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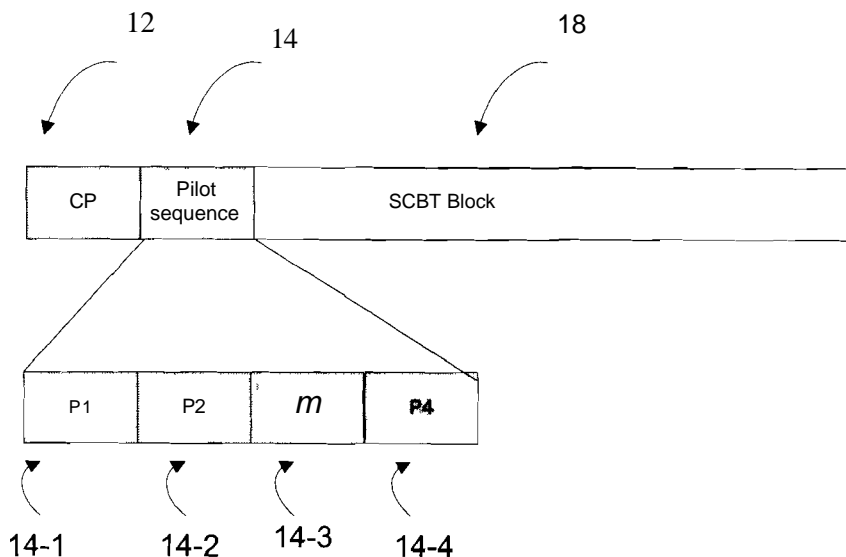
- (81) **Designated States (unless otherwise indicated, for every kind of national protection available):** AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IS, JP, KE, KG, 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, PG, PH, PL, PT, RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, SV, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW
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**Declarations under Rule 4.17:**

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(U))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(Ui))

[Continued on next page]

(54) **Title:** SINGLE CARRIER MODULATION SYSTEM WITH PILOTS AT THE BEGINNING OF EACH DATA BLOCK TO IMPROVE FREQUENCY / PHASE ERROR TRACKING



**FIG. 2B**

(57) **Abstract:** A single carrier modulation scheme suitable for use in high frequency communication systems is provided that achieves improved residual frequency error and phase noise estimation. At a transmitter, cyclically orthogonal constant amplitude pilot signals are inserted at the beginning (or end) of a plurality of SCBT blocks of a block coded data stream. At a receiver, a phase rotation of the received data stream is determined to remove a residual frequency error or to estimate the phase noise.

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# INTERNATIONAL SEARCH REPORT

International application No  
**PCT/IB2008/050134**

<b>A. CLASSIFICATION OF SUBJECT MATTER</b> <b>INV. H04L27/26</b>				
According to International Patent Classification (IPC) or to both national classification and IPC				
<b>B. RELEASABLE DOCUMENTS SEARCHED</b>				
Minimum documentation searched (classification system followed by classification symbols) <b>H04L</b>				
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) <b>EPO-Internal</b>				
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>				
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.		
<b>X</b>	WITSCHNIG H ET AL: "A different look on cyclic prefix for SC/FDE" PERSONAL, INDOOR AND MOBILE RADIO COMMUNICATIONS, 2002. THE 13TH IEEE INTERNATIONAL SYMPOSIUM ON SEPT. 15-18, 2002, PISCATAWAY, NJ, USA, IEEE, vol. 2, 15 September 2002 (2002-09-15), pages 824-828, XP010614340 ISBN: 978-0-7803-7589-5 abstract the whole document paragraph [OIVB] <p style="text-align: center;">----- -/--</p>	1-5, 7-17, 19-23		
<table style="width: 100%; border: none;"> <tr> <td style="width: 50%; border: none;"> <input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.                 </td> <td style="width: 50%; border: none;"> <input type="checkbox"/> See patent family annex.                 </td> </tr> </table>			<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.	<input type="checkbox"/> See patent family annex.
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C.	<input type="checkbox"/> See patent family annex.			
* Special categories of cited documents :				
1A" document defining the general state of the art which is not considered to be of particular relevance 'E' earlier document but published on or after the international filing date 1L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) O' document referring to an oral disclosure, use, exhibition or other means 'P' document published prior to the international filing date but later than the priority date claimed	1T* later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention 'X' document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone 1Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. '&' document member of the same patent family			
Date of the actual completion of the international search  <p style="text-align: center;"><b>1 July 2008</b></p>	Date of mailing of the international search report  <p style="text-align: center;">19/09/2008</p>			
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax- (+31-70) 340-3016	Authorized officer  <p style="text-align: center;"><b>Douglas, Ian</b></p>			

**INTERNATIONAL SEARCH REPORT**

International application No  
**PCT/IB2008/050134**

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	<p>HUEMER M ET AL: "Unique word based phase tracking algorithms for SC/FDE-systems" GLOBECOM'03. 2003 - IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE. CONFERENCE PROCEEDINGS. SAN FRANCISCO, CA, DEC. 1 - 5, 2003; [IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE], NEW YORK, NY : IEEE, US, vol. 1, 1 December 2003 (2003-12-01), pages 70-74, XP010677848 ISBN: 978-0-7803-7974-9 abstract paragraph [0001] - paragraph [00II] paragraph [00IV]</p> <p align="center">-----</p>	<p>1-5, 7-17, 19-23</p>
X	<p>LUC DENEIRE ET AL: "Training Sequence versus Cyclic Prefix-A New Look on Single Carrier Communication" IEEE COMMUNICATIONS LETTERS, IEEE SERVICE CENTER, PISCATAWAY, NJ, US, vol. 5, no. 7, 1 July 2001 (2001-07-01), XP011010376 ISSN: 1089-7798 abstract paragraph [0001] - paragraph [0III]</p> <p align="center">-----</p>	<p>1-5, 7-17, 19-23</p>
X	<p>CZYLWIK A ED - INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS: "LOW OVERHEAD PILOT-AIDED SYNCHRONIZATION FOR SINGLE CARRIER MODULATION WITH FREQUENCY DOMAIN EQUALIZATION" IEEE GLOBECOM 1998. GLOBECOM '98. THE BRIDGE TO GLOBAL INTEGRATION. SYDNEY, NOV. 8 - 12, 1998; [IEEE GLOBAL TELECOMMUNICATIONS CONFERENCE], NEW YORK, NY : IEEE, US, 8 November 1998 (1998-11-08), pages 2068-2073, XP000894410 ISBN: 978-0-7803-4985-8 abstract paragraph [0001] - paragraph [00IV]</p> <p align="center">-----</p>	<p>1-5, 7-17, 19-23</p>
A	<p>HYUNG G MYUNG ET AL: "Single carrier FDMA for uplink wireless transmission" IEEE VEHICULAR TECHNOLOGY MAGAZINE, IEEE, US, vol. 1, no. 3, 1 September 2006 (2006-09-01), pages 30-38, XP011165321 ISSN: 1556-6072 the whole document</p> <p align="center">-----</p>	<p>1-5, 7-17, 19-23</p>

# INTERNATIONAL SEARCH REPORT

International application No.  
PCT/IB2008/050134

## Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1.  Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
  
2.  Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
  
3.  Claims NOS.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

## Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

see additional sheet

1.  As all required additional search fees were timely paid by the applicant, this international search report covers allsearchable claims.
  
2.  As all searchable claims could be searched without effort justifying an additional fees, this Authority did not invite payment of additional fees.
  
3.  As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
  
4.  No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:  
1-5,7-17, 19-23

### Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM POT/ISA/ 210

This International Searching Authority found multiple (groups of) inventions in this international application, as follows:

1. claims: 1-5,7-17,19-23

Inserting a pilot sequence into at least two or more blocks of the partitioned data stream

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2. claims: 6,18

Adapt the length of the cyclic prefix to the delay spread of the channel .

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