(81) **Designated States** *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK, LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PE, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ,

[Continued on next page]

(54) Title: APPARATUS AND METHOD FOR TRANSMITTING UPLINK SCHEDULING REQUEST IN MOBILE COMMUNICATION SYSTEM

[Fig. 4]



(57) **Abstract**: The present invention provides a method for transmitting an uplink Scheduling Request (SR), and the method includes, obtaining SR subframe configuration by receiving signaling, and transmitting SR information to an BS by using physical resources of other non SR channel for transmitting other uplink control information. By applying the present invention, the SR, acknowledgement/non-acknowledgement (ACK/NACK) or Channel Quality Indicator (CQI) information is returned to a Base Station (BS) when low Constant Modulus (CM) characteristic of an uplink Component Carrier (CC) is ensured.

WO 2011/126320 A2

TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that report (Rule 48.2(g))*

Description

Title of Invention: APPARATUS AND METHOD FOR TRANSMITTING UPLINK SCHEDULING REQUEST IN MOBILE COMMUNICATION SYSTEM

Technical Field

[1] The present invention relates to mobile communication technologies, and more particularly to a method for transmitting an uplink scheduling requirement.

Background Art

[2] In Long Term Evolution (LTE) systems, uplink control information includes acknowledgement/non-acknowledgement (ACK/NACK) of a downlink data packet, a Channel Quality Indicator (CQI), a Rank Indicator (RI) for downlink Multi-input Multi-output (MIMO) feedback, a Precoding Matrix Indicator (PMI) and a scheduling request (SR). Similar to the structure of a uplink ACK/NACK control channel shown in FIG. 1b, the structure of a uplink SR control channel for transmitting SR information, as shown in FIG. 1a, is a two-dimension orthogonalization channel structure of different circular shifts and time domain orthogonal grouping expansion of a basic Constant Amplitude Zero Auto Correlation (CAZAC) sequence. In the LTE system, fixed SR resources are distributed to each UE for sending the SR information, and each SR is sent by using a method of On-Off Key (OOK).

[3] In the LTE system, when needing to apply a new uplink resource scheduling, the UE sends a SR a modulation symbol of which is in a SR subframe conFIG.d by the UE, so as to request a new uplink data resource. The SR in this case is called as a positive SR. When the UE does not have uplink resource scheduling requirement, the SR is not sent on a distributed SR channel. The SR in this case is called as a negative SR. In order to ensure a low Constant Modulus (CM) characteristic of uplink signals, it is defined in the LTE system that, if the SR and the ACK/NACK are transmitted in the same subframe at it happens, for the positive SR, the UE sends the ACK/NACK on the distributed SR channel; for the negative SR, the UE sends the ACK/NACK on a distributed ACK/NACK channel.

[4] Along with the continuous evolution of the LTE technology, enhanced LTE (LTE-A) systems appear. In the LTE-A system, in order to improve peak speed rate of the whole system, a method of Carrier Aggregation (CA) is used to implement configurable system bandwidth, and each carrier unit is called as a Component Carrier (CC). LTE User Equipment (UE) can work normally at each CC, which is specifically shown in FIG. 2.

[5] FIG. 2 is a schematic diagram illustrating a structure of a radio frame in a mobile

communication system. Referring to FIG. 2, a radio frame 210 includes a plurality of subframes 220. A length of the radio frame 210 may be 10 ms, and a a length of the subframe 220 may be 1 ms. The subframe 220 consists of a plurality of CCs 230-1 to 230-5 in frequenty domain. A bandwidth of each of the CCs 230-1 to 230-5 may be 20 M, and total bandwidth may be 100M.

[6] In view of partition of conventional radio spectrum, in a recent conference of 3GPP RAN 4 work groups, operators of the LTE-A system distribute the CC configured in the further LTE-A system to two different frequency bands, which is specifically shown in FIG. 3. In addition, in order to reduce complexity of LTE-A terminals, it is defined in the LTE-A criterion by the 3GPP RAN4 that, in the future LTE-A system, when the UE configures multiple downlink and uplink CCs, all the SR and CQI information are sent in the same CC, downlink data ACK/NACK of different CCs are sent in a certain single CC. Since it is important to ensure the low CM characteristic of the uplink single CC for a receiving capability of uplink control information, there is a technical problem needed to be solved currently that how to return the SR, ACK/NACK or CQI information to an BS at the same time when uplink CM is reduced as much as possible. However, in the prior art, no method is provided for returning the SR, ACK/NACK or CQI information to the BS when the low CM characteristic of the uplink CC is ensured as much as possible.

Disclosure of Invention

Solution to Problem

[7] To address the above-discussed deficiencies of the prior art, it is a primary aspect of the present invention to provide an apparatus and a method for trnastmitting an uplink SR information in a mobile communication system.

[8] Another aspect of the present invention is to provide an apparatus and a method for increasing efficiency of trnastmitting an uplink SR information in a mobile communication system.

[9] Another aspect of the present invention is to provide an apparatus and a method trnastmitting an uplink SR information with other uplink control informaion in a mobile communication system.

[10] According to another aspect of the present invention, an method for transtmitting an uplink SR information is provided. The method includes obtaing SR subframe configuration by receiving signaling, and transmitting SR information to an BS by using physical resources of other non SR channel for transmitting other uplink control information.

Brief Description of Drawings

[11] FIG. 1a is a schematic diagram illustrating a SR contol channel in a mobile communication

nication system,

[12] FIG. 1b is a schematic diagram illustrating a uplink ACK/NACK contol channel in a mobile communication system,

[13] FIG. 2 is a schematic diagram illustrating a structure of a radio frame in a mobile communication system,

[14] FIG. 3 is a schematic diagram illustrating examples of CC allocations in a mobile communication system,

[15] FIG. 4 illustrates a SR transmission precedure in a mobile communication system according to an embodiment embodiment of the present invention,

[16] FIG. 5 illustrates a joint coding precedure based on a mode 1 in a mobile communication system according to an embodiment embodiment of the present invention,

[17] FIGs. 6 and 7 illustrate a data precessing precedure based on a mode 1 in a mobile communication system according to an embodiment embodiment of the present invention,

[18] FIG. 8 illustrates a operation precedure based on a mode 2 in a mobile communication system according to an embodiment embodiment of the present invention,

[19] FIG. 9 illustrates a data precessing precedure based on a mode 2 in a mobile communication system according to an embodiment embodiment of the present invention,

[20] FIG. 10 illustrates a data precessing precedure based on a mode 3 in a mobile communication system according to an embodiment embodiment of the present invention.

[21] FIG. 11 illustrates a SR transmission precedure in a mobile communication system according to another embodiment embodiment of the present invention,

[22] FIG. 12 illustrates a data precessing precedure in a mobile communication system according to an embodiment embodiment of the present invention.

[23] FIG, 13 illustrates a block diagram of a UE in a mobile communication system according to an embodiment embodiment of the present invention.Figure 1a is a schematic diagram illustrating a structure of a conventional uplink SR control channel.

Best Mode for Carrying out the Invention

[24] The present invention will be illustrated in detail hereinafter with reference to the accompanying drawings and specific embodiment to make the objects, technical solutions and merits of the present invention more clear.

[25] Embodiments of the present invention provide an apparatus and a method for transmitting an uplink SR information in a mobile communication system. Hereinafter, the present inventon uses technical terms and representations defined in LTE standard. However, the present invention does not limited the technical terms and representations, and is applicable to communication system based on another standard.

[26] FIG. 4 illustrates a SR transmission precedure in a mobile communication system

according to an embodiment embodiment of the present invention.

[27] Referring to FIG. 4, in Step 301, UE obtains SR subframe configuration of the UE by receiving higher layer signaling. For example, the SR subframe configuration includes a SR configuration number. The UE may determine a SR subframe by using the obtained SR configuration number, a table stored by the UE and existed system specification,. The table stored by the UE may be defined as shown in Table 1 below.

[28] Table 1

[Table 1]

Table 1

SR subframe configuration number I_{SR}	SR cycle (millisecond) $SR_{PERIODICITY}$	SR subframe offset $N_{OFFSET,SR}$
0 – 4	5	I_{SR}
5 – 14	10	$I_{SR}-5$
15 – 34	20	$I_{SR}-15$
35 – 74	40	$I_{SR}-35$
75 – 154	80	$I_{SR}-75$
155 – 156	2	$I_{SR}-155$
157	1	$I_{SR}-157$

[29] The determing of the SR subframe includes that make the serial number of the determined SR subframe satisfy the following Equation 1.

[30] $(10 X n_f + \lfloor n_s/2 \rfloor - N_{OFFSET,SR}) \bmod SR_{PERIODICITY} = 0$; Equation (1)

[31] In Equation (1), n_f denotes a system frame number, n_s denotes a time slot number, $N_{OFFSET,SR}$ denotes an offset of a SR subframe, $SR_{PERIODICITY}$ denotes a cycle of SR subframes. In the embodiment, the SR configuration number obtained by the UE is $I_{SR} = 3$, it is can be obtained according to the following table 1 that $N_{OFFSET,SR} = 3$, $SR_{PERIODICITY} = 5$, and $n_s = \{0,1,...,19\}$ is time slot numbers.

[32] According to the Equation 1, the UE obtains that a uplink resource SR is to be sent in the subframe #3, #8, #11, #14, … and etc., so as to request a Base Station (BS) to reallocate uplink data resources. Herein, the BS may be referd as ‘eNodeB (eNB)’. In order to accurately describe the method in the present invention which is performed when the SR information and other control information are transmitted in a single subframe at the same time, in the undermentioned embodiments, only subframe #3 is taken as an example, and the principles of other subframes are similar.

[33] In step 303, in case the transmission of SR information coincides in time with the transmission of the other uplink control information, the UE returns the SR information to the BS by using physical resources of other non SR channel for transmitting the other uplink control information. That is to say, in step 303, in case the transmission of SR information coincides in time with the transmission of the other

uplink control information, i.e. the subframe #3, the UE returns the SR information to the BS by using the physical resources of the non SR channel for transmitting the other uplink control information.

[34] It should be explained that, the methods provided by the embodiments of the present invention mainly aim at how to return the SR, ACK/NACK or CQI information to the BS at the same time when uplink CM is reduced as much as possible, if the UE cons multiple CCs, especially the multiple CCs are located at different bands. It is can be seen that the other uplink control information in step 303 302 includes: ACK/NACK information, CQI information. In order to make the technical solutions provided by the embodiments of the present invention more clear, it is described in detail that operations respectively corresponding to transmitting the SR information and the ACK/NACK information in the same subframe, i.e. the subframe #3 (refered as a first embodiment) and transmitting the SR information and the CQI information in the same subframe, i.e. the subframe #3 (refered as a second embodiment).

[35] The first embodiment:

[36] Solutions according to The tirst embodiment may be implemented by using the following three modes in the first case.

[37] Mode 1:

[38] In this embodiment, when transmitting the SR information and the ACK/NACK information at the same subframe, the UE performs joint coding for the SR information and the ACK/NACK information, and returns these by using an ACK/NACK channel distributed to the UE. The operation of performing the joint coding for the SR information and the ACK/NACK information by the UE is illustrasted in FIG. 5.

[39] FIG. 5 illustrates a joint coding precedure based on a mode 1 in a mobile communication system according to an embodiment embodiment of the present invention.

[40] Referring to FIG. 5, in step 401, the UE maps the SR information as bit information s_0. Specifically, the step 401 includes that: when the SR information is a positive SR, $s_0 = 1$, when the SR information is a negative SR, $s_0 = 0$. Other mapping modes may be adopted in step 401, and only one example is provided to make the present invention more clear.

[41] In step 403, the UE makes bit stream of the ACK/NACK information $a_0,a_1,...,a_{A-2}$ and the s_0 concatenated. The step 403 may include that: the s_0 and the bit stream of the ACK/NACK information $a_0,a_1,...,a_{A-2}$ are located at predetermined locations. Specifically, the UE makes the s_0 located in front of the bit stream of the ACK/NACK information $a_0,a_1,...,a_{A-2}$, and obtains $<s_0,a_0,a_1,...,a_{A-2}>$, or the UE makes s_0 be appended at the end of the sequence of the concatenated bit stream of the ACK/NACK information $a_0,a_1,...,a_{A-2}$, and obtains $<a_0,a_1,...,a_{A-2},s_0>$.

[42] In step 405, Reed-Muller coding processing of (20, A) is performed for the con-

catenated bit stream;. Herein, (r, m) are RM coding parameters and denote that an order is r, and a length of a binary vector is 2^m. Quaternary Phase Shift Keying (QPSK) modulation is adopted, and the coded bit stream is sent to the BS. For example the coded bit stream is sent by using a structure of uplink control channel format 2 in the LTE system.

[43] Thus, the flow of the UE performing joint coding for the SR information and the ACK/NACK information in the embodiment of the present invention is implemented.

[44] In order to make the above mode 1 more clear, a specific embodiment is provided.

[45] FIGs. 6 and 7 illustrate a data precessing precedure based on a mode 1 in a mobile communication system according to an embodiment embodiment of the present invention.

[46] Referring to FIGs 6 and 7, the SR information and the ACK/NACK information is provided to a RM coding block 510, and a result of RM coding is provided to QPSK modulationg block 520. Modulated symbols modulated by the QPSK modulation block 520 are conveted to a parallel symbol stream in a parallel-serial convert block 530, and 10 symbols included the parallel symbol stream are provided to multipliers 540-1 to 540-5 coresponding to a time slot #1 and multipliers (not illustrated) coresponding to a time slot #2. In each of the multipliers 540-1 to 540-5, a base sequence $\bar{r}_{u,0}$ is multiplied with each symbol, and each symbol is cyclic shifted as $a_{cs,0}$ by a circular shift block 550. Symbols which is multiplied by $\bar{r}_{u,0}$ and is cyclic shifted $a_{cs,0}$ may be represented $d_0 r_{r,o}^{a1}$, $d_1 r_{r,o}^{a2}$, $d_2 r_{r,o}^{a3}$, and so on. Herein, $r_{u,v}^{(a)}$ denotes a reference signal sequence. After that, symbols multiplied by the reference signal sequence pass an Inverse Fast Fourier Transform (IFFT) block 560, and are mapped in time slots.

[47] In FIGs 6 and 7, it is supposed that the UE needs to request the BS to reallocate uplink resources, i.e. the UE needs to send a positive SR in the subframe #3. According to step 401, it is obtained that $s_0 = 1$; at the same time, the UE also needs to return ACK/NACK information corresponding to that the BS configures multiple CCs in the subframe #3. It is supposed in the embodiment of the present invention that the length of ACK/NACK information bits to be sent is A-1, the ACK/NACK information bits are $<a_0,a_1,.....,a_{A-2}>$, without lost of generality, for the sake of convenience, it is taken as an example that A=9, and the bit stream of the ACK/NACK information to be sent is < 0 1 1 1 1 0 1 0 >. The UE makes SR information bit, i.e. s_0 and the ACK/NACK information bits, i.e. the < 0 1 1 1 1 0 1 0 > concatenated. It is supposed that, in this embodiment, the SR information bit is located in front of the ACK/NACK information bits, thus the concatenated bit stream of ACK/NACK and SR bits is $<c_0,c_1$

,......,c_{A-1}> = < 1 0 1 1 1 1 0 1 0 >. Afterwards, RM coding of (20, A) is performed for the bit stream output after the concatenation (recorded as <b_0,b_1,......,b_{19}>), specifically,

[48]

$$b_i = \sum_{n=0}^{8} (c_n \cdot M_{i,n}) \bmod 2$$

[49] herein, i = 0, 1, 2, …, 19. Equation (2)

[50] In Equation (2), b_i denotes ith bit of RM coded bit stream, n denotes a bit index, c_n denotes nth bit of concatenated bit stream of ACK/NACK and SR, and Mi,n denotes a parameter for RM coding. The $M_{i,n}$ may be defined as shown in Table 2 below.

[51] Table 2

[Table 2]

Table 2

i	$M_{i,0}$	$M_{i,1}$	$M_{i,2}$	$M_{i,3}$	$M_{i,4}$	$M_{i,5}$	$M_{i,6}$	$M_{i,7}$	$M_{i,8}$	$M_{i,9}$	$M_{i,10}$	$M_{i,11}$	$M_{i,12}$
0	1	1	0	0	0	0	0	0	0	0	1	1	0
1	1	1	1	0	0	0	0	0	0	1	1	1	0
2	1	0	0	1	0	0	1	0	1	1	1	1	1
3	1	0	1	1	0	0	0	0	1	0	1	1	1
4	1	1	1	1	0	0	0	1	0	0	1	1	1
5	1	1	0	0	1	0	1	1	1	0	1	1	1
6	1	0	1	0	1	0	1	0	1	1	1	1	1
7	1	0	0	1	1	0	0	1	1	0	1	1	1
8	1	1	0	1	1	0	0	1	0	1	1	1	1
9	1	0	1	1	1	0	1	0	0	1	1	1	1
10	1	0	1	0	0	1	1	1	0	1	1	1	1
11	1	1	1	0	0	1	1	0	1	0	1	1	1
12	1	0	0	1	0	1	0	1	1	1	1	1	1
13	1	1	0	1	0	1	0	1	0	1	1	1	1
14	1	0	0	0	1	1	0	1	0	0	1	0	1
15	1	1	0	0	1	1	1	1	0	1	1	0	1
16	1	1	1	0	1	1	1	0	0	1	0	1	1
17	1	0	0	1	1	1	0	0	1	0	0	1	1
18	1	1	0	1	1	1	1	1	0	0	0	0	0
19	1	0	0	0	0	1	1	0	0	0	0	0	0

[52] After RM coding, the UE performs QPSK modulation for the coded bit stream <b_0,b_1,......,b_{19}>, and obtains a modulation symbol <b_0,b_1,......,b_9>, and then returns the modulation symbol <b_0,b_1,......,b_9> to the 13 SR is to be sent in the subframe #3, i.e. s_0 = 1; in addition, the UE also needs to return ACK/NACK information corresponding to that the BS configures multiple CCs in the subframe #3. As illustrated in FIG. 8, the process includes the following steps.

[53] In step 601, the UE firstly solely determines ACK/NACK channel parameters <n_{cs},n_{oc} > for returning the ACK/NACK information. Herein, n_{cs} denotes a cyclic shift index and the n_{oc} denotes a orthogonal sequence index. It is supposed, in the embodiment, that the ACK/NACK channel parameters determined by the UE are $n_{cs} = 6, n_{oc} = 0$. According to relationship between n_{oc} and time domain orthogonal extended codes as shown in following table 3, it is obtained that when $n_{cs} = 6, n_{oc} = 0$, the sequence 0 is taken as the time domain orthogonal extended code, i.e. [+1 +1 +1 +1]. For example, orthogonal codes corresponding to sequence index may be defiend as shown in Table 3 below.

[54] Table 3

[Table 3]

Table 3

n_{oc}	Orthogonal code sequence [$w(0)$ $w(1)$ $w(2)$ $w(3)$]
0	[+1 +1 +1 +1]
1	[+1 -1 +1 -1]
2	[+1 -1 -1 +1]
3	[-1 +1 -1 +1]

[55] In step 603, the UE obtains that the positive SR needs to be sent in the subframe #3, and the UE reconfigures the ACK/NACK channel parameters.

[56] The ACK/NACK channel parameters reconfigured by the UE are $n_{cs} = 6, n_{oc} = 3$, i.e. the index of CS is not changed, and the ACK/NACK channel is constructed by using a fixed orthogonal extended code $n_{oc} = 3$ (orthogonal extended code is [-1 +1 -1 +1]) which is not used in conventional solutions.

[57] In step 605, the UE sends the ACK/NACK information in a new ACK/NACK channel constructed according to the reconfigured ACK/NACK channel parameters.

[58] It should be explained that, in the above operations, if the UE determines that it is unnecessary to request the BS to reallocate the uplink resources, i.e. the UE needs to send the negative SR in the current subframe #3, then the UE does not need to reconfigured. the ACK/NACK channel parameters of the UE, i.e. the UE does not perform any operation, but returns the ACK/NACK information by using the original ACK/NACK channel.

[59] The above mode 2 is illustrated by FIG. 9. FIG. 9 illustrates a data precessing precedure based on a mode 2 in a mobile communication system according to an embodiment embodiment of the present invention, Referring to FIG. 9, the ACK/NACK information is generated by using code 0, code 1 or code 2 when not transmitting the SR information, and the ACK/NACK information is generated by using code 3 when

transmitting the SR information.

[60] Mode 3:

[61] The mode 3 is relatively simple, specifically, when the SR information and the ACK/NACK information are transmitted in the same subframe, the UE performs coding modulation for the SR information, and returns the SR information to the BS by using channel resources of one OFDM symbol in the uplink ACK/NACK channel structure in the LTE system. The channel resources of the OFDM symbol include a CAZAC code and an orthogonal code sequence of a time domain. The mode 3 is illustrated by FIG. 10.

[62] FIG. 10 illustrates a data precessing precedure based on a mode 3 in a mobile communication system according to an embodiment embodiment of the present invention.

[63] Referring to FIG. 10, 1 bit SR information is BPSK modulated in BPSK block 810, and is multiplied by a CAZAC sequence in a multiplier 820. After that, a symbol multiplied by the CAZAC seqeuence is provided to an IFFT block 830, is multiplied by an orthogonal code 0 in a multiplier 840, and is mapped into time slots. The ACK/NACK information bits are BPSK or QPSK modulated in BPSK/QPSK block 850, and are multiplied by a CAZAC sequence in a multiplier 860. After that,symbols multiplied by the CAZAC seqeuence are provided to IFFT blocks 870-1 to 870-3, are multiplied by an orthogonal code 1, an orthogonal code 2 or an orthogonal code 3 in multipliers 880-1 to 880-3, and are mapped into time slots.

[64] The implemented modes of the first embodiment, i.e. transmitting the SR information and the ACK/NACK information in the same subframe are described. The second embodiment, i.e. transmitting the SR information and the CQI information in the same subframe are described hereinafter.

[65] The second embodiment:

[66] FIG. 11 illustrates a SR transmission precedure in a mobile communication system according to another embodiment embodiment of the present invention.

[67] Referring to FIG. 11, in step 901, when transmitting the SR information and the CQI information in the same subframe, the UE performs coding modulation for the SR information and generates a SR modulation symbol d_{SR}. Specifically, performing coding modulation for the SR information and generating the SR modulation symbol d_{SR} may include: mapping the SR information as bit information s_0, and performing Binary Phase Shift Keying (BPSK) modulation for the bit information s_0 to generate the SR modulation symbol d_{SR}. The operation for mapping the SR information as the bit information s_0 may refer to the above step 401.

[68] In step 903, a second reference symbol of each CQI time slot is modulated by using single SR modulation symbol d_{SR}. That is, the second reference symbol of each CQI time slot is generated by using SR modulation symbol d_{SR}. Therefore, the second

reference symbol of each CQI time slot includes the SR information.

[69] The second embodiment is illustrated by FIG. 12. FIG. 12 illustrates a data precessing precedure in a mobile communication system according to an embodiment embodiment of the present invention. Referring to FIG. 12, 1 bit SR information is modulated in a BPSK block 1010. The CQI information is block coded in a block code block 1120, and is QPSK modulated in QPSK block 1030. After that, a SR information symbol and CQI information symbols are provided multiplying and IFFT block 1040. The SR information symbol passes thougth a multiplying operation and IFFT operation, and is output as the second reference symbol of each CQI time slot. The CQI information symbols and the SR information symbol are mapped into time slots.

[70] FIG, 13 illustrates a block diagram of a UE in a mobile communication system according to an embodiment embodiment of the present invention.

[71] Referring to FIG. 13, the small BS includes a Radio Frequency (RF) processor 1110, a modem 1120, a storage unit 1130 and a controller 1140.

[72] The RF processor 1110 performs functions, such as signal band converting and amplification, to transmit and receive signals over a radio channel. That is, the RF processor 1110 up-converts a baseband signal output from the modem 1120 to the RF signal and transmits the RF signal over an antenna, and down-converts the RF signal received over the antenna to the baseband signal. For example, the RF processor 1110 may include an amplifier, a mixer, an oscillator, a Digital to Analog Convertor (DAC), a Analog to Digital Convertor (ADC) and so on.

[73] The modem 1120 converts the baseband signal and a bit string according to a physical layer standard of the system. For example, to transmit data, the modem 1120 generates complex symbols by encoding and modulating the transmit bit string, maps the complex symbols to subcarriers, and constitutes OFDM symbols by applying Inverse Fast Fourier Transform (IFFT) and inserting a Cyclic Prefix (CP). When receiving data, the modem 1120 splits the baseband signal output from the RF processor 1110 to OFDM symbols, restores the signals mapped to the subcarriers using FFT, and restores the receive bit string by demodulating and decoding the signals. For example, the modem 1120 may include a structure as illustrated in FIGs 6 and 7, FIG. 10, or FIG. 12.

[74] The storage unit 1130 stores program codes and system information required for the operations of the UE. The storage unit 1130 provide stored data to the controller 1140 upon a request from the controller 1140.

[75] The controller 1140 controls the functions of the UE. For example, the controller 1140 generates a transmit packet and a message and provides the modem 1140 with the transmit packet and the message. And, the controller 1140 processes a receive packet and a message from the modem 1120. More particularly, according to an exemplary

embodiment of the present invention, the controller 1140 controls fuctions to transmit the SR information and other uplink control information. For example, the controller 1140 controls so that the UE operates as illustrated in one of FIG. 4 to FIG. 12.

[76] As can be seen from the above technical scheme, in the embodiments of the present invention, when transmitting the SR information and other uplink control information in the same subframe, the UE returns the SR information to the BS by using physical resources on other non SR channel for transmitting the other uplink control information, that is to say, the UE does not return the SR information to the BS by using a special SR channel, but return the SR information to the BS by using physical resources on other non SR channel for transmitting the other uplink control information, which obviously ensure a low CM characteristic of an uplink CC when the SR, ACK/NACK or CQI information is returned to the BS.

[77] The foregoing is only the preferred embodiments of the present invention and is not intended to limit the scope of the present invention. Any modification, equivalent substitution, or improvement made without departing from the spirit and principle of the present invention should be covered by the scope set forth in the appended claims.

Claims

[Claim 1] A method for transmitting an uplink scheduling request (SR), the method comprising:
obtaing SR subframe configuration by receiving signaling; and
transmitting SR information to an BS by using physical resources of other non SR channel for transmitting other uplink control information.

[Claim 2] The method of claim 1, wherein the other uplink control information comprises at least one of acknowledgement/non-acknowledgement (ACK/NACK) information, and, Channel Quality Indicator (CQI) information.

[Claim 3] The method of claim 2, wherein the transmitting of the SR information comprises,
performing joint coding for the SR information and the ACK/NACK information;
trnamitting the SR information and the ACK/NACK information by using an ACK/NACK channel distributed to the UE.

[Claim 4] The method of claim 3, wherein the performing of the joint coding for the SR information and the ACK/NACK information comprises,
mapping the SR information as 1-bit information;
concatenating the 1-bit information and a bit stream of the ACK/NACK information with a length of A; and
performing Reed-Muller coding processing of (20, A) for the concatenated bit stream.

[Claim 5] The method of claims 4, wherein mapping the SR information as 1-bit information comprises,
determing the 1-bit information as ‘1’ when the SR information is a positive SR; and
determing the 1-bit information as ‘0’ when the SR information is a negative SR.

[Claim 6] The method of claim 4, wherein the mapping of the SR information as 1-bit information comprises,
locating the 1-bit information in front of the bit stream or at the end of the bit stream of the ACK/NACK information.

[Claim 7] The method of claim 2, wherein the transmitting of the SR information comprises,
performing modulation for the SR information; and
transmitting the SR information to the BS by using channel resources

of one OFDM symbol in the uplink ACK/NACK channel.

[Claim 8] The method of claim 7, wherein the channel resources of the OFDM symbol comprises a Constant Amplitude Zero Auto Correlation (CAZAC) code and an orthogonal code sequence of a time domain.

[Claim 9] The method of claims 2, wherein the transmitting of the SR information comprises,
determing ACK/NACK channel parameters that are a cyclic shift index and a orthorgonal sequence index;
determing whether the SR information is a positive SR;
when the SR information is the positive SR, reconfiguring the orthorgonal sequence index, and transmitting the SR information and the ACK/NACK information to the BS by using a ACK/NACK channel constructed according to the cyclic shift index and the reconfigured orthorgonal sequence index; and
when the SR information is not the positive SR, transmitting the SR information and the ACK/NACK information by using a ACK/NACK channel constructed according to the cyclic shift index and the orthorgonal sequence index.

[Claim 10] The method of claim 9, wherein the reconfiguring of the orthorgonal sequence index comprises,
determing a value of the orthorgonal sequence index as a fixed value.

[Claim 11] The method of claim 10, wherein a orthorgonal sequence corresponding to the fixed value comprins [-1 +1 -1 +1].

[Claim 12] The method of claims 2, wherein the transmitting of the SR information comprises,
performing modulation for the SR information and generating a SR modulation symbol; and
modulating the second reference symbol of each CQI time slot by using the single SR modulation symbol.

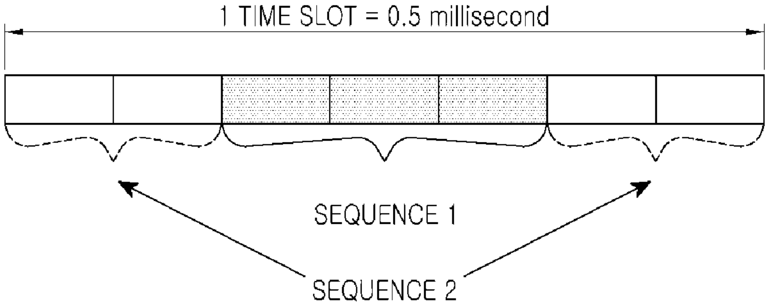
[Claim 13] The method of claim 12, wherein the performing modulation for the SR information and generating a SR modulation symbol comprises,
mapping the SR information as 1-bit information; and
generating the SR modulation symbol by using a Binary Phase Shift Keying (BPSK) modulation.

[Claim 14] The method of claims 13, wherein mapping the SR information as 1-bit information comprises,
determing the 1-bit information as ‘1’ when the SR information is a positive SR; and

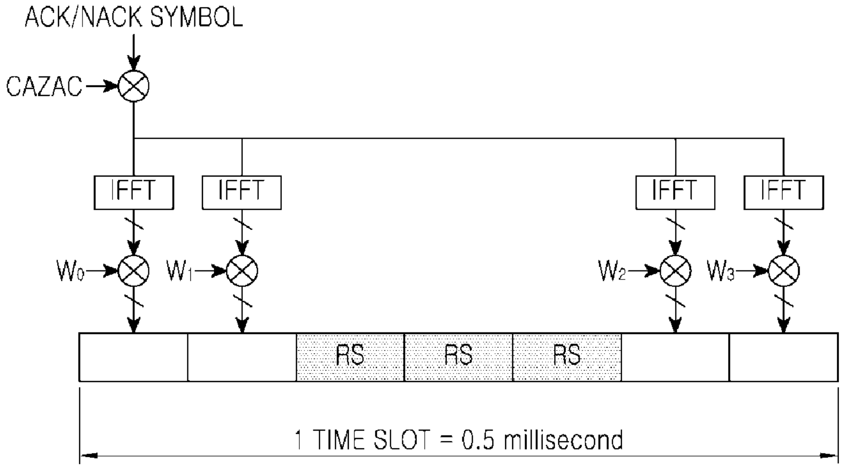
determing the 1-bit information as ‘0’ when the SR information is a negative SR.

[Claim 15] An apparatus for transmitting an uplink scheduling request (SR) arranged to implement a method of one of claims 1 to 14.

[Fig. 1]

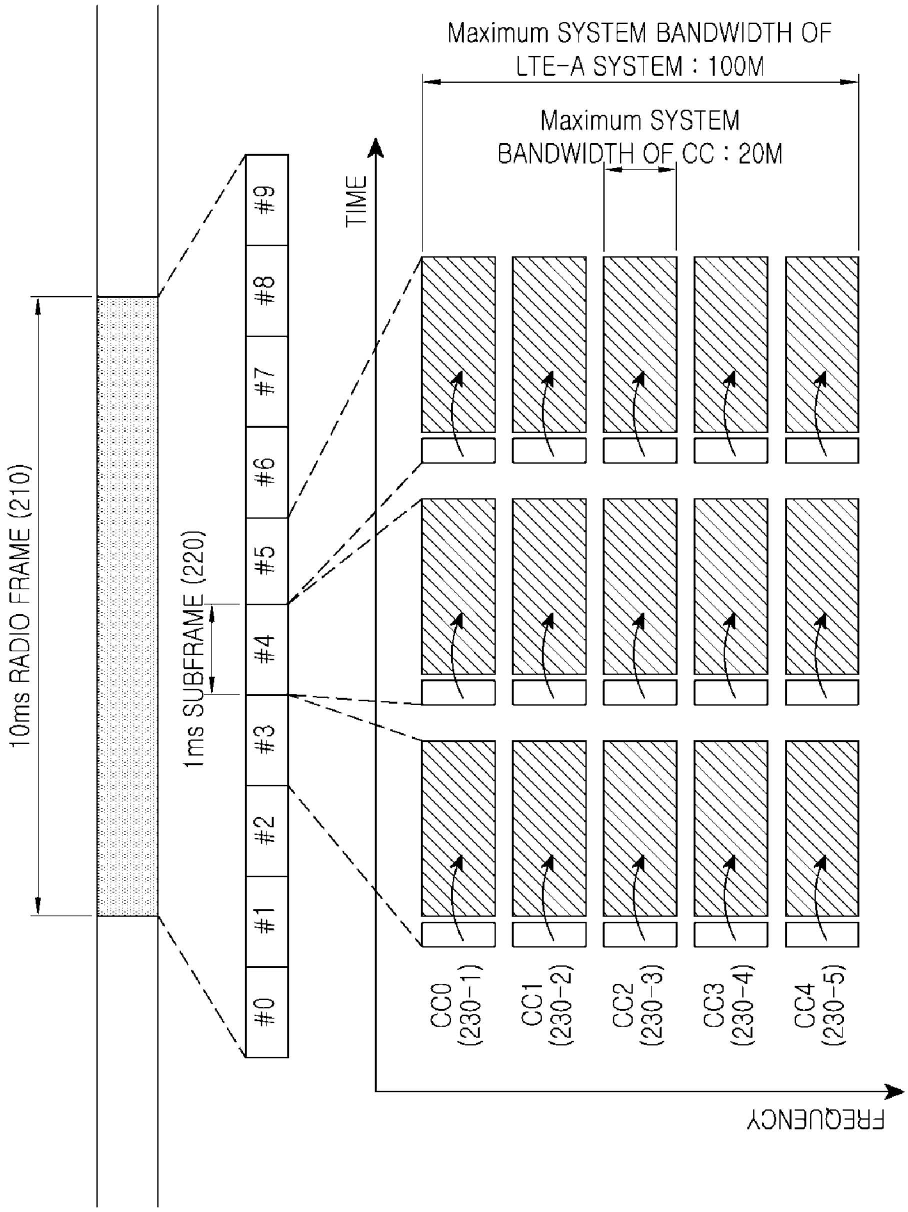

1 TIME SLOT = 0.5 millisecond
SEQUENCE 1
SEQUENCE 2

A

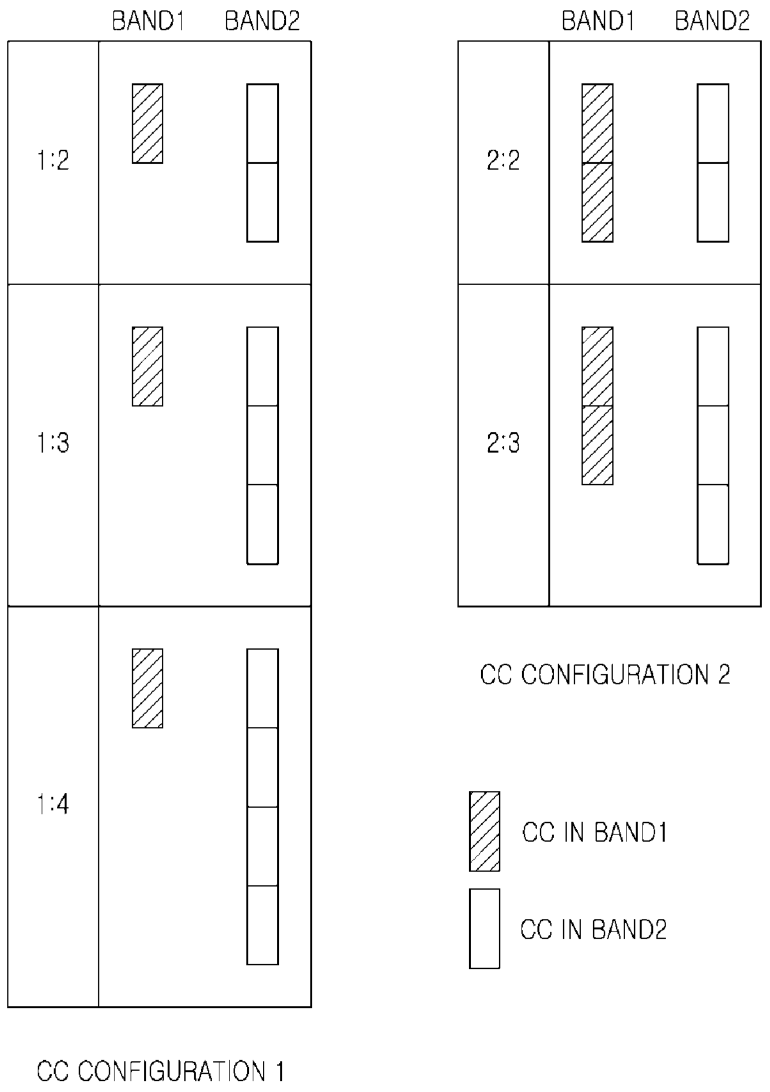

ACK/NACK SYMBOL
CAZAC
IFFT
IFFT
IFFT
IFFT
W0
W1
W2
W3
RS
RS
RS
1 TIME SLOT = 0.5 millisecond

B

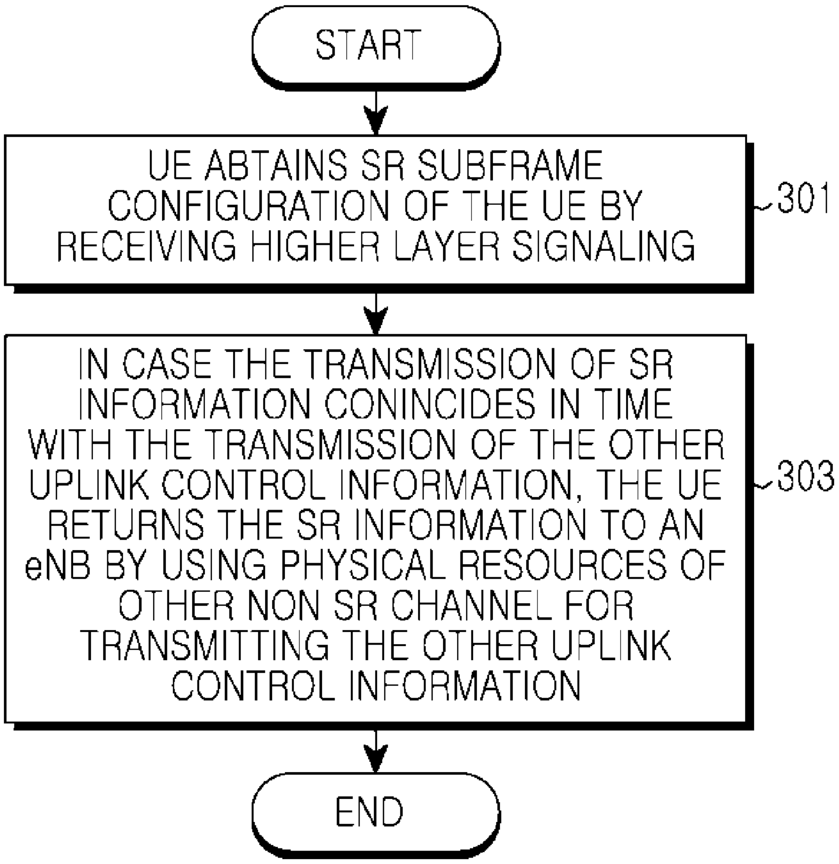
[Fig. 2]


Maximum SYSTEM BANDWIDTH OF LTE-A SYSTEM : 100M
Maximum SYSTEM BANDWIDTH OF CC : 20M
TIME
FREQUENCY
10ms RADIO FRAME (210)
1ms SUBFRAME (220)
#0
#1
#2
#3
#4
#5
#6
#7
#8
#9
CC0 (230-1)
CC1 (230-2)
CC2 (230-3)
CC3 (230-4)
CC4 (230-5)

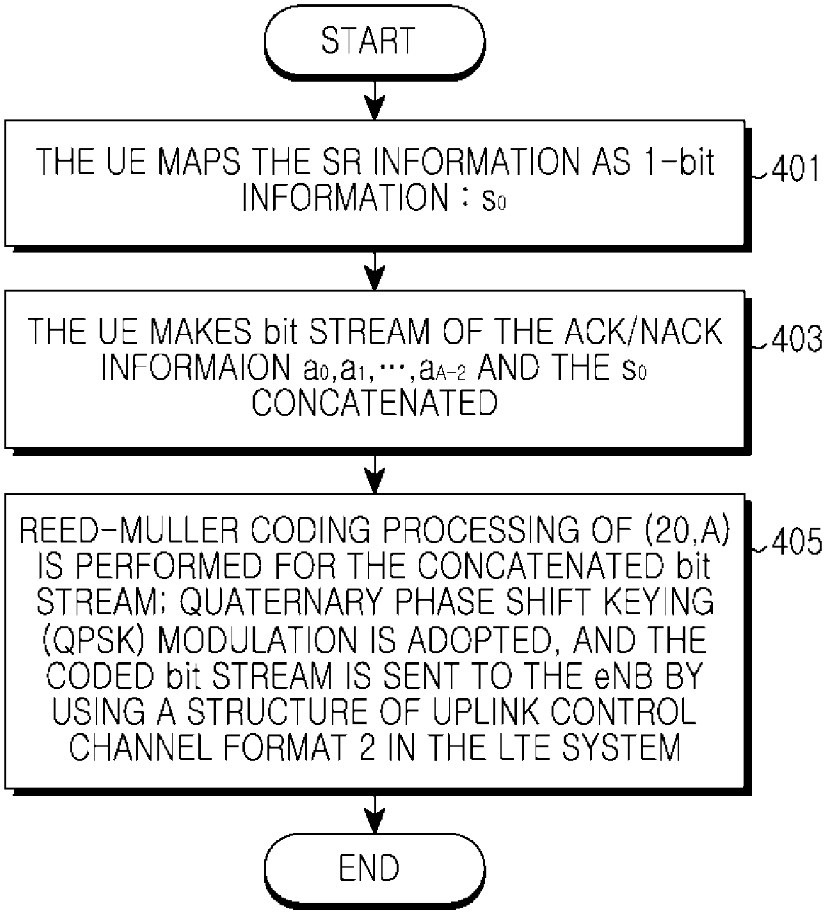
[Fig. 3]


BAND1
BAND2
1:2
1:3
1:4
CC CONFIGURATION 1
BAND1
BAND2
2:2
2:3
CC CONFIGURATION 2
CC IN BAND1
CC IN BAND2

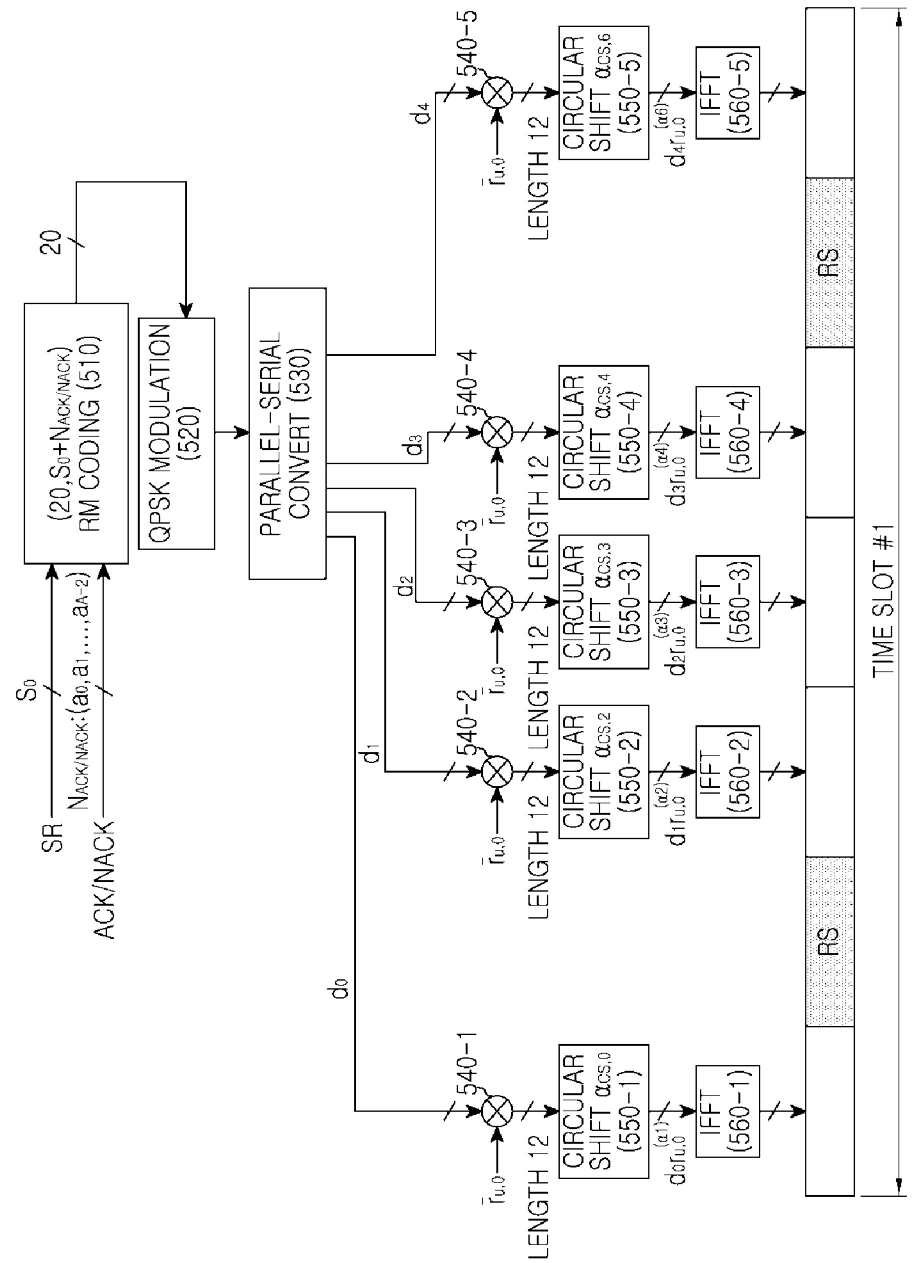
[Fig. 4]


START
UE ABTAINS SR SUBFRAME CONFIGURATION OF THE UE BY RECEIVING HIGHER LAYER SIGNALING
301
IN CASE THE TRANSMISSION OF SR INFORMATION CONINCIDES IN TIME WITH THE TRANSMISSION OF THE OTHER UPLINK CONTROL INFORMATION, THE UE RETURNS THE SR INFORMATION TO AN eNB BY USING PHYSICAL RESOURCES OF OTHER NON SR CHANNEL FOR TRANSMITTING THE OTHER UPLINK CONTROL INFORMATION
303
END

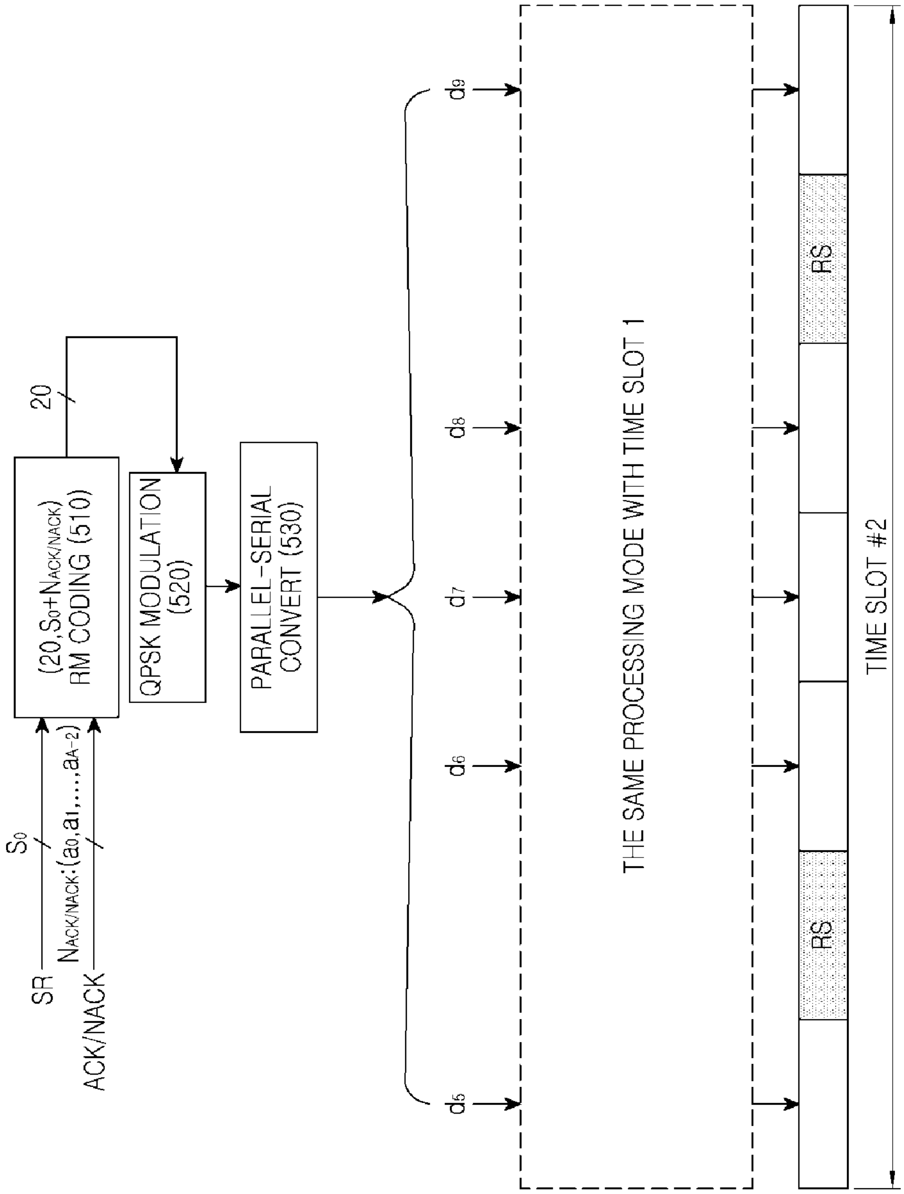
[Fig. 5]


START
THE UE MAPS THE SR INFORMATION AS 1-bit INFORMATION : s0
401
THE UE MAKES bit STREAM OF THE ACK/NACK INFORMAION a0,a1,⋯,aA-2 AND THE s0 CONCATENATED
403
REED-MULLER CODING PROCESSING OF (20,A) IS PERFORMED FOR THE CONCATENATED bit STREAM; QUATERNARY PHASE SHIFT KEYING (QPSK) MODULATION IS ADOPTED, AND THE CODED bit STREAM IS SENT TO THE eNB BY USING A STRUCTURE OF UPLINK CONTROL CHANNEL FORMAT 2 IN THE LTE SYSTEM
405
END

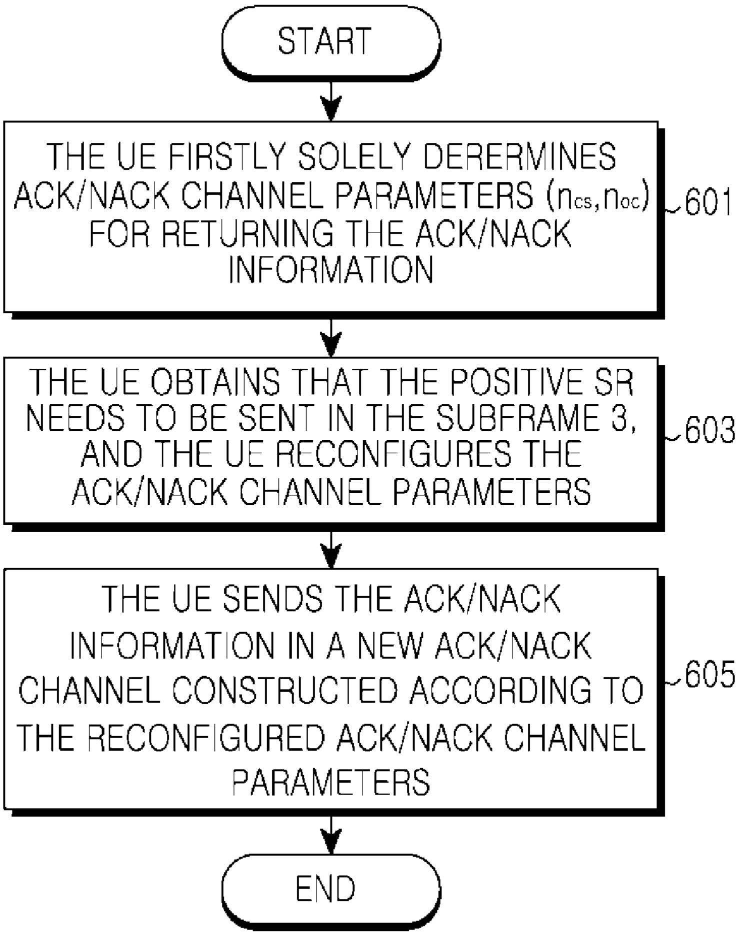
[Fig. 6]


SR
ACK/NACK
(20,S0+NACK/NACK) RM CODING (510)
20
QPSK MODULATION (520)
PARALLEL-SERIAL CONVERT (530)
d0
d1
d2
d3
d4
540-1
540-2
540-3
540-4
540-5
LENGTH 12
CIRCULAR SHIFT αCS,0 (550-1)
CIRCULAR SHIFT αCS,2 (550-2)
CIRCULAR SHIFT αCS,3 (550-3)
CIRCULAR SHIFT αCS,4 (550-4)
CIRCULAR SHIFT αCS,6 (550-5)
IFFT (560-1)
IFFT (560-2)
IFFT (560-3)
IFFT (560-4)
IFFT (560-5)
RS
RS
TIME SLOT #1

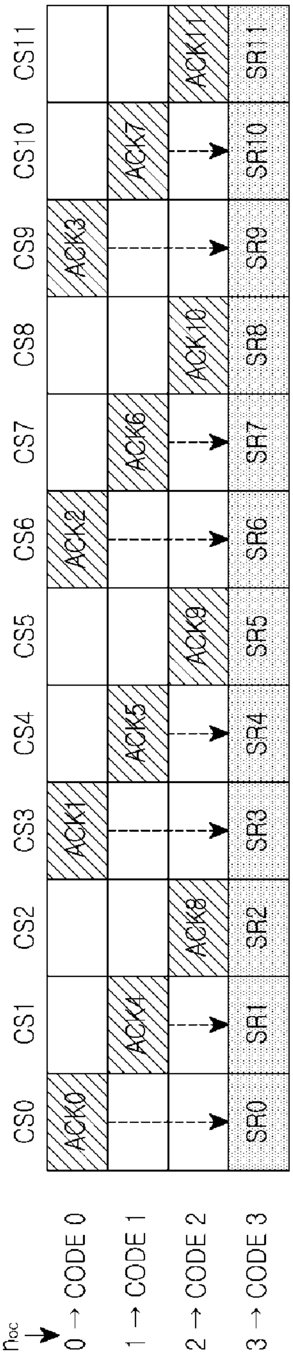
[Fig. 7]


SR
S_0
ACK/NACK
$N_{ACK/NACK}$:(a_0,a_1,...,a_{A-2})
(20,S_0+$N_{ACK/NACK}$)
RM CODING (510)
20
QPSK MODULATION
(520)
PARALLEL-SERIAL
CONVERT (530)
d_5
d_6
d_7
d_8
d_9
THE SAME PROCESSING MODE WITH TIME SLOT 1
RS
RS
TIME SLOT #2

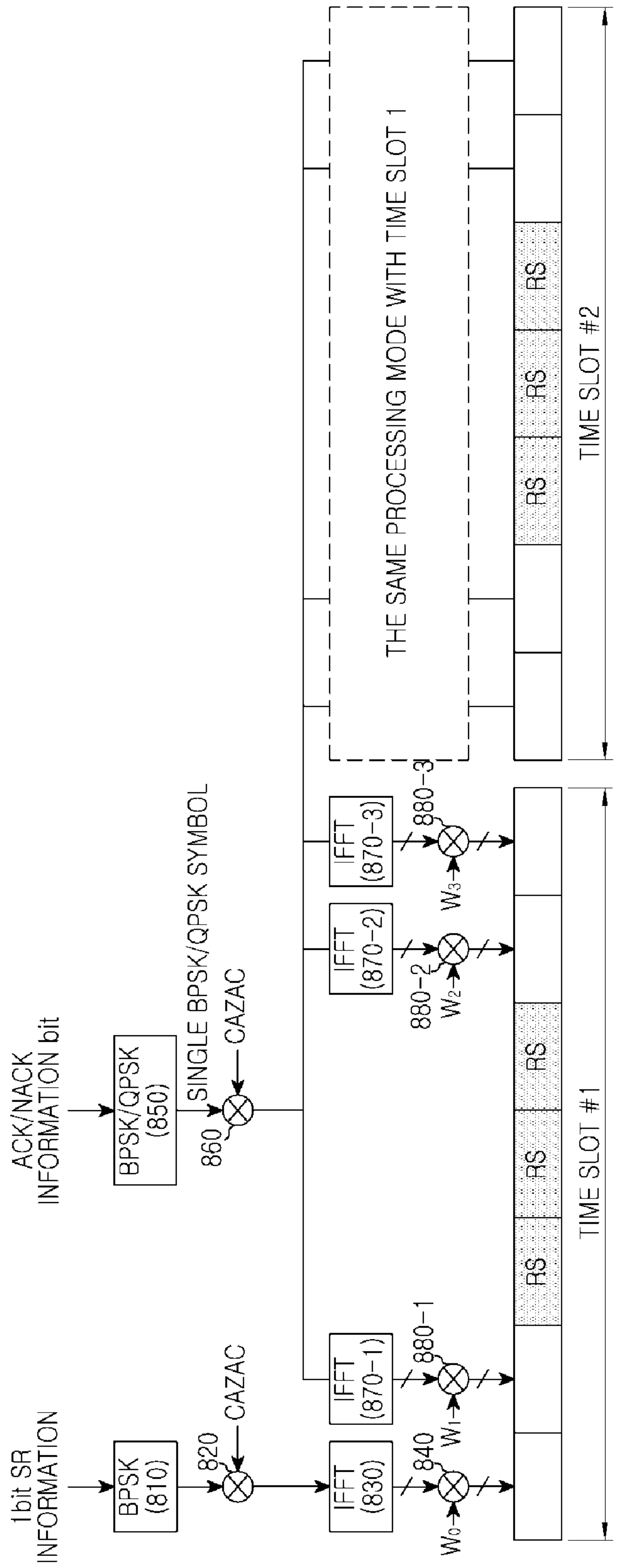
[Fig. 8]


START
THE UE FIRSTLY SOLELY DERERMINES ACK/NACK CHANNEL PARAMETERS (n_{cs},n_{oc}) FOR RETURNING THE ACK/NACK INFORMATION
601
THE UE OBTAINS THAT THE POSITIVE SR NEEDS TO BE SENT IN THE SUBFRAME 3, AND THE UE RECONFIGURES THE ACK/NACK CHANNEL PARAMETERS
603
THE UE SENDS THE ACK/NACK INFORMATION IN A NEW ACK/NACK CHANNEL CONSTRUCTED ACCORDING TO THE RECONFIGURED ACK/NACK CHANNEL PARAMETERS
605
END

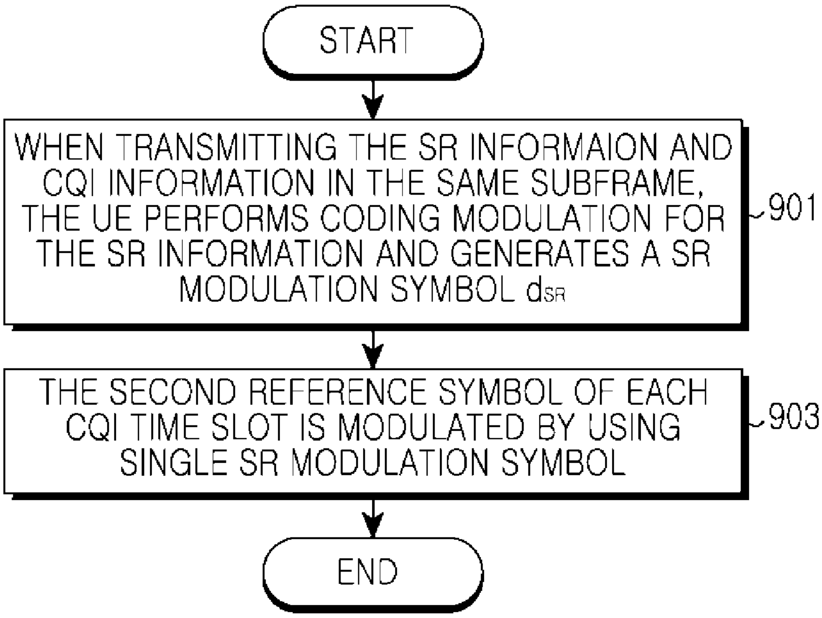
[Fig. 9]


CS0
CS1
CS2
CS3
CS4
CS5
CS6
CS7
CS8
CS9
CS10
CS11
ACK0
ACK1
ACK2
ACK3
ACK4
ACK5
ACK6
ACK7
ACK8
ACK9
ACK10
ACK11
SR0
SR1
SR2
SR3
SR4
SR5
SR6
SR7
SR8
SR9
SR10
SR11
n_{oc}
0 → CODE 0
1 → CODE 1
2 → CODE 2
3 → CODE 3

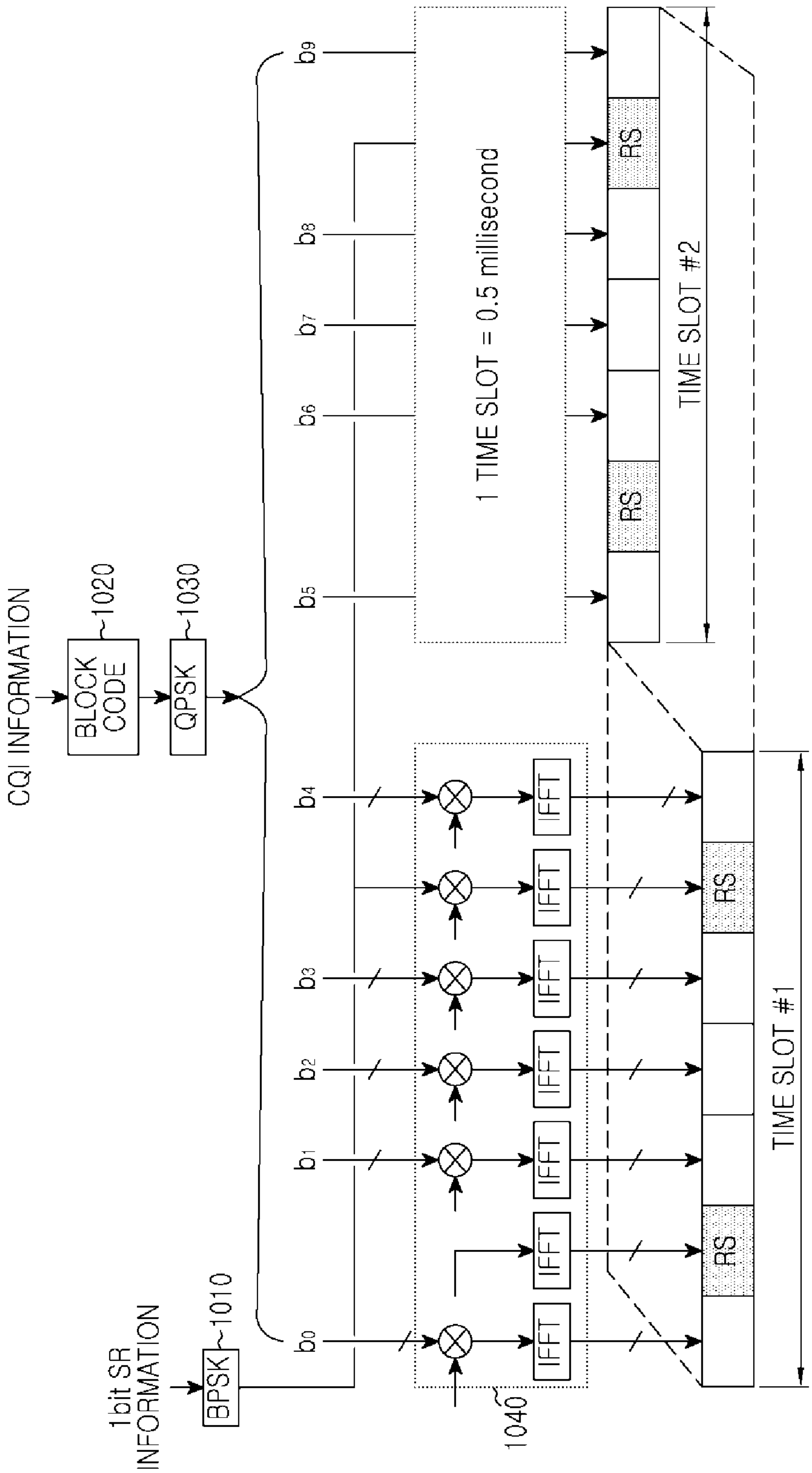
[Fig. 10]


1bit SR INFORMATION
BPSK (810)
820
CAZAC
IFFT (830)
840
W0
W1
IFFT (870-1)
880-1
ACK/NACK INFORMATION bit
BPSK/QPSK (850)
860
SINGLE BPSK/QPSK SYMBOL
CAZAC
IFFT (870-2)
880-2
W2
IFFT (870-3)
880-3
W3
RS
RS
RS
TIME SLOT #1
THE SAME PROCESSING MODE WITH TIME SLOT 1
RS
RS
RS
TIME SLOT #2

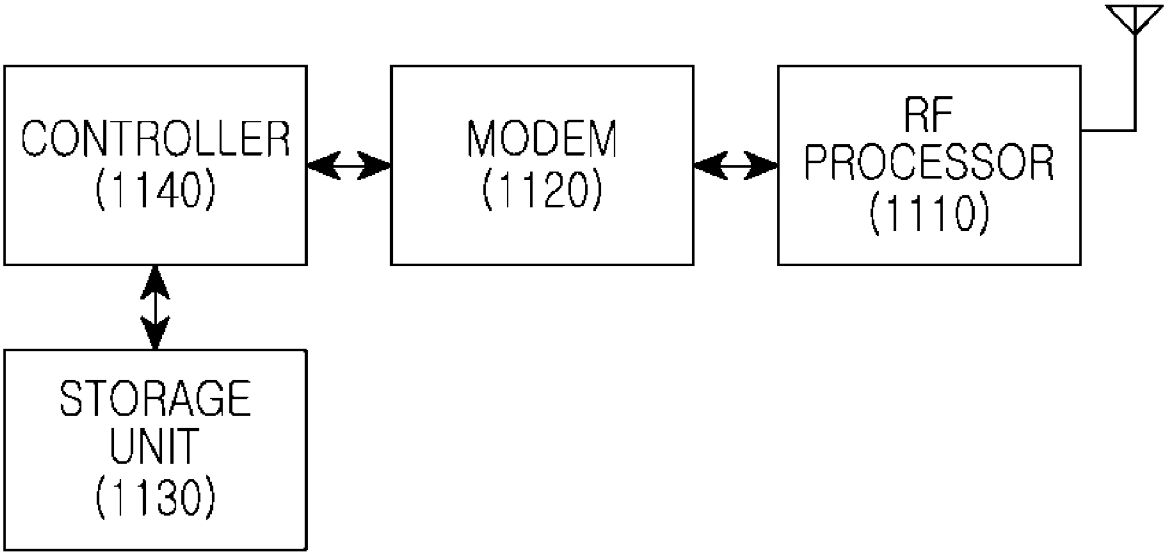
[Fig. 11]


START
WHEN TRANSMITTING THE SR INFORMAION AND CQI INFORMATION IN THE SAME SUBFRAME, THE UE PERFORMS CODING MODULATION FOR THE SR INFORMATION AND GENERATES A SR MODULATION SYMBOL dSR
901
THE SECOND REFERENCE SYMBOL OF EACH CQI TIME SLOT IS MODULATED BY USING SINGLE SR MODULATION SYMBOL
903
END

[Fig. 12]


CQI INFORMATION
BLOCK CODE
1020
QPSK
1030
1bit SR INFORMATION
BPSK
1010
b0
b1
b2
b3
b4
b5
b6
b7
b8
b9
IFFT
1040
RS
TIME SLOT #1
TIME SLOT #2
1 TIME SLOT = 0.5 millisecond

[Fig. 13]


CONTROLLER
(1140)
MODEM
(1120)
RF
PROCESSOR
(1110)
STORAGE
UNIT
(1130)