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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/491,332	06/25/2009	Thomas P. McElwain	C108D3/US

CONFIRMATION NO. 5178

POA ACCEPTANCE LETTER

114420
Collision Communications, Inc.
5400 Trinity Road
Suite 303
Raleigh, NC 27607

OC000000062160423

Date Mailed: 06/28/2013

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/14/2013.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/ttkim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

UNITED STATES PATENT AND TRADEMARK OFFICE

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/491,332	06/25/2009	Thomas P. McElwain	234/8/4 (DIV 3)

CONFIRMATION NO. 5178

POWER OF ATTORNEY NOTICE

79683
OLIVE LAW GROUP, PLLC
125 EDINBURGH SOUTH DRIVE, SUITE 100
CARY, NC 27511

OC000000062160414

Date Mailed: 06/28/2013

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/14/2013.

- The Power of Attorney to you in this application has been revoked by the assignee who has intervened as provided by 37 CFR 3.71. Future correspondence will be mailed to the new address of record(37 CFR 1.33).

/ttkim/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

I hereby revoke all previous powers of attorney given in the application identified in the attached statement under 37 CFR 3.73(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 114420

OR

☐ Practitioner(s) named below (if more than ten patent practitioners are to be named, then a customer number must be used):

Name	Registration Number	Name	Registration Number

as attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment documents attached to this form in accordance with 37 CFR 3.73(b).

Please change the correspondence address for the application identified in the attached statement under 37 CFR 3.73(b) to:

☑ The address associated with Customer Number: 114420

OR

☐ Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address:

Collision Communications, Inc.
20 Depot Street, Suite 2A
Peterborough, NH 03458

A copy of this form, together with a statement under 37 CFR 3.73(b) (Form PTO/SB/96 or equivalent) is required to be filed in each application in which this form is used. The statement under 37 CFR 3.73(b) may be completed by one of the practitioners appointed in this form if the appointed practitioner is authorized to act on behalf of the assignee, and must identify the application in which this Power of Attorney is to be filed.

SIGNATURE of Assignee of Record

The individual whose signature and title is supplied below is authorized to act on behalf of the assignee

Signature		Date	4/10/2013
Name	Jared Fry	Telephone	(857) 222-0690
Title	Co-Chairman, Collision Communications, Inc.		

This collection of information is required by 37 CFR 1.31, 1.32 and 1.33. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 3 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

Electronic Acknowledgement Receipt

EFS ID:	16040815
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	79683
Filer:	Theodosios Thomas/Jeanine Young
Filer Authorized By:	Theodosios Thomas
Attorney Docket Number:	234/8/4 (DIV 3)
Receipt Date:	14-JUN-2013
Filing Date:	25-JUN-2009
Time Stamp:	11:40:28
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		C108D3_373_Statement.pdf	413550 9478f49ca2ecce3f3dfb8279ba783463a2aac9d4	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Assignee showing of ownership per 37 CFR 3.73.	1	2
	Power of Attorney	3	3
Warnings:			
Information:			
	Total Files Size (in bytes):	413550	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:	Customer No.: 114420
Inventor: Thomas P. Mcelwain	Confirmation Number: 5178
Application Number: 12/491,332	Group Art Unit: 2611
Filed: 6/25/2009	Examiner: Temesghen Ghebretinsae

For: Joint Symbol, Amplitude, And Rate Estimator

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

STATEMENT UNDER 37 CFR 3.73(b)

IN ACCORDANCE WITH 37 CFR 3.71(a), PROSECUTION OF THE PRESENT APPLICATION SHALL BE CONDUCTED BY THE ASSIGNEE, TO THE EXCLUSION OF THE INVENTOR(S).

Applicant, **Collision Communications, Inc.**, a Limited Liability Company, states that it is:

1. ☑ the assignee of the entire right, title, and interest; or
2. ☐ an assignee of less than the entire right, title, and interest
   (The extent (by percentage) of its ownership interest is _____%)

in the patent application identified above by virtue of an assignment from the inventor(s) to the current assignee as follows:

1. From: **Inventor(s)** To: **BAE Systems Information And Electronic Systems Integration Inc.**
   The document was recorded in the United States Patent and Trademark Office at Reel / Frame: **022879 / 0419**, or for which a copy thereof is attached.
2. From: **BAE Systems Information And Electronic Systems Integration Inc.** To: **Collision Technology LLC**
   The document was recorded in the United States Patent and Trademark Office at Reel / Frame: **026190 / 0812**, or for which a copy thereof is attached.

Additional documents in the chain of title are listed on a supplemental sheet.
As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

[NOTE: A separate copy (i.e., a true copy of the original assignment document(s)) must be submitted to the Assignment Division in accordance with 37 CFR Part 3, to record the assignment in the records of the USPTO. See MPEP 302.08]

The undersigned (whose title is supplied below) is authorized to act on behalf of the assignee.

Signature: _____ Date: 06/06/13
Theodosios Thomas
Reg. No. 45159, Patent Counsel, Phone No. 919-233-1942 x-203

STATEMENT UNDER 37 CFR 3.73(c)

(Supplemental Sheet)

3. From: **Collision Technology LLC** To: **Collision Communications, Inc.**

The document was recorded in the United States Patent and Trademark Office at Reel / Frame: **028490 / 0285**, or for which a copy thereof is attached.

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3

CONFIRMATION NO. 5178

79683
OLIVE LAW GROUP, PLLC
125 EDINBURGH SOUTH DRIVE, SUITE 100
CARY, NC 27511

POA ACCEPTANCE LETTER

OC000000049432258

Date Mailed: 08/24/2011

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/15/2011.

The Power of Attorney in this application is accepted. Correspondence in this application will be mailed to the above address as provided by 37 CFR 1.33.

/gbien-aime/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

POWER OF ATTORNEY FOR PATENT APPLICATIONS

Under CFR § 3.73(b), Collision Technology, LLC, a corporation, hereby certifies that it is the Assignee of the entire right, title, and interest in and to the patent applications listed below. Each of the patent applications listed below is assigned to Collision Technology, LLC. As required by 37 CFR 3.73(b)(1)(i), the documentary evidence of the chain of title from the original owner to the Assignee was submitted for recordation pursuant to 37 CFR 3.11 as shown in the Reel/Frame numbers listed below.

Filing Date	**Application Serial No.; Patent No. (if issued)**	**Title**	**Reel/Frame**
10/03/2003	10/678,203; 6,831,574	MULTI-TURBO MULTI-USER DETECTOR	014073/0269 026190/0812
04/05/2004	10/818,536; 6,967,598	REDUCED COMPLEXITY MULTI-TURBO MULTI-USER DETECTOR	014525/0140 026190/0812
03/24/2005	10/529,019; 7,599,346	BANDWIDTH-EFFICIENT WIRELESS NETWORK MODEM	016520/0107 026190/0812 026193/0661
08/27/2009	12/548,502	BANDWIDTH EFFICIENT WIRELESS NETWORK MODEM	026190/0812
02/03/2004	10/486,004; 7,486,722	BANDWIDTH EFFICIENT CABLE NETWORK MODEM	013771/0874 014405/0749 026190/0812 026193/0661
02/11/2004	10/486,871; 7,245,673	WINDOWED MULTIUSER DETECTION	013816/0233 015656/0249 026190/0812 026193/0661
12/21/2004	10/497,556; 7,126,533	DIRECTION-FINDING FOR MULTIPLE COCHANNEL SOURCES	014737/0931 013824/0323 026190/0812 026193/0661
04/19/2005	10/531,772; 7,463,703	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR	015999/0543 026190/0812 026193/0661
10/15/2008	12/251,571; 7,590,203	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR	021690/0566 026190/0812
10/15/2008	12/251,575; 7,583,757	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR	021690/0608 026190/0812
06/25/2009	12/491,332; 7,920,651	JOINT SYMBOL, AMPLITUDE, AND RATE	022879/0419 026190/0812

		ESTIMATOR	
12/23/2003	10/482,599; 7,428,261	CROSS-SYSTEM INTERFERENCE CANCELLATION FOR MULTICARRIER CDMA AND OFDM	013823/0522 014271/0189 026190/0812 026193/0661
12/01/2005	11/291,883; 7,593,473	TREE STRUCTURED MULTICARRIER MULTIPLE ACCESS SYSTEMS	016887/0516 026190/0812
12/01/2005	11/292,233; 7,817,754	M-ALGORITHM WITH PRIORITIZED USER ORDERING	017098/0162 026190/0812
04/10/2006	11/400,922; 7,783,110	SEMICOHERENT CHANNEL ESTIMATOR	017623/0177 026190/0812
08/10/2006	11/463,877; 7,613,228	M-ALGORITHM MULTIUSER DETECTOR WITH CORRELATION BASED PRUNING	018151/0479 026190/0812
09/15/2006	11/532,125; 7,593,492	COMBINATIONAL HYBRID TURBO-MUD	018272/0171 026190/0812
08/12/2009	12/539,691	METHOD FOR SIMULTANEOUS DETECTION OF A PLURALITY OF RFID TAGS USING MULTIUSER DETECTION	023099/0858 026190/0812
05/13/2010	12/742,686	MEDIA ACCESS CONTROL PROTOCOL FOR MULTIUSER DETECTION ENABLED AD-HOC WIRELESS COMMUNICATIONS	025578/0117 024673/0287 026190/0812
07/24/2003	10/626,146; 7,218,690	HYBRID TURBO-MUD FOR MULTIPLE ACCESS SYSTEMS	013859/0734 026190/0812
04/11/2002	10/120,955; 6,947,506	METHOD AND APPARATUS FOR IMPROVED TURBO MULTIUSER DETECTOR	013095/0631 026190/0812
01/23/2002	10/055,155; 6,839,390	VOTING SYSTEM FOR IMPROVING THE PERFORMANCE OF SINGLE-USER	012540/0669 024907/0140 026190/0812

		DECODERS WITHIN AN ITERATIVE MULTI-USER DETECTION SYSTEM	
11/12/2004	10/987,140; 7,350,136	VOTING SYSTEM FOR IMPROVING THE PERFORMANCE OF SINGLE-USER DECODERS WITHIN AN ITERATIVE MULTI-USER DETECTION SYSTEM	026190/0812
07/29/2002	10/208,409; 6,704,376	POWER AND CONFIDENCE ORDERED LOW COMPLEXITY SOFT TURBOMUD WITH VOTING SYSTEM	013020/0053 026190/0812
06/08/2004	10/863,081; 7,092,464	MULTIUSER DETECTION WITH TARGETED ERROR CORRECTION CODING	014778/0014 026190/0812
03/25/2002	10/105,918; 7,110,439	SYSTEM FOR DECREASING PROCESSING TIME IN AN ITERATIVE MULTI-USER DETECTOR SYSTEM	012744/0987 026190/0812
04/25/2003	10/423,695; 7,190,747	FREQUENCY MISMATCH COMPENSATION FOR MULTIUSER DETECTION	013676/0030 026190/0812
04/25/2003	10/423,740; 7,092,452	CO-CHANNEL INTERFERENCE RECEIVER	013674/0904 026190/0812
07/29/2002	10/207,490; 7,190,743	METHOD AND APPARATUS FOR OPTIMIZING TREE PRUNING IN A MULTIUSER DETECTOR	013198/0060 026190/0812
04/16/2003	10/414,738; 7,269,223	SYSTEM AND METHOD FOR INCREASING THROUGHPUT IN A MULTIUSER DETECTION BASED MULTIPLE ACCESS	013633/0069 026190/0812

		COMMUNICATIONS SYSTEM	
02/14/2005	11/057,479; 7,724,851	RECEIVER WITH MULTIPLE COLLECTORS IN A MULTIPLE USER DETECTION SYSTEM	016000/0309 026190/0812
04/29/2002	10/134,330; 6,981,203	METHOD AND APPARATUS FOR RANDOM SHUFFLED TURBO MULTIUSER DETECTOR	012877/0237 013129/0802 026190/0812
04/25/2003	10/423,655; 7,218,665	DEFERRED DECORRELATING DECISION-FEEDBACK DETECTOR FOR SUPERSATURATED COMMUNICATIONS	013633/0393 025710/0043 026190/0812
04/24/2003	10/422,340; 6,954,482	SOFT-DECISION TRELLIS-CODED DIFFERENTIAL FREQUENCY-HOPPED SPREAD SPECTRUM (DFHSS)	013643/0771 026190/0812
04/22/2005	10/482,598; 6,999,498	MULTIUSER DETECTION AIDED MULTIPLE ACCESS DIFFERENTIAL FREQUENCY-HOPPED SPREAD SPECTRUM	013904/0597 014293/0674 026190/0812 026193/0661
04/19/2004	10/827,462; 7,376,171	MULTIUSER DETECTION AIDED MULTIPLE ACCESS DIFFERENTIAL M-ARY CODING APPLICATIONS	014602/0733 026190/0812
09/10/2003	10/659,567; 7,236,546	PIPELINED TURBO MULTIUSER DETECTION	014002/0447 026190/0812
08/07/2001	09/923,709; 7,058,422	METHOD FOR OVERUSING FREQUENCIES TO PERMIT SIMULTANEOUS TRANSMISSION OF SIGNALS FROM TWO OR MORE USERS ON THE	012100/0995 026190/0812

		SAME FREQUENCY AND TIME SLOT	
08/31/2001	09/943,770; 6,947,505	SYSTEM FOR PARAMETER ESTIMATION AND TRACKING OF INTERFERING DIGITALLY MODULATED SIGNALS	012151/0553 026190/0812
04/16/2003	10/414,784; 6,985,699	EFFICIENT AND OPTIMAL CHANNEL ENCODING AND CHANNEL DECODING IN A MULTIPLE ACCESS COMMUNICATIONS SYSTEM	013633/0018 026190/0812
04/18/2002	10/125,241; 7,233,620	BANDWIDTH-EFFICIENT WIRELESS NETWORK MODEM	012670/0320 026190/0812
06/20/2002	10/176,011; 7,200,103	REDUCED ALGORITHM RECEIVER	013191/0058 026190/0812
06/20/2002	10/175,693; 7,139,334	COOPERATIVE CODE-ENHANCED MULTI-USER COMMUNICATIONS SYSTEM	013192/0370 013194/0865 026190/0812
08/26/2002	10/228,787; 6,947,502	PARAMETER ESTIMATOR FOR A MULTIUSER DETECTION RECEIVER	013198/0089 026190/0812
09/20/2002	10/251,187; 6,826,140	MULTICHANNEL DIGITAL RECORDING SYSTEM WITH MULTI-USER DETECTION	013147/0391 026190/0812
06/30/2004	10/497,557; 7,126,890	MULTITRACK READBACK AND MULTIUSER DETECTION FOR DISK DRIVES	014764/0397 014052/0594 026190/0812 026193/0661
08/27/2010	12/869,875	QR-RLS ADAPTIVE DIGITAL FILTER WITH 18-BIT PIPELINE ARCHITECTURE	024974/0911 026190/0812 026193/0661
04/20/2011	13/090,435	DISTRIBUTED SCHEDULER DESIGN FOR MULTIUSER	026155/0754 026190/0812 026193/0661

		DETECTION ENABLED WIRELESS MOBILE AD HOC NETWORKS	
01/31/2011	13/017,819	MULTIUSER DETECTION ENABLED MEDIUM ACCESS CONTROLE IN MOBILE AD HOC NETWORKS	026126/0450 026190/0812 026193/0661
02/23/2011	12/932,318	POWER AWARE SCHEDULING AND POWER CONTROL TECHNIQUES FOR MULTIUSER DETECTION ENABLED WIRELESS AD-HOC NETWORKS	025895/0099 026190/0812 026193/0661

The undersigned, acting as the Assignee, hereby revokes all prior powers of attorney, if applicable, and appoints the practitioners associated with the customer number 79683 as my/our attorney(s) or agent(s) to prosecute the patent(s) and/or patent application(s) and transact all business in the United States Patent and Trademark Office connected therewith.

By: _____ Date: 8/13/2011

Jared Fry

Member, Collision Technology, LLC

Electronic Acknowledgement Receipt

EFS ID:	10732414
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	22500
Filer:	Justin Robert Nifong
Filer Authorized By:	
Attorney Docket Number:	20030076-DIV3
Receipt Date:	15-AUG-2011
Filing Date:	25-JUN-2009
Time Stamp:	08:07:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Power of Attorney	POA_Collision_OliveLawGroup_20110812.pdf	3476082 a15fd5bbebf4103df873fa8db61954b90f35cfba	no	6

Warnings:	
Information:	

Total Files Size (in bytes):	3476082

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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UNITED STATES PATENT AND TRADEMARK OFFICE

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	04/05/2011	7920651	20030076-DIV3	5178

22500 7590 03/16/2011

BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)
(application filed on or after May 29, 2000)

The Patent Term Adjustment is 21 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Data Management (ODM) at (571)-272-4200.

APPLICANT(s) (Please see PAIR WEB site http://pair.uspto.gov for additional applicants):

Thomas P. McElwain, Merrimack, NH;

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3	5178

22500 7590 03/07/2011

BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868

EXAMINER	
GHEBRETINSAE, TEMESGHEN	
ART UNIT	PAPER NUMBER
2611	
MAIL DATE	DELIVERY MODE
03/07/2011	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Response to Rule 312 Communication	Application No.	Applicant(s)
	12/491,332	MCELWAIN, THOMAS P.
	Examiner	**Art Unit**
	Temesghen Ghebretinsae	2611

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address –

1. ☒ The amendment filed on *24 February 2011* under 37 CFR 1.312 has been considered, and has been:

   a) ☒ entered.

   b) ☐ entered as directed to matters of form not affecting the scope of the invention.

   c) ☐ disapproved because the amendment was filed after the payment of the issue fee.
   Any amendment filed after the date the issue fee is paid must be accompanied by a petition under 37 CFR 1.313(c)(1) and the required fee to withdraw the application from issue.

   d) ☐ disapproved. See explanation below.

   e) ☐ entered in part. See explanation below.

/Temesghen Ghebretinsae/
Primary Examiner, Art Unit 2611

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	MCELWAIN, Thomas P.	Group Art Unit: 2611	
Serial No.	12/491,332	Examiner: GHEBRETINSAE, Temesghen	
Filing or 371 (c) Date:	06/25/2009	Atty. Dkt. No: 20030076-DIV3	

For: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

To: Mail Stop AF
Commissioner for Patents
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From: **22500**

OK TO ENTER: /T.G./

/T.G./ 03/01/2011

AMENDMENT AFTER NOTICE OF ALLOWANCE
37 C.F.R. §1.312

In response to the Notice of Allowance mailed on 12/10/2010, the Applicants respectfully request that the following amendment and remarks be entered in accordance with the provisions of 37. C.F.R. § 1.312 and MPEP §714.16.

Transmitted herewith is 4 pages of amendments and remarks.

[X] DEPOSIT ACCOUNT **190130** AUTHORIZATION – The Office is hereby authorized to charge the required fee, and any deficiency or credit any overpayment in the fees to the above deposit account, owned by BAE SYSTEMS Information and Electronic Systems Integration Inc. an authorized signator for which is Kevin M. Perkins, V.P. & Company Counsel, and for whom the undersigned are authorized agents.

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22500 7590 12/10/2010

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3	5178

TITLE OF INVENTION: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1510	$300	$0	$1810	03/10/2011

EXAMINER	ART UNIT	CLASS-SUBCLASS
GHEBRETINSAE, TEMESGHEN	2611	375-320000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).

☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list
(1) the names of up to 3 registered patent attorneys or agents OR, alternatively,
(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed.

1 Vern Maine & Associates
2 Andrew P. Cernota
3 Daniel J. Long

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE: BAE Systems Information and Electronic Systems Integration Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Nashua, NH

Please check the appropriate assignee category or categories (will not be printed on the patent): ☐ Individual ☒ Corporation or other private group entity ☐ Government

4a. The following fee(s) are submitted:

☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
☐ Advance Order - # of Copies _____

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☐ A check is enclosed.
☐ Payment by credit card. Form PTO-2038 is attached.
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 190130 (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

☐ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.
☐ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature Daniel J. Long Date 2/28/2011

Typed or printed name Daniel J. Long Registration No. 29,404

This collection of information is required by 37 CFR 1.311. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, Virginia 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450.

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Electronic Patent Application Fee Transmittal

Application Number:	12491332
Filing Date:	25-Jun-2009
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Filer:	Daniel J. Long/Nancy Young
Attorney Docket Number:	20030076-DIV3

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1510	1510
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1810**

Electronic Acknowledgement Receipt

EFS ID:	9549434
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	22500
Filer:	Daniel J. Long/Nancy Young
Filer Authorized By:	Daniel J. Long
Attorney Docket Number:	20030076-DIV3
Receipt Date:	28-FEB-2011
Filing Date:	25-JUN-2009
Time Stamp:	16:02:35
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1810
RAM confirmation Number	3472
Deposit Account	190130
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Issue Fee Payment (PTO-85B)	20030076DIV3-IssueFee.pdf	429030 dffb16e0c292d7a8c4321d33f0634d01200e3609	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	31963 cb17278dcd37ec4b3a786c72c233694428cdc65d	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	460993	

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National Stage of an International Application under 35 U.S.C. 371
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New International Application Filed with the USPTO as a Receiving Office
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	MCELWAIN, Thomas P.	Group Art Unit: 2611	
Serial No.	12/491,332	Examiner: GHEBRETINSAE, Temesghen	
Filing or 371 (c) Date:	06/25/2009	Atty. Dkt. No: 20030076-DIV3	

For: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

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Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

From: **22500**

AMENDMENT AFTER NOTICE OF ALLOWANCE
37 C.F.R. §1.312

In response to the Notice of Allowance mailed on 12/10/2010, the Applicants respectfully request that the following amendment and remarks be entered in accordance with the provisions of 37. C.F.R. § 1.312 and MPEP §714.16.

Transmitted herewith is 4 pages of amendments and remarks.

[X] DEPOSIT ACCOUNT **190130** AUTHORIZATION – The Office is hereby authorized to charge the required fee, and any deficiency or credit any overpayment in the fees to the above deposit account, owned by BAE SYSTEMS Information and Electronic Systems Integration Inc. an authorized signator for which is Kevin M. Perkins, V.P. & Company Counsel, and for whom the undersigned are authorized agents.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claim 1 (Currently Amended). A joint amplitude estimator for a data stream from multiple users, comprising:

a data stream from said multiple users divided into a plurality of observation intervals;

a plurality of processing modules coupled to said observation intervals, wherein said processing modules calculates interference cancellation values for each of said users and computes a filter for each of said observation intervals, said filter being applied to said data within said observation interval to compute individual amplitude estimates; and

an amplitude estimation unit which processes said individual amplitude estimates and calculates new amplitude estimates, wherein said new amplitude estimates are iteratively passed back to said processing modules either a ~~maxium~~ maximum number of iterations or a desired bit error rate have been reached.

Claim 2 (Original). The joint amplitude estimator according to claim 1, wherein said final condition is selected from at least one of the group consisting of: bit error rate metric level and fixed number of iterations.

Claim 3 (Original). The joint amplitude estimator according to claim 1, wherein said amplitude estimation unit sums and weighs said individual estimates.

Claim 4 (Original). The joint amplitude estimator according to claim 1, wherein said observation intervals are based on distinguishing attributes selected from at least one of the group consisting of: time, code, and frequency.

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Claim 5 (Currently Amended). The joint amplitude estimator according to claim 1, wherein said filter is calculated for an arbitrary observation interval m as:

$$G_m = \mathbf{B}_m \mathbf{S}_m^H \left(\mathbf{S}_m \chi_m \mathbf{S}_m^H + \sigma_n^2 I \right)^{-1}$$

wherein G_m is a MMSE filter, B_m is a diagonal matrix representing the expected bit or symbol value, S_m is an S matrix defined over a single observation interval, I is an ~~iteration~~ identity matrix and m is an arbitrary observation interval.

Claim 6 (Currently Amended). A method for processing amplitude estimates for a multiuser data stream divided into a plurality of observation intervals, comprising:

computing a filter for each said observation interval of said data stream;

applying interference cancellation to said data stream for each said observation interval;

applying said filter to said data stream for each said observation interval from said interference cancellation to produce individual amplitude estimates for each said observation interval;

computing new amplitude estimates using said individual amplitude estimates; and

passing said new amplitude estimates back to said filter for iterative processing until either a ~~maxium~~ maximum number of iterations or a desired bit error rate have been reached.

Claim 7 (Original). The method according to claim 6, wherein said computing further comprises summing said individual amplitude estimates and weighing.

Claim 8 (Original). The method according to claim 6, wherein said final condition is selected from at least from the group consisting of: bit error rate metric level and fixed number of iterations.

REMARKS

Claims 1-8 were examined and allowed on December 10, 2010.

The Applicants submit that these amendments merely embody the correction of formal matters, and do not change the scope of the claimed invention. As such, the Applicants respectfully request that this amendment after notice of allowance be entered in accordance with 37 C.F.R. §1.312 and MPEP § 714.16.

Favorable action is solicited. The Examiner is invited to contact the Applicants' attorney by telephone, facsimile, or email for quickest resolution, if there are any remaining issues.

Respectfully submitted,

/Andrew P. Cernota, Reg. No. 52,711/

Vernon C. Maine, Reg. No. 37,389
Andrew P. Cernota, Reg. No. 52,711
David A. Rardin, Reg. No. 52,153
Michael J. Albaneze, Reg. No. 66,977
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Tel. No. (603) 886-6100, Fax. No. (603) 886-4796
patents@vernmaine.com

Electronic Acknowledgement Receipt

EFS ID:	9524505
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	22500
Filer:	Andrew Paul Cernota/Jacqueline Judkins
Filer Authorized By:	Andrew Paul Cernota
Attorney Docket Number:	20030076-DIV3
Receipt Date:	24-FEB-2011
Filing Date:	25-JUN-2009
Time Stamp:	15:07:52
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20030076-DIV3_312Amendment_Final.pdf	101117 f91ef062484c40f1b12e7d03d96fd96541b28574	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment after Notice of Allowance (Rule 312)	1	1
	Claims	2	3
	Applicant Arguments/Remarks Made in an Amendment	4	4
Warnings:			
Information:			
	Total Files Size (in bytes):	101117	

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New Applications Under 35 U.S.C. 111
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EXAMINER	
GHEBRETINSAE, TEMESGHEN	
ART UNIT	PAPER NUMBER
2611	

DATE MAILED: 12/10/2010

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3	5178

TITLE OF INVENTION: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1510	$300	$0	$1810	03/10/2011

THE APPLICATION IDENTIFIED ABOVE HAS BEEN EXAMINED AND IS ALLOWED FOR ISSUANCE AS A PATENT. PROSECUTION ON THE MERITS IS CLOSED. THIS NOTICE OF ALLOWANCE IS NOT A GRANT OF PATENT RIGHTS. THIS APPLICATION IS SUBJECT TO WITHDRAWAL FROM ISSUE AT THE INITIATIVE OF THE OFFICE OR UPON PETITION BY THE APPLICANT. SEE 37 CFR 1.313 AND MPEP 1308.

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A. Pay TOTAL FEE(S) DUE shown above, or

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(Depositor's name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3	5178

TITLE OF INVENTION: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
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EXAMINER	ART UNIT	CLASS-SUBCLASS
GHEBRETINSAE, TEMESGHEN	2611	375-320000

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❑ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

2. For printing on the patent front page, list

(1) the names of up to 3 registered patent attorneys or agents OR, alternatively, 1_____

(2) the name of a single firm (having as a member a registered attorney or agent) and the names of up to 2 registered patent attorneys or agents. If no name is listed, no name will be printed. 2_____ 3_____

3. ASSIGNEE NAME AND RESIDENCE DATA TO BE PRINTED ON THE PATENT (print or type)

PLEASE NOTE: Unless an assignee is identified below, no assignee data will appear on the patent. If an assignee is identified below, the document has been filed for recordation as set forth in 37 CFR 3.11. Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

Please check the appropriate assignee category or categories (will not be printed on the patent) : ❑ Individual ❑ Corporation or other private group entity ❑ Government

4a. The following fee(s) are submitted:

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

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❑ A check is enclosed.

❑ Payment by credit card. Form PTO-2038 is attached.

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

5. **Change in Entity Status** (from status indicated above)

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

❑ b. Applicant is no longer claiming SMALL ENTITY status. See 37 CFR 1.27(g)(2).

NOTE: The Issue Fee and Publication Fee (if required) will not be accepted from anyone other than the applicant; a registered attorney or agent; or the assignee or other party in interest as shown by the records of the United States Patent and Trademark Office.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3	5178

22500 7590 12/10/2010

BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868

EXAMINER	
GHEBRETINSAE, TEMESGHEN	
ART UNIT	PAPER NUMBER
2611	

DATE MAILED: 12/10/2010

Determination of Patent Term Adjustment under 35 U.S.C. 154 (b)

(application filed on or after May 29, 2000)

The Patent Term Adjustment to date is 33 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 33 day(s).

If a Continued Prosecution Application (CPA) was filed in the above-identified application, the filing date that determines Patent Term Adjustment is the filing date of the most recent CPA.

Applicant will be able to obtain more detailed information by accessing the Patent Application Information Retrieval (PAIR) WEB site (http://pair.uspto.gov).

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Customer Service Center of the Office of Patent Publication at 1-(888)-786-0101 or (571)-272-4200.

Notice of Allowability	Application No.	Applicant(s)	
	12/491,332	MCELWAIN, THOMAS P.	
	Examiner	Art Unit	
	Temesghen Ghebretinsae	2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address--

All claims being allowable, PROSECUTION ON THE MERITS IS (OR REMAINS) CLOSED in this application. If not included herewith (or previously mailed), a Notice of Allowance (PTOL-85) or other appropriate communication will be mailed in due course. **THIS NOTICE OF ALLOWABILITY IS NOT A GRANT OF PATENT RIGHTS.** This application is subject to withdrawal from issue at the initiative of the Office or upon petition by the applicant. See 37 CFR 1.313 and MPEP 1308.

1. ☒ This communication is responsive to *amendment filed 11/29/10*.

2. ☒ The allowed claim(s) is/are *1-8*.

3. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
   a) ☐ All b) ☐ Some* c) ☐ None of the:
      1. ☐ Certified copies of the priority documents have been received.
      2. ☐ Certified copies of the priority documents have been received in Application No. _____ .
      3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

   * Certified copies not received: _____.

Applicant has THREE MONTHS FROM THE "MAILING DATE" of this communication to file a reply complying with the requirements noted below. Failure to timely comply will result in ABANDONMENT of this application.
THIS THREE-MONTH PERIOD IS NOT EXTENDABLE.

4. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
      1) ☐ hereto or 2) ☐ to Paper No./Mail Date _____.
   (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date _____.

   Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).

6. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☐ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____
4. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material
5. ☐ Notice of Informal Patent Application
6. ☐ Interview Summary (PTO-413), Paper No./Mail Date _____ .
7. ☐ Examiner's Amendment/Comment
8. ☐ Examiner's Statement of Reasons for Allowance
9. ☐ Other _____.

/Temesghen Ghebretinsae/
Primary Examiner, Art Unit 2611

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12491332	MCELWAIN, THOMAS P.
	Examiner	**Art Unit**
	Temesghen Ghebretinsae	2611

ORIGINAL		INTERNATIONAL CLASSIFICATION														
CLASS	SUBCLASS	CLAIMED					NON-CLAIMED									
375	320	H	0	3	D	1 / 24 (2006.01.01)										

CROSS REFERENCE(S)					
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
375	316				

☒ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
	1														
	2														
	3														
	4														
	5														
	6														
	7														
	8														

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	8	
/Temesghen Ghebretinsae/ Primary Examiner.Art Unit 2611	12/2/10	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	1	4

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12491332	MCELWAIN, THOMAS P.
	Examiner	Art Unit
	Temesghen Ghebretinsae	2611

SEARCHED			
Class	Subclass	Date	Examiner
375	320,341,316	12/2/2010	tg

SEARCH NOTES		
Search Notes	Date	Examiner
EAST, IEEE, inventor search	12/2/2010	tg

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
375	320	12/2/2010	tg

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of: MCELWAIN, Thomas, P. TC/AU: 2611

Serial No. 12/491,332 Examiner: GHEBRETINSAE, Temesghen

Filing or 371 (c) Date: 06/25/2009 Dkt No: 20030076-DIV3

For: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

To: Mail Stop Amendment
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Customer No: 22500

Commissioner:

OFFICE ACTION RESPONSE
AMENDMENT

INTRODUCTORY COMMENTS

In response to the Office's Non-Final Office Action dated 09/27/2010, the Applicant has timely enclosed herein: 4 pages Office Action Response. Please amend the above-identified application as follows:

Amendments to the Claims are reflected in the listing of claims which begins on page 2 of this paper.

Remarks/Arguments begin on page 4 of this paper.

DEPOSIT ACCOUNT **190130** AUTHORIZATION – The Office is hereby authorized to charge the required fee, and any deficiency or credit any overpayment in the fees to the above deposit account, owned by BAE SYSTEMS Information and Electronic Systems Integration Inc. an authorized signator for which is Kevin M. Perkins, V.P. & Company Counsel, and for whom the undersigned are authorized agents.

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions, and listings, of claims in the application:

Claim 1 (Currently Amended). A joint amplitude estimator for a data stream from multiple users, comprising:

a data stream from said multiple users divided into a plurality of observation intervals;

a plurality of processing modules coupled to said observation intervals, wherein said processing modules calculates interference cancellation values for each of said users and computes a filter for each of said observation intervals, said filter being applied to said data within said observation interval to compute individual amplitude estimates; and

an amplitude estimation unit which processes said individual amplitude estimates and calculates new amplitude estimates, wherein said new amplitude estimates are iteratively passed back to said processing modules ~~a final condition is obtained~~ either a maxium number of iterations or a desired bit error rate have been reached.

Claim 2 (Original). The joint amplitude estimator according to claim 1, wherein said final condition is selected from at least one of the group consisting of: bit error rate metric level and fixed number of iterations.

Claim 3 (Original). The joint amplitude estimator according to claim 1, wherein said amplitude estimation unit sums and weighs said individual estimates.

Claim 4 (Original). The joint amplitude estimator according to claim 1, wherein said observation intervals are based on distinguishing attributes selected from at least one of the group consisting of: time, code, and frequency.

Claim 5 (Currently Amended). The joint amplitude estimator according to claim 1, wherein said filter is calculated for an arbitrary observation interval m as:

$$G_m = \mathbf{B}_m \mathbf{S}_m^H \left(\mathbf{S}_m \chi_m \mathbf{S}_m^H + \sigma_n^2 I \right)^{-1}$$

wherein G_m is a MMSE filter, B_m is a diagonal matrix representing the expected bit or symbol value, S_m is an S matrix defined over a single observation interval, I is an iteration and m is an arbitrary observation interval.

Claim 6 (Currently Amended). A method for processing amplitude estimates for a multiuser data stream divided into a plurality of observation intervals, comprising:

computing a filter for each said observation interval of said data stream;

applying interference cancellation to said data stream for each said observation interval;

applying said filter to said data stream for each said observation interval from said interference cancellation to produce individual amplitude estimates for each said observation interval;

computing new amplitude estimates using said individual amplitude estimates; and

passing said new amplitude estimates back to said filter for iterative processing until ~~a final condition is obtained~~ either a maxium number of iterations or a desired bit error rate have been reached .

Claim 7 (Original). The method according to claim 6, wherein said computing further comprises summing said individual amplitude estimates and weighing.

Claim 8 (Original). The method according to claim 6, wherein said final condition is selected from at least from the group consisting of: bit error rate metric level and fixed number of iterations.

REMARKS

Claim Objections

Claims 1, 5 and 6 were subject to objections by the Office. The Applicant herein submits amendments to cure the Office's objection. The applicant respectfully requests that the Office withdraw its objection to claims 1, 5, and 6.

Applicant believes the above amendments and remarks to be fully responsive to the Office Action, thereby placing this application in condition for allowance. No new matter is added. Applicant requests speedy reconsideration, and further requests that Examiner contact its attorney by telephone, facsimile, or email for quickest resolution, if there are any remaining issues.

Respectfully submitted,

/Andrew P. Cernota, Reg. No. 52,711/

Vernon C. Maine, Reg. No. 37,389
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patents@vernmaine.com

Electronic Acknowledgement Receipt

EFS ID:	8920086
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	22500
Filer:	Andrew Paul Cernota/Jacqueline Judkins
Filer Authorized By:	Andrew Paul Cernota
Attorney Docket Number:	20030076-DIV3
Receipt Date:	29-NOV-2010
Filing Date:	25-JUN-2009
Time Stamp:	14:34:59
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20030076-DIV3_OAR_Final_Filed.pdf	101615 b1d9c554aad7c8996e0628c04e5169ef04056510	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	3
	Applicant Arguments/Remarks Made in an Amendment	4	4
Warnings:			
Information:			
	Total Files Size (in bytes):	101615	

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
12/491,332	06/25/2009	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

AMENDMENT 11/29/2010	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	* 8	Minus	** 20	= 0	X $ =		OR	X $52=	0
Independent (37 CFR 1.16(h))	* 2	Minus	***3	= 0	X $ =		OR	X $220=	0
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
Total (37 CFR 1.16(i))	*	Minus	**	=	X $ =		OR	X $ =	
Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
☐ Application Size Fee (37 CFR 1.16(s))									
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/BONNIE PHOENIX/

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3	5178

22500 7590 09/27/2010

BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868

EXAMINER	
GHEBRETINSAE, TEMESGHEN	
ART UNIT	PAPER NUMBER
2611	
MAIL DATE	DELIVERY MODE
09/27/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	12/491,332	MCELWAIN, THOMAS P.	
	Examiner	Art Unit	
	Temesghen Ghebretinsae	2611	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 2 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☐ Responsive to communication(s) filed on _____.

2a)☐ This action is **FINAL**. 2b)☐ This action is non-final.

3)☒ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 1-8 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) 1-8 is/are allowed.

6)☐ Claim(s) _____ is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☐ The drawing(s) filed on _____ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☐ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date 8/17/09.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. It would be of great assistance to the Office if all incoming papers pertaining to a filed application carried the following items:

1. Application number (checked for accuracy, including series code and serial no.).
2. Group art unit number (copied from most recent Office communication).
3. Filing date.
4. Name of the examiner who prepared the most recent Office action.
5. Title of invention.
6. Confirmation number (See MPEP § 503).

Information Disclosure Statement

The IDS filed 8/17/09 has been considered by the examiner.

Claim Objections

2. Claims1, 5 and 6 are objected to because of the following informalities: in claims 1 and 6 the phrase "until a final condition is obtained" is unclear. In claim 5, the parameters Gm, Bm, Sm and I and m need to be defined. Appropriate correction is required.

Allowable Subject Matter

3. This application is in condition for allowance except for the following formal matters:

See above claim objection.

Prosecution on the merits is closed in accordance with the practice under *Ex parte Quayle*, 25 USPQ 74, 453 O.G. 213, (Comm'r Pat. 1935).

A shortened statutory period for reply to this action is set to expire **TWO MONTHS** from the mailing date of this letter.

4. The following is an examiner's statement of reasons for allowance: the prior art of record fail to anticipate or render obvious the claimed joint amplitude estimator for a data stream from multiple users, comprising: a data stream from said multiple users divided into a plurality of observation intervals; ***in combination with*** *a plurality of processing modules coupled to said observation intervals, wherein said* ***processing modules calculates interference cancellation values for each of said users and computes a filter for each of said observation intervals, said filter being applied to said data within said observation interval to compute individual amplitude estimates; and an amplitude estimation unit which processes said individual amplitude estimates and calculates new amplitude estimates, wherein said new amplitude estimates are iteratively passed back to said processing modules until a final condition is obtained*** In the manner and complexity explicitly recited in the claimed invention.

Any comments considered necessary by applicant must be submitted no later than the payment of the issue fee and, to avoid processing delays, should preferably accompany the issue fee. Such submissions should be clearly labeled "Comments on Statement of Reasons for Allowance."

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Temesghen Ghebretinsae whose telephone number is 571-272-3017. The examiner can normally be reached on Monday-Friday from 8 to 6. The examiner can also be reached on alternate.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Ghayour Mohammed, can be reached on 571-272-3021. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://portal.uspto.gov/external/portal. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Temesghen Ghebretinsae
Primary Examiner
Art Unit 2611

5. /Temesghen Ghebretinsae/

6. Primary Examiner, Art Unit 2611

7. 9/16/10

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12491332	MCELWAIN, THOMAS P.
	Examiner	Art Unit
	Temesghen Ghebretinsae	2611

SEARCHED			
Class	Subclass	Date	Examiner
375	320,341,316	9/16/2010	tg

SEARCH NOTES		
Search Notes	Date	Examiner
EAST, IEEE, inventor search	9/16/2010	tg

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	12491332	MCELWAIN, THOMAS P.
	Examiner	**Art Unit**
	Temesghen Ghebretinsae	2611

✓	Rejected	-	Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

☐ Claims renumbered in the same order as presented by applicant ☐ CPA ☐ T.D. ☐ R.1.47

CLAIM		DATE								
Final	Original	09/16/2010								
	1	=								
	2	=								
	3	=								
	4	=								
	5	=								
	6	=								
	7	=								
	8	=								

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

BIB DATA SHEET

CONFIRMATION NO. 5178

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
12/491,332	06/25/2009 RULE	375	2611	20030076-DIV3

APPLICANTS

Thomas P. McElwain, Merrimack, NH;

**** CONTINUING DATA ***************************

This application is a DIV of 12/251,575 10/15/2008 PAT 7,583,757
which is a DIV of 10/531,772 04/19/2005 PAT 7,463,703 *
which is a 371 of PCT/US03/38190 11/25/2003
which claims benefit of 60/462,657 04/14/2003
(*)Data provided by applicant is not consistent with PTO records.

**** FOREIGN APPLICATIONS ***************************

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

07/06/2009

Foreign Priority claimed	☐ Yes ☑ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☑ No		NH	6	8	2
Verified and Acknowledged	/TEMESGH GHEBRETINSAE/ Examiner's Signature	Initials				

ADDRESS

BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868
UNITED STATES

TITLE

JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

FILING FEE RECEIVED	FEES: Authority has been given in Paper	☐ All Fees
1090	No._____ to charge/credit DEPOSIT ACCOUNT	☐ 1.16 Fees (Filing)
	No._____ for following:	☐ 1.17 Fees (Processing Ext. of time)
		☐ 1.18 Fees (Issue)
		☐ Other _____
		☐ Credit

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	8	mmse near2 symbol adj estimator	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:28
L2	13	mmse with symbol adj estimator	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:29
L3	15	new adj amplitude adj estimat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:38
L4	2064	minimum adj mean adj squared adj error	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:40
L5	7	3 and 4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41
L6	1867	amplitude adj estimat $3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41
L7	48	4 and 6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41

L8	6233	interference adj cancellat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41
L9	17	7 and 8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:42
L10	11	joint near2 amplitude adj estimat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:15
S1	17	((THOMAS) near2 (MCELWAIN)).INV.	US-PGPUB; USPAT	OR	ON	2010/09/16 13:21
S2	19	("20020110206" | "20020122464" | "20030031237" | "20030074191" | "20030086512" | "20030102905" | "20030125937" | "20030128836" | "20030138054" | "20030179698" | "20030189979" | "6023783" | "6298461" | "6373858" | "6397367" | "6473417" | "6510536" | "6574291" | "7136428").PN. OR ("7583757").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/16 13:36
S3	10	joint adj amplitude adj estimat$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 13:58

S4	10	joint adj amplitude adj estimat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 13:58
S5	1	2004-795942.NRAN.	DERWENT	OR	ON	2010/09/16 13:59
S6	22	calculat$3 adj interference adj cancellat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 14:00
S7	1867	amplitude adj estimat $3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 14:00
S8	7	S6 and S7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 14:01

9/ 16/ 2010 4:16:21 PM

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	8	mmse near2 symbol adj estimator	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:28
L2	13	mmse with symbol adj estimator	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:29
L3	15	new adj amplitude adj estimat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:38
L4	2064	minimum adj mean adj squared adj error	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:40
L5	7	3 and 4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41
L6	1867	amplitude adj estimat $3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41
L7	48	4 and 6	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41

L8	6233	interference adj cancellat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:41
L9	17	7 and 8	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 15:42
L10	11	joint near2 amplitude adj estimat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:15
L11	7	individual adj amplitude adj estimat $3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:17
L12	32	amplitude adj estimat $3 with multiuser	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:17
L13	31	8 and 12	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:17
L14	22	calculat$3 adj interference adj cancellat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:25
L15	7	6 and 14	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 16:25
S1	17	((THOMAS) near2 (MCELWAIN)).INV.	US-PGPUB; USPAT	OR	ON	2010/09/16 13:21

S2	19	("20020110206" | "20020122464" | "20030031237" | "20030074191" | "20030086512" | "20030102905" | "20030125937" | "20030128836" | "20030138054" | "20030179698" | "20030189979" | "6023783" | "6298461" | "6373858" | "6397367" | "6473417" | "6510536" | "6574291" | "7136428").PN. OR ("7583757").URPN.	US-PGPUB; USPAT; USOCR	OR	ON	2010/09/16 13:36
S3	10	joint adj amplitude adj estimat$2	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 13:58
S4	10	joint adj amplitude adj estimat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 13:58
S5	1	2004-795942.NRAN.	DERWENT	OR	ON	2010/09/16 13:59
S6	22	calculat$3 adj interference adj cancellat$3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 14:00
S7	1867	amplitude adj estimat $3	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 14:00

S8	7	S6 and S7	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2010/09/16 14:01

9/16/2010 4:26:02 PM

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(Not for submission under 37 CFR 1.99)

Application Number	12491332
Filing Date	2009-06-25
First Named Inventor	MCELWAIN, Thomas P.
Art Unit	2611
Examiner Name	
Attorney Docket Number	20030076-DIV3

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6298461		2001-10-02	Tong et al.	
	2	6373858	B	2002-04-16	Soleimani et al.	
	3	6473417	B1	2002-10-29	Herzog	
	4	6510536	B1	2003-01-21	Crozier et al.	
	5	6574291	B2	2003-06-03	Doetsch et al.	
	6	6023783	A	2000-02-08	Divsalar et al.	
	7	6397367	B1	2002-05-28	Park et al.	
	8	7136428	B2	2006-11-14	Corbaton et al.	

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	Art Unit	2611
	Examiner Name	
	Attorney Docket Number	20030076-DIV3

	9	6956893	B2	2005-10-18	Frank et al.	
	10	7218690	B2	2007-05-15	Learned	
	11	7110439		2006-09-19	MacLeod	
	12	7218665		2007-05-15	McElwain	

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	1	20020110206	A1	2002-08-15	Becker et al.	
	2	20020122464	A1	2002-09-05	Dodge	
	3	20030031237	A1	2003-02-13	Bachl et al.	
	4	20030074191	A1	2003-04-17	Byrnes et al.	
	5	20030086512	A1	2003-05-08	Rick et al.	

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	Attorney Docket Number	20030076-DIV3

	6	20030102905	A1	2003-06-05	Ha et al.	
	7	20030125937	A1	2003-07-03	Thomson	
	8	20030128836	A1	2003-07-10	Stephens et al.	
	9	20030138054	A1	2003-07-24	Ha et al.	
	10	20030179698	A1	2003-09-25	Lu	
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	Examiner Name	
	Attorney Docket Number	20030076-DIV3

	1	PCT Search Report dated April 5, 2006 of Patent Application No. PCT/US03/38190 filed November 25, 2003.	☐
	2	PCT Search Report dated September 8, 2003 of Patent Application No. PCT/US03/15503 filed May 14, 2003.	☐
	3	WEI et al., "Synchronous DS-SSMA System with Improved Decorrelating Decision-Feedback Multiuser Detection", IEEE Transactions on Vehicular Technology, August 1994, pp. 767-772, Vol. 43, No. 3.	☐
	4	DUEL-HALLEN, ALEXANDRIA, "Decorrelating Decision-Feedback Multiuser Detector for Synchronous Code-Division Multiple-Access Channel", IEEE Transactions on Communications, February 1993, pp. 285-290, Vol. 41, No. 2.	☐
	5	VARANASI et al., "Near-Optimum Detection in Synchronous Code-Division Multiple-Access Systems", IEEE Transactions on Communications, May 1991, pp. 725-736, Vol. 39, No. 5.	☐
	6	LUPAS, R. et al., "Near-Far Resistance of Multiuser Detectors in Asynchronous Channels", IEEE Transactions on Communications, April 1990., pp. 496-508, Vol. 38, No. 4.	☐
	7	LUPAS, R. et al., "Linear Multiuser Detectors for Synchronous Code-Division Multiple-Access Channels", IEEE Transactions on Information Theory, January 1989, pp. 123-136, Vol. 35, No. 1.	☐
	8	VERDU, SERGIO, "Minimum Probability of Error for Asynchronous Gaussian Multiple-Access Channels", IEEE Transactions on Information Theory, January 1986, pp. 95-96, Vol. IT-32, No. 1.	☐
	9	CHAN, A. et al., "A Class of Asymptotically Optimum Iterated-Decision Multiuser Detectors", May 2001, pp. 1-4.	☐
	10	ALEXANDER, P. et al., "Iterative Multiuser Interference Reduction: Turbo CDMA", IEEE Transactions on Communications, July 1999, pp. 1008-1014, Vol. 47, No. 7.	☐
	11	POOR, H. VINCENT, "Turbo Multiuser Detection: An Overview", IEEE 6th Int. Symp. on Spread-Spectrum Tech. & Appl., September 2000, pp. 583-587.	☐

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	Attorney Docket Number	20030076-DIV3

	12	WANG, X. et al., "Iterative (Turbo) Soft Interference Cancellation and Decoding for Coded CDMA", IEEE Transactions on Communications, July 1999, pp. 1046-1061, Vol. 47, No. 7.	☐
	13	DAS, S. et al., "Computationally Efficient Iterative Multiuser Detection and Decoding", IEEE, 1998, pp. 631-635.	☐
	14	HERZOG, R. et al, "Iterative Decoding and Despreading Improves CDMA-Systems Using M-ary Orthogonal Modulation and FEC", IEEE, 1997, pp. 909-913.	☐
	15	WANG, D. et al., "Low-Complexity MAP Decoding for Turbo Codes", IEEE, 2000, pp. 1035-1039.	☐
	16	BERROU, C. et al., "Near Shannon Limit Error - Correcting Coding and Decoding: Turbo-Codes (1)", IEEE, 1993, pp. 1064-1070.	☐
	17	BERROU, C. et al., "Near Optimum Error Correcting Coding and Decoding: Turbo-Codes", IEEE Transactions on Communications, October 1996, pp. 1261-1271, Vol. 44, No. 10.	☐
	18	ROBERTSON, P. et al., "A Comparison of Optimal and Sub-Optimal MAP Decoding Algorithms Operating in the Log Domain", IEEE, 1995, pp. 1009-1013.	☐
	19	HAGENAUER, J. et al., "A Viterbi Algorithm with Soft-Decision Outputs and its Applications", IEEE, 1989, pp. 1680-1686..	☐
	20	POTTIE, G. et al., "A Comparison of Reduced Complexity Decoding Algorithms for Trellis Codes", IEEE Journal on Selected Areas in Communications, December 1989, pp. 1369-1380, Vol. 7, No. 9.	☐

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3

CONFIRMATION NO. 5178

22500
BAE SYSTEMS
PO BOX 868
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PUBLICATION NOTICE

OC00000038990815

Title:JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

Publication No.US-2009-0290667-A1
Publication Date:11/26/2009

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/491,332	06/25/2009	2611	1090	20030076-DIV3	8	2

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Applicant(s)

Thomas P. McElwain, Merrimack, NH;

Assignment For Published Patent Application

BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION INC., Nashua, NH

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a DIV of 12/251,575 10/15/2008 PAT 7,583,757
which is a DIV of 10/531,772 04/19/2005 PAT 7,463,703 *
which is a 371 of PCT/US03/38190 11/25/2003
which claims benefit of 60/462,657 04/14/2003
(*)Data provided by applicant is not consistent with PTO records.

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Projected Publication Date: 11/26/2009

Non-Publication Request: No

Early Publication Request: No

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JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

Preliminary Class

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Not for submission under 37 CFR 1.99)

Application Number	12491332
Filing Date	2009-06-25
First Named Inventor	MCELWAIN, Thomas P.
Art Unit	2611
Examiner Name	
Attorney Docket Number	20030076-DIV3

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Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	6298461		2001-10-02	Tong et al.	
	2	6373858	B	2002-04-16	Soleimani et al.	
	3	6473417	B1	2002-10-29	Herzog	
	4	6510536	B1	2003-01-21	Crozier et al.	
	5	6574291	B2	2003-06-03	Doetsch et al.	
	6	6023783	A	2000-02-08	Divsalar et al.	
	7	6397367	B1	2002-05-28	Park et al.	
	8	7136428	B2	2006-11-14	Corbaton et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	12491332
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	First Named Inventor	MCELWAIN, Thomas P.
	Art Unit	2611
	Examiner Name	
	Attorney Docket Number	20030076-DIV3

	9	6956893	B2	2005-10-18	Frank et al.	
	10	7218690	B2	2007-05-15	Learned	
	11	7110439		2006-09-19	MacLeod	
	12	7218665		2007-05-15	McElwain	

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	1	20020110206	A1	2002-08-15	Becker et al.	
	2	20020122464	A1	2002-09-05	Dodge	
	3	20030031237	A1	2003-02-13	Bachl et al.	
	4	20030074191	A1	2003-04-17	Byrnes et al.	
	5	20030086512	A1	2003-05-08	Rick et al.	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Filing Date	2009-06-25
	First Named Inventor	MCELWAIN, Thomas P.
	Art Unit	2611
	Examiner Name	
	Attorney Docket Number	20030076-DIV3

	6	20030102905	A1	2003-06-05	Ha et al.	
	7	20030125937	A1	2003-07-03	Thomson	
	8	20030128836	A1	2003-07-10	Stephens et al.	
	9	20030138054	A1	2003-07-24	Ha et al.	
	10	20030179698	A1	2003-09-25	Lu	
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	Application Number	12491332
	Filing Date	2009-06-25
	First Named Inventor	MCELWAIN, Thomas P.
	Art Unit	2611
	Examiner Name	
	Attorney Docket Number	20030076-DIV3

	1	PCT Search Report dated April 5, 2006 of Patent Application No. PCT/US03/38190 filed November 25, 2003.	☐
	2	PCT Search Report dated September 8, 2003 of Patent Application No. PCT/US03/15503 filed May 14, 2003.	☐
	3	WEI et al., "Synchronous DS-SSMA System with Improved Decorrelating Decision-Feedback Multiuser Detection", IEEE Transactions on Vehicular Technology, August 1994, pp. 767-772, Vol. 43, No. 3.	☐
	4	DUEL-HALLEN, ALEXANDRIA, "Decorrelating Decision-Feedback Multiuser Detector for Synchronous Code-Division Multiple-Access Channel", IEEE Transactions on Communications, February 1993, pp. 285-290, Vol. 41, No. 2.	☐
	5	VARANASI et al., "Near-Optimum Detection in Synchronous Code-Division Multiple-Access Systems", IEEE Transactions on Communications, May 1991, pp. 725-736, Vol. 39, No. 5.	☐
	6	LUPAS, R. et al., "Near-Far Resistance of Multiuser Detectors in Asynchronous Channels", IEEE Transactions on Communications, April 1990., pp. 496-508, Vol. 38, No. 4.	☐
	7	LUPAS, R. et al., "Linear Multiuser Detectors for Synchronous Code-Division Multiple-Access Channels", IEEE Transactions on Information Theory, January 1989, pp. 123-136, Vol. 35, No. 1.	☐
	8	VERDU, SERGIO, "Minimum Probability of Error for Asynchronous Gaussian Multiple-Access Channels", IEEE Transactions on Information Theory, January 1986, pp. 95-96, Vol. IT-32, No. 1.	☐
	9	CHAN, A. et al., "A Class of Asymptotically Optimum Iterated-Decision Multiuser Detectors", May 2001, pp. 1-4.	☐
	10	ALEXANDER, P. et al., "Iterative Multiuser Interference Reduction: Turbo CDMA", IEEE Transactions on Communications, July 1999, pp. 1008-1014, Vol. 47, No. 7.	☐
	11	POOR, H. VINCENT, "Turbo Multiuser Detection: An Overview", IEEE 6th Int. Symp. on Spread-Spectrum Tech. & Appl., September 2000, pp. 583-587.	☐

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	Attorney Docket Number	20030076-DIV3

	12	WANG, X. et al., "Iterative (Turbo) Soft Interference Cancellation and Decoding for Coded CDMA", IEEE Transactions on Communications, July 1999, pp. 1046-1061, Vol. 47, No. 7.	☐
	13	DAS, S. et al., "Computationally Efficient Iterative Multiuser Detection and Decoding", IEEE, 1998, pp. 631-635.	☐
	14	HERZOG, R. et al, "Iterative Decoding and Despreading Improves CDMA-Systems Using M-ary Orthogonal Modulation and FEC", IEEE, 1997, pp. 909-913.	☐
	15	WANG, D. et al., "Low-Complexity MAP Decoding for Turbo Codes", IEEE, 2000, pp. 1035-1039.	☐
	16	BERROU, C. et al., "Near Shannon Limit Error - Correcting Coding and Decoding: Turbo-Codes (1)", IEEE, 1993, pp. 1064-1070.	☐
	17	BERROU, C. et al., "Near Optimum Error Correcting Coding and Decoding: Turbo-Codes", IEEE Transactions on Communications, October 1996, pp. 1261-1271, Vol. 44, No. 10.	☐
	18	ROBERTSON, P. et al., "A Comparison of Optimal and Sub-Optimal MAP Decoding Algorithms Operating in the Log Domain", IEEE, 1995, pp. 1009-1013.	☐
	19	HAGENAUER, J. et al., "A Viterbi Algorithm with Soft-Decision Outputs and its Applications", IEEE, 1989, pp. 1680-1686..	☐
	20	POTTIE, G. et al., "A Comparison of Reduced Complexity Decoding Algorithms for Trellis Codes", IEEE Journal on Selected Areas in Communications, December 1989, pp. 1369-1380, Vol. 7, No. 9.	☐

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	Application Number	12491332
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	Filing Date	2009-06-25
	First Named Inventor	MCELWAIN, Thomas P.
	Art Unit	2611
	Examiner Name	
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Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

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☐ See attached certification statement.

☐ Fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ None

SIGNATURE

A signature of the applicant or representative is required in accordance with CFR 1.33, 10.18. Please see CFR 1.4(d) for the form of the signature.

Signature	/Andrew P. Cernota, Reg. No. 52,711/	Date (YYYY-MM-DD)	2009-08-17
Name/Print	Andrew P. Cernota	Registration Number	52711

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/15503

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H03M 13/23, 13/12

US CL :714/786, 792

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)

U.S. : 714/786, 792, 759, 791, 793, 794, 797; 375/262, 265, 341, 346

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

NONE

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

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 6,023,783 A (DIVSALAR et al) 08 February 2000, see figs. 20b-20g and col.19, lines 58-67 and col.20, lines 5-67 and col.21, lines 1-20	1-23
Y	US 6,397,367 B1 (PARK et al) 28 May 2002, see fig.4 and col.1, lines 56-67 and col.2, lines 5-15	1-23

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INTERNATIONAL SEARCH REPORT

International application No.
PCT/US03/38190

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) : H03D 1/00
US CL : 375/343

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)
U.S. : 375/343,346

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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A,P	US 2003/0189979 A1 (Li et al) 09 October 2003(9.10.2003) parag. {0009} claims 1-18.	6-21
A,P	US 2003/0179698 A1 (Lu) 25 September 2003 (25.9.2003)parag. {0009-0010}.	6-21

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EFS ID:	5899528
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	22500
Filer:	Andrew Paul Cernota/Jacqueline Judkins
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Attorney Docket Number:	20030076-DIV3
Receipt Date:	17-AUG-2009
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Application Type:	Utility under 35 USC 111(a)

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: MCELWAIN, Thomas, P. Group Art Unit:

Serial No. 12/491,332 Examiner:

Filed: 06/25/2009 Atty. Dkt. No: 20030076-DIV3

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RESPONSE TO NOTICE TO FILE CORRECTED APPLICATION PAPERS

This is a response to the NOTICE TO FILE CORRECTED APPLICATION PAPERS, dated 03/12/2003, for the above cited patent application. Transmitted herewith is 3 pages replacement drawings.

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Respectfully submitted,

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Vernon C. Maine, Reg. No. 37,389
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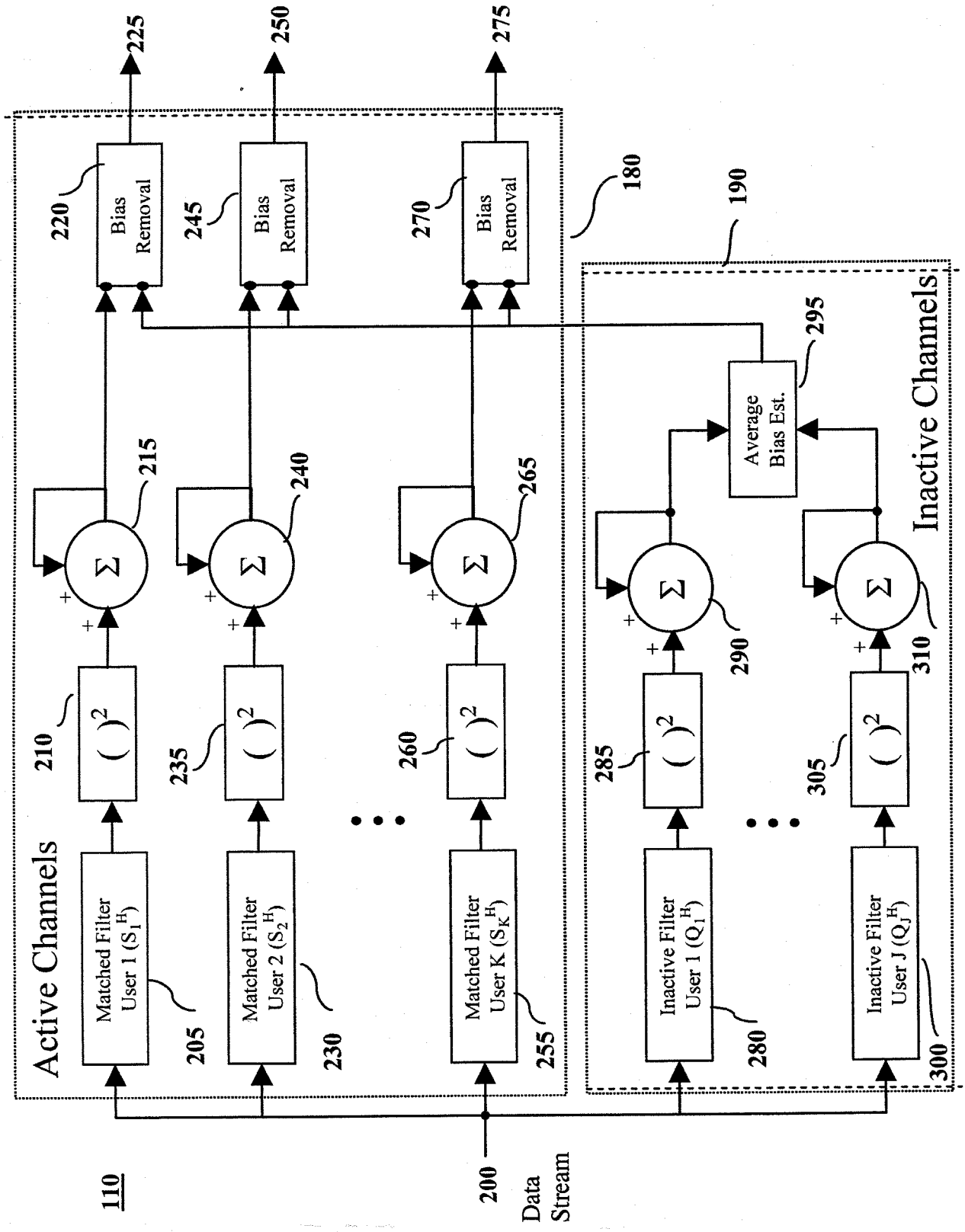
PO Box 868
Nashua, NH 03061-0868
Tel. No. (603) 886-6100, Fax. No. (603) 886-4796
patents@vernmaine.com


110
200
Data Stream
Active Channels
Inactive Channels
Matched Filter User 1 (S_1^H)
Matched Filter User 2 (S_2^H)
Matched Filter User K (S_K^H)
Inactive Filter User 1 (Q_1^H)
Inactive Filter User J (Q_J^H)
( )^2
Σ
Bias Removal
Average Bias Est.
205
210
215
220
225
230
235
240
245
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300
305
310
180
190

Figure 3

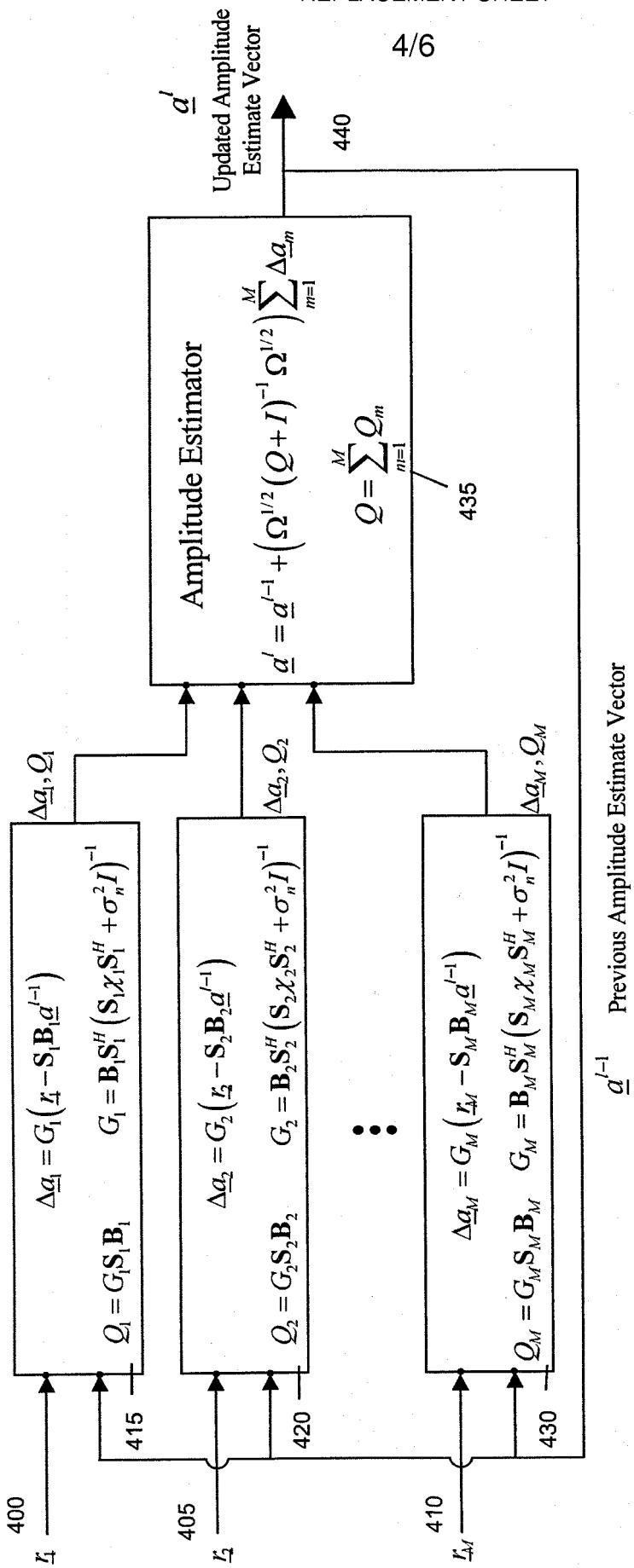
Updated Amplitude Estimate Vector
440
Amplitude Estimator
435
Previous Amplitude Estimate Vector
400
405
410
415
420
430

Figure 4

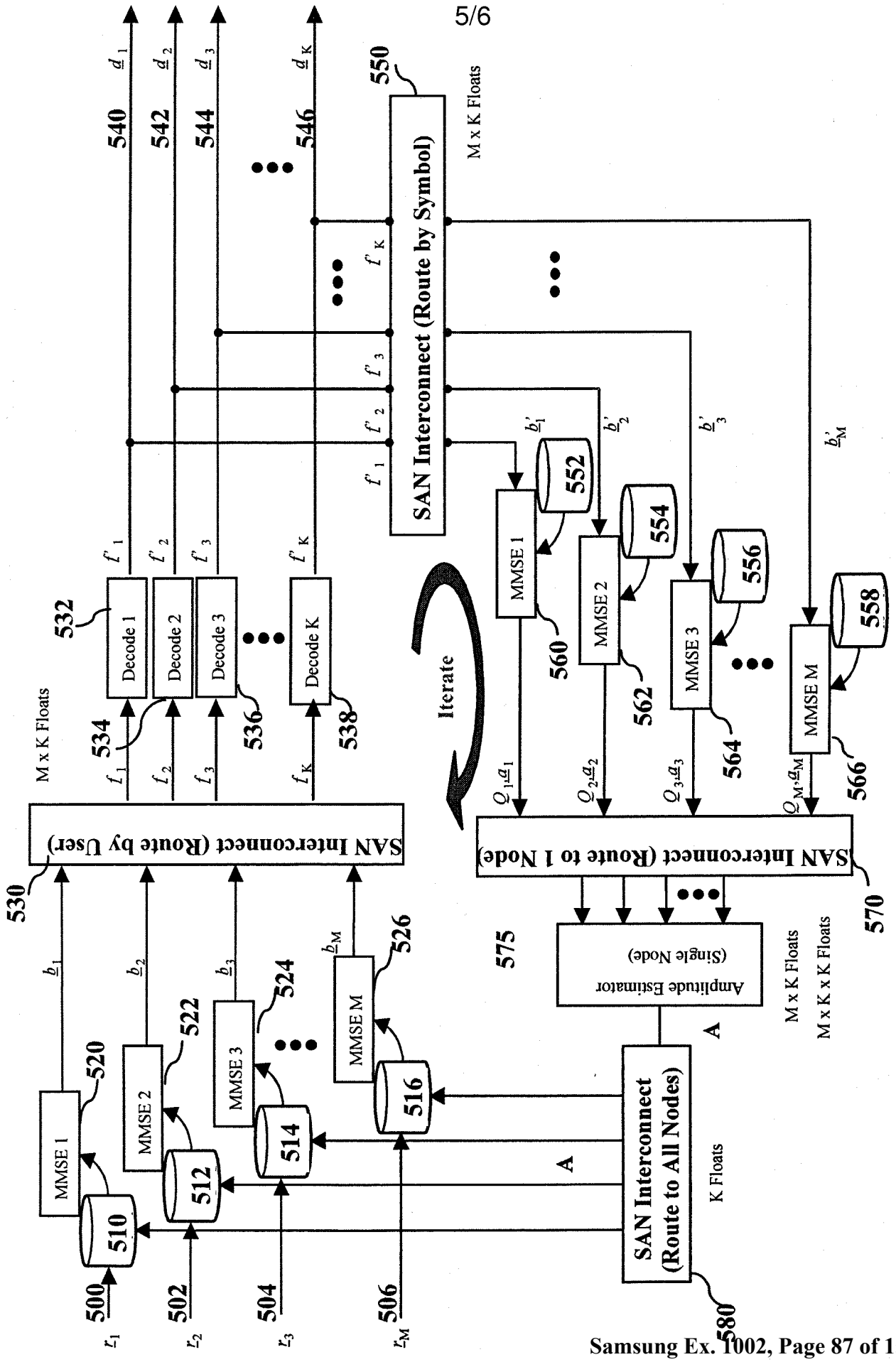
SAN Interconnect (Route by Symbol)
M x K Floats
SAN Interconnect (Route by User)
SAN Interconnect (Route to 1 Node)
SAN Interconnect (Route to All Nodes)
Amplitude Estimator (Single Node)
Decode 1
Decode 2
Decode 3
Decode K
MMSE 1
MMSE 2
MMSE 3
MMSE M
Iterate
K Floats
M x K x K Floats

Figure 5

Electronic Acknowledgement Receipt

EFS ID:	5856741
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P. McElwain
Customer Number:	22500
Filer:	Andrew Paul Cernota/Debra Stengel
Filer Authorized By:	Andrew Paul Cernota
Attorney Docket Number:	20030076-DIV3
Receipt Date:	10-AUG-2009
Filing Date:	25-JUN-2009
Time Stamp:	14:15:31
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Applicant Response to Pre-Exam Formalities Notice	20030076-DIV3_Response_File_Corrected_Papers.pdf	90256 076db7228242945661 9b0cda6921e41c9598dd98	no	1

Warnings:	
Information:	

2	New or Additional Drawings	20030076-DIV3_Replacement-Dwgs.pdf	132978 20fac23a67a883bf8292171c49d58b469d57ff4b	no	3

Warnings:	
Information:	
Total Files Size (in bytes):	223234

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
12/491,332	06/25/2009	2611	1090	20030076-DIV3	8	2

CONFIRMATION NO. 5178

22500
BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868

FILING RECEIPT

OC000000036792734

Date Mailed: 07/09/2009

Receipt is acknowledged of this non-provisional patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF APPLICANT, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection. Please verify the accuracy of the data presented on this receipt. **If an error is noted on this Filing Receipt, please submit a written request for a Filing Receipt Correction. Please provide a copy of this Filing Receipt with the changes noted thereon. If you received a "Notice to File Missing Parts" for this application, please submit any corrections to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections**

Applicant(s)

Thomas P. McElwain, Merrimack, NH;

Assignment For Published Patent Application

BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION INC., Nashua, NH

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a DIV of 12/251,575 10/15/2008
which is a DIV of 10/531,772 04/19/2005 PAT 7,463,703 *
which is a 371 of PCT/US03/38190 11/25/2003
which claims benefit of 60/462,657 04/14/2003
(*)Data provided by applicant is not consistent with PTO records.

Foreign Applications

If Required, Foreign Filing License Granted: 07/06/2009

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 12/491,332**

Projected Publication Date: To Be Determined - pending completion of Corrected Papers

Non-Publication Request: No

Early Publication Request: No

Title

JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

Preliminary Class

375

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

Since the rights granted by a U.S. patent extend only throughout the territory of the United States and have no effect in a foreign country, an inventor who wishes patent protection in another country must apply for a patent in a specific country or in regional patent offices. Applicants may wish to consider the filing of an international application under the Patent Cooperation Treaty (PCT). An international (PCT) application generally has the same effect as a regular national patent application in each PCT-member country. The PCT process **simplifies** the filing of patent applications on the same invention in member countries, but **does not result** in a grant of "an international patent" and does not eliminate the need of applicants to file additional documents and fees in countries where patent protection is desired.

Almost every country has its own patent law, and a person desiring a patent in a particular country must make an application for patent in that country in accordance with its particular laws. Since the laws of many countries differ in various respects from the patent law of the United States, applicants are advised to seek guidance from specific foreign countries to ensure that patent rights are not lost prematurely.

Applicants also are advised that in the case of inventions made in the United States, the Director of the USPTO must issue a license before applicants can apply for a patent in a foreign country. The filing of a U.S. patent application serves as a request for a foreign filing license. The application's filing receipt contains further information and guidance as to the status of applicant's license for foreign filing.

Applicants may wish to consult the USPTO booklet, "General Information Concerning Patents" (specifically, the section entitled "Treaties and Foreign Patents") for more information on timeframes and deadlines for filing foreign patent applications. The guide is available either by contacting the USPTO Contact Center at 800-786-9199, or it can be viewed on the USPTO website at http://www.uspto.gov/web/offices/pac/doc/general/index.html.

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4158).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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This license is to be retained by the licensee and may be used at any time on or after the effective date thereof unless it is revoked. This license is automatically transferred to any related applications(s) filed under 37 CFR 1.53(d). This license is not retroactive.

The grant of a license does not in any way lessen the responsibility of a licensee for the security of the subject matter as imposed by any Government contract or the provisions of existing laws relating to espionage and the national security or the export of technical data. Licensees should apprise themselves of current regulations especially with respect to certain countries, of other agencies, particularly the Office of Defense Trade Controls, Department of State (with respect to Arms, Munitions and Implements of War (22 CFR 121-128)); the Bureau of Industry and Security, Department of Commerce (15 CFR parts 730-774); the Office of Foreign AssetsControl, Department of Treasury (31 CFR Parts 500+) and the Department of Energy.

NOT GRANTED

No license under 35 U.S.C. 184 has been granted at this time, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" DOES NOT appear on this form. Applicant may still petition for a license under 37 CFR 5.12, if a license is desired before the expiration of 6 months from the filing date of the application. If 6 months has lapsed from the filing date of this application and the licensee has not received any indication of a secrecy order under 35 U.S.C. 181, the licensee may foreign file the application pursuant to 37 CFR 5.15(b).

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/491,332	06/25/2009	Thomas P. McElwain	20030076-DIV3

CONFIRMATION NO. 5178

22500
BAE SYSTEMS
PO BOX 868
NASHUA, NH 03061-0868

FORMALITIES LETTER

OC00000036792735

Date Mailed: 07/09/2009

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

An application number and filing date have been accorded to this application. The application is informal since it does not comply with the regulations for the reason(s) indicated below. Applicant is given TWO MONTHS from the date of this Notice within which to correct the informalities indicated below. Extensions of time may be obtained by filing a petition accompanied by the extension fee under the provisions of 37 CFR 1.136(a).

The required item(s) identified below must be timely submitted to avoid abandonment:

- Replacement drawings in compliance with 37 CFR 1.84 and 37 CFR 1.121(d) are required. The drawings submitted are not acceptable because:
  - Numbers, letters, and reference characters on the drawings must measure at least 0.32 cm (1/8 inch) in height. See Figure(s) 3-5.

Applicant is cautioned that correction of the above items may cause the specification and drawings page count to exceed 100 pages. If the specification and drawings exceed 100 pages, applicant will need to submit the required application size fee.

Replies should be mailed to:

Mail Stop Missing Parts
Commissioner for Patents
P.O. Box 1450
Alexandria VA 22313-1450

Registered users of EFS-Web may alternatively submit their reply to this notice via EFS-Web.
https://sportal.uspto.gov/authenticate/AuthenticateUserLocalEPF.html

For more information about EFS-Web please call the USPTO Electronic Business Center at **1-866-217-9197** or visit our website at http://www.uspto.gov/ebc.

If you are not using EFS-Web to submit your reply, you must include a copy of this notice.

/mgabre/

Office of Data Management, Application Assistance Unit (571) 272-4000, or (571) 272-4200, or 1-888-786-0101

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: MCELWAIN, Thomas, P. Group Art Unit:

Serial No. Examiner:

Filed: HEREIN Atty. Dkt. No: 20030076-DIV3

For: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

To: Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Fm: 22500

Commissioner:

LETTER OF TRANSMITTAL

Submitted herewith is a application for United States patent consisting of __4__ pages Patent Application Data Sheet, __43__ pages of specification and claims,__6__sheets of drawings, __1__ page of declaration and power of attorney.

[ ] (37 CFR 1.9(f) & 1.27(c)) Small Entity status applies.
[ ] (35 U.S.C. 122(b)(2)(B)(i)) PTO form PTO/SB/35 re: Publication enclosed
[X] (37 CFR 1.84(J)) – Applicant requests FIG. __2__ for inclusion on the front page of the patent application publication and patent.
[ ] PCT application being filed concurrently

The invention was not made by an agency of the United States Government nor under a contract with an agency of the United States Government.

Fee calculation table:

Fee calculation is based on __2__ independent and __8___ total claims

☒ Basic filing fee – Utility - $330.00	$330.00
☒ Search fee – Utility - $540.00	$540.00
☒ Examination fee – Utility - $220.00	$220.00
☐ Independent claims in excess of three - ___x $220.00 ea.	$
☐ Claims in excess of twenty - ___x $52.00 ea.	
TOTAL DUE:	$1090.00

DEPOSIT ACCOUNT **190130** AUTHORIZATION – The Office is hereby authorized to charge the required fee, and any deficiency or credit any overpayment in the fees to the above deposit account, owned by BAE SYSTEMS Information and Electronic Systems Integration Inc. an authorized signator for which is Kevin M. Perkins, V.P. & Company Counsel, and for whom the undersigned are authorized agents.

Respectfully submitted,

/Andrew P. Cernota, Reg. No. 52,711

Vernon C. Maine, Reg. No. 37,389
Andrew P. Cernota, Reg. No. 52,711
David A. Rardin, Reg. No. 52,153
Attorneys/Agents for Applicant

Cus. No. 22500
BAE SYSTEMS
PO Box 868
Nashua, NH 03061-0868
Tel. No. (603) 886-6100, Fax. No. (603) 886-4796
patents@vernmaine.com

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of: MCELWAIN, Thomas, P. Group Art Unit:

Serial No. Examiner:

Filed: HEREIN Atty. Dkt. No: 20030076-DIV3

For: JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

To: Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Fm: 22500

Commissioner:

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☐ Independent claims in excess of three - ___x $220.00 ea.	$
☐ Claims in excess of twenty - ___x $52.00 ea.	
TOTAL DUE:	$1090.00

DEPOSIT ACCOUNT **190130** AUTHORIZATION – The Office is hereby authorized to charge the required fee, and any deficiency or credit any overpayment in the fees to the above deposit account, owned by BAE SYSTEMS Information and Electronic Systems Integration Inc. an authorized signator for which is Kevin M. Perkins, V.P. & Company Counsel, and for whom the undersigned are authorized agents.

Respectfully submitted,

/Andrew P. Cernota, Reg. No. 52,711

Vernon C. Maine, Reg. No. 37,389
Andrew P. Cernota, Reg. No. 52,711
David A. Rardin, Reg. No. 52,153
Attorneys/Agents for Applicant

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PTO/SB/14 (07-07)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20030076-DIV3
	Application Number	
Title of Invention	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Thomas	P	McElwain	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Merrimack	State/Province	NH	Country of Residence i	US

Citizenship under 37 CFR 1.41(b) i: US

Mailing Address of Applicant:

Address 1	21 Sarah Drive		
Address 2			
City	Merrimack	State/Province	NH
Postal Code	03054	Country i	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	22500		
Email Address	patents@vernmaine.com	Add Email	Remove Email

Application Information:

Title of the Invention	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR		
Attorney Docket Number	20030076-DIV3	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	6	Suggested Figure for Publication (if any)	2

PTO/SB/14 (07-07)
Approved for use through 06/30/2010. OMB 0651-0032
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20030076-DIV3
	Application Number	
Title of Invention	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)

☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	22500		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Division of	12/251575	2008-10-15
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
12/251575	Division of	10/531772	2008-04-19
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
10/531772	a 371 of international	PCT/US03/38190	2003-11-25
Prior Application Status	Expired		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
PCT/US03/38190	non provisional of	60/462657	2003-04-14

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

PTO/SB/14 (07-07)
Approved for use through 06/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	20030076-DIV3
	Application Number	
Title of Invention	JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR	

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			(•) Yes ( ) No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Remove

Assignee 1

If the Assignee is an Organization check here. [X]

Organization Name	BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION INC.		
Mailing Address Information:			
Address 1	65 Spit Brook Road		
Address 2			
City	Nashua	**State/Province**	NH
Country [i]	US	Postal Code	03061
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Andrew P. Cernota, Reg. No. 52,711/			Date (YYYY-MM-DD)	2009-06-25
First Name	Andrew	Last Name	Cernota	Registration Number	52711

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

Privacy Act Statement

The Privacy Act of 1974 (P.L. 93-579) requires that you be given certain information in connection with your submission of the attached form related to a patent application or patent. Accordingly, pursuant to the requirements of the Act, please be advised that: (1) the general authority for the collection of this information is 35 U.S.C. 2(b)(2); (2) furnishing of the information solicited is voluntary; and (3) the principal purpose for which the information is used by the U.S. Patent and Trademark Office is to process and/or examine your submission related to a patent application or patent. If you do not furnish the requested information, the U.S. Patent and Trademark Office may not be able to process and/or examine your submission, which may result in termination of proceedings or abandonment of the application or expiration of the patent.

The information provided by you in this form will be subject to the following routine uses:

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.

3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

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8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

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JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

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RELATED APPLICATIONS

[0001] This application is a divisional of U.S. Patent Application No. 12,251,575, filed 10/15/2008, which is a divisional of U.S. Patent Application No. 10/531,772, filed 04/19/2008, which is a U.S. National Phase Application of PCT Application No. PCT/US2003/038190, filed November 25, 2003, which claims the benefit of U.S. Provisional Application No. 60/462657, filed April 14, 2003. This application is also related to U.S. Patent application Serial No. 10/105,918, filed March 25, 2002 entitled "System for Decreasing Processing Time in an Iterative Multi-User Detector System"; U.S. Patent Application Serial No. 10/414,738 filed April 16, 2003 entitled "System and Method for Increasing Throughput in a Multiuser Detection Based Multiple Access Communications System"; U.S. Patent Application Serial No. 10/208409 entitled "Power and Confidence Ordered Low Complexity Soft TurboMUD with Voting System"; and U.S. Patent Application Serial No. 12/251,571, filed October 15, 2008 entitled "JOINT SYMBOL, AMPLITURE, AND RATE ESTIMATOR". Each of these applications is herein incorporated in their entirety by reference.

FIELD OF THE INVENTION

[0002] The present invention relates to communications and more particularly to co-channel communications, and more particularly to increasing capacity by allowing interfering channels.

BACKGROUND OF THE INVENTION

[0003] The telecommunications industry has been expanding at an unprecedented growth rate throughout the World. In particular, the wireless sector, including cell phones, PCS, wireless local area networks and Bluetooth such as IS95, GSM, 3G, IEEE 802.11a/b/g, and 802.16 has grown far beyond expectations and at a much higher rate than the fixed

telecommunications (wired) counterpart. The ability to access data and communicate anywhere at anytime has enormous potential and commercial value.

[0004] The content of the wireless sector is also changing, with more and more data being transmitted, including Internet connectivity and live feeds. The usage involving personal digital assistants (PDA's) and even smart appliances have created new markets utilizing wireless data communications. Despite advancements in wireless transmission and reception, there is a growing problem of extracting more information signals within a limited bandwidth.

[0005] Emerging multiple-access receiver processing procedures allow for multiple users to access the same communications medium to transmit or receive information. Multiple access communication systems allow the transmission of multiple digital data streams between multiple transmitting and receiving devices. However, since many users transmit energy on the same communications channel, a number of inherent difficulties arise, particularly when receivers attempt to detect the information associated with a particular user when there is heavy signal interference created by other users of the system at the same time. Typically the signal of interest cannot be received or the quality of reception is significantly degraded.

[0006] For example, a base station that processes a number of cellular devices has to receive and transmit data within a certain frequency range. The ability to extract the correct data from a given user is a difficult task when the effects of interference and multipaths are considered. The problem is further complicated when the number of users exceeds the number of dimensions (e.g. time slots, frequency slots, polarizations, etc), resulting in an overloaded condition.

[0007] In addition to the problems associated with multiple users in a given bandwidth, an additional problem is the inability to process the data in the receivers in real time. Advanced receiver techniques cover several areas, namely interference suppression (also called Multi-User Detection or MUD), multipath combining and space-time processing, equalization, and channel estimation. These various techniques can be mixed and matched depending upon the circumstances.

[0008] One way of alleviating some of the multiple access problems is to separate the interfering transmissions at the receiver using signal processing techniques. However, state of the art receivers are not capable of detecting and decoding the information associated with each user under conditions of heavy interference. Another solution to the co-channel interference problem is to decrease the number of users per channel. This, of course, is not an attractive option for telecommunication companies, since obtaining the maximum number of users or managing peak volume transmission periods are important business objectives.

[0009] It should be understood that the discussion herein illustrates wireless cellular communications the multiple access topologies are equally applicable to wired cable systems and local area networks, read/write operations of a disc drive, satellite communications and any application that benefits from extracting digital information from among many multiple interfering signals.

[0010] Several techniques are used to improve results in co-channel multiple access communications systems. Frequency-Division Multiple Access (FDMA) assigns a different frequency to each user and parses an allocated band for a communication system wherein a single user's signal transmission power is concentrated into a single narrower radio frequency band. Interference from adjacent channels is limited by the use of band pass filters, however for each channel being assigned a different frequency system the total capacity is limited by the available frequency slots and by physical limitations imposed by frequency reuse. In a cellular telephone configuration this poses problems because all proximate cells must operate on different frequencies. However, frequency bands may be re-used, provided that the same frequency cells are positioned at a certain distance apart. A further drawback with FDMA schemes is that users will pay full-time for their assigned frequency regardless of their actual use of the system.

[0011] Code Division Multiple Access (CDMA) is another multiplexing technique wherein for each communication channel the signals are encoded using a sequence known to the transmitter and the receiver for that specific channel. In CDMA, all users use the same frequency at the same time. However, before transmission, the signal from each user is multiplied by a distinct signature waveform. The signature waveform is a signal that has a larger bandwidth than the information-bearing signal from the user. However, in a

CDMA system, the total level of co-channel interference limits the number of active users at any instant of time.

[0012] In Time Division Multiple Access (TDMA) technology, multiple channels of data are temporally interleaved, i.e. each signal is assigned to a different time interval and the signals are transmitted individually, according to their assigned time slot. The TDMA channel consists of a time slot or frame in a periodic train of time intervals over the same frequency, with a given signal's energy confined to one of these time slots. However, in a TDMA system, all transmitters and receivers must have access to a common clock, as time-synchronization among the users is required. Adjacent channel interference is limited by the use of a time gate or other synchronization element that only passes signal energy received at the proper time. The system capacity is limited by the available time slots (within a given frequency band) as well as by physical limitations imposed by frequency reuse, as each channel is assigned a different time slot within a particular frequency band.

[0013] One of the goals of FDMA and TDMA systems is to try and prevent two potentially interfering signals from occupying the same frequency at the same time. In contrast, Code Division Multiple Access (CDMA) techniques allow signals to overlap in both time and frequency. CDMA signals share the same frequency spectrum at the same time, hence, the CDMA signals appear to overlap one another. The scrambled signal format of CDMA virtually eliminates cross talk between interfering transmitters.

[0014] In a CDMA system, each signal is transmitted using spread spectrum techniques. The transmitted informational data stream is impressed upon a much higher rate data stream termed a signature sequence. The bit stream of the signature sequence data is typically binary, and can be generated using a pseudo-noise (PN) process that appears random, but can be replicated by an authorized receiver. The informational data stream and the high bit rate signature sequence stream are combined by multiplying the two bit streams together, assuming the binary values of the two bit streams are represented by +1 or -1. This combination of the higher bit rate signal with the lower bit rate data stream is called spreading the informational data stream signal. Each informational data stream or channel is allocated a unique signature sequence.

[0015] In operation, a stream of spread information signature signals are modulated by weights corresponding to the information that is to be transmitted. Some modulation

examples include binary phase shift keying (BPSK) and quadrature phase shift keying (QPSK). If several transmitters modulate their data onto the signature waveform and modulate again with the carrier tone, a radio frequency (RF) signal comprised of a continuous stream of information modulated signature pulses will be present at the receiver, one corresponding to each transmitter. The plurality of transmitted signals and are jointly received as a composite signal at the receiver. Each of the spread signals overlaps all of the other spread signals in time and frequency. Moreover, environmental noise as well as receiver electronic noise is also present in the measured received signal. The state of the art receiver correlates the composite noisy signal with one of the unique signature sequences, and the corresponding information signal is isolated and despread while the other signals appear as only small additions to the noise floor.

[0016] A signature sequence is often used to represent one bit of information. Receiving the transmitted sequence or its complement indicates whether the information bit is a +1 or -1, sometimes denoted "0" or "1". The signature sequence usually comprises N pulses, and each pulse is called a "chip". The entire N-chip sequence, or its complement, depending on the information bit to be conveyed, is referred to as a transmitted symbol.

[0017] The receiver correlates the received signal with the complex conjugate of the known signature sequence to produce a correlation value. When a 'large' positive correlation results, a "0" is detected, and when a 'large' negative correlation results, a "1" is detected.

[0018] It should be understood that the information bits could also be coded bits, where the code is a block or convolutional code. Also, the signature sequence can be much longer than a single transmitted symbol, in which case a subsequence of the signature sequence is used to spread the information bit.

[0019] The prior systems do not properly account for the real world mobile communication signals that suffer from signal degradation such as interference and multipath problems. The systems of the state of the art generally tended to make assumptions that all other interferers and multipaths were additive white Gaussian noise. However, this assumption is not accurate for co-channel interference and multipaths.

[0020] Multipath dispersion occurs when a signal proceeds to the receiver along not one but many paths so that the receiver encounters echoes having different and randomly

varying delays and amplitudes. The receiver receives a composite signal of multiple versions of the transmitted symbol that have propagated along different paths, called rays, having different relative time. Each distinguishable ray has a certain relative time of arrival, a certain amplitude and phase, and as a result, the correlator outputs several smaller spikes. RAKE receivers are well known and attempt to 'rake' together all the contributions to detect the transmitted symbol and recover the information bit.

[0021] Conventional RAKE receivers provide satisfactory performance for operation in the presence of multipath under ideal conditions however the signature sequence must be uncorrelated with time shifted versions of itself as well as various shifted versions of the signature sequences of the other CDMA signals. Co-channel interference refers to signals received from other users either directly or reflected. If one received signal corresponding to the signature sequence of interest has a non-negligible cross correlation with the received signal originating from another transmitter (a co-channel interferer), then the value measured at the receiver, e.g. the correlation value for the signal of interest, is corrupted. In other words, the correlation computed at the receiver that would be used to decode a particular signal of interest is overwhelmed by an interfering signal; this is referred to as the near-far problem. The interference caused by an echo of one transmitted symbol overlapping with the next transmitted symbol might also be non-negligible. If this is the case, the transmitted symbols interfere with past and future transmitted symbols. This is commonly referred to as intersymbol interference (ISI). In actuality, performance is degraded both by co-channel interference and ISI.

[0022] There has been much research to address signal interference with known multipath time dispersion. This is termed joint demodulation with no multipath and is further described in S. Verdu, "Minimum Probability of Error For Asynchronous Gaussian Multiple-Access Channels," IEEE Trans. Info. Theory, Vol. IT-32, pp. 85-96, R. Lupas and S. Verdu, "Linear multiuser detectors for synchronous code-division multiple-access channels," IEEE Trans. Inform. Theory, Vol. 35, pp. 123-136, Jan. 1989; and R. Lupas and S. Verdu, "Near-far resistance of multiuser detectors in asynchronous channels," IEEE Trans. Commun., Vol. 38, pp. 496-508, Apr. 1990.

[0023] There are a host of approaches for jointly demodulating any set of interfering digitally modulated signals, including multiple digitally modulated signals. Maximum

Likelihood Sequence Estimation determines the most likely set of transmitted information bits for a plurality of digital signals without multipath time dispersion. The maximum likelihood joint demodulator is capable, in theory, of accommodating the largest number of interfering signals, but has a prohibitive computational complexity that makes it unrealizable in practice. The decorrelation receiver is another, less computationally complex receiver processing approach that zeroes out or decorrelates the different signals so that they no longer interfere with one another. The decorrelator as well as virtually every other lower complexity joint demodulator, is not capable of operation when the number of signals is over a set threshold which falls significantly short of the theoretical maximum.

[0024] In a real world multi-user system, there are a number of independent users simultaneously transmitting signals. These transmissions have the real-time problems of multi-path and co-channel interference, fading, and dispersion that affect the received signals. As described in the prior art, multiple user systems communicate on the same frequency and at the same time by utilizing parameter and channel estimates that are processed by a multi-user detector. The output of the optimal multi-user detector operating within the multiuser capacity limits of the channel is an accurate estimation as to the individual bits for an individual user.

[0025] Moreover, in an article by Paul D. Alexander, Mark C. Reed, John A. Asenstorfer and Christian B. Schlagel in IEEE Transactions on Communications, vol. 47, number 7, July 1999, entitled "Iterative Multi-User Interference Reduction: Turbo CDMA," a system is described in which multiple users can transmit coded information on the same frequency at the same time, with the multi-user detection system separating the scrambled result into interference-free voice or data streams.

[0026] Low complexity multiuser detector have been contemplated that use linear multiuser detectors to achieve optimal near-far resistance. (Near-Far Resistance of Multiuser Detectors for Coherent Multiuser Communications, R. Lupas, S. Verdu, IEEE Trans. Commun. Vol. 38, no. 4, pp 495-508, April 1990). While providing certain advantages, the performance has not been demonstrably improved. Varanasi and Aazhang proposed a multistage technique as described in the article Near-Optimum Detection in

Synchronous Code-Division Multiple Access Systems, IEEE Trans. Commun., Vol. 39, No. 5, May 1991.

[0027] Decorrelating decision feedback detectors (DDFD) have been described by A. Duel-Hallen in Decorrelating Decision-Feedback Multiuser Detector for Synchronous Code-division Multiple Access Channel, IEEE Trans. Commun., Vol. 41, pp 285-290, Feb. 1993. Wei and Schlegel proposed soft-decision feedback to suppress error propagation of the DDFD in Synchronous DS-SSMA with Improved Decorrelating Decision-Feedback Multiuser Detection, IEEE Trans. Veh. Technol., Vol. 43, pp 767-772, Aug. 1994. Tree-type maximum-likelihood sequence detectors were also proposed for multiuser systems as were breadth-first algorithms and sequential detection including using the M-algorithm tree-search scheme with a matched filter (MF). The prior references also reveal schemes that include some form of decorrelating noise whitening filter (WF).

[0028] However, one of the primary disadvantages of the prior references implementations is the inability to accommodate overloaded conditions. Decision feedback techniques are limited in that they are incapable of working in supersaturated environments. Although the MMSE-based decision feedback detector can work in a supersaturated environment, it has been demonstrated to be too aggressive with hypothesis testing to produce accurate results.

[0029] Multi-user detection (MUD) refers to the detection of data in non-orthogonal multiplexes. MUD processing increases the number of bits available per chip or signaling dimension for systems having interference limited systems. A MUD receiver jointly demodulates co-channel interfering digital signals. Multiuser detection systems take full advantage of all information available at the receiver, by making use of any "knowledge" that the receiver has about the interfering signals. Because the number of users that can be packed into a MUD-based multiple access (MA) system is a function of the number of independent dimensions over which the set of signals is spread (the dimension of the span of the set of signals), the total number of users in the system can be increased if more dimensions are used for transmitting the signals and the same dimensions are accessible at the receiver.

[0030] In addition to expanding the number of dimensions, favorably “spreading” the received signals out over those dimensions can also allow for increases in the number of users a MUD-based system can accommodate. For example, typical signaling sets for

multiuser communications do not include as a free parameter the reference amplitude of each user. In the IS95 code division protocol, amplitude is controlled completely for purposes of power control to meet a signal-to-noise specification (all users ideally being received with the same signal-to-noise ratio (SNR)). Therefore the advantages offered to the MUD are not exploited and the aggregate throughput of a multiple access system is limited if amplitude is not exploited.

[0031] There are various multiuser detectors in the art, including optimal or maximum likelihood MUD, maximum likelihood sequence estimator for multiple interfering users, successive interference cancellation, TurboMUD or iterative MUD, and various linear algebra based multi-user detectors such as all of those detailed in the well-known text "Multiuser Detection" by Sergio Verdu. In the state of the art, algebraic means are used to compute linear operators for the entire set of users (communications channels) simultaneously. This is done by utilizing prior information, or knowledge of the likely value of each user's bit of information, each at a particular instant in time. This multiuser detection processing is described in the text S. Verdu, Multiuser Detection, Cambridge Press, 1998. However, this suffers from a significant disadvantage in that it requires knowledge of all parameters to perform the processing.

[0032] Optimal MUD based on the maximum likelihood sequence estimator operates by comparing the received signal with the entire number of possibilities that could have resulted, one for each bit or symbol epoch. The number of possible measured levels for the received signal is exponentially related to the number of users and the duration of the ISI. Hence, the optimal processing is a computationally complex and it is not possible to accomplish in a real-time environment. Thus for those multi-user detectors that examine the entire space, real-time operation is often elusive.

[0033] In general, optimal MUD units function by examining a number of possibilities for each bit. However, for multi-user detectors that examine a larger capacity of signal, the computations are complex and time-consuming, thus making real-time operation impossible. Numerous attempts at reliable pruning of the optimal MUD decision process or the use of linear approximation to the replace the optimal MUD have still not produced a workable solution for the real world environment.

[0034] There are several suboptimal multiuser detectors that are less computationally complex and known in the art. One example of suboptimal detectors, called linear detectors, includes decorrelators, minimum mean square error or MMSE detectors, and zero-forcing block linear equalizers. The conventional Minimum Mean Squared Error (MMSE) Multiuser detector utilizing prior information is described by Wang and Poor in "Iterative (Turbo) Soft Interference Cancellation and Decoding for Coded CDMA", in the Transactions on Communications, July 1999. See also Alexander, Reed, Asenstorfer, and Schlegel, "Iterative Multiuser Interference Reduction: Turbo CDMA," IEEE Trans on Comm, July 1999; and Poor, "Turbo Multiuser Detection: An Overview" ISSSTA 2000. But, linear algebra based MUD (non-iterative) and successive interference cancellation fails for cases of overloaded multiple access systems.

[0035] One example of overloading is where the number of simultaneous users is doubled or tripled relative to existing state of the art. Even for underloaded multiple access systems, the performance of non-iterative MUD and successive interference cancellation degrades significantly as the number of users increases, while the computation complexity of the optimal MUD increases significantly as the number of users increases. The computing problems are so extreme that even the most expensive hardware unbound by size and weight can often to keep us with this overwhelming complex processing requirement of optimal MUD. Moreover, an unreasonable delay would be required to decode each bit or symbol rendering such a system useless in practice.

[0036] Reduced complexity approaches based on tree-pruning help to some extent to eliminate the improper bit combination from consideration where, ideally, such a procedure should prune out many 'bad' paths in the decision tree but maintain the proper path. Thus, the entire tree does not need to be traversed to make the final decision.

[0037] The M-algorithm is a pruning process that limits the number of hypotheses extended to each stage to a fixed tree width and prunes based on ranking metrics for all hypotheses and retaining only the M most likely hypotheses. The T-algorithm prunes hypotheses by comparing the metrics representing all active hypotheses to a threshold based on the metric corresponding to the most-likely candidate. Performance of M-algorithm based MUD degrades as the parameter M is decreased, but M governs the number of computations required. Similar effects are seen for other tree-pruning based

MUD (T- algorithm, etc). To combat improper pruning, basic tree-pruning must ensure that M is "large enough", and therefore still encounters increased complexity for acceptable performance levels when the number of interfering signals and/or ISI lengths are moderate to large.

[0038] As an illustration of the M-algorithm as a tree-pruning algorithm, consider a tree made up of nodes and branches. Each branch has a weight or metric, and a complete path is sequences of nodes connected by branches between the root of the tree and its branches. When applied as a short cut to the optimal MUD, each branch weight is a function of the signature signal of a certain transmitter, the possible bit or symbol value associated with that transmitter at that point in time, and the actual received signal which includes all the signals from all the interfering transmissions. The weight of each path is the sum of the branch metrics in a complete path. The goal of a tree searching algorithm is to try to find the complete path through a tree with the lowest metric. With the present invention the metrics of multiple complete paths are not calculated. Rather, the metrics of individual branches in a tree are calculated in the process of locating one complete path through the tree and thereby defines one unknown characteristic of each of the co-channel, interfering signals needed to decode the signals.

[0039] A MUD algorithm within the TurboMUD system determines discrete estimates of the transmitted channel symbols, with the estimates then provided to a bank of single-user decoders (one decoder for each user) to recover the input bit streams of all transmitted signals. Two general types of multi-user detectors within the TurboMUD system are possible, namely those that provide hard outputs, which are discrete values, and those that provide soft outputs, which indicate both the discrete estimate and the probability that the estimate is correct. In basic terms, turbodecoding refers to breaking a large processing process into smaller pieces and performing iterative processing on the smaller pieces until the larger processing is completed, and this basic principle was applied to the MUD.

[0040] However, single-user decoders operating on hard values, or discrete integers, have unacceptable error rates when there is a large amount of interference or noise in the received signal. The reason is that discrete integers do not provide adequate confidence values on which the single-user decoder can operate. These decoders operate better on so-

called soft inputs in which confidence values can range from -1 to 1, such as for instance 0.75 as opposed to being either -1 or +1. To provide soft values that can then be utilized by a single-user decoder, the multi-user detector chosen for the TurboMUD can generate these soft values. The invention described below will work with soft output or a hard output MUDs, or a combination of the two.

[0041] In general, soft or hard output versions of the optimum maximum likelihood multi-user detector (Verdu, Multiuser Detection, Cambridge University Press, 1998) or an M algorithm (as described, for instance, in Schlegel, Trellis Coding, IEEE Press, 1997) with a moderate to high value of M causes the Turbo MUD to require too many computations to keep up with real time transmissions. Using a fast, but inferior, multiuser detection scheme such as a linear-based detector or those detailed in the text "Multiuser Detection" by Sergio Verdu causes poor quality output when there are many interferers or users.

[0042] Moreover, when dealing with hand-held communications units such as wireless handsets, the amount of processing within the device is limited, directly limiting the amount of computational complexity that is allowed. In order to provide real-time performance both at a cell site and the handset, it therefore becomes important to be able to reduce the amount of computational complexity and processing time so as to achieve real-time performance.

[0043] A great number of communications and data transfer systems operate at or near a full capacity. Conventional receiver performance is unsatisfactory in the presence of co-channel interference. Furthermore, many receivers require prior knowledge of signal parameters such as phase and amplitude of the channel to perform processing functions without co-channel interference. What is needed is a means to increase the number of available channels, by reassigning channels to be perhaps slightly interfering, thereby increasing the overall throughput without increasing bandwidth. Such a system should provide an efficient means of jointly estimating symbols, channel amplitude, and data rate transmitted in a super-saturated communications channel. And, any such invention should have the ability to estimate the symbols and data rate, blindly without prior knowledge of channel amplitudes and phase.

BRIEF SUMMARY OF THE INVENTION

[0044] While adaptable in many forms, one embodiment of the invention is an apparatus for processing a digital data stream from multiple users, comprising an initial amplitude estimation unit processing the data stream and producing initial amplitude estimates on a first iteration. There is a joint amplitude estimator coupled to the data stream and the initial amplitude estimator, wherein the joint amplitude estimator produces updated amplitude estimates. A symbol estimator is coupled to the data stream, the initial amplitude estimator, and the joint amplitude estimator, wherein the symbol estimator produces a plurality of symbols estimates for each user. There is a bank of decoders coupled to the symbol estimator, producing a plurality of symbol likelihood estimates for each user, wherein the symbol likelihood estimates are iteratively fed back to the symbol estimator and the joint amplitude estimator until a final condition is obtained.

[0045] Further variations of the invention include wherein the final condition is selected from at least one of the group consisting of: bit error rate metric level and fixed number of iterations.

[0046] The symbol hypothesis testing module can generally be any module that is a member selected from at least one of the group consisting Minimum Mean Squared Error (MMSE), maximum likelihood, M-algorithm, T-algorithm, and Q-algorithm, decorrelating decision-feedback detector (DDFD), improved decorrelating decision-feedback detector (IDDFD), successive interference cancellation (SIC), parallel interference cancellation (PIC) and multi-stage detector; block-iterative interference cancellation; and a deferred decorrelating decision-feedback detector.

[0047] The apparatus can further comprise an energy detector coupled to the joint amplitude estimator which can determine activity on a channel, such as code, time slot or frequency channel.

[0048] The bank of decoders can be selected from at least one decoder of the group consisting of: Soft-output Viterbi , Maximum A Posteriori , and BCJR.

[0049] Another embodiment includes a method for providing initial amplitude estimation for a plurality of user channels, comprising separating the user channels into active channels and inactive channels. Processing the inactive channels is according to the sub-steps comprising applying a bank of filters to the inactive channels for each inactive user,

squaring an output from the filters, summing an output from the squaring operation, and calculating an average bias estimate from an output of the summing. Processing the active channels is according to the sub-steps comprising applying a bank of filters to the user data of the active channels, squaring an output from the bank of filters, summing an output from the squaring, and removing the average bias estimate from an output from the summing.

[0050] The method can include processing the inactive channels by dividing the inactive channels into groups and calculating at least one group average bias estimate. It can also include processing the active channels by dividing the active channels into groups and respectively removing the at least one group average bias estimate.

[0051] A further variation includes scaling by the summers and may include an energy detector for separating the active channel from the inactive channels.

[0052] Another embodiment of the invention is an apparatus for processing initial amplitude estimates from a data stream of multiple users, comprising an energy detector measuring an energy level of the data stream, wherein the energy detector separates a plurality of active channels from a plurality of inactive channels. There is a bank of filters coupled to the inactive channels, a bank of squaring operators coupled to the bank of filters, a bank of inactive summers coupled to the squaring operators, and an average bias estimator coupled to the inactive summers calculating an average bias estimate. There is also a bank of filters coupled to the active channels, a bank of squaring operators coupled to the bank of filters, a bank of active summers coupled to the squaring operators, and a bias removal section coupled to the active summers and the average bias estimator.

[0053] Another embodiment includes a joint amplitude estimator for a data stream from multiple users, comprising a data stream from the multiple users divided into a plurality of observation intervals. There are a plurality of processing modules coupled to the observation intervals, wherein the processing modules calculates interference cancellation values for each of the users and computes a filter for each of the observation intervals. The filter being applied to the data within the observation interval is used to compute individual amplitude estimates. There is an amplitude estimation unit that processes the individual amplitude estimates and calculates new amplitude estimates, wherein the new amplitude

estimates are iteratively passed back to the processing modules until a final condition is obtained.

[0054] One aspect includes where the amplitude estimation unit sums and weighs the individual estimates such that the new amplitude estimate is a weighted average of individual amplitude estimates.

[0055] It should be understood that the observation intervals may be based on distinguishing attributes selected from at least one of the group consisting of: time, code, and frequency.

[0056] The filter may be calculated for an arbitrary observation interval m by the equation:

$$G_m = \mathbf{B}_m \mathbf{S}_m^H \left(\mathbf{S}_m \chi_m \mathbf{S}_m^H + \sigma_n^2 I \right)^{-1}.$$

[0057] Yet a further embodiment includes a method for processing amplitude estimates for a multiuser data stream divided into a plurality of observation intervals, comprising computing a filter for each observation interval of the data stream, applying interference cancellation to the data stream for each observation interval, applying the filter to the data stream for each observation interval from the interference cancellation to produce individual amplitude estimates for each observation interval, computing new amplitude estimates using the individual amplitude estimates; and passing the new amplitude estimates back to the filter for iterative processing until a final condition is obtained.

[0058] One embodiment is a turbo-decoding system for joint signal demodulation, comprising a data stream from a plurality of users divided into a plurality of observation intervals. There is a plurality of symbol processing nodes processing the observation intervals to compute symbol estimates for the data stream within the observation interval. A plurality of decoder nodes is present for processing the symbol estimates and producing a plurality of symbol likelihoods. There is a plurality of amplitude update nodes processing the symbol likelihoods and calculating a plurality of amplitude update vectors. And, there is an amplitude estimator node processing the amplitude update vectors and producing an amplitude estimate update, wherein the amplitude estimate update is passed back to the processing nodes for iterative processing between the symbol processing nodes,

the decoder nodes, the amplitude update nodes, and the amplitude estimator node until a final condition is obtained.

[0059] The turbo-decoding system can encompass a plurality of memory units, wherein at least one memory unit is coupled to each of the processing nodes and to each of the amplitude estimation nodes. There can also be a first system area network (SAN) coupling the processing nodes and the decoder nodes, a second system area network (SAN) coupling the decoder nodes and the amplitude estimation nodes, a third system area network coupling the amplitude estimation nodes and the amplitude estimator, and a fourth system area network coupling the amplitude estimator and the processing nodes. The processing nodes, the decoder nodes and the amplitude estimation nodes can even be one set of nodes. A set of nodes can also be comprised of at least one processor.

[0060] A further embodiment of the system includes wherein the likelihood symbols from the decoders are accessible at any time for post-processing. The processing nodes can further comprise a thresholder to convert the symbol estimates to symbol bits. And, the bank of decoder can also perform de-interleaving, rate identification, de-puncturing and de-scrambling.

[0061] The features and advantages described herein are not all-inclusive and, in particular, many additional features and advantages will be apparent to one of ordinary skill in the art in view of the drawings, specification, and claims. Moreover, it should be noted that the language used in the specification has been principally selected for readability and instructional purposes, and not to limit the scope of the inventive subject matter.

BRIEF DESCRIPTION OF THE DRAWINGS

[0062] **Figure 1** illustrates a basic diagrammatic processing perspective for the prior art transmitter end and receiver end with iterative multiuser detection processing;

[0063] **Figure 2** is a block diagram perspective showing joint symbol amplitude and data rate estimator for one embodiment of the invention;

[0064] **Figure 3** is a schematic block diagram showing initial amplitude estimation;

[0065] **Figure 4** is a schematic block diagram showing joint amplitude estimator;

[0066] **Figure 5** is a schematic block diagram showing parallelization of joint symbol amplitude and data rate estimator; and

[0067] **Figure 6** is a schematic block diagram showing hardware conceptualization according to one embodiment of the present invention with nodes used to depict the processing.

DETAILED DESCRIPTION OF THE INVENTION

[0068] The methods and embodiments of the joint symbol, amplitude and rate estimator disclosed herein enable implementations of advanced receiver processing providing high quality real-time processing for multiple access systems, including overloaded situations. One embodiment illustrates the signal processing technique applicable to many variations that are all within the scope of the invention. It should be understood that the reference to a data stream of multiple users is understood to represent digital data from a number of references and not necessarily multiple users in communications.

[0069] In order to fully appreciate the processing of the present invention, it is useful to consider a description of the processing known in the art. Referring to **Figure 1,** prior art transmitter section **5** and receiver section **10** is depicted with MUD processing. There are *K* users with data $d_1 - d_k$ as the input to the channel encoders **20** where the data is convolutionally encoded at a code rate R_k. The interleaver **25** performs the interleaving of the data, which is then symbol mapped by the symbol mapper **30**, such as BPSK symbol mapped with data symbols having a duration T. Each data symbol is then modulated by a spreading waveform from the spreader **35**, and the signal data $s_k(t)$ is output from the transmitter end with a number of data symbols per user per frame. In the typical wireless communication application presented herein, a number of users (1-K) generate signals that are transmitted by antennas **40** into free space. The transmission on hard-wire or fixed wire systems is also known in the art, however the present example is directed towards the wireless communications systems. Noise n(t), such as white Gaussian noise, is an inherent component of most transmission signals and some random noise components are generally present in transmitted data signals r(t).

[0070] On the receiving end **10**, antenna(s) **42** receive the transmitted signals r(t) as well as the various interfering signals, such as n(t). There is normally a noise component n(t)

that is introduced from the environment of a random nature in the received signal. While any noise that has a repeatable or non-random nature can be eliminated through processing, random noise elements are reduced in other manners such as filtering but are inherent conditions. The various signals are received at antennas **42** wherein there is typically one signal for each polarization feed. The received signals represent directly received signals, as well as multi-path signals from the same user, and interfering signals from other users.

[0071] The input signals of raw non-manipulated data at the receiver **10** is comprised of the aggregate of many signals from many different transmitters/users, where each signal is generally assigned a channel (frequency, timeslot, and/or spreading code) from a finite set of channels. The interference from these various users generally requires complex processing and associated processing time. The input data represents a vector of data, transferred at some rate (e.g., the symbol rate), and this data is typically transmitted to a matched filter (not shown).

[0072] The plurality of signals from each antenna **42** is processed in a RF front end unit **44**. The front end unit **44** generally downconverts the higher frequency signals into baseband signals and provide processing and filtering as is known in the art. The baseband signals are also digitized by analog to digital converters (ADC). The front end **44** cooperates with the parameter estimation unit **46** to retrieve needed information for the signals such as relative received timing offsets, carrier phase, frequency offsets, received amplitudes, and multipath structure for each of the interfering signals present in the received signal.

[0073] A parameter estimation unit **46** is coupled to the front end **44** and processes the various parameters for the received vector data. A parameter estimator **46**, as known in the art, is a broad description for a unit that provides information to the MUD **50** such as convolutional code, signatures, and multiplexing format. While the term parameter estimator is used herein, the term is intended to be interpreted in the broader sense as known in the joint demodulation field. The parameter estimation module **46** generally tries to estimate timing, signal amplitudes, phases, polarization, and identification of transmission channels.

[0074] The MUD element **50** consists of functional blocks that process the digital data and extract the user symbol streams. The MUD **50** performs pre-processing and converts

the baseband digital data into the proper format for further processing according to the detection scheme. The format is often one measurement per 'dimension' per symbol. The MUD unit **50** outputs a bit (or symbol) stream associated with each interfering signals present on the channel for one data block.

[0075] Turbo MUD processing assumes knowledge of various parameters such as relative received timing offsets, carrier phase, frequency offsets, received amplitudes, and multipath structure for each of the interfering signals present in the received signal. This input data represents raw data after some front end processing such as downconversion, amplification, and analog-to-digital conversion. MUD **50** needs some raw data parameters in order to establish accurate decision trees for processing.

[0076] There is an iterative processing topology with a MUD section **50** that interacts with the *K* number of channel decoders **65** for the received signal r(t) for each user. The multiuser detector **50** is generally a SISO detector, receiving and outputting soft values, although hard value processing is known in the art. The MUD section **50** utilizes a priori information and delivers values such as a posteriori log-likelihood ratio (LLR) data of a transmitted '+1' or '-1' for each bit of every user. Certain a priori information is computed by the channel decoder **65** from a previous iteration which is interleaved and fed back to the MUD section **50**. The interleaver **60** and deinterleaver **75** perform the interleaving and deinterleaving functions respectfully for the encoding schema. Likewise, the summers **55**, **70** perform the summations for the data. Once the processing is complete the channel decoders **65** produce the output data stream (dk)' representing the best estimate of the transmitted signal (dk).

[0077] Various schemes for TurboMUD processing are well known in the art and utilize a priori information about the received signals wherein the processing continues through a number of iterations until certain conditional parameters are satisfied. The basic Turbo-Mud procedure is presented in published literature such as Poor, "Turbo Multiuser Detection: An overview," IEEE 6th Int. Symp. On Spread-Spectrum Tech. And Appli., NJIT, New Jersey, Sept. 6-8, 2000 and Alexander, Reed, Asenstorfer, and Schlegel, "Iterative Multiuser Interference Reduction: Turbo CDMA," IEEE Trans. On Comms., v41, n7, July 1999. The iterative MUD algorithm such as representative of the approaches

used to incorporate turbo decoding methods into joint MUD/FEC (Fourier Error Correction) decoding and to then reduce the complexity of the system are known in the art.

[0078] The bit streams from the MUD **50** are passed to a bank of error correction decoders unit **65**. The decoders **65** calculate conditional probabilities, one for each decoded symbol of each user, and output them as confidence values back to the MUD **50**. In one embodiment, there is a bank of error correction decoders **65** such as Viterbi decoders or MAP.

[0079] Soft outputs for each bit of each user from the bank of decoders **65** is fed back to the multiuser detector **50** for each iteration, one stream of outputs for each interfering user present in the received signal. These soft outputs are passed back to the MUD **50** to produce an improved stream of soft bit (or symbol) decisions that fed into the decoder **65** for another iteration of improvement. The information between the MUD **50** and the decoders **65** repeats in subsequent iterations until an asymptote is reached or the desired performance level is attained. At that point, estimates of the data sequences for all active users are output. Operation then commences for the next block of data, repeating the process described above. The multiuser detector **50** takes these soft inputs along with the original raw input signal to calculate an improved, less corrupted bit stream for each user. This iterative process continues until a desired metric is reached or a fixed number is reached. At that point, estimates of the data sequences for all active users are output. Operation then commences for the next block of data, repeating the process described above.

[0080] The number of iterations for processing between the MUD **50** and the decoders **65** can be set to a fixed counter or by checking if there were significant changes to the data from the last iteration. Once the data is no longer being altered or reaches a certain iteration counter limit, the data from the decoder **65** can be output as final estimates of what the user sent, (dk)'. A fixed number of iterations can be stored and used and processed by the decision block. Alternatively, the information between the multiuser detector **50** and the decoders **65** repeats in subsequent iterations until an asymptote is reached or the desired performance level is attained. A buffer can store the previous values and compare them to the latter processed values during the iterative process.

[0081] MMSE detectors with prior information are usually described in a turbo or iterative application, but also function in non-iterative operations. As described herein, a complete solution to the problem is computed, and one approximate (low complexity) method is described. Furthermore, prior schemes are generally inferior for overloaded systems, and this is alleviated by the present invention.

[0082] The apparatus in **Figure 2** is now described in more detail. A Data Stream **100**, potentially complex, is received from some source. For the case of Code Division Multiple Access (CDMA) communications schemes, the data stream is sampled by some multiple of the chip rate. For TDMA communication schemes, the data stream is sampled at some multiple of the symbol rate. The received signal can effectively be modeled as the linear combination of many co-channel signals, mathematically illustrated by

$$r[n] = \sum_{i=1}^{F} \sum_{k=1}^{K} b_k[i] a_k s_k(nT_n - iT_i) + n_w(nT_n). \qquad \textbf{Equation 1}$$

[0083] The term $b_k[i]$ represents the symbol for user k at time index i. The term $s_k(nT_n - iT_i)$ represents the user's signal characteristic for sample index n for the symbol period i for the user k. The characteristic waveform, $s_k(\cdot)$, is normalized such that the amplitude of the transmitted signal for user k is represented by a_k. The symbol period is defined by T_i and the sample period is represented by T_n. The linear model represents a summation of K separate users and over F symbols. The received signal can represent a collection from multiple sources. For example, the collection may consist of multiple antennas, not necessarily co-located, with potentially different polarizations.

[0084] The user's signal characteristic, $s_k(nT_n - iT_i)$, combines a sequence of signal transformations: pulse shaping filter, signal delays, receiver filters, code channels (for CDMA) and multipath. It should be understood that the characteristic waveform is not restricted to a sample or symbol interval.

[0085] The multiple access interference model in Equation 1 is represented concisely using matrix notation in Equation 2. The KF symbols, corresponding to

the KF simultaneous users, is represented by the KF -element vector, $\mathbf{b}[i]$ at time i. A linear model is used to represent the received signal at time index i by

$$\mathbf{r}[i] = \mathbf{SAb}[i] + \mathbf{n}_w[i], \qquad \textbf{Equation 2}$$

where $\mathbf{b}[i]$ represents the KF symbols at time index i. The term $\mathbf{S}$ is a $N \times KF$ matrix representing the combination of the spreading code, channel codes, pulse shaping filter, and propagation effects

$$\mathbf{S} = \begin{bmatrix} s_1[1,i] & s_2[1,i] & \cdots & s_{KF}[1,i] \\ s_1[2,i] & s_2[2,i] & \cdots & s_{KF}[2,i] \\ \vdots & \vdots & \ddots & \vdots \\ s_1[N,i] & s_2[N,i] & \cdots & s_{KF}[N,i] \end{bmatrix} \qquad \textbf{Equation 3}$$

[0086] The matrix entries, $s_k[n,i]$, represents the nth sample of the signal characteristic waveform for user k at time i. The term $\mathbf{A}$ is a $KF \times KF$ diagonal matrix that represents the complex signal amplitudes, which can include phase and polarization weighting. The term $\mathbf{n}_w[i]$ is a $N \times 1$ vector that represents additive white Gaussian noise (AWGN).

[0087] Referring again to **Figure 2**, the data stream **100** represents a vector of data, representing the received signal. This data is communicated to the symbol hypothesis testing module **105** which is indicated in this implementation as Minimum Mean Squared Error (MMSE) based symbol estimator. The MMSE implementation for symbol hypothesis testing **105** is better for computational efficiency however other forms of symbol estimators such as the maximum likelihood detector are within the scope of the invention. The maximum likelihood detector is a brute force approach which performs an exhaustive evaluation of the Euclidean distances between the received samples and the linear model of the samples using every possible hypothesis of the bit sequence. Instead of the optimal detector for the symbol estimation testing module **105**, more computationally efficient forms of symbol hypothesis testing includes, the M-algorithm, T-algorithm, etc. Although the most efficient approach appears to be the MMSE-based symbol estimator, another

efficient implementation for symbol estimation is referred to as the Q-algorithm, disclosed in U.S. Patent application Serial No. 10/105,918, filed March 25, 2002 entitled "System for Decreasing Processing Time in an Iterative Multi-User Detector System". The Q-algorithm used for the MMSE-symbol estimator cancels interference based on symbol estimates obtained from thresholding the symbol likelihoods.

[0088] The computational efficiency utilizing the MMSE based symbol estimation is described in further details for the MMSE-based joint amplitude estimation and the parallelization of the algorithm. It should be noted that the symbol hypothesis testing is performed following completion of the initial amplitude estimate.

[0089] The same data vector **100** is passed to the initial amplitude estimation module **110**. As indicated by the name, the purpose of initial amplitude estimation module **110** is to provide an initial estimate of the amplitude for each interfering signal. The approach implemented in initial amplitude estimation module **110** consists of incoherently integrating the energy out of a properly normalized matched filter for all users determined to be active. Note these users can be transmitted over code, temporal, and/or frequency channels and this estimation procedure are appropriate for these modes of digital communication. Part of the function performed in the initial amplitude estimation module **110**, is the identification of which users are active. User identification can be easily obtained via an energy detector based on some sufficiently long observation interval that can determine activity on a channel: code, time slot, or frequency channel. The energy detector is generally integrated within the initial amplitude estimation module **110**.

[0090] The initial amplitudes from the estimator **110** are passed to the MMSE-based symbol estimator **105** and the MMSE-based Joint Amplitude Estimator **120**. The MMSE-based symbol estimator **105** uses the initial amplitude estimate only on the first iteration, for all other iterations it uses the amplitude estimates from the MMSE-based Joint Amplitude Estimator **120**. This module may implement any type of symbol hypothesis testing procedure however an MMSE-based approach is used because of computational efficiency. It should be understood that other linear detectors, such as the decorreator, may also be used for computational efficiency. While the linear detectors are efficient, the performance is sacrificed through BER performance and loading capacity.

[0091] There are numerous non-linear symbol-hypothesis testing procedures adaptable to the present invention, including the M-algorithm/T-algorithm; maximum likelihood; decorrelating decision-feedback detector (DDFD) and improved decorrelating decision-feedback detector (IDDFD); successive interference cancellation (SIC), parallel interference cancellation (PIC) or multi-stage detector; block-iterative interference cancellation. A further symbol-hypothesis testing implementation is described in the commonly owned application entitled "Deferred Decorrelating Decision-Feedback Detector for Supersaturated Communications", U.S. Patent Application Serial No. 10/423655, filed April 25, 2003.

[0092] The MMSE-based symbol estimator **105** provides symbols estimates to a bank of single user decoders **130**. The symbols estimates from the symbol estimator **105** are routed to the decoders **130** based on user number. For example, all symbol likelihoods corresponding to the first user are passed to the decoder dedicated to the first user. This mapping is repeated for all users. The single user decoders consist of a bank of K decoders that may consist of Soft-output Viterbi or Maximum A Posteriori based techniques such as BCJR. Soft-input, soft-output (SISO) decoders are used in one embodiment for this implementation, but hard values can be processed as is known in the art.

[0093] Inherent in most processing is a de-interleaving, rate identification, de-puncturing and de-scrambling processing depicted merely as deinterleaving **125** for illustrative purposes. The symbol estimates and their respective likelihoods are output from the bank of decoders **130** for one of the most-likely data rates. In addition, symbol likelihood estimates from the decoders **130** are also fed back around to both the MMSE-based symbol estimator **105** and MMSE-based amplitude estimator **120** respectively. However, prior to feedback the symbol likelihoods are processed by an interleaving section **135** performing re-interleaving, re-puncturing, re-scrambling and symbol repeating (for low rate frames). The purpose of this re-coding task is to properly emulate the interference.

[0094] As referenced herein, the term 'data rate' refers to the rate at which the information bits are transmitted over the channel, defined in terms of bits per second. Sometime the data can be transmitted at one of a number of different rates. The likelihoods of the bits are maximized when the data rate is known. However, if the

receiver is non-cooperative, the 'most likely' data rate must be identified. One approach for determining the most likely data rate is through joint maximization of the bit likelihoods and data rate.

[0095] The new symbol likelihoods from the decoders **130** are used to update previous amplitude estimates in the joint amplitude estimator **120**. The procedure for processing the MMSE-based amplitude estimator is described in further detail herein. The new amplitude estimates from the joint amplitude estimator **120** are passed to the MMSE-based Symbol Estimator **105** that re-estimates the symbols based on prior information on the symbols and the updated parameter estimates. These updated symbol estimates from the symbol estimator **105** are then re-routed to the bank of decoders **130**. This process is repeated for either some fixed number of iterations or until the estimates of the bit error rate or frame error rate achieve some desired level.

[0096] **Figure 3** illustrates the system and processing for calculating initial amplitude estimates with the Initial Amplitude Estimator **110** of **Figure 2**. Referring to **Figure 2** and **Figure 3**, the initial amplitude estimate obtained from the Initial Amplitude Estimator **110** is based on the incoherent integration of the matched filter output of the Active Channel **180** over some observation interval. The procedure consists of applying a bank of matched filters **205**, **230**, **255** for all users K and all symbols F to the received data vector **100**. The $KF \times 1$ vector representing the matched filter outputs is represented by

$$\mathbf{y} = \mathbf{S}^H \mathbf{r} = \mathbf{S}^H \mathbf{S} \mathbf{A} \mathbf{b} + \mathbf{S}^H \mathbf{n}_w . \qquad \textbf{Equation 4}$$

[0097] The estimate of the amplitude for a user k is based on summing the squared outputs of the matched filter for that user k, summed over an observation interval of F symbols. An estimate of the amplitude squared is represented by

$$\hat{a}_k^2 = \frac{1}{F} \sum_{i=1}^{F} \left| y_{i,k} \right|^2 \qquad \textbf{Equation 5}$$

[0098] The summation over F is performed for all K users to obtain K initial amplitude estimates for the K users. Since the estimate is based on incoherent integration,

the estimate is biased which is illustrated by the expected value of the initial amplitude estimate for an arbitrary users k,

$$E\left[\hat{a}_k^2\right] = a_k^2 + \frac{1}{F}\sum_{i=1}^{F}\sum_{\substack{j=1 \\ j\neq k}}^{K}\rho_{j,k}^2(i)a_j^2 \qquad \textbf{Equation 6}$$

where the bias is represented by the last term in Equation 6 and $\rho_{j,k}^2(i) = \left(\mathbf{s}_k^H(i)\mathbf{s}_j(i)\right)^2$.

Note that the bias in Equation 6 is based on the expected values of the bits in the vector b, in Equation 4, equaling zero. This is mathematically represented by

$$E[\underline{b}] = 0$$

In addition, Equation 6 assumes the symbols are defined such that $b_i^2 = 1$. A generalization of Equation 6 for the case of non-zero mean bit values and $b_i^2 \neq 1$ is obvious.

[0099] An inactive user **190** is defined as a signature signal that is not present. The expected value of the amplitude estimate for an arbitrary inactive channel is defined as

$$E\left[\hat{a}_{inactive}^2\right] = \frac{1}{F}\sum_{i=1}^{F}\sum_{j=1}^{K}\rho_{j,inacive}^2(i)a_j^2 \qquad \textbf{Equation 7}$$

where $\rho_{j,inactive}^2(i) = \left(\mathbf{s}_{inactive}^H(i)\mathbf{s}_j(i)\right)^2$. Since no signal is present for inactive users, a nonzero value for the expected value of the estimate for amplitude squared for inactive signature vectors is due to the presence of other active channels. Comparing Equations 6 and 7 reveals that examination of the estimate of squared amplitudes for non-active users can be used to estimate the bias relative to active users. Thus the Initial Amplitude Estimation concept is based on Equations 5 through 7 is illustrated in **Figure 3**.

[00100] A data stream **200** representing the received signal, potentially complex, is received from some source. A bank of filters **205**, **230**, **255**, **280** and **300** is applied to the data stream **100**. The Active Channel **180** set of filters **205**, **230**, **255** consists of filters matched to users that have been determined to be active based on an energy detector.

Filter **205** corresponds to a filter matched to the signature signal for user 1. Similarly, filter **230** corresponds to a filter matched to the signature signal for user 2. It should be noted that the size of the bank of matched filters is based on the number of users determined to be active and represented by the term K.

[00101] The output data from each matched filter (1-K) **205**, **230**, **255** is then processed by a squaring operation **210**, **235**, **260** for all K users. The outputs from the squaring operations **210**, **235**, **260** for each active channel user (1-K) are then passed to a bank of summers **215**, **240**, **265** which performs the incoherent integration. The bank of summer **215**, **240**, **265** for each user 1-K used to implement Equation 5, accumulates energy in each of their respective processing chains. The proper scaling required for averaging is included in the output of the summers. As previously mentioned these estimates of squared amplitude are biased, therefore, the bias removal component must be implemented to minimize the bias.

[00102] A set of filters **280**, **300** for the Inactive Channel **190** representing those channels that were determined to be inactive based on an energy detector. The bank of filters **280**, **300** matched to the inactive user's signature signals is applied to the data stream **200** and processed. The size of the bank of filters **280**, **300** is based on the number of users determined to be inactive, defined herein as the number J.

[00103] Following the processing of the inactive filters **280**, **300** for the users 1-J, the user data is further processed by a squaring operation **285**, **305** for all J users. The outputs from the squaring operations **285, 305** for each inactive channel user (1-J) are then passed to a bank of summers **290, 310**. The bank of summer **290, 310** for each user 1-J accumulates energy in each of their respective processing chains. The proper scaling required for averaging is included in the output of the summers **290, 310**, wherein the output is then processed by the Average Bias Estimator **295**.

[00104] Following the computation of the amplitude bias by the Average Bias Estimator **295**, the bias is passed to Bias Removal **220**, **245**, **270** that is applied to each of the Active Channel Users 1-K. The illustration in **Figure 3** shows the output from the active channel summers **215**, **240**, **265** going to all bias removal modules **220**, **245**, **270**. The initial amplitude squared estimate obtained for the active channels has an estimate of the bias removed in modules **220**, **245**, **270**. Following the bias removal, the initial amplitude

squared estimates **225**, **250**, **275** for each user 1-K are passed out to the remaining processing shown in **Figure 2**.

[00105] **Figure 3** shows the computation of one amplitude bias in module **295**, which is then applied to all bias-removal modules **220**, **245**, and **270**, for all active channels. The processing configuration of **Figure 3** is also extendable to other embodiments in which different biases are computed for different sets of active channels, which are obvious extensions and within the scope of the present invention. For example, in a wireless communications system the bias removal could be restricted to channels within certain sectors. More specifically, for all non-active channels identified in a sector, a bias estimate is computed and then applied to all active channels in the same sector. Therefore, active channels identified in a different sector will only use a bias based on non-active channels in this same sector.

[00106] Referring to **Figure 2**, the initial amplitude squared estimates are updated in the MMSE-based Joint Amplitude Estimator **120**. The apparatus for updating these amplitude squared estimates is described in **Figure 4**. The solution described in **Figure 4** is based on the assumption that the amplitude is nearly constant over some observation window. Since this solution is based on the MMSE criteria, this approach is easily extended to time-varying amplitudes, however, only the windowed based estimator is detailed herein for illustrative purposes. For example, when the amplitude fluctuates by rate, the amplitudes over multiple frames are linked based upon the data rate. Incorporating data rate into the amplitude estimator, the module described in **Figure 4** actually evolves into an energy-per-bit estimator. When the amplitude fluctuates based on temporal instability, then this implementation is extended into a Kalman filter framework by using a temporal model of the channel variation. The Kalman filter equation itself is well known to those in the art.

[00107] Referring to **Figure 2** and **Figure 4**, the stream of data representing the received signal **100** is passed to the MMSE-based Joint Amplitude Estimator **120**. This data stream **100** is divided up into M observation intervals as illustrated by r_1, r_2, through r_M **400**, **405**, **410**. These intervals can be based on distinguishing attributes such as time, code, or frequency. For the example presented herein, the observation interval refers to time. These observation intervals each enter a different processing section **415**, **420**, **430**,

representing 1 to M observation intervals. In each processing module, **415**, **420**, **430**, an MMSE filter is computed which is defined for an arbitrary observation interval m as:

$$G_m = \mathbf{B}_m \mathbf{S}_m^H \left(\mathbf{S}_m \chi_m \mathbf{S}_m^H + \sigma_n^2 I \right)^{-1}. \qquad \textbf{Equation 8}$$

[00108] The term $\mathbf{B}_m$ refers to a diagonal matrix representing the expected bit or symbol value in interval m for all K users. For example,

$$\mathbf{B}_m = \begin{bmatrix} \hat{b}_1 & 0 & \cdots & 0 \\ 0 & \hat{b}_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & \hat{b}_K \end{bmatrix}, \qquad \textbf{Equation 9}$$

where $\hat{b}_k$ represents the expected value of the symbol for user k. For illustrative purposes, for BPSK systems, $\hat{b}_k = 2p_k - 1$, where p_k equals the probability that the symbol equals 1. The term $\mathbf{S}_m$, is similar to that presented in Equation 2, except here $\mathbf{S}_m$ represents the "S-matrix" defined over a single observation interval, while $\mathbf{S}$ in Equation 2 is defined over F observation intervals. Therefore, $\mathbf{S}$ in Equation 2 contains the $\mathbf{S}_m$ defined herein. The term χ_m represents the amplitude uncertainty and is rewritten as:

$$\chi_m = \left(\Omega + \mathbf{A}^2 \right) \Lambda_m \qquad \textbf{Equation 10}$$

which more clearly defined the amplitude uncertainty in terms of the bit uncertainty, Λ_m, the initial amplitude uncertainty, Ω, and the expected value of the amplitude $\mathbf{A}$. The terms, Λ_m, Ω, and $\mathbf{A}$ are all diagonal matrices, and each element along the diagonal corresponding to a different active user, therefore, χ_m is a diagonal matrix. This formulation assumes the amplitudes and corresponding uncertainties are constant for the M observation intervals.

[00109] Following the computation of M different MMSE filters in each of the 1-M modules **415**, **420**, **430**, each MMSE filter is applied to components of the respective data stream **400**, **405**, **410** corresponding to the same observation interval.

[00110] Prior to application of the MMSE filter, interference cancellation is performed based on the expected value of the bits, represented by $\mathbf{B}_m$ and prior estimates of the amplitude for all K users, represented by the $K \times 1$ vector $\underline{a}^{l-1}$. The interference cancellation is represented by

$$\underline{\tilde{r}}_m = \underline{r}_m - \mathbf{S}_m \mathbf{B}_m \underline{a}^{l-1}. \qquad \textbf{Equation 11}$$

And, each MMSE processor cancels out different interference.

[00111] Therefore, application of the MMSE filter following interference cancellation is represented by

$$\Delta \underline{a}_m = G_m \left(\underline{r}_m - \mathbf{S}_m \mathbf{B}_m \underline{a}^{l-1} \right) \qquad \textbf{Equation 12.}$$

[00112] The amplitude estimator is defined in module **435** of **Figure 4**. It is an iterative formulation that updates previous estimates, represented by $\underline{a}^{l-1}$, with information based on new estimates of the users' bits and data rate. These new estimates are represented by $\underline{a}^{l}$. The MMSE-based joint amplitude estimator **435** combines the individual estimates, $\Delta \underline{a}_m$, in a weighted manner. The weighted combination in this embodiment is expressed by:

$$\underline{a}^{l} = \underline{a}^{l-1} + \left(\Omega^{1/2} \left(Q + I \right)^{-1} \Omega^{1/2} \right) \sum_{m=1}^{M} \Delta \underline{a}_m \qquad \textbf{Equation 13}$$

where

$$Q = \sum_{m=1}^{M} Q_m \qquad \textbf{Equation 14}$$

[00113] As indicated by Equation 13 and illustrated in **Figure 4**, the individual estimates from the filter modules **415**, **420**, **430** are passed to the Amplitude Estimator **435** for each interval 1-M. These individual estimates, $\Delta\underline{a}_m$, are $K \times 1$ vectors which are then summed together in Amplitude Estimator **435**. Theses estimates are then weighted by $\left(\Omega^{1/2}\left(Q+I\right)^{-1}\Omega^{1/2}\right)$ where $\Omega^{1/2}$ is a diagonal matrix containing the standard deviation of the amplitude estimates and Q is represented in Equation 14. The term Q is a summation of quadratics computed in the filter modules **415**, **420**, **430**. Each quadratic is computed by

$$Q_m = G_m \mathbf{S}_m \mathbf{B}_m \qquad \textbf{Equation 15}$$

which is shown to be based on the MMSE filter for the respective observation region defined in interval m. Therefore each filter module **415**, **420**, **430** responsible for an observation interval must compute: the MMSE filter (see Equation 8); apply interference cancellation to the section of the data stream corresponding to the observation interval (see Equation 11); apply the MMSE filter to the interference mitigated data vector (see Equation 12); and computed the quadratic (see Equation 15).

[00114] In this embodiment the outputs of each module **415**, **420**, **430** is a $K \times 1$ vector $\Delta\underline{a}_m$ and a hermitian matrix Q_m which is a $K \times K$ matrix with $K\left(K+1\right)/2$ unique elements. These two outputs are passed to the Amplitude Estimator **435** for each interval 1-M. The prior amplitude estimates, $\underline{a}^{l-1}$ are updated to $\underline{a}^{l}$ and passed out from the Amplitude Estimator **435** back to the individual filter modules **415**, **420**, **430** defined for the observation intervals. This feedback is part of the iterative implementation inherent in this MMSE formulation.

[00115] Referring again to **Figure 2**, it should be understood that the amplitude estimates are not updated until the bits (or symbols) have been updated in the bank of decoders **130**. Following the processing by the MMSE-based symbol estimator **105** and the decoders **130** in **Figure 2**, the symbols are fed back to the MMSE-based joint amplitude estimator **120** where prior amplitude estimates are updated as detailed herein. As previously described, the number of iterations is typically dictated by the user which is defined for either a fixed

iteration number or until the frame error rate or estimate bit error rate metric reaches some desired level.

[00116] Once processing is completed, the updated amplitude estimate vector **440** is transmitted from the MMSE-based Joint Amplitude Estimator **120** to the MMSE-based symbol estimator **105**. Since for this particular implementation, the amplitudes are constant over the observation interval described for M smaller observation intervals, the same amplitude estimate **440** is reported to each MMSE-based symbol estimator **105**. This approach is easily modified for a variable amplitude estimate which varies over the entire observation interval.

[00117] The apparatus in **Figure 5** is one embodiment of a hardware implementation that provides a more detailed characterization of the processing shown in **Figure 2**. It should be noted that **Figure 5** shows an implementation that parallels the joint estimation based on M observation intervals. The data stream in **100** of **Figure 2** is partitioned into M observation intervals as the data vectors **500**, **502**, **504**, **506** representing intervals 1 - M. As in previous diagrams, the number of observation intervals is generalized to M intervals. The observation intervals may overlap (not necessarily disjoint) to account for asynchronous reception and multipath signals.

[00118] These data vectors **500**, **502**, **504**, **506** are processed immediately by a bank of MMSE filters which are implemented on the M processors, **520**, **522**, **524**, **526**, for all M observation intervals and each processor simultaneously estimates symbols for all K users. The filter processing can be considered a node, wherein a node is a generic processing component as is known in the art, such as a microprocessor chip or processing board, and wherein it should be readily apparent that there can be more than one processor per node.

[00119] In addition, these data vectors **500**, **502**, **504**, **506** are read into local memory **510**, **512**, **514**, **516** on the processors, because they are used repeatedly for the multiple iterations in this iterative approach to symbol, amplitude, and rate estimation. Any of the forms of memory known in the art are applicable.

[00120] Each symbol estimation MMSE processor, **520**, **522**, **524**, **526** outputs $\underline{b}_m$, which is a vector of K symbol likelihoods or symbol bits for observation interval m. Recall that

K corresponds to the number of users and therefore b_m represents the collection of symbol estimates for K users in observation interval m. Symbol bits are provided on the output if thresholding is performed within the MMSE processor **520**, **522**, **524**, **526**. The output from each MMSE processor, **520**, **522**, **524**, **526**, is intended to represent M $K \times 1$ vectors passed to the system area network (SAN) **530** which will then pass K $M \times 1$ frames of likelihoods (or symbols) to a bank of decoders **532**, **534**, **536**, **538** for each user 1-K. The benefit of supplying likelihoods to the decoders **532**, **534**, **536**, **538** is the improved performance when using soft-decoders. It should be noted that the same processing nodes used for implementing the bank of MMSE filters for symbol estimation for processors **520**, **522**, **524**, **526** can be used to implement the K decoders, **532**, **534**, **536**, **538** which are partitioned between the compute nodes. However, this embodiment also covers an implementation for hardware dedicated to MMSE processing and separate hardware for decoding.

[00121] The following discussion describes one embodiment for an implementation when a bank of processing nodes is used for both MMSE processing and decoding. Symbol likelihoods are routed over the SAN **530** based on the assignment of decoders **532**, **534**, **536**, **538** to processing components for decoding. The SAN **530** routes the M $K \times 1$ vectors of symbol likelihoods from the symbol estimation processing previously used to perform MMSE-based symbol estimation on processors **520**, **522**, **524**, **526** to the same set of processing nodes that now perform the decoder processing on the bank of decoders **532**, **534**, **536**, **538**. The SAN **530** passes K frames of $M \times 1$ symbol estimates to the K decoders **532**, **534**, **536**, **538**, wherein the frames of symbols are represented by $\underline{f}_k$ for the K users. The frames, f_k, represent a frame for each user that contains M symbols.

[00122] The number of decoders **532**, **534**, **536**, **538** corresponds to the number of users, 1-K. The bank of decoders **532**, **534**, **536**, **538** may implement hard-in, soft-out (HISO) or soft-in, soft-out (SISO) decoders. In addition to decoding, the bank of decoders **532**, **534**, **536**, **538** performs descrambling, de-interleaving, de-puncturing, and rate identification. The output of each decoder **532**, **534**, **536**, **538** is, $\underline{f}_k$', which is a $M \times 1$ vector representing an update of M likelihoods in the frame following the implementation of the decoders. In addition, the decoders **532**, **534**, **536**, **538** supply

likelihoods of the information bits values d_k' for the same collection of symbols. These information bits are passed out as output **540**, **542**, **544**, and **546**. The number of bits per user is dependent on the data rate, and there bit likelihoods are available at any time in the iterative scheme for post-processing such as a cyclic reduction check, which is used to determine frame errors. The number of information bits transmitted per second is less than the number of symbols per second. Therefore, the number of information bits will be less than M, which defines the number of symbols per frame.

[00123] The updated likelihoods of the symbols $K\ M \times 1$ vectors of likelihoods, $\underline{f}_k$', are fed-back through SAN **550** and processed by a bank of MMSE filters which are implemented on the M processor nodes, **560, 562, 564, 566**. The $K\ M \times 1$ vectors of likelihoods, $\underline{f}_k$', prior to the SAN **550** are sent to the MMSE filters as $M\ \ K \times 1$ vectors of likelihoods, $\underline{b}_m$'. However, now the bank of MMSE filters is used for amplitude estimation **575**.

[00124] The same bank of $1 - M$ symbol estimation processors **520**, **522**, **524**, **526** used to implement the initial MMSE filters for symbol estimation can be used for the further MMSE filter implementation for amplitude estimation, illustrated by processing modules **560, 562, 564, 566**. The MMSE processing modules **560, 562, 564, 566** in amplitude updating focus on the same observation intervals analyzed during the symbol estimation. The MMSE processors **560, 562, 564, 566** at this stage implement the functionality of the filter module **415**, **420**, **430** of **Figure 4**. This bank of MMSE filters implemented by MMSE processors **560, 562, 564, 566** draw from local memory **552**, **554**, **556**, **558** to retrieve prior amplitude estimates, updated symbol estimates, S-matrices, and the received data vector corresponding to the observation interval m.

[00125] Referring back to **Figure 4**, each amplitude processing module **415**, **420**, **430** computes an amplitude update vector, $\Delta\underline{a}_m$, which is $K \times 1$ vectors. Each amplitude update vector is passed to a central node that implements the functionality of the Amplitude Estimator **435**. In **Figure 5**, all individual update vectors from the amplitude estimation processors **560, 562, 564, 566** are passed to a central processing node **575** via the SAN **570**. As detailed herein, the amplitude estimate is updated by weighting the sum of all amplitude updating vectors, wherein the weighting is based on quadratic terms

reflecting the uncertainty in the update, Q_m. These quadratic terms are also passed to the central node **575** to provide the necessary weighting.

[00126] The SAN **570** passes all $\Delta \underline{a}_m$ vectors (M vectors of size $K \times 1$) and Q_m matrices, (M hermitian $K \times K$ matrices with $K(K+1)/2$ unique elements) from the MMSE processors **560, 562, 564, 566** to the central processing node, **575**. The Amplitude Estimator **575** computes the functionality described for the Amplitude Estimator **435** of **Figure 4** and the updated estimate gets distributed to all M processors used for the next MMSE-based symbol estimation. Therefore, Amplitude Estimator **575** passes the updated amplitude estimate to SAN **580** that fan out these estimates for all K users to the M processors **520**, **522**, **524**, **526** for the symbol estimation processing.

[00127] The updated amplitude estimates refreshes the amplitude estimates stored in the local memory **510**, **512**, **514**, **516** coupled to the MMSE processors **520**, **522**, **524**, **526**. Following the receipt of the updated amplitude estimates, the next iteration of the MMSE-based symbol estimator is implemented. Therefore, the MMSE modules **510**, **512**, **514**, **516** perform the symbol estimation processing and repeat the symbol estimation on the next iteration using the new amplitude estimates. As described herein, the iterative processing continues until estimates of the bit error rate metric achieves a certain level or until a fixed number of iterations have been executed.

[00128] The hardware configuration presented in **Figure 5** is an attractive implementation because bandwidth requirements are minimized by passing a total of only $K \cdot M$ floating point numbers over the SAN **530**, except during amplitude updating when the matrices Q_m are passed over the SAN **570** to a central node **575**. Bandwidth can be further minimized during the amplitude testing by approximating Q_m as a diagonal and therefore pass a total of $2K \cdot M$ floating point numbers during amplitude updating. Since the MMSE operations, both symbol and amplitude, occur at the same processing nodes on processors, **520**, **522**, **524**, **526** and **552**, **554**, **556**, **558**, less data is processed and efficient techniques can be used to exploit previous MMSE filter weights.

[00129] The communications configuration described in **Figure 5**, is more easily recognized in **Figure 6**, which shows 1 - L nodes responsible for all processing. These L

nodes pass data between themselves using a high speed interconnect **625** for the system area network (SAN). The modules **600** correspond to the time when the nodes 1 - L are used to implement the bank of M MMSE filters for symbol estimation in M observation intervals. The symbol estimation processing at node **600** is comparable to processing performed on MMSE processors **520**, **522**, **524**, **526** shown in **Figure 5**.

[00130] The number of L nodes depends upon the size of the problem, typically the number of K users, and the available hardware. For example, if K is small, then more than one MMSE filter operation can be performed per node in which case $L<M$. If K is large such that more than one node is required per MMSE filter operation, then $L>M$. The capability of the node is based on processing speed, local memory, design constraints, and concept of operation.

[00131] The data from symbol estimation processing nodes **600** is passed by the high speed interconnect **625** to the decoder processing nodes **605**. The decoder processing nodes **605** are L nodes used to implement a bank of decoders such as SISO decoders, wherein the decoders for K users are distributed among the L nodes. This decoder processing corresponds to the bank of decoders **532**, **534**, **536**, **538** of **Figure 5**. While **Figure 6** illustrates an implementation using common hardware, for the implementation where the hardware for MMSE and decoders are different, the L nodes **605** could refer to dedicated decoder hardware.

[00132] The communication between nodes from the MMSE symbol estimation processing stage to the nodes for the decoding stage of the algorithm is illustrated by the following example. For illustrative purposes, let the number of nodes equal the number of observation intervals, $L = M$. This simplification is not an architecture restriction, but simply a convenient way to illustrate the communication between nodes. Based on this simplification, the output of each node **600** in the symbol estimation section is a $K \times 1$ vector representing symbol estimates for the K users. Each node **605** in the decoder section is responsible for decoding a subset of the number of users. To further simplify the discussion, let each node **605** in the decoder section execute two decoders. In other words, each node **605** performs the processing for two processors of the bank of decoders **532**, **534**, **536**, **538** from **Figure 5** so that the number of nodes L in this example would be one half the number of users K ($L = ½ K$).

[00133] Therefore, based on these simplifications, for purposes of explanation only, the symbols from the symbol estimation nodes **600** that correspond to users 1 and 2 in the first observation interval are two of the K symbol estimates determined in Node 1. The symbols from Node 1 of the symbol estimation section **600** are transmitted to the Node 1 of the decoder section nodes **605**, wherein Node 1 of the decoders nodes **605** represents the decoding of users 1 and 2 for the first time interval. The symbols for the users 1 and 2 in the second observation interval, Node 2, from the symbol estimations section **600** are passed over the high-speed interconnect **625** to Node 1 in the decoder section **605**. Similarly, the symbols for the same two users, users 1 and 2, in the third observation interval, Node 3, from the symbol estimation section **600** are passed via **625** to Node 1 in the decoder section **605**. This procedure continues for the M observation intervals for the symbols corresponding to the first 2 users, user 1 and user 2.

[00134] As should be readily apparent from this example, Node 2 of the decoder section **605** processes user 3 and user 4 for all the L observation nodes **600**; Node 3 of the decoder section **605** processes user 5 and user 6 for all the L observation nodes. By way of further explanation, Node 4 in the decoder section **605** is responsible for decoding users 7 and 8, and receives two symbols corresponding to users 7 and 8 from all the L observation nodes **600**. For example, Node 1 of the symbol estimation section **600** passes the symbol estimates of users 7 and 8 to Node 4 of decoder section **605**. Similarly, Node 2 of the symbol estimation section **600** passes the symbol estimates for users 7 and 8 for the 2nd observation interval to Node 4 of decoder section **605**. This procedure continues for all L nodes in the decoder section **605**. Therefore, symbol estimates out of the MMSE symbol estimators **600** are routed from the M observation intervals to the K decoders of the decoder section **605** based on the mapping of the K decoders to the L available processing nodes.

[00135] The next section is the amplitude estimation section **610** for nodes $1 - L$. The amplitude estimation section **610** represents L nodes implementing the MMSE stage of the amplitude estimator, as shown by modules **560**, **562**, **564**, **566** in **Figure 5**. Prior to implementing amplitude estimation, the amplitude estimation nodes **610** receives all symbol likelihoods via the high speed interconnect **630** following the execution of the nodes from the decoders **605**. As described in **Figure 5**, the likelihoods of the symbols out

of the K decoders **532**, **534**, **536**, **538** are routed back to M MMSE filters **560**, **562**, **564**, **566** for the amplitude estimation stage of the algorithm. For this example, two decoders are implemented per node in the decoder section **605** and one MMSE filter processor in the amplitude estimation section **610** is executed per node. The output of Node 1 in the decoder section is a $M \times 2$ array of likelihoods corresponding to the M symbol likelihoods for the first two users after implementing the decoder processing **605**, descrambler, de-interleaver, and rate identification. Node 1 in the amplitude estimation section **610** retains the symbol likelihoods for the first two users, user 1 and user 2, in the first observation interval. Node 2 in the amplitude estimation section **610** is responsible for the MMSE implementation over the second observation interval. Therefore, the second set of bits in the $M \times 2$ array is passed from Node 1 in the decoder section **605** to Node 2 in the amplitude estimation section **610**. This is repeated for all M observation intervals. Therefore, the outputs of the decoder section **605** are passed to all nodes **610** computing the amplitude updating vector in the M observation intervals.

[00136] The next set of nodes is the amplitude weighing section **615** responsible for updating the amplitude estimate and which implements the functionality of the amplitude estimator **575** of **Figure 5**. This processing is performed at a single node, and for illustrative purposes Node 3 is depicted and described herein. It should be noted that the other nodes of this section **615** of the algorithm remain idle while the amplitude estimation is completed. Therefore the high-speed interconnect **635** passes the amplitude updating vector and quadratics from the L nodes in the amplitude estimation section **610** Node 3 of the amplitude weighing section **615**.

[00137] The functionality of the Amplitude Estimator **435** of **Figure 4** provides a more detailed explanation concerning the weighing implementation. The amplitude estimate calculated by Node 3 of the amplitude weighing section **615** is "fanned-out" to all the L processing nodes for further processing of symbol estimation at the next iteration (I+1). Thus, the new amplitude estimate for all K users is distributed via the high speed interconnect **640** to all the L nodes of the next iteration symbol estimation section **620** for the I+1 iteration. The L nodes in the next iteration symbol estimation section **620** re-compute the symbol estimates, using the new amplitude estimates, for the K users in the

M observation intervals. The stages and data routing are repeated until the maximum number of iterations is achieved or the desired bit error rate is reached.

[00138] One aspect of the present invention is that it solves the previously described problem of tightly integrating parameter estimation, symbol hypothesis testing, decoding, and rate identification. The approach in one embodiment assumes a modulation scheme (e.g. CDMA) has been utilized. The solution presented herein in one embodiment is a windowed-based Minimum Mean Squared Error (MMSE) approach to Turbo-decoding for joint signal demodulation, which is easily extended to time-varying channels. The invention is based on an iterative decoding solution that exploits error correction codes. In addition, the approach of the present invention is suitable for symbol asynchronous as well as symbol synchronous. Also, the algorithm used is suitable for a variety of signaling schemes such as M-ary Phase Shift Keying (MPSK).

[00139] It will be appreciated that implementation of the present invention solves the problem of the unknown channel parameters in state of the art detectors. The present invention works with many varieties of multiuser detectors and is easily implemented into different multiuser detecting systems. Specifically, the MMSE symbol estimators in modules **600** and **620** of **Figure 6** can be substituted with any of the known or referenced MUD algorithms.

[00140] The present invention dramatically reduces the number of computations needed in a blind approach to joint signal demodulation and without pilot tones or training sequences, so that reliable operation can be achieved in a real-time implementation. It will also be appreciated that since the present technique does not require knowledge of training sequences or existence of a pilot signal, it is considered a blind approach to symbol and data rate estimation. The efficient implementation of blind estimation is realized because of the high degree of parallelism. This provides an efficient implementation because of reduced number of operations associated with updating MMSE filter tap weights.

[00141] Further efficiency is realized because the number of iterations required to achieve a certain bit-error-rate for case of unknown amplitudes is typically similar to the case when the amplitudes are completely known. The present efficiency occurs because the degradation in bit-error-rate for the case of unknown amplitudes is manageable relative to the case of known amplitudes. Thus, the present approach represents a new method to

estimate channel amplitudes and extension to time-varying channels is obvious to those in the art. The present approach also represents a new method to reduce biases in amplitude estimates based on incoherent integration.

[00142] The foregoing description of the embodiments of the invention has been presented for the purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed. Many modifications and variations are possible in light of this disclosure. It is intended that the scope of the invention be limited not by this detailed description, but rather by the claims appended hereto.

CLAIMS

What is claimed is:

1. A joint amplitude estimator for a data stream from multiple users, comprising:

a data stream from said multiple users divided into a plurality of observation intervals;

a plurality of processing modules coupled to said observation intervals, wherein said processing modules calculates interference cancellation values for each of said users and computes a filter for each of said observation intervals, said filter being applied to said data within said observation interval to compute individual amplitude estimates; and

an amplitude estimation unit which processes said individual amplitude estimates and calculates new amplitude estimates, wherein said new amplitude estimates are iteratively passed back to said processing modules until a final condition is obtained.

2. The joint amplitude estimator according to claim 1, wherein said final condition is selected from at least one of the group consisting of: bit error rate metric level and fixed number of iterations.

3. The joint amplitude estimator according to claim 1, wherein said amplitude estimation unit sums and weighs said individual estimates.

4. The joint amplitude estimator according to claim 1, wherein said observation intervals are based on distinguishing attributes selected from at least one of the group consisting of: time, code, and frequency.

5. The joint amplitude estimator according to claim 1, wherein said filter is calculated for an arbitrary observation interval m as:

$$G_m = \mathbf{B}_m \mathbf{S}_m^H \left(\mathbf{S}_m \chi_m \mathbf{S}_m^H + \sigma_n^2 I \right)^{-1}.$$

6. A method for processing amplitude estimates for a multiuser data stream divided into a plurality of observation intervals, comprising:

computing a filter for each said observation interval of said data stream;

applying interference cancellation to said data stream for each said observation interval;

applying said filter to said data stream for each said observation interval from said interference cancellation to produce individual amplitude estimates for each said observation interval;

computing new amplitude estimates using said individual amplitude estimates; and

passing said new amplitude estimates back to said filter for iterative processing until a final condition is obtained.

7. The method according to claim 6, wherein said computing further comprises summing said individual amplitude estimates and weighing.

8. The method according to claim 6, wherein said final condition is selected from at least from the group consisting of: bit error rate metric level and fixed number of iterations.

JOINT SYMBOL, AMPLITUDE, AND RATE ESTIMATOR

ABSTRACT OF THE DISCLOSURE

[00143] The system in one embodiment relates to tightly integrating parameter estimation, symbol hypothesis testing, decoding, and rate identification. The present invention provides Turbo-decoding for joint signal demodulation based on an iterative decoding solution that exploits error correction codes. The system iteratively couples an initial amplitude estimator, a symbol estimator, a bank of decoders, and a joint amplitude estimator to produce the symbol estimates.

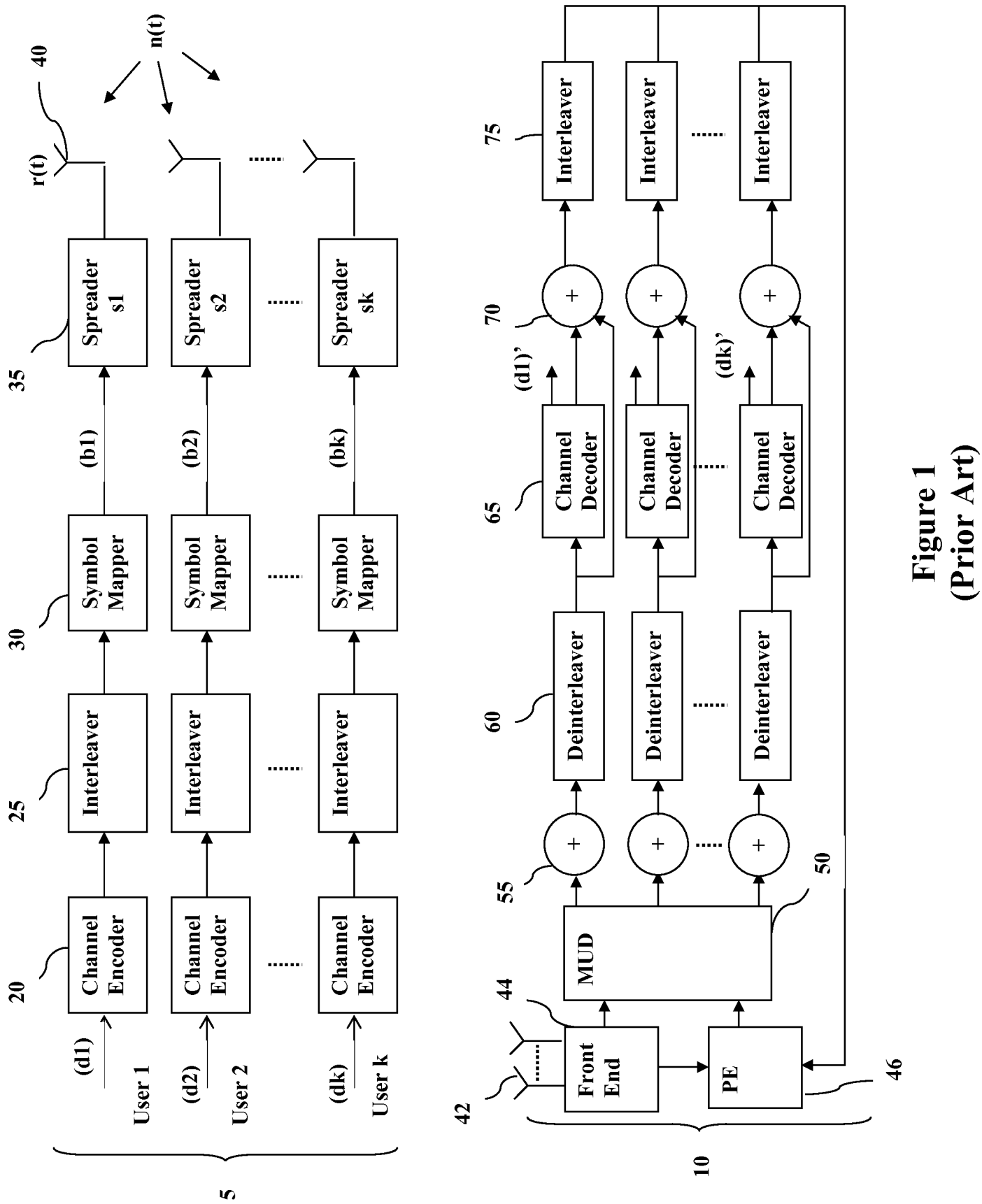


Figure 1
(Prior Art)

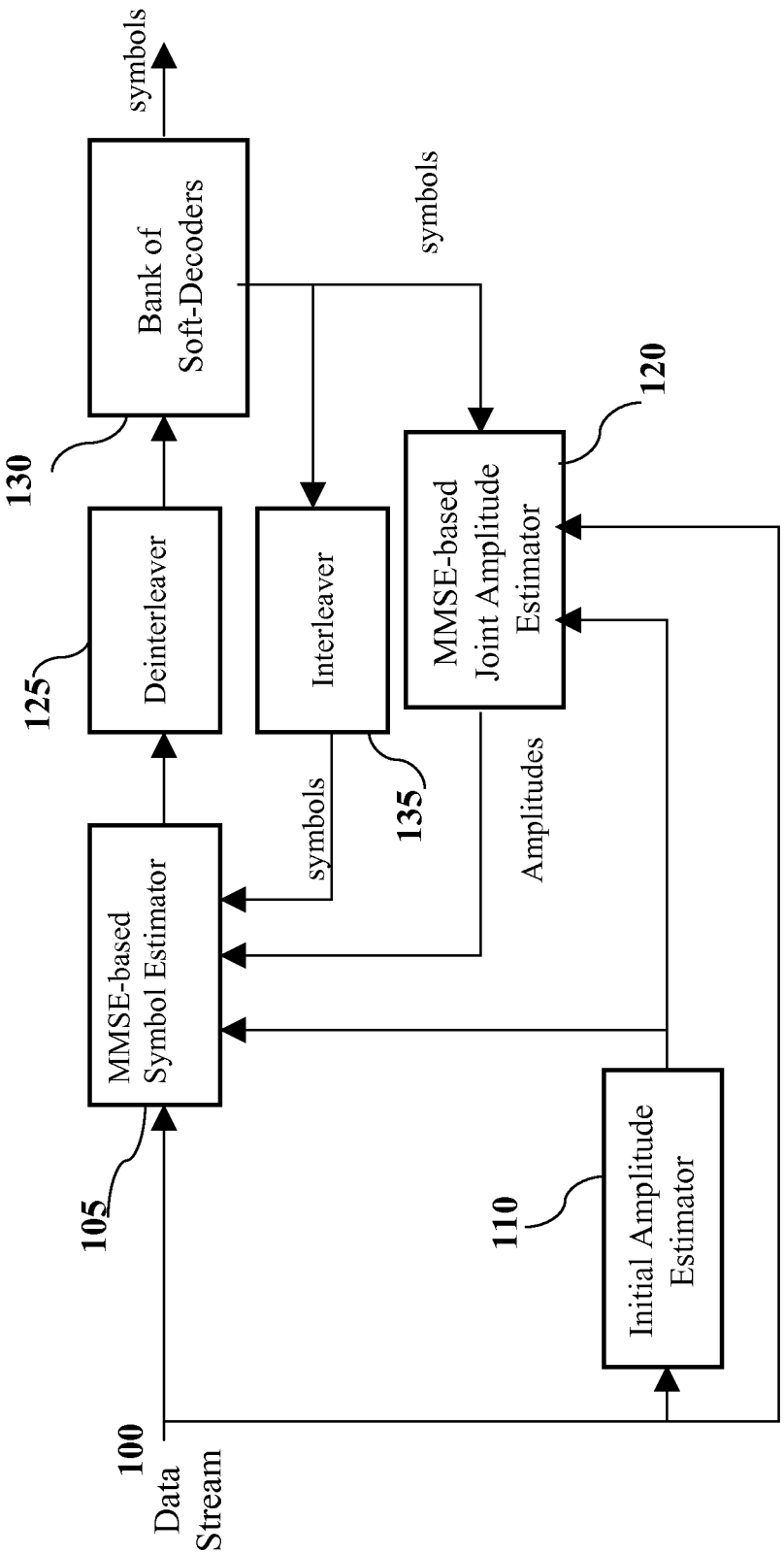

symbols
Bank of Soft-Decoders
symbols
120
130
MMSE-based Joint Amplitude Estimator
Deinterleaver
Interleaver
125
135
symbols
Amplitudes
MMSE-based Symbol Estimator
105
110
Initial Amplitude Estimator
100
Data Stream

Figure 2

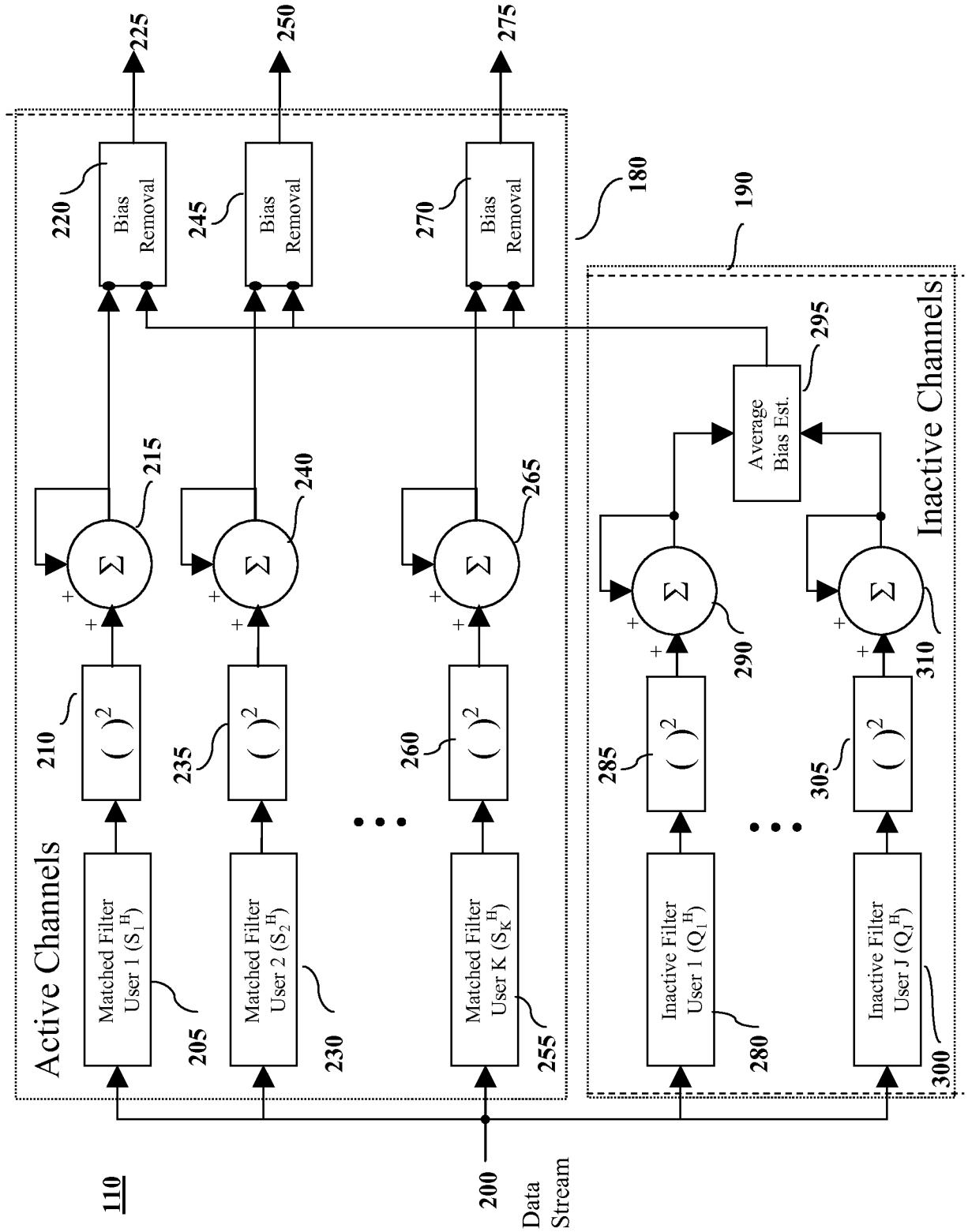

110
200
Data Stream
Active Channels
Matched Filter User 1 (S_1^H)
Matched Filter User 2 (S_2^H)
Matched Filter User K (S_K^H)
205
230
255
210
235
260
215
240
265
( )^2
Σ
220
245
270
Bias Removal
225
250
275
180
190
Inactive Channels
Inactive Filter User 1 (Q_1^H)
Inactive Filter User J (Q_J^H)
280
300
285
305
290
310
Average Bias Est.
295

Figure 3

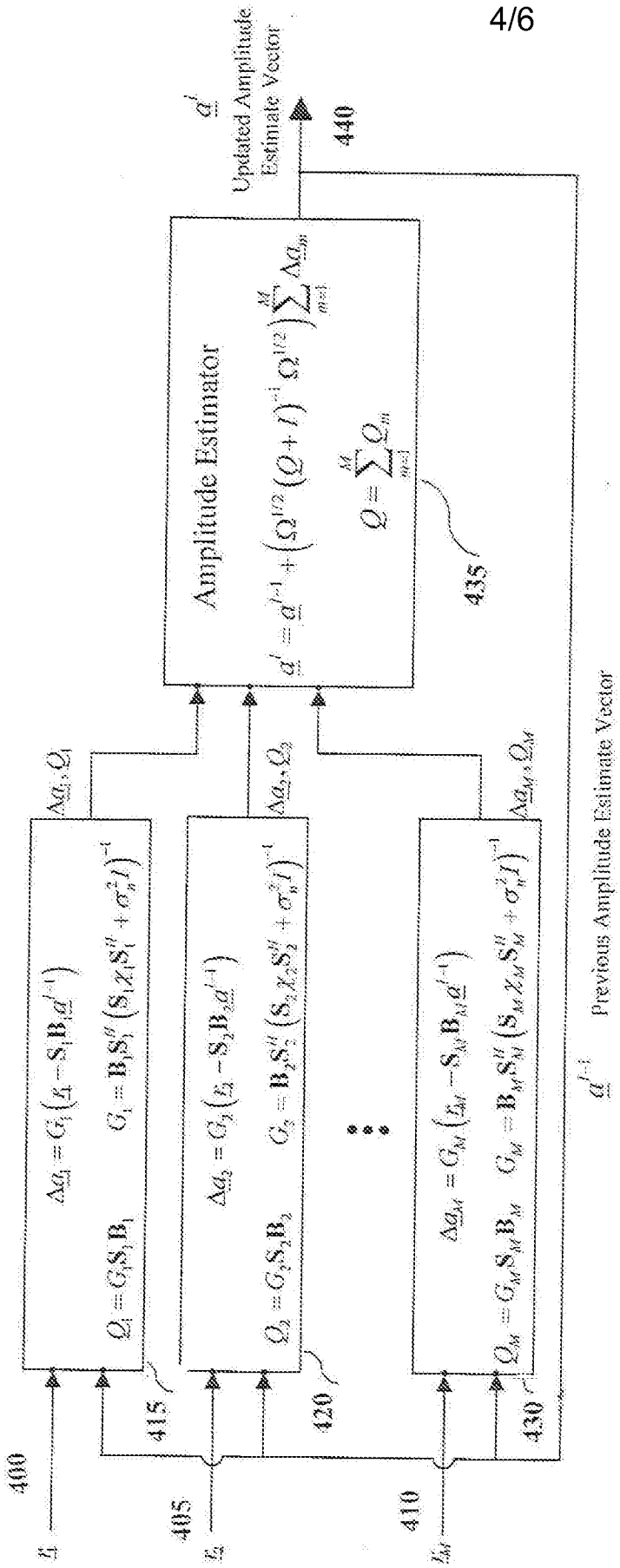
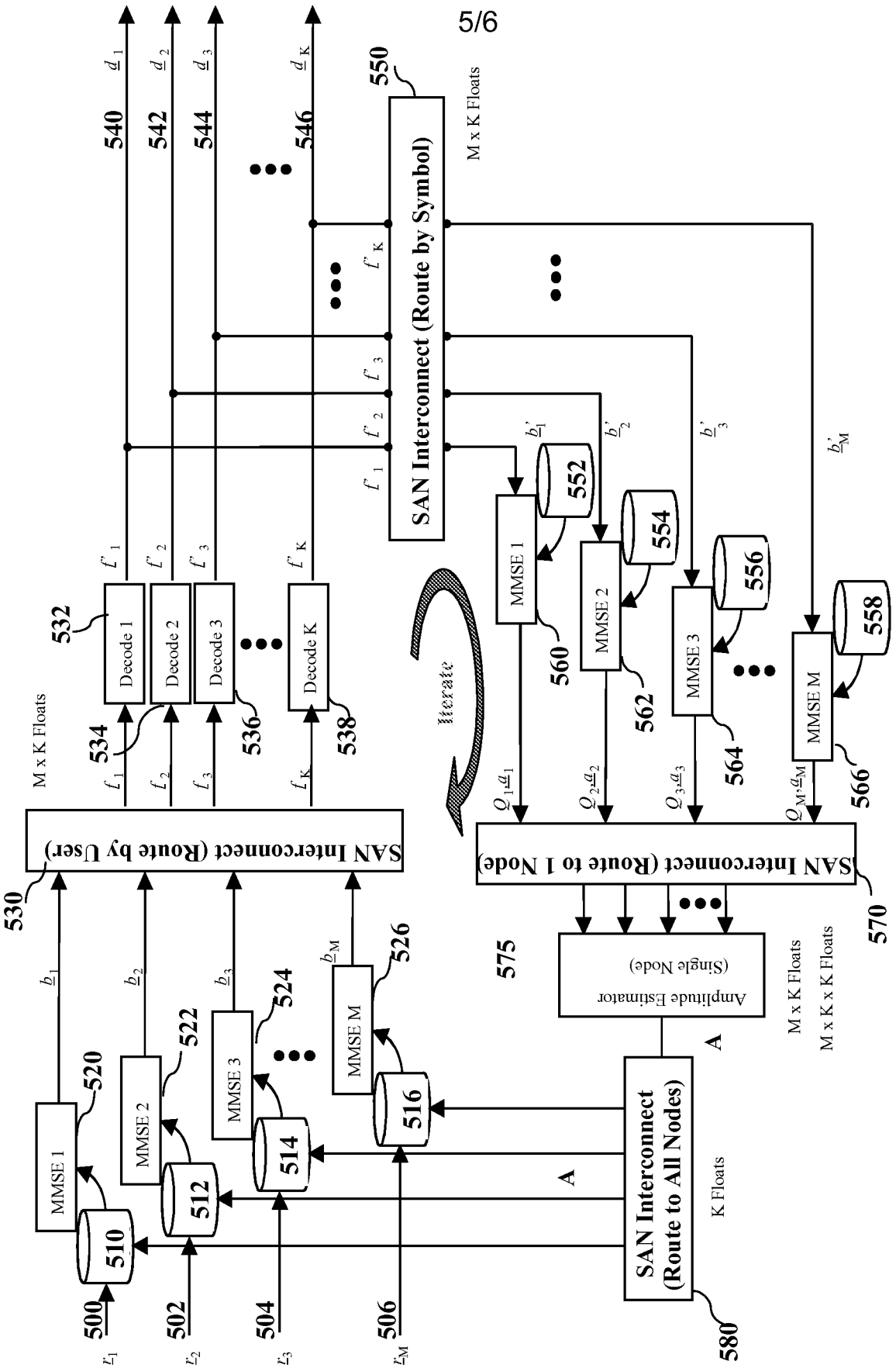

Updated Amplitude Estimate Vector
440
Amplitude Estimator
435
Previous Amplitude Estimate Vector
400
405
410
415
420
430

Figure 4


SAN Interconnect (Route by User)
SAN Interconnect (Route to 1 Node)
SAN Interconnect (Route to All Nodes)
SAN Interconnect (Route by Symbol)
Amplitude Estimator (Single Node)
MMSE 1
MMSE 2
MMSE 3
MMSE M
Decode 1
Decode 2
Decode 3
Decode K
Iterate
M x K Floats
M x K x K Floats
K Floats
A
530
570
575
580
500
502
504
506
510
512
514
516
520
522
524
526
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542
544
546
550
552
554
556
558
560
562
564
566

Figure 5

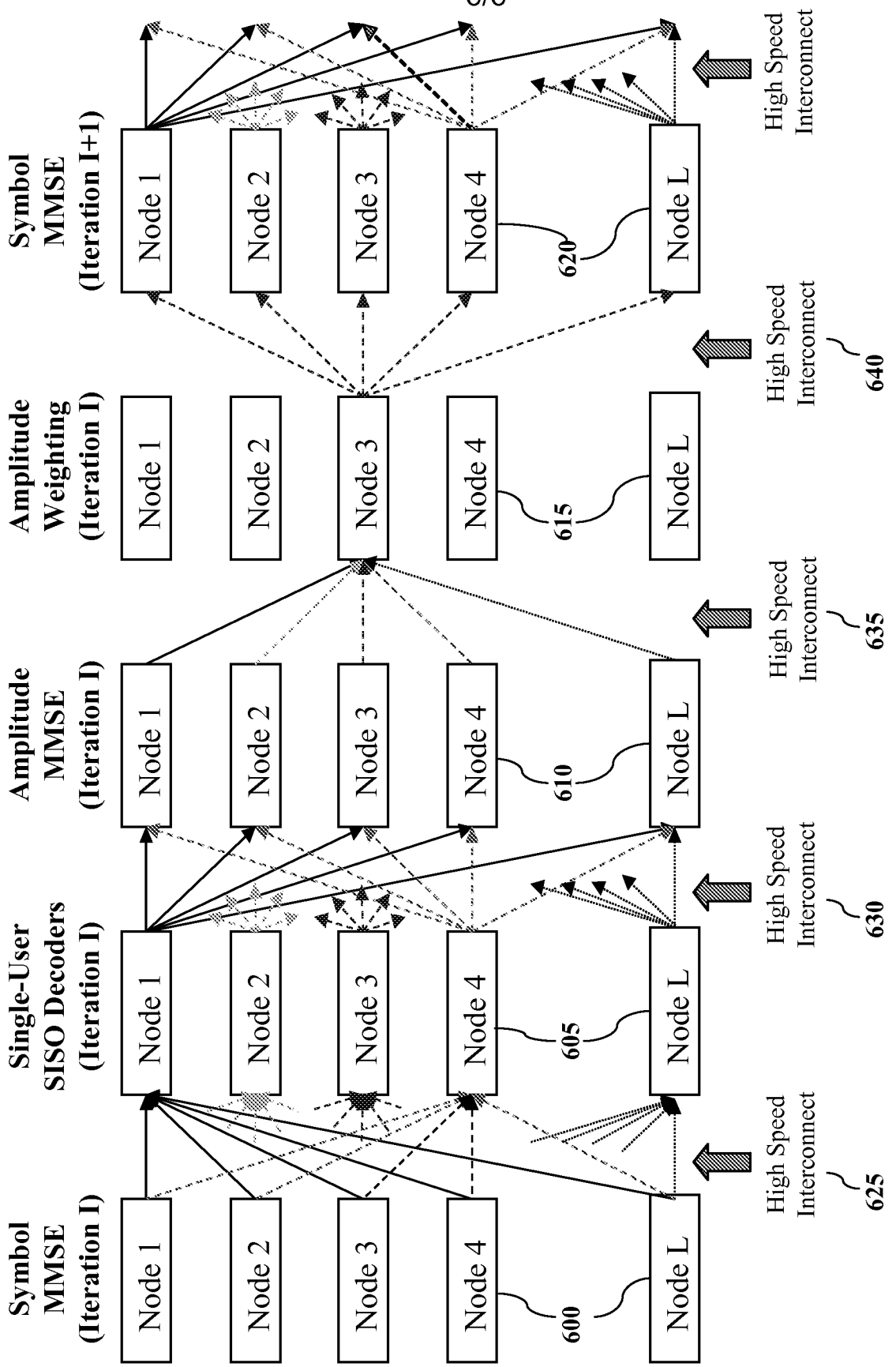
Symbol MMSE (Iteration I)
Single-User SISO Decoders (Iteration I)
Amplitude MMSE (Iteration I)
Amplitude Weighting (Iteration I)
Symbol MMSE (Iteration I+1)
Node 1
Node 2
Node 3
Node 4
Node L
600
605
610
615
620
High Speed Interconnect
625
630
635
640

Figure 6

Box No. VIII (iv) DECLARATION: INVENTORSHIP (only for the purposes of the designation of the United States of America)

The declaration must conform to the following standardized wording provided for in Section 214; see Notes to Boxes Nos. VIII, VIII (i) to (v) (in general) and the specific Notes to Box No. VIII (iv). If this Box is not used, this sheet should not be included in the request.

Declaration of inventorship (Rules 4.17(iv) and 51*bis*.1(a)(iv)) for the purposes of the designation of the United States of America:

I hereby declare that I believe I am the original, first and sole (if only one inventor is listed below) or joint (if more than one inventor is listed below) inventor of the subject matter which is claimed and for which a patent is sought.

This declaration is directed to the international application of which it forms a part (if filing declaration with application).

This declaration is directed to international application No. PCT/..... (if furnishing declaration pursuant to Rule 26*ter*).

I hereby declare that my residence, mailing address, and citizenship are as stated next to my name.

I hereby state that I have reviewed and understand the contents of the above-identified international application, including the claims of said application. I have identified in the request of said application, in compliance with PCT Rule 4.10, any claim to foreign priority, and I have identified below, under the heading "Prior Applications," by application number, country or Member of the World Trade Organization, day, month and year of filing, any application for a patent or inventor's certificate filed in a country other than the United States of America, including any PCT international application designating at least one country other than the United States of America, having a filing date before that of the application on which foreign priority is claimed.

Prior Applications: .....

.....

I hereby acknowledge the duty to disclose information that is known by me to be material to patentability as defined by 37 C.F.R. § 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the PCT international filing date of the continuation-in-part application.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Mailing Address: 21 Sarah Drive, Merrimack, NH 03054

.....

Citizenship: USA

Inventor's Signature: ..... Date: .....
(if not contained in the request, or if declaration is corrected or added under Rule 26*ter* after the filing of the international application. The signature must be that of the inventor, not that of the agent)

(of signature which is not contained in the request, or of the declaration that is corrected or added under Rule 26*ter* after the filing of the international application)

Name: .....

Residence: .....
(city and either US state, if applicable, or country)

Mailing Address: .....

.....

Citizenship: .....

Inventor's Signature: ..... Date: .....
(if not contained in the request, or if declaration is corrected or added under Rule 26*ter* after the filing of the international application. The signature must be that of the inventor, not that of the agent)

(of signature which is not contained in the request, or of the declaration that is corrected or added under Rule 26*ter* after the filing of the international application)

☐ This declaration is continued on the following sheet, "Continuation of Box No. VIII (iv)".

NOV-25-2003 16:43 FROM:BAE SYSTEMS MER15 6038850631 TO:6038864796 P.004/004

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	JOINT SYMBOL, AMPLITURE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P McElwain
Filer:	Andrew Paul Cernota/Debra Stengel
Attorney Docket Number:	20030076-DIV3

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	1090

Electronic Acknowledgement Receipt

EFS ID:	5578021
Application Number:	12491332
International Application Number:	
Confirmation Number:	5178
Title of Invention:	JOINT SYMBOL, AMPLITURE, AND RATE ESTIMATOR
First Named Inventor/Applicant Name:	Thomas P McElwain
Customer Number:	22500
Filer:	Andrew Paul Cernota/Debra Stengel
Filer Authorized By:	Andrew Paul Cernota
Attorney Docket Number:	20030076-DIV3
Receipt Date:	25-JUN-2009
Filing Date:	
Time Stamp:	10:54:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1090
RAM confirmation Number	12782
Deposit Account	190130
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)

1	Transmittal of New Application	20030076-DIV3_Transmittal.pdf	79894 c4a5d00d22bbfc82ade69e926eda9b1616084ec5	no	2
Warnings:					
Information:					
2	Application Data Sheet	US_ADS_Form_SB_14.pdf	1199247 1154a3311656e409b9101e0a87177477e16e71e8	no	4
Warnings:					
Information:					
3		20030076-DIV3_Final.pdf	264198 0ab225288937cbb978380d675cffbdc3560d8329	yes	43

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	40
Claims	41	42
Abstract	43	43

Warnings:					
Information:					
4	Drawings-only black and white line drawings	20030076-DIV3_Figures.pdf	556542 a5e40338375404c1323eb294f5c7e2a8e75250b7	no	6
Warnings:					
Information:					
5	Oath or Declaration filed	20030076-PCT_Dec.pdf	3670008 31a183468ddbd2e98be87b6ca88a3a82825da9cb	no	1
Warnings:					
Information:					
6	Fee Worksheet (PTO-875)	fee-info.pdf	33142 2515e941edb062cf391f120582921acdfe9a2ee2	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	5803031		

This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

SCORE Placeholder Sheet for IFW Content

Application Number: 12491332 Document Date: 6/25/2009

The presence of this form in the IFW record indicates that the following document type was received in electronic format on the date identified above. This content is stored in the SCORE database.

- Drawings – Other than Black and White Line Drawings

Since this was an electronic submission, there is no physical artifact folder, no artifact folder is recorded in PALM, and no paper documents or physical media exist. The TIFF images in the IFW record were created from the original documents that are stored in SCORE.

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- Examiners may access SCORE content via the eDAN interface.
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Form Revision Date: February 8, 2006

PTO/SB/06 (12-04)

Filing Date: 06/25/09

Approved for use through 7/31/2006. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: **12/491,332**

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	330
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	540
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	220
TOTAL CLAIMS (37 CFR 1.16(i))	8 minus 20 =		x$26		OR	x$52	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*	x$110			x$220	
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $260 ($130 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR						
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))			195			390	
			TOTAL			TOTAL	1090

* If the difference in column 1 is less than zero, enter "0" in column 2.

APPLICATION AS AMENDED – PART II

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
AMENDMENT A	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
AMENDMENT B	Total (37 CFR 1.16(i))	*	Minus	**	=	x =		OR	x =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=	x =		OR	x =	
	Application Size Fee (37 CFR 1.16(s))									
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.
** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".
*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".
The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

This collection of information is required by 37 CFR 1.16. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

If you need assistance in completing the form, call 1-800-PTO-9199 and select Option 2.