

(43) International Publication Date  
26 May 2006 (26.05.2006)

PCT

(10) International Publication Number  
**WO 2006/055797 A3**(51) International Patent Classification:  
**H04L 25/03** (2006.01)(21) International Application Number:  
PCT/US2005/041856(22) International Filing Date:  
17 November 2005 (17.11.2005)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
60/629,656 19 November 2004 (19.11.2004) US  
11/122,654 4 May 2005 (04.05.2005) US(71) Applicant (for all designated States except US): **QUALCOMM INCORPORATED** [US/US]; 5775 Morehouse Drive, San Diego, California 92121 (US).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **CHALLA, Raghu** [IN/US]; 11928 Tivoli Park Row, #2, San Diego, California 92128 (US). **RICK, Roland, Reinhard** [US/US]; 11456 Northwick Way, San Diego, California 92131 (US).(74) Agents: **WADSWORTH, Philip R.** et al.; 5775 Morehouse Drive, San Diego, California 92121 (US).

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

(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IS, IT, LT, LU, LV, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

## Declarations under Rule 4.17:

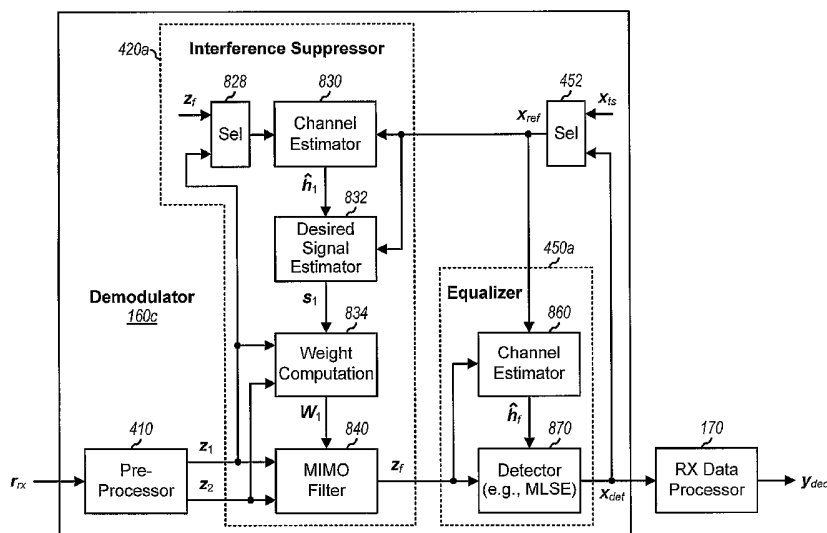
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))

## Published:

- with international search report

[Continued on next page]

(54) Title: INTERFERENCE SUPPRESSION WITH VIRTUAL ANTENNAS



(57) Abstract: A receiver suppresses co-channel interference (CCI) from other transmitters and intersymbol interference (ISI) due to channel distortion using "virtual" antennas. The virtual antennas may be formed by (1) oversampling a received signal for each actual antenna at the receiver and/or (1) decomposing a sequence of complex-valued samples into a sequence of inphase samples and a sequence of quadrature samples. In one design, the receiver includes a pre-processor, an interference suppressor, and an equalizer. The pre-processor processes received samples for at least one actual antenna and generates at least two sequences of input samples for each actual antenna. The interference suppressor suppresses co-channel interference in the input sample sequences and provides at least one sequence of CCI-suppressed samples. The equalizer performs detection on the CCI-suppressed sample sequence(s) and provides detected bits. The interference suppressor and equalizer may be operated for one or multiple iterations.



— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

*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.*

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

19 October 2006

# INTERNATIONAL SEARCH REPORT

international application No  
PCT/US2005/041856

## A. CLASSIFICATION OF SUBJECT MATTER

INV. H04L25/03

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, IBM-TDB, INSPEC, COMPENDEX

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6 177 951 B1 (GHOSH MONISHA) 23 January 2001 (2001-01-23) column 4, line 36 - line 40 -----	1,4,27, 37
X	US 5 453 797 A (NICOLAS ET AL) 26 September 1995 (1995-09-26) column 8, line 47 - line 51 -----	1,4,27, 37
X	US 6 314 147 B1 (LIANG JEN-WEI ET AL) 6 November 2001 (2001-11-06) column 3, line 37 - column 4, line 5 Y column 17, line 10 - line 16 -----	1,3,4, 27,37 2,26
	-/--	

☒ 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

22 March 2006

Date of mailing of the international search report

25. 08. 2006

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

Agudo Cortada, E

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2005/041856

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WARNER E S ET AL: "Single-channel blind signal separation of filtered MPSK signals" IEE PROCEEDINGS: RADAR, SONAR & NAVIGATION, INSTITUTION OF ELECTRICAL ENGINEERS, GB, vol. 150, no. 6, 1 December 2003 (2003-12-01), pages 396-402, XP006024347 ISSN: 1350-2395	2,26
A	page 396, right-hand column, paragraph 2  page 397, right-hand column, paragraph 2 -----	1,3,4, 27,37
A	WONG H E ET AL: "Two-stage interference immune blind equaliser which exploits cyclostationary statistics" ELECTRONICS LETTERS, IEE STEVENAGE, GB, vol. 32, no. 19, 12 September 1996 (1996-09-12), pages 1763-1764, XP006005686 ISSN: 0013-5194 abstract page 1763, right-hand column, paragraph 2 -----	1-4,26, 27,37

# INTERNATIONAL SEARCH REPORT

international application No.  
PCT/US2005/041856

## 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, 26-27, 37

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, 26-27, 37

use of oversampling or to separation of in-phase and quadrature of the input signal in order to refine the resolution of the calculations in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

---

2. claims: 5, 28, 38

filtering and rotation of the input signal in order to transform a GMSK signal to a BPSK signal in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

---

3. claims: 6-12, 29-30, 39-40

MIMO filtering for co-channel interference rejection in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

---

4. claims: 13-16, 31-32, 41-42

equalization employing a channel estimate based on the CCI suppressed samples in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

---

5. claims: 17, 21-22, 34, 44

selection and processing of bits in order to obtain reference bits for the interference suppressor and the equalizer in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

---

6. claims: 18-20, 25, 33, 43

iterative operation of the interference suppressor and the equalizer in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

---

7. claims: 23-24, 35-36, 45-46

reencoding of the received bits, which are fed to the equalizer in order for the equalizer to operate in a feedback structure in a serial concatenation of a co-channel interference rejection stage and an equalizer stage

## Information on patent family members

International application No

PCT/US2005/041856

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6177951	B1	23-01-2001	DE 69730418 D1 30-09-2004
			DE 69730418 T2 08-09-2005
			EP 0891667 A2 20-01-1999
			WO 9827719 A2 25-06-1998
			JP 2000507067 T 06-06-2000
US 5453797	A	26-09-1995	NONE
US 6314147	B1	06-11-2001	NONE