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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 October 2002 (17.10.2002)

PCT

(10) International Publication Number
WO 02/082689 A3

(51) International Patent Classification[7]: H04B 7/06, 7/08

(21) International Application Number: PCT/US02/10599

(22) International Filing Date: 5 April 2002 (05.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/281,985 7 April 2001 (07.04.2001) US
10/113,699 1 April 2002 (01.04.2002) US

(71) Applicant: MOTOROLA, INC. [US/US]; 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

(72) Inventors: PAUTLER, Joseph, J.; 6111 North Beach Street #1118, Fort Worth, TX 76137 (US). ROHANI, Kamyar; 535 Arcadia Drive, Keller, TX 76248 (US). HARRISON, Robert, M.; 1714 Parkwood Drive, Grapevine, TX 76051 (US).

(74) Agents: JACOBS, Jeffrey, K. et al.; Motorola, Inc., Intellectual Property Dept., 1303 East Algonquin Road, Schaumburg, IL 60196 (US).

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

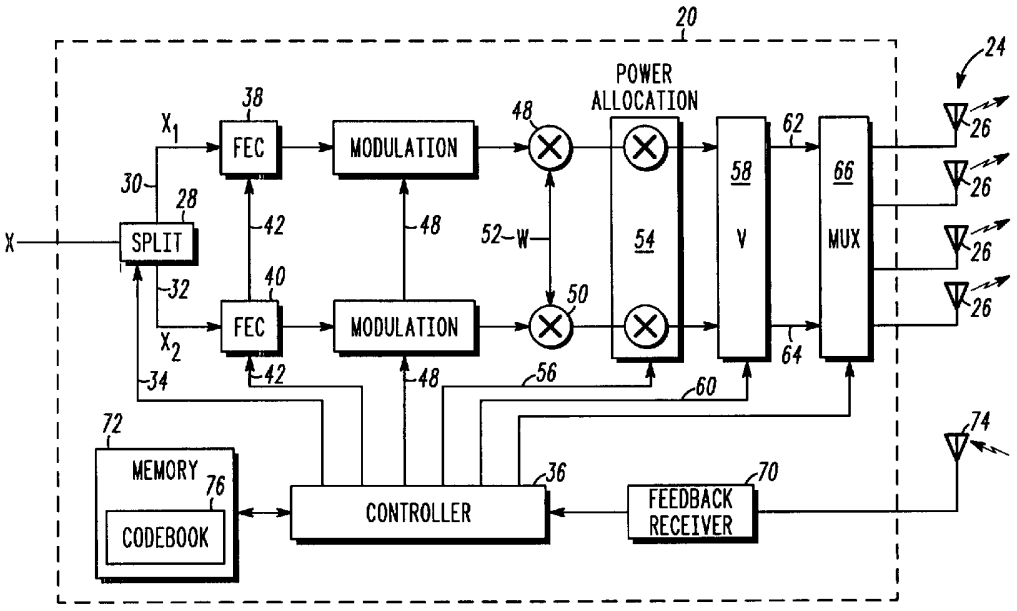
(84) Designated States (regional): ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

(88) Date of publication of the international search report:
30 October 2003

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: FEEDBACK METHOD FOR CONTROLLING A MULTIPLE-INPUT, MULTIPLE-OUTPUT COMMUNICATIONS CHANNEL



(57) Abstract: The present invention makes it possible to increase a data rate between a transmitter and receiver using a multiple-input, multiple-output radio frequency channel. A multiple-stream, multiple-antenna receiver measures a composite channel between a multiple-antenna transmitter and a multiple-antenna receiver to produce a composite channel measurement. The receiver selects a plurality of antenna array weight sets for use in the multiple-antenna transmitter in response to the composite channel measurement, where each antenna array weight set is associated with one of multiple data streams. Information describing the plurality of antenna array weight sets for use in the multiple-antenna transmitter are then transmitted.

WO 02/082689 A3

INTERNATIONAL SEARCH REPORT

International Application No
I US 02/10599

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/06 H04B7/08

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 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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 073 212 A (TEXAS INSTRUMENTS INC) 31 January 2001 (2001-01-31) abstract page 3, line 28 -page 4, line 17 page 6, line 26 -page 7, line 38 page 13, line 21,22 figures 1,4 ---	1,2,7,8
X	WO 00 36764 A (NOKIA NETWORKS OY ;WICHMAN RISTO (FI); HOTTINEN ARI (FI)) 22 June 2000 (2000-06-22) abstract figures 2A,3A,3B -----	1,2,7,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in 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	Date of mailing of the international search report
3 July 2002	05. 04. 03

Name and mailing address of the ISA	Authorized officer
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	Helms, J

2

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
S 02/10599

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 H04B7/06 H04B7/08

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 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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 073 212 A (TEXAS INSTRUMENTS INC) 31 January 2001 (2001-01-31) abstract page 3, line 28 -page 4, line 17 page 6, line 26 -page 7, line 38 page 13, line 21,22 figures 1,4 ---	1,2,7,8
X	WO 00 36764 A (NOKIA NETWORKS OY ;WICHMAN RISTO (FI); HOTTINEN ARI (FI)) 22 June 2000 (2000-06-22) abstract figures 2A,3A,3B -----	1,2,7,8

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in 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	Date of mailing of the international search report
3 July 2002	15. 04. 03

Name and mailing address of the ISA	Authorized officer
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	Helms, J

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

ational application No.
PCT/US 02/10599

Box I Observations where certain claims were found unsearchable (Continuation of item 1 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 II Observations where unity of invention is lacking (Continuation of item 2 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.:

1,2,7,8

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: 1,2,7,8

Independent claim 1 relates to a feedback method in a multiple-antenna receiver comprising the steps of measuring a composite channel between a multiple-antenna transmitter and the multiple-antenna receiver, selecting a plurality of antenna array weight sets for the transmitter based on the channel measurement and transmitting information describing the weight sets.

Claim 2 depending on claim 1 states that a plurality of antenna array weight sets having a cross correlation less than the inverse of a number of transmit antenna elements is selected.

1.1. Claims: 7, 8

The features of independent claim 7 (method in transmitter) correspond to the features of independent claim 1 (method in a receiver). Additionally, claim 7 mentions the transmission of a pilot signal from each antenna of an antenna array.

Claim 8 depending on claim 7 states that each data stream is encoded, modulated and weighted to produce antenna signals.

2. Claims: 3, 9, 10

Claim 3 depending on claim 1 states that a data rate for each stream is selected in response to the channel measurement and that information describing the data rate selection is transmitted.
Claim 9 depending on claim 7 comprises the corresponding steps in the transmitter.

3. Claim : 4

Claim 4 depending on claim 1 states that information used to describe a quality of each data stream is transmitted.

4. Claim : 5

Claim 5 depending on claim 1 states that a first antenna array weight set is selected from a codebook and a second a second weight set from a subset of a codebook.

5. Claim : 6

FURTHER INFORMATION CONTINUED FROM PCT/ISA/ 210

Claim 6 depending on claim 1 states that N antennas to be used at the transmitter are selected from M available antennas in response to the channel measurement.

Please note that all inventions mentioned under item 1, although not necessarily linked by a common inventive concept, could be searched without effort justifying an additional fee.

INTERNATIONAL SEARCH REPORT

formation on patent family members

International Application No
JS 02/10599

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 1073212 A	31-01-2001	EP 1073212 A2	31-01-2001
		JP 2001044900 A	16-02-2001
WO 0036764 A	22-06-2000	FI 982715 A	16-06-2000
		AU 1984700 A	03-07-2000
		BR 9916239 A	04-09-2001
		CN 1330816 T	09-01-2002
		EP 1131903 A2	12-09-2001
		WO 0036764 A2	22-06-2000
		JP 2002533010 T	02-10-2002
		US 2002012380 A1	31-01-2002