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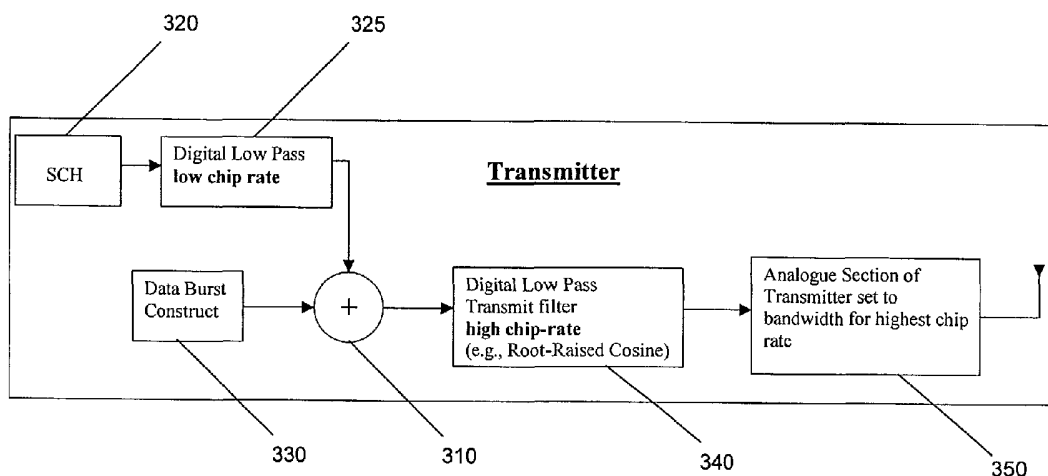
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(54) Title: METHOD, COMMUNICATION SYSTEM AND COMMUNICATION UNIT FOR SYNCHRONISATION FOR MULTI-RATE COMMUNICATION



(57) Abstract: A method, communication system and communication unit for synchronisation for multi-rate communication by transmitting a signal (fig. 4A) having a synchronisation portion at a first, predetermined chip rate and containing an indication of chip rate used for a further portion; receiving the transmitted signal, recovering the indication from the synchronisation portion at the first, predetermined chip rate (fig. 4B), and recovering information in the further portion at the chip rate indicated by the indication (fig. 4C). This provides improved efficiency in supporting multi-chip rates.

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METHOD, COMMUNICATION SYSTEM AND COMMUNICATION UNIT FOR
SYNCHRONISATION FOR MULTI-RATE COMMUNICATION

5 **Field of the Invention**

This invention relates to digital communication systems,
and particularly to synchronisation in digital
communication systems such as wireless cellular
10 communication systems. The invention finds particular
application in modern digital wireless communication
systems such as Universal Mobile Telecommunication
Systems (UMTS).

15

Background of the Invention

It is known that synchronisation is an essential
procedure in a modern digital communication system. It
20 is the procedure used by a remote unit (often referred to
as User Equipment, UE, in UMTS or Customer Premises
Equipment, CPE) to identify valid transmissions from
infrastructure equipment (often referred to as Node Bs in
UMTS) and align the remote frequency reference and timing
25 to that used by the infrastructure.

UMTS Terrestrial Radio Access (UTRA) Time Division Duplex
(TDD) and Frequency Division Duplex (FDD) modes both
provide a synchronisation channel (SCH) that is used by
30 the UE to search for valid signals and perform the
synchronisation procedure. The SCH transmission consists

of one real valued Primary Synchronisation Code (PSC) and three complex Secondary Synchronisation Codes (SSC), all of length 256 chips. The PSC is common for all Node Bs, but the SSCs are Node B specific. The PSC and SSC are
5 transmitted simultaneously from a given Node B at a specific fixed time offset (t_{offset}) from the start of time slot 0. The time offset is included to prevent the possible capture effect that would otherwise occur as a consequence of all Node Bs transmitting the common
10 primary code at the same time.

The UE uses the PSC to search for and identify transmissions from Node Bs. The PSC is also used as a reference from which the UE is able to generate a
15 correction that can be used to correct the frequency of the UE's reference oscillator. The SSC is included to signal the additional information required by the UE in order to achieve the full time-aligned synchronization and also to begin to demodulate system information
20 broadcast on the Broadcast Channel (BCH) which is carried by the Primary Common Control Physical Channel P-CCPCH.

For single chip-rate systems where the chip rate used by the Node B and the UE is predetermined by the system
25 design, the synchronization procedure briefly outlined above is sufficiently complete.

However, considering a network where multi-chip rates are supported, in an initial start-up condition, the UE will
30 not be aware of the chip rate that is available;

therefore, the receiver in the UE is unable to select the correct chip-rate.

In some known systems such as those using fixed line
5 modems, the available bandwidth is negotiated in the initial data transfers between sender and receiver. This is done at a predetermined fixed rate, usually determined by the system design or backwards compatibility with early implementations.

10

Other possible schemes might transmit the whole timeslot in which SCH bursts are transmitted at the lower chip-rate (note that for a UMTS TDD system, the SCH is transmitted in every radio frame).

15

However, the above known fixed initial rate negotiation scheme and the other possible schemes have the disadvantage that they are inefficient.

20 A need therefore exists for a synchronisation scheme for multi-rate communication wherein the abovementioned disadvantage may be alleviated.

25 **Statement of Invention**

In accordance with a first aspect of the present invention there is provided a method, for synchronisation in a multi-rate communication system, as claimed in
30 claim 1.

In accordance with a second aspect of the present invention there is provided a method, for synchronisation in a multi-rate communication system, as claimed in claim 8.

5

In accordance with a third aspect of the present invention there is provided a multi-rate communication system, as claimed in claim 13.

10 In accordance with a fourth aspect of the present invention there is provided a communication unit, for use in a multi-rate communication system, as claimed in claim 20.

15 In accordance with a fifth aspect of the present invention there is provided a communication unit, for use in a multi-rate communication system, as claimed in claim 27.

20

Brief Description of the Drawings

One method, communication unit and communication system for synchronisation for multi-rate communication
25 incorporating the present invention will now be described, by way of example only, with reference to the accompanying drawings, in which:

FIG. 1 shows a block diagram of a wireless
30 communication system that can be adapted to support

the various inventive concepts of a preferred embodiment of the present invention;

FIG. 2 shows a block diagram of a wireless communication unit that can be adapted to support the various inventive concepts of a preferred embodiment of the present invention;

FIG. 3 shows a block schematic diagram illustrating SCH transmission and reception in a single chip rate system incorporating the invention; and

FIG. 4 shows a block schematic diagram illustrating SCH transmission and reception in a multi chip-rate system incorporating the invention.

Description of Preferred Embodiment

Referring now to FIG. 3, a multi-rate cellular-based wireless telephone communication system 100 is shown in outline, in accordance with a preferred embodiment of the invention. Preferably, the cellular-based telephone communication system 100 is compliant with, and contains network elements capable of operating over, a UMTS air-interface. In particular, the invention relates to the Third Generation Partnership Project (3GPP) specification for wide-band code-division multiple access (WCDMA) standard relating to the UTRAN Radio Interface (described in the 3G TS 25.xxx series of specifications).

A plurality of subscriber terminals (or user equipment (UE) in UMTS nomenclature) 112, 114, 116 communicate over radio links 118, 119, 120 with a plurality of base transceiver stations, referred to under UMTS terminology as Node-Bs, 122, 124, 126, 128, 130, 132. The system comprises many other UEs and Node Bs, which for clarity purposes are not shown.

The wireless communication system, sometimes referred to as a Network Operator's Network Domain, is connected to an external network 134, for example the Internet. The Network Operator's Network Domain includes:

- (i) A core network, namely at least one Gateway GPRS Support Node (GGSN) 144 and or at least one Serving GPRS Support Nodes (SGSN); and
- (ii) An access network, namely:
 - (ai) a GPRS (or UMTS) Radio network controller (RNC) 136-140; or
 - (aai) Base Site Controller (BSC) in a GSM system and/or
 - (bi) a GPRS (or UMTS) Node B 122-132; or
 - (bii) a Base Transceiver Station (BTS) in a GSM system.

25

The GGSN/SGSN 144 is responsible for GPRS (or UMTS) interfacing with a Public Switched Data Network (PSDN) such as the Internet 134 or a Public Switched Telephone Network (PSTN) 134. A SGSN 144 performs a routing and tunnelling function for traffic within say, a GPRS core network, whilst a GGSN 144 links to external packet

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networks, in this case ones accessing the GPRS mode of the system.

The Node-Bs 122-132 are connected to external networks, through base station controllers, referred to under UMTS terminology as Radio Network Controller stations (RNC), including the RNCs 136, 138, 140 and mobile switching centres (MSCs), such as MSC 142 (the others are, for clarity purposes, not shown) and SGSN 144 (the others are, for clarity purposes, not shown).

Each Node-B 122-132 contains one or more transceiver units and communicates with the rest of the cell-based system infrastructure via an I_{ub} interface, as defined in the UMTS specification.

Each RNC 136-140 may control one or more Node-Bs 122-132. Each MSC 142 provides a gateway to the external network 134. The Operations and Management Centre (OMC) 146 is operably connected to RNCs 136-140 and Node-Bs 122-132 (shown only with respect to Node-B 126 for clarity). The OMC 146 administers and manages sections of the cellular telephone communication system 100, as is understood by those skilled in the art.

25

In the preferred embodiment of the invention, at least one UE 312-316 and at least one Node-B 322-332 have been adapted, to offer, and provide for, transmission, reception and processing of multi-rate high-speed signals generated in accordance with the approach discussed in detail below.

30

More particularly, in this embodiment the above elements have been adapted to implement the present invention in both transmitting and receiving modes of operation, such
5 that in this embodiment the invention may be applied to both down-link and up-link transmissions.

It is also within the contemplation of the invention that such adaptation of the physical layer (air-interface)
10 elements may alternatively be controlled, implemented in full or implemented in part by adapting any other suitable part of the communication system 100. For example, equivalent parts in other types of systems may, in some circumstances, be adapted to provide some or all
15 of the digital filtering implementation provided in this embodiment.

Further, in the case of other network infrastructures, implementation of the processing operations may be
20 performed at any appropriate node such as any other appropriate type of base station, base station controller, etc.

Alternatively the aforementioned digital filtering
25 operations may be carried out by various components distributed at different locations or entities within any suitable network or system.

Although the preferred embodiment of the invention is
30 described with reference to a wireless communication system employing a UMTS air-interface, it is within the

contemplation of the invention that the inventive concepts described herein can be applied to any multi-bandwidth/multi-data rate communication system - fixed or wireless.

5

Referring now to FIG. 2, a block diagram of a communication unit 200, for example user equipment (UE) 112, adapted to support the inventive concepts of the preferred embodiments of the present invention, is shown.

10 However, it is within the contemplation of the invention that a similar block diagram would apply to a Node B element, say Node B 122. Therefore, in the following description FIG. 2 is described such that it also encompasses an implementation of a Node B baseband
15 processing circuit, in broad principle, as would be appreciated by a person skilled in the art.

The UE 112 contains an antenna 202 preferably coupled to a duplex filter or circulator or switch 204 that provides
20 isolation between receive and transmit chains within UE 112.

The receiver chain includes scanning receiver front-end circuitry 206 (effectively providing reception, filtering
25 and intermediate or baseband frequency conversion). The scanning front-end circuit 206 scans signal transmissions from its associated Node B. The scanning front-end circuit 206 is serially coupled to a signal processing function (processor, generally realised by a DSP) 208.
30 The final receiver circuits are a baseband back-end

circuit 209 operably coupled to a display unit 210, if the communication unit is a subscriber unit.

Alternatively, if the communication unit is a Node B, the
5 final receiver circuits are a baseband back-end circuit 209 operably coupled to an interface port 210, in order to forward the demodulated received signal to, say, a PC or a RNC.

10 In accordance with a preferred embodiment of the invention, the receiver chain, in particular the signal processing function 208, coupled to the scanning baseband back-end circuit 209, has been adapted for a receiving communication unit to receive and process multiple, high-
15 speed signals of varying bandwidths.

A controller 214 is operably coupled to the scanning front-end circuitry 206 so that the receiver can calculate receive bit-error-rate (BER) or frame-error-
20 rate (FER) or similar link-quality measurement data from recovered information via a received signal strength indication (RSSI) 212 function. The RSSI 212 function is operably coupled to the scanning front-end circuit 206. A memory device 216 in the controller 214 stores a wide
25 array of UE-specific data, such as decoding/encoding functions, timing details, neighbour and serving cell information relating to timing, channels, power control and the like, as well as link quality measurement information to enable an optimal communication link to be
30 selected.

A timer 218 is operably coupled to the controller 214 to control the timing of operations, namely the transmission or reception of time-dependent signals, within the UE 112.

5 In the context of the preferred embodiment of the present invention, timer 218 is used to synchronize the timing of the receiving communication unit 200 to be able to switch between two or more filter configurations, as will be described below, as well as to co-ordinate appropriate
10 clocking of signals throughout the receiver.

For completeness, in broad terms, the transmit chain of the communication unit (either a UE or Node B) essentially includes an input device 220, coupled in
15 series through the processor 208, transmitter/modulation circuitry 222 and a power amplifier 224. The processor 208, transmitter/modulation circuitry 222 and the power amplifier 224 are operationally responsive to the controller 214, with an output from the power amplifier
20 coupled to the duplex filter or circulator 204, as known in the art.

The signal processor function 208 in the transmit chain may be implemented as distinct from the processor in the
25 receive chain. Alternatively, a single processor 208 may be used to implement processing of both transmit and receive signals, as shown in FIG. 2.

Of course, it will be understood that the various
30 components within the communication unit 200 can be realised in discrete or integrated component form, with

an ultimate structure therefore being merely an arbitrary selection.

More generally, the digital filtering algorithms
5 associated with the preferred embodiment of the present invention may be implemented in a respective communication unit in any suitable manner. For example, new apparatus may be added to a conventional communication unit (for example UE 112, or Node B 122),
10 or alternatively existing parts of a conventional communication unit may be adapted, for example by reprogramming one or more processors therein. As such the required adaptation may be implemented in the form of processor-implementable instructions stored on a storage
15 medium or data carrier, such as a floppy disk, hard disk, PROM, RAM or any combination of these or other storage multimedia.

This invention, at least in a preferred form, implements
20 a scheme where the SCH channel in the UTRA air-interface is transmitted at the lowest chip-rate supported by the system design. Note that only the SCH channel is always transmitted at the lower chip rate.

25 As the SCH is transmitted at the lower chip rate, the receiving UE will by default, select the receiver bandwidth appropriate to this lower chip-rate. In this configuration, the UE will be able to recover the SCH, irrespective of the chip rate used at the transmitting
30 Node B.

The modulation of data onto the secondary SCH defined by the UTRA standard does not use all of the degrees of freedom available in the modulation scheme. Therefore, the mapping of the synchronisation specific data on to the SSC can be expanded to allow the additional signalling of the transmitting Node B chip rate to be added (see GB patent application no. 0122109.2, filed on 13 September 2001 by the same applicant as the present application and entitled "ENCODER AND METHOD FOR EFFICIENT SYNCHRONISATION CHANNEL ENCODING IN UTRA TDD MODE", the content of which is hereby incorporated herein by reference).

A simplified diagram of the single chip-rate implementation of a preferred embodiment of the invention is shown in FIG. 3.

In this example, the SCH is treated identically to the rest of the data burst. That is, the SCH is processed by the same transmit and receive filters as the physical channels used to transport the information having the same chip rate.

Thus, as shown in FIG. 3A, in the transmit path of the transmitting Node B a combiner 310 combines SCH information 320 with the appropriate data burst construct 330. The resultant data burst containing the SCH information is filtered in the digital low-pass transmit filter 340 (which may, for example, be of the 'root-raised cosine' type). The analogue section 350 of the transmitter is set to the bandwidth (narrowest)

appropriate for the lowest chip rate, and the data burst is passed to the antenna for transmission.

Correspondingly, as shown in FIG. 3B, in the receive path of the receiving UE the analogue section 360 of the receiver is set to the bandwidth (narrowest) appropriate for the lowest chip rate, and performs initial filtering of the data burst received at the antenna. The output of the analogue section 360 is then filtered in the digital low-pass receive filter 370 (which may, like the digital transmit filter 340, be of the 'root-raised cosine' type). The output of the digital low-pass receive filter 370 is processed to recover the SCH information and (as will be explained in greater detail below) to decode the system chip rate information therefrom (as depicted at 380). Since (in this single chip rate case) the decoded system chip rate information does not indicate that the system chip rate is different than the chip rate used for the SCH information (i.e., it indicates that a single chip rate is used), the receive path digital filters remain configured for the single, lowest chip rate for subsequent processing of the data burst (as indicated at 390) and transport channel information as for the SCH information.

25

Referring now also FIG. 4, in the case where a different chip-rate is available for the physical channel that is used to transport data, it is necessary to provide different filters (or to differently configure the filter(s)) for the SCH channel and the physical channels used to transport the data. Such different filters, or

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re-configuration of the same filter(s), may be implemented as in GB patent application no. 018414.2, filed on 30 July 2001 by the same applicant as the present application and entitled "DIGITAL FILTER FOR
5 MULTI-RATE COMMUNICATION", the content of which is hereby incorporated herein by reference.

Suppose the chip rate in a multi chip-rate system is given by

$$10 \quad f_c = n f_b ; n = 1, \dots, N$$

where f_b is the base chip rate and N is the number of available chip rates in the multi-chip rate system. When a UE is initialised it knows *a priori* that the chip-rate being used for the SCH is f_b , but it does not know the
15 system chip rate being used, f_c . In the Node B transmitter, it is necessary to pass the SCH physical channel through a filter (typically a digital filter) optimised for f_b . The physical channels transporting the data are filtered with a (digital) filter optimised for
20 f_c . In the analogue section of the Node B transmitter, the filter bandwidth is always equal to f_c .

In the receive section of the user equipment, the receiver bandwidth is set to f_b in both the analogue
25 section and digital sections. In this configuration, the physical channels with chip-rate f_c may suffer severe inter-symbol interference when $f_c \neq f_b$. However, the SCH physical channel is received with minimal degradation. It is necessary to use a bandwidth of f_b in the analogue

filter and the digital filter in order to apply maximum attenuation to potentially high-power adjacent channel interferers.

5 With a UE in this configuration, it is possible to demodulate the SCH channel and decode the data transported by the SSC to determine f_c . When initial synchronisation has been achieved, the analogue and digital filters are set to f_c .

10

FIG. 4 shows the receiver/transmitter implementation of this multi-chip rate scheme.

Thus, as shown in FIG. 4A, in the transmit path of the transmitting Node B a combiner 310 combines SCH
15 information 320 (filtered by a digital low-pass filter 325 set to the low chip rate f_b , so as to ensure that the SCH information can be recovered in the receiver by filtering at this chip rate) with the appropriate data
20 burst construct 330. The SCH information is encoded with the desired higher system chip rate f_c , as explained in detail in the above-mentioned GB patent application no. 018414.2. The resultant data burst containing the SCH
information is filtered in the digital low-pass transmit
25 filter 340 (now set for the desired high chip rate f_c). The analogue section 350 of the transmitter is set to a bandwidth (wider than in the case of FIG. 3A) appropriate for the higher chip rate, and the data burst is passed to the antenna for transmission.

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Correspondingly, in the receive path of the receiving UE, in a first state, as shown in FIG. 4B, the analogue section 360 of the receiver is set to the bandwidth (narrowest) appropriate for the lowest chip rate, and
5 performs initial filtering of the data burst received at the antenna. The output of the analogue section 360 is then filtered in the digital low-pass receive filter 370. The output of the digital low-pass receive filter 370 is processed to recover the SCH information and decode the
10 system chip rate information therefrom. It will be appreciated that this initial stage of receive path processing is similar to that shown and described above in relation to the single chip-rate case shown in FIG. 3A. As will be explained further below, at this
15 stage (since the indicated system chip rate f_c is higher than the lowest chip rate f_b used for the SCH information) data burst processing is disabled (as indicated at 395).

20 In this multi chip-rate case, the system chip rate information decoded from the SCH information indicates the higher chip rate used for transport channel information. Since this indicated system chip rate f_c is higher than the low chip rate f_b used for the SCH
25 information, the receive path is then configured into a second state, as shown in FIG. 4C, in which the analogue section 360 and the digital low pass receive filter 370 are set to bandwidths appropriate for the higher chip rate f_c .

In this second state, in the receive path of the receiving UE the analogue section 360 of the receiver performs (now at the higher bandwidth appropriate for the higher chip rate f_c) filtering of the signals received at the antenna. The output of the analogue section 360 is then filtered (now at the higher bandwidth appropriate for the higher chip rate f_c) in the digital low-pass receive filter 370. The output of the digital low-pass receive filter 370 is then processed (i) to recover the data burst information (now enabled, as depicted at 390) and transport channel information at the higher chip rate, and (ii) to further process (after filtering by a digital low-pass filter 385 set to the low chip rate f_b so as to ensure that the SCH information can be recovered in the receiver by filtering at this chip rate) the SCH information (as depicted at 380).

It will be understood that the method, communication unit and communication system for synchronisation for multi-rate communication described above provides improved efficiency in supporting multi-chip rates.

Claims

1. A method for synchronisation in a multi-rate communication system, the method comprising:
 - 5 receiving a signal having a synchronisation portion at a first, predetermined chip rate and containing an indication of chip rate used for a further portion; and
 - recovering the indication from the synchronisation
 - 10 portion at the first, predetermined chip rate; and
 - recovering information in the further portion at the chip rate indicated by the indication.
2. The method of claim 1, wherein the step of
15 recovering the indication comprises processing the synchronisation portion by filter means set at a bandpass appropriate for the first, predetermined chip rate, and the step of recovering information in the further portion comprises processing the further portion by filter means
20 set at a bandpass appropriate for the indicated chip rate.
3. The method of claim 2, wherein the filter means processing the synchronisation portion and the filter
25 means processing the further portion comprise common, re-configurable filter means.
4. The method of claim 1, 2 or 3, wherein the first, predetermined chip rate is lower than the indicated chip
30 rate.

5. The method of any preceding claim, wherein the signal comprises a data burst and the synchronisation portion comprises a synchronisation channel signal.

5 6. The method of any preceding claim, wherein the system is a wireless communication system.

7. The method of claim 6, wherein the system is a UMTS system.

10

8. A method for synchronisation in a multi-rate communication system, the method comprising:

transmitting a signal having a synchronisation

portion at a first, predetermined chip rate and

15 containing an indication of chip rate used for a further portion,

whereby the indication may be recovered from the synchronisation portion at the first,

predetermined chip rate; and information in the

20 further portion may be recovered at the chip rate indicated by the indication.

9. The method of claim 8, wherein the first, predetermined chip rate is lower than the indicated chip
25 rate.

10. The method of claim 8 or 9, wherein the signal comprises a data burst and the synchronisation portion comprises a synchronisation channel signal.

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11. The method of claim 8, 9 or 10, wherein the system is a wireless communication system.
12. The method of claim 11, wherein the system is a UMTS system.
13. A multi-rate communication system comprising:
a transmitter having means for transmitting a signal having a synchronisation portion at a first, predetermined chip rate and containing an indication of chip rate used for a further portion;
a receiver having
means for receiving the transmitted signal,
means for recovering the indication from the synchronisation portion at the first, predetermined chip rate, and
means for recovering information in the further portion at the chip rate indicated by the indication.
14. The system of claim 13, wherein the means for recovering the indication comprises filter means set at a bandpass appropriate for the first, predetermined chip rate, and the means for recovering information in the further portion comprises filter means set at a bandpass appropriate for the indicated chip rate.
15. The system of claim 14, wherein the filter means set at a bandpass appropriate for the first, predetermined chip rate and the filter means set at a bandpass

appropriate for the indicated chip rate comprise common, re-configurable filter means.

16. The system of claim 13, 14 or 15, wherein the first,
5 predetermined chip rate is lower than the indicated chip rate.

17. The system of any one of claims 13 to 16, wherein the signal comprises a data burst and the synchronisation
10 portion comprises a synchronisation channel signal.

18. The system of any one of claims 13 to 17, wherein the system is a wireless communication system.

15 19. The system of claim 18, wherein the system is a UMTS system.

20. A communication unit for use in a multi-rate communication system, the communication unit comprising:
20 means for receiving a signal having a
synchronisation portion at a first, predetermined chip rate and containing an indication of chip rate used for a further portion;
means for recovering the indication from the
25 synchronisation portion at the first, predetermined chip rate; and
means for recovering information in the further portion at the chip rate indicated by the indication.

21. The communication unit of claim 20, wherein the means for recovering the indication comprises filter means set at a bandpass appropriate for the first, predetermined chip rate, and the means for recovering
5 information in the further portion comprises filter means set at a bandpass appropriate for the indicated chip rate.

22. The communication unit of claim 21, wherein the
10 filter means set at a bandpass appropriate for the first, predetermined chip rate and the filter means set at a bandpass appropriate for the indicated chip rate comprise common, re-configurable filter means.

15 23. The communication unit of claim 20, 21 or 22, wherein the first, predetermined chip rate is lower than the indicated chip rate.

24. The communication unit of any one of claims 20 to
20 23, wherein the signal comprises a data burst and the synchronisation portion comprises a synchronisation channel signal.

25. The communication unit of any one of claims 20 to
25 24, wherein the system is a wireless communication system.

26. The communication unit of claim 25, wherein the system is a UMTS system.

27. A communication unit for use in a multi-rate communication system, the communication unit comprising:
means for transmitting a signal having a
synchronisation portion at a first, predetermined
5 chip rate and containing an indication of chip
rate used for a further portion,
whereby the indication may be recovered from the
synchronisation portion at the first,
predetermined chip rate; and information in the
10 further portion may be recovered at the chip rate
indicated by the indication.

28. The communication unit of claim 27, wherein the
first, predetermined chip rate is lower than the
15 indicated chip rate.

29. The communication unit of claim 27 or 28, wherein
the signal comprises a data burst and the synchronisation
portion comprises a synchronisation channel signal.

20

30. The communication unit of claim 27, 28 or 29,
wherein the system is a wireless communication system.

31. The communication unit of claim 30, wherein the
25 system is a UMTS system.

32. The communication unit of any one of claims 20 to
31, wherein the communication unit is one of:

a user equipment,

30 Node B.

33. A computer program element comprising computer
program means for performing the method for
synchronisation in a multi-rate communication system
encoding functions as claimed in any one of claims 1 to
5 12.

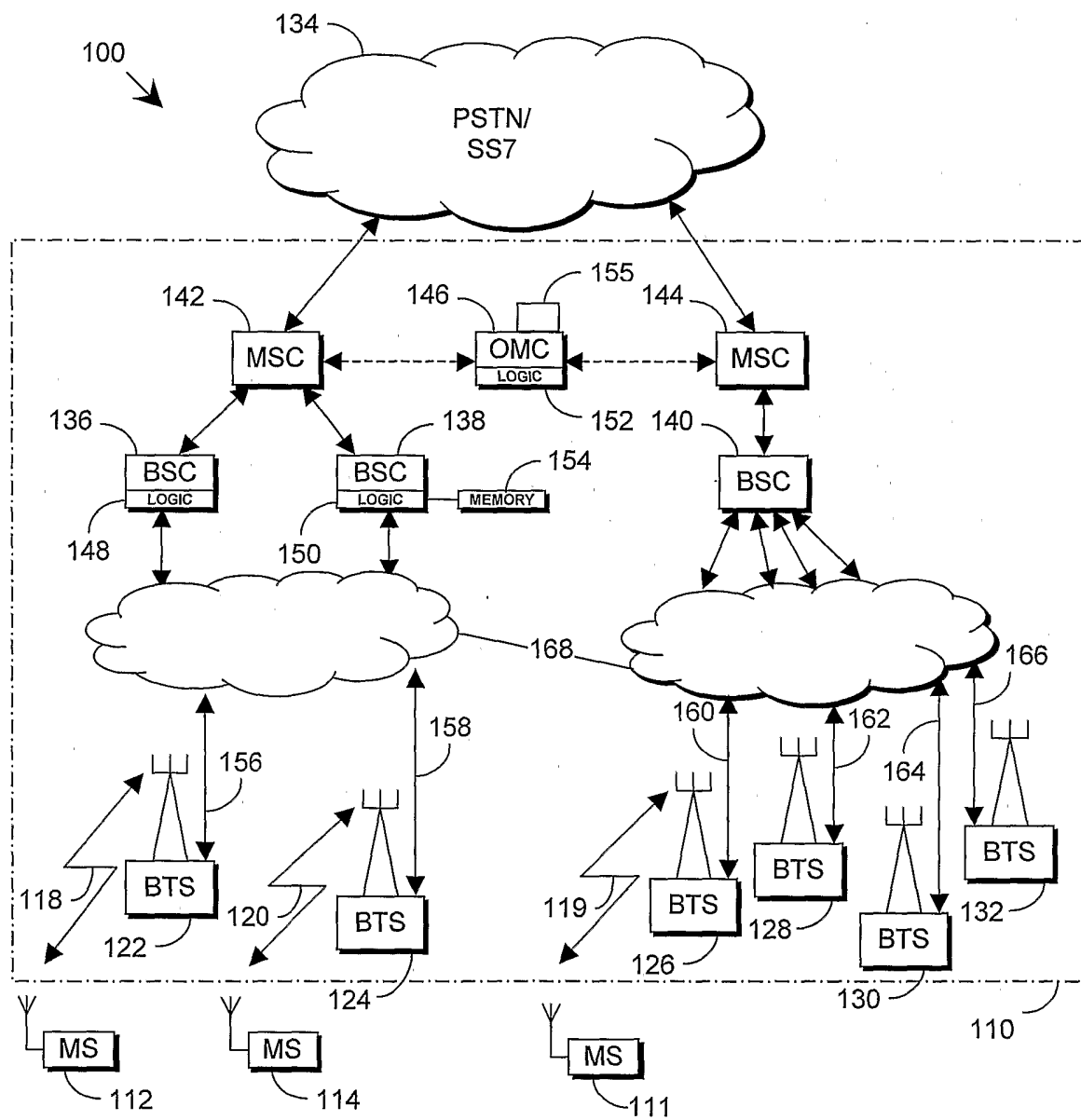


FIG. 1

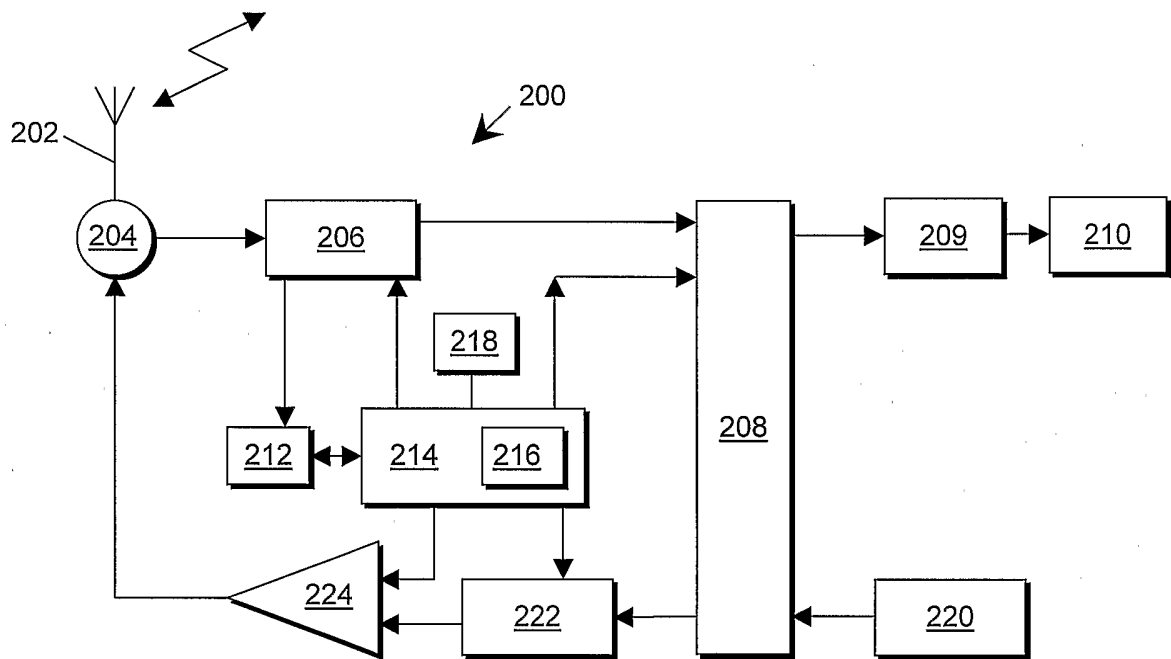


FIG. 2

FIG. 3A

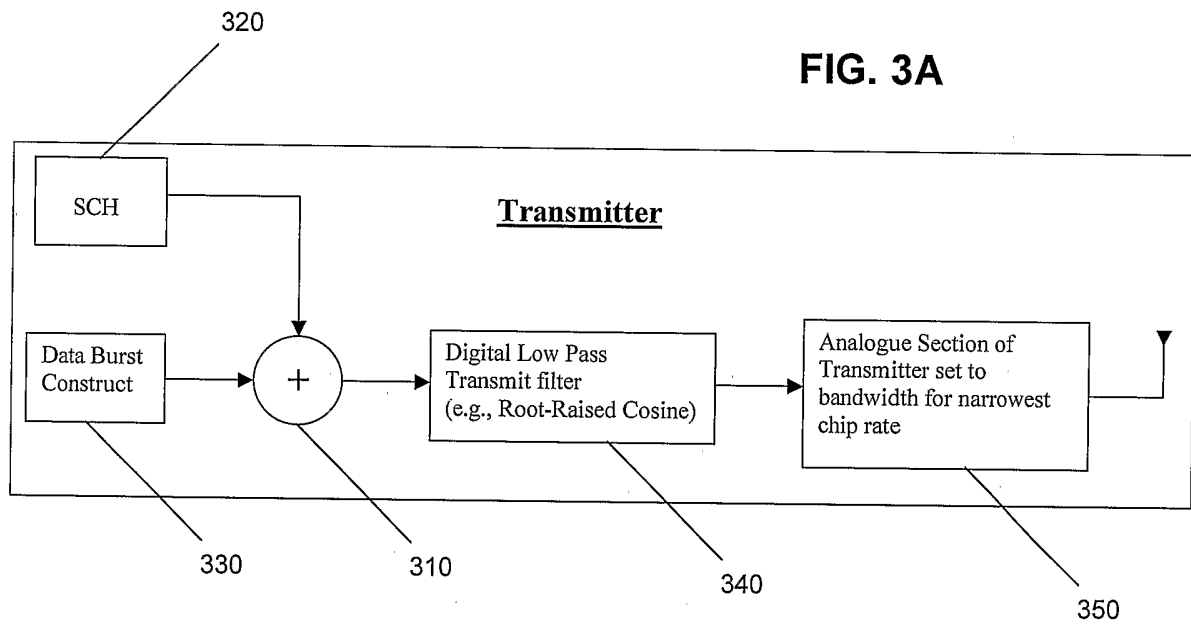


FIG. 3B

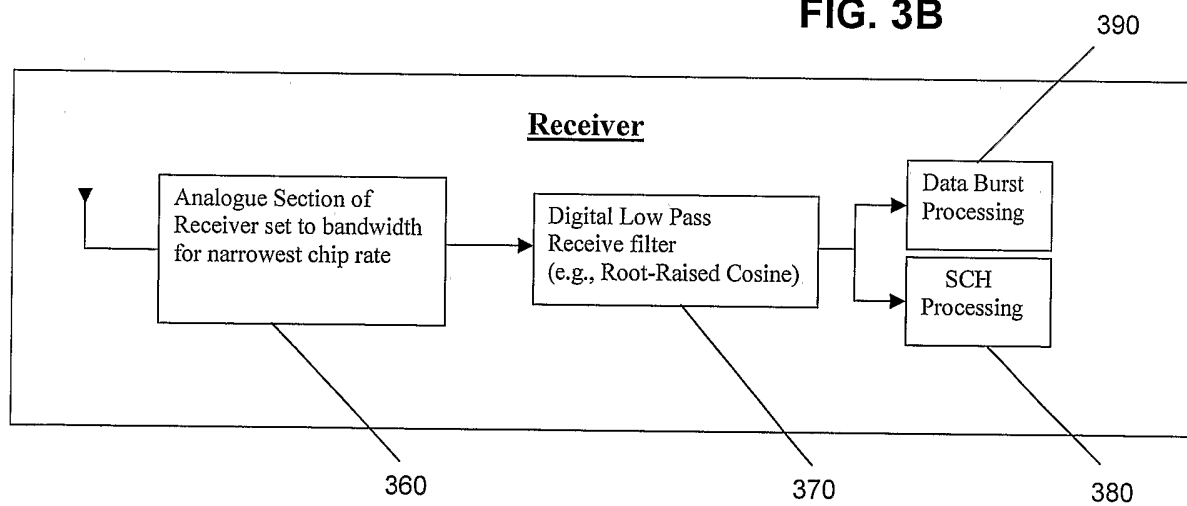


FIG. 4A

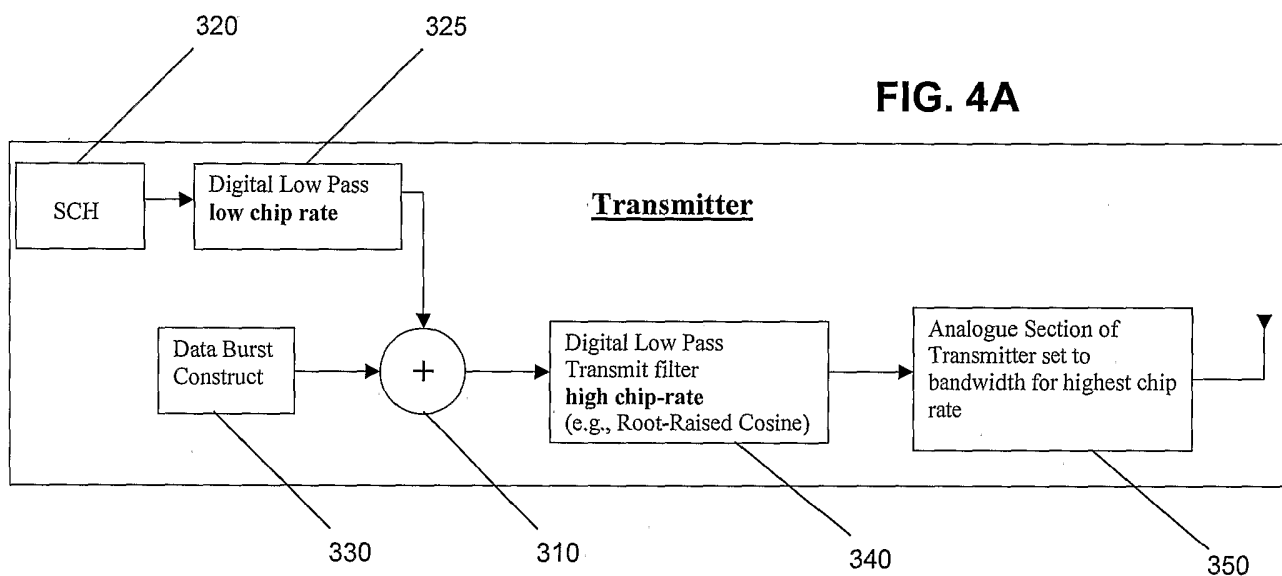


FIG. 4B

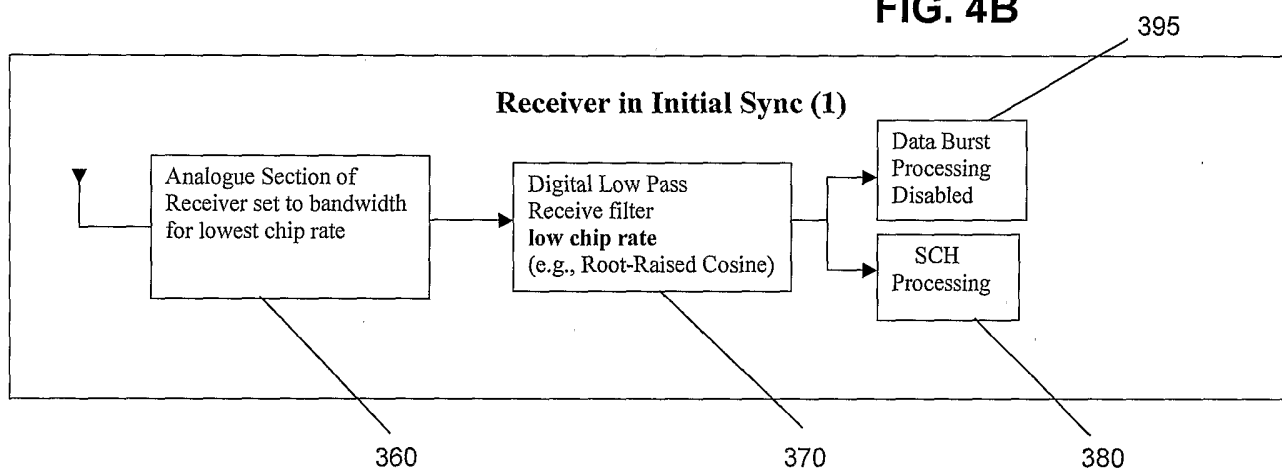
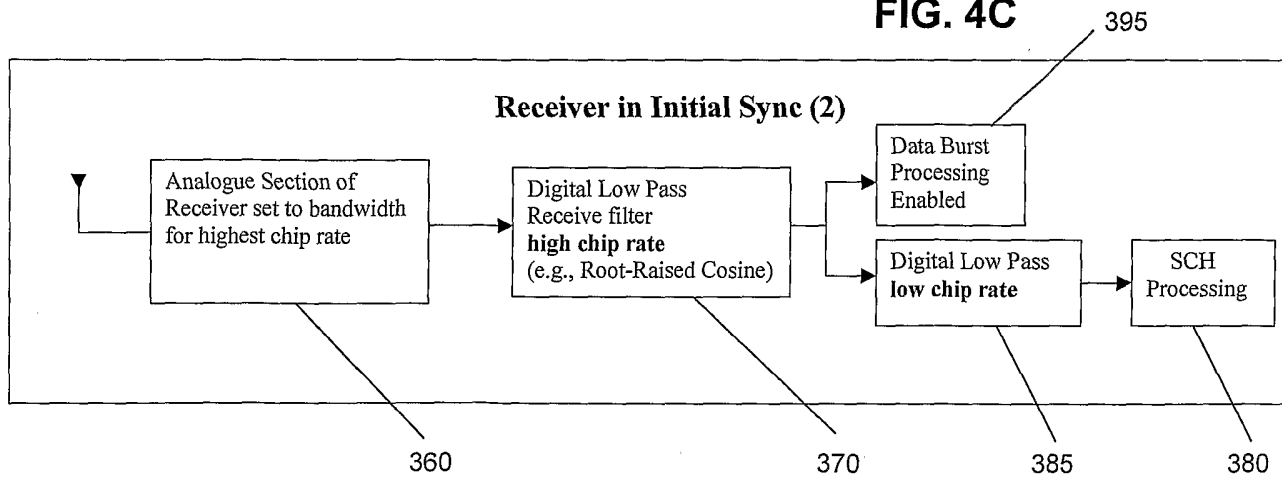


FIG. 4C



INTERNATIONAL SEARCH REPORT

PCT/GB 02/05151

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 H04B7/26 H04J13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 H04J H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, INSPEC

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 950 124 A (GRIM III GEORGE L ET AL) 7 September 1999 (1999-09-07) abstract; figures 3A,3B,3C,8E column 6, line 27 - line 46 column 16, line 36 - line 49 column 19, line 45 - line 65 column 21, line 61 -column 22, line 18 column 33, line 39 -----	1,8,13, 20,27
A	HOLMA H ET AL: "Physical layer of FRAMES Mode 2-wideband CDMA" VEHICULAR TECHNOLOGY CONFERENCE, 1998. VTC 98. 48TH IEEE OTTAWA, ONT., CANADA 18-21 MAY 1998, NEW YORK, NY, USA,IEEE, US, 18 May 1998 (1998-05-18), pages 978-982, XP010287947 ISBN: 0-7803-4320-4 page 979 -page 980 -----	1,8,13, 20,27



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

26 February 2003

Date of mailing of the international search report

05/03/2003

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