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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(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

Published:

- with international search report
- before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments

(88) Date of publication of the international search report:

14 December 2006

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: SYMBOL TIMING CORRECTIONS IN A MULTI CARRIER SYSTEM BY USING THE CHANNEL ESTIMATION

OFDM Symbols

n-3	n-2	n-1	n	n+1	n+2	n+3
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Channel Observations

y(n-4)	y(n-3)	y(n-2)	y(n-1)	y(n)	y(n+1)	y(n+2)
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Channel Estimates

h(n-5)	h(n-4)	h(n-3)	h(n-2)	h(n-1)	h(n)	h(n+1)
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DMTT Processing on chanEst i
Affecting sampling of symbol k

$i=n-5, k=n-2$	$i=n-4, k=n-1$	$i=n-3, k=n$	$i=n-2, k=n+1$	$i=n-1, k=n+2$	$i=n, k=n+3$	$i=n+1, k=n+4$
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Sampling Correction

1. 2.

1. Cyclic shift on $h(n)$ before demodulating symbol n
2. Apply correction on $y(n-1)$ and $y(n)$ before calculating $h(n)$

(57) Abstract: Systems and methods are provided for determining and applying timing corrections in a multi-carrier system. The symbol alignment is first carried out to generate channel estimates. The channel estimates, thus generated, along with the timing alignment information are in turn used for determining timing corrections to be applied to future symbols.

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INTERNATIONAL SEARCH REPORT

International application No

PCT/US2006/008490

A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L25/02 H04L27/26

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)

H04L

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	LARSSON E G ET AL: "An algorithm for joint symbol timing and channel estimation for OFDM systems" STATISTICAL SIGNAL PROCESSING, 2001. PROCEEDINGS OF THE 11TH IEEE SIGNAL PROCESSING WORKSHOP ON 6-8 AUGUST 2001, PISCATAWAY, NJ, USA, IEEE, 6 August 2001 (2001-08-06), pages 393-396, XP010561159 ISBN: 0-7803-7011-2 paragraph [0003]	1,3,4, 7-9, 11-23
A	-----	2
X	WO 01/59980 A (COMSAT CORPORATION; THOMAS, JAMES, RUSSELL) 16 August 2001 (2001-08-16) figures 1,5 -----	27-30

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

* Special categories of cited documents :

"A" 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

"L" 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

"T" 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

"Y" 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

30 June 2006

Date of mailing of the international search report

02.11.2006

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

PCT/US2006/008490

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date

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member(s)

Publication
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WO 0159980

A

16-08-2001

NONE

INTERNATIONAL SEARCH REPORT

International application No.
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Box 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 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 all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
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.:
1-4, 7-9, 11-23, 27-30

Remark on Protest

- ☐ The additional search fees were accompanied by the applicant's protest.
- ☐ No protest accompanied the payment of additional search fees.

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

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

1. claims: 1-4,7-9,11-23, 27-30

Generation of timing corrections

2. claims: 5,6

Channel estimate dimensioning

3. claim: 10

improving timing corrections

4. claims: 24, 26

Synchronization of receiving steps in a receiver

5. claim: 25

Improving channel estimation
