AO 120 (Rev. 08/10)

TO:	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	

In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court District of Delaware on the following

☐ Trademarks or ☑ Patents. (☐ the patent action involves 35 U.S.C. § 292.):

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	10/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	Nextel Operations, Inc. and Sprint Spectrum L.P.

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 See Attached Sheet		
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In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

Copy 1—Upon initiation of action, mail this copy to Director **Copy 3—Upon termination of action, mail this copy to Director**
Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 6,640,248 B1	10/28/2003	Intellectual Ventures I
2	5,602,831	2/11/1997	Intellectual Ventures I
3	6,023,783	2/8/2000	Intellectual Ventures I
4	US 6,952,408 B2	10/4/2005	Intellectual Ventures I
5	US 6,370,153 B1	4/9/2002	Intellectual Ventures II
6	5,963,557	10/5/1999	Intellectual Ventures II
7	US 8,310,993 B2	11/13/2012	Intellectual Ventures II
8	US 7,269,127 B2	9/11/2007	Intellectual Ventures II
9	US 7,848,353 B2	12/7/2010	Intellectual Ventures II
10	US 8,396,079 B2	3/12/2013	Intellectual Ventures II
11	US 7,787,431 B2	8/31/2010	Intellectual Ventures II

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	10/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	AT&T Mobility LLC, AT&T Mobility II LLC, New Cingular Wireless Services, Inc.

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	10/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	T-Mobile USA, Inc. and T-Mobile US, Inc.

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	10/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	United States Cellular Corporation

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	10/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	Leap Wireless International, Inc. and Cricket Communications, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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	10/7/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	AT&T Mobility LLC, AT&T Mobility II LLC, New Cingular Wireless Services, Inc.

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DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	10/7/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	United States Cellular Corporation

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
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PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	T-Mobile USA, Inc. and T-Mobile US, Inc.

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	10/7/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	Leap Wireless International, Inc. and Cricket Communications, Inc.

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13-1655	10/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
Intellectual Ventures I LLC and Intellectual Ventures II LLC	United States Cellular Corporation

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DECISION/JUDGEMENT
Notice of Dismissal

CLERK	(BY) DEPUTY CLERK	DATE
John A. Cerino		10-11-13

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Apurva N. Mody et al.

Examiner: John Pezzlo

Art Unit: 2616

Serial No: 10/264,546

Docket No. 20070007

Filed: 10/04/2002

For: PREAMBLE STRUCTURES FOR SINGLE INPUT, SINGLE OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATIONS SYSTEMS

March 12, 2009

To: Mail Stop 16

Commissioner for Patents
Box 1450
Alexandria, VA 22313-1450

REQUEST FOR REFUND

In response to the Request for Acceptance of December 17, 2008, we are requesting a refund the amount of $130 for the above captioned application to Deposit Account 190130.

We believe this amount should be refunded for the following reason: A Notice regarding our request for acceptance of a fee deficiency submission under 37 CFR 1.28 was sent to us notifying us that we may request a refund of the petition fee. This notice is attached herein.

Respectfully submitted,

/Daniel J. Long/

Daniel J. Long
Attorney for Applicant
Registration No. 29,404

BAE SYSTEMS Information and Electronic Systems Integration Inc.
P.O. Box 868
Nashua, NH 03061-0868
Tel: 603- 885-2643

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

BAE SYSTEMS
PO BOX 868
NASHUA NH 03061-0868

In re Patent No. 7,269,127 :
Issue Date: September 11, 2007 :
Application No. 10/264,546 : NOTICE
Filed: October 4, 2002 :
Attorney Docket No. 20070007 :

This is a notice regarding your request for acceptance of a fee deficiency submission under 37 CFR 1.28.

The Office no longer investigates or rejects original or reissue patent under 37 CFR 1.56. **1098 Off. Gaz. Pat. Office 502 (January 3, 1989).** Therefore, nothing in this Notice is intended to imply that an investigation was done.

Your fee deficiency submission under 37 CFR 1.28 is hereby **ACCEPTED.**

This patent is no longer entitled to small entity status. Accordingly, all future fees paid in this patent must be paid at the large entity rate.

There is no fee for the filing of the above request under 37 CFR 1.28. Petitioner may request a refund of the petition fee of $130.00 paid on December 17, 2008. A copy of this notice should accompany the request.

Inquiries related to this communication should be directed to the undersigned at (571) 272-3208.

Karen Creasy

Karen Creasy
Petitions Examiner
Office of Petitions

7,269,127

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Examiner: John Pezzlo

MODY et al. Patent No.: 7,269,127

Issued: 9/11/2007

Serial No: 10/264,546 Docket No. 20070007

Filed: 10/04/2002

For: Preamble Structures For Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems

December 17, 2008

To: Mail Stop Post Issue

Commissioner for Patents
Box 1450
Alexandria, VA 22313-1450

Dear Sir:

SUBMISSION OF DEFICIENCY OWED AND ITEMIZATION OF DEFICIENCY PAYMENT UNDER 37 CFR§1.28(c)(1) AND (c)(2)

1. On August 8, 2007 Applicant erroneously and inadvertently paid the "small entity" issue fee of $700 under 37CFR 1.18(a) on the above captioned application which is now US Patent No. 7,269,127. On that date, the Assignee of this application was and the Assignee still is BAE Systems Information and Electronic Systems Integration Inc. which was then and now is a non-small entity corporation.

2. It is requested that the deficiency in the amount of $810 be accepted. Please charge this amount of $810 and any other deficiency due to Deposit Account 190130.

3. The deficiency payment is itemized as follows:

(A) The fee which was paid as a small entity was the issue fee. The correct fee amount for a non-small entity issue fee under 37 CFR §1.18(a) is $1510.

(B) The small entity issue fee actually paid was $700.

(C) The deficiency owed for this issue fee is $810.

12/19/2008 DALLEN 00000013 190130 10264546

01 FC:1461 810.00 DA
02 FC:1464 130.00 DA

1

Adjustment date: 03/23/2009 SDIRETA1
12/19/2008 DALLEN 00000013 190130 10264546
02 FC:1464 130.00 CR

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 NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/264,546	10/04/2002	Apurva N. Mody	088245-6146

CONFIRMATION NO. 5338

23524
FOLEY & LARDNER LLP
150 EAST GILMAN STREET
P.O. BOX 1497
MADISON, WI 53701-1497

POA ACCEPTANCE LETTER

OC00000034975164

Date Mailed: 03/13/2009

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/05/2009.

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.

/klee/

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

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/264,546	10/04/2002	Apurva N. Mody	20070007

CONFIRMATION NO. 5338

POWER OF ATTORNEY NOTICE

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

OC000000034975123

Date Mailed: 03/13/2009

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 03/05/2009.

- 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).

/klee/

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

Electronic Acknowledgement Receipt

EFS ID:	4955644
Application Number:	10264546
International Application Number:	
Confirmation Number:	5338
Title of Invention:	PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Apurva N. Mody
Customer Number:	23524
Filer:	Daniel J. Long/Nancy Young
Filer Authorized By:	Daniel J. Long
Attorney Docket Number:	088245-6146
Receipt Date:	12-MAR-2009
Filing Date:	04-OCT-2002
Time Stamp:	15:17:11
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	Refund Request	20070007-requestforrefund.pdf	552905 5c6b95bfd6e22ceebb144adc1858dbcf0732bcca	no	2

Warnings:	
Information:	

Total Files Size (in bytes):	552905

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 application of: Apurva N. Mody et al.

Examiner: John Pezzlo

Art Unit: 2616

Serial No: 10/264,546

Docket No. 20070007

Filed: 10/04/2002

For: PREAMBLE STRUCTURES FOR SINGLE INPUT, SINGLE OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATIONS SYSTEMS

March 12, 2009

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/Daniel J. Long/

Daniel J. Long
Attorney for Applicant
Registration No. 29,404

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P.O. Box 868
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Tel: 603- 885-2643

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Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
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www.uspto.gov

BAE SYSTEMS
PO BOX 868
NASHUA NH 03061-0868

In re Patent No. 7,269,127 :
Issue Date: September 11, 2007 :
Application No. 10/264,546 : NOTICE
Filed: October 4, 2002 :
Attorney Docket No. 20070007 :

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Inquiries related to this communication should be directed to the undersigned at (571) 272-3208.

Karen Creasy

Karen Creasy
Petitions Examiner
Office of Petitions

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

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:

[X] Practitioners associated with the Customer Number: **23524**

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:

[X] The address associated with Customer Number: **23524**

OR

[ ] Firm or Individual Name

Address					
City		State		Zip	
Country		Telephone		Email	

Assignee Name and Address:

TaffCo Three Fund, L.L.C.
2711 Centerville Rd., Suite 400
Wilmington, DE 19808
USA

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	Mary Brown	Date	2/27/09
Name	Mary Brown	Telephone	
Title	Authorized Person for TaffCo Three Fund, L.L.C.		

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.

MADI_1810026.1

DECLARATION REGARDING AUTHORITY TO SIGN ON BEHALF OF A LEGAL ENTITY
(37 C.F.R. 3.73(b)(2)(ii))

I, Mary Brown (whose title is supplied below), hereby declare that I am authorized to sign the Power of Attorney to Prosecute Applications before the USPTO on behalf of TaffCo Three Fund, L.L.C.

Mary Brown

Mary Brown, Authorized Person

2/27/09

[date]

Electronic Acknowledgement Receipt

EFS ID:	4909857
Application Number:	10264546
International Application Number:	
Confirmation Number:	5338
Title of Invention:	PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS
First Named Inventor/Applicant Name:	Apurva N. Mody
Customer Number:	22500
Filer:	Paul S. Hunter/Bill Morris
Filer Authorized By:	Paul S. Hunter
Attorney Docket Number:	20070007
Receipt Date:	05-MAR-2009
Filing Date:	04-OCT-2002
Time Stamp:	15:12:34
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		PowerofAttorney6146.pdf	275932 070e2bbfeb4f4568128cb7422c933ef5e41ff05b	yes	3

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Assignee showing of ownership per 37 CFR 3.73(b).	1	1
	Power of Attorney	2	3
Warnings:			
Information:			
	Total Files Size (in bytes):	275932	

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.

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PTO/SB/96 (06-04)
Approved for use through 07/31/2006. OMB 0651-0031
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.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner:	Mody Apurva N., et al.		Confirmation No. 5338
Application No.:	10/264,546	Filed:	10-04-2002
Patent No.:	7,269,127	Issue Date:	09-11-2007
Docket Number:	088245-6146		
Entitled:	PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS		

TAFFCO THREE FUND, L.L.C. (Name of Assignee)

LLC (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

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/patent identified above by virtue of either:

A. ☐ An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel/Frame _____ or for which a copy thereof is attached.

OR

B. ☒ A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as shown below:

1. From: Mody Apurva N., et al. To: GEORGIA TECH RESEARCH CORPORATION
   The document was recorded in the United States Patent and Trademark Office at Reel 013590, Frame 0021, or for which a copy thereof is attached.

2. From: GEORGIA TECH RESEARCH CORPORATION To: BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION, INC.
   The document was recorded in the United States Patent and Trademark Office at Reel 019183, Frame 0640, or for which a copy thereof is attached.

3. From: BAE SYSTEMS INFORMATION AND ELECTRONIC SYSTEMS INTEGRATION, INC. To: TAFFCO THREE FUND, LLC
   The document was recorded in the United States Patent and Trademark Office at Reel 022277, Frame 0511, or for which a copy thereof is attached.

☐ Additional documents in the chain of title are listed on a supplemental sheet.

☐ Copies of assignments or other documents in the chain of title are attached.

[NOTE: A separate copy (i.e., a true copy of the original document(s)) must be submitted to Assignment Division in accordance with 37 CFR Part 3, if the assignment is to be recorded 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: MARCH 4, 2009
Paul S. Hunter (Reg. No. 44,787)	(608) 258-4292
Printed or Typed Name	Telephone Number
Attorney for Applicant	
Title	

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
United States Patent and Trademark Office
P.O. Box 1450
Alexandria, VA 22313-1450
www.uspto.gov

BAE SYSTEMS
PO BOX 868
NASHUA NH 03061-0868

MAILED

MAR 05 2009

OFFICE OF PETITIONS

In re Patent No. 7,269,127 :
Issue Date: September 11, 2007 :
Application No. 10/264,546 : NOTICE
Filed: October 4, 2002 :
Attorney Docket No. 20070007 :

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Karen Creasy

Karen Creasy
Petitions Examiner
Office of Petitions

IFW

Please submit to:

Mail Stop M Correspondence
Director of the US Patent and Trademark Office
PO Box 1450
Alexandria, VA 22313-1450

or by fax to: Status & Entity Branch, Office of Finance at 571-273-6500.

Re: USA Application 10/264,546, Patent 7,269,127;
Your Ref: 062020-1120

Please note that the referenced patent(s) qualify as a LARGE entity.

Sincerely,

Daniel J. Long

Daniel J. Long
Printed Name:

29,404
Reg. No.:

7,269,127

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of: Examiner: John Pezzlo

MODY et al. Patent No.: 7,269,127

Issued: 9/11/2007

Serial No: 10/264,546 Docket No. 20070007

Filed: 10/04/2002

For: Preamble Structures For Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems

December 17, 2008

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(A) The fee which was paid as a small entity was the issue fee. The correct fee amount for a non-small entity issue fee under 37 CFR §1.18(a) is $1510.

(B) The small entity issue fee actually paid was $700.

(C) The deficiency owed for this issue fee is $810.

12/19/2008 DALLEN 00000013 190130 10264546

01 FC:1461 810.00 DA
02 FC:1464 130.00 DA

(D) The total deficiency owed is $810.

4. Please charge the processing fee of $130 due under 37 CFR§1.17(i) and any other amount due to Deposit Account No. 190130.

Respectfully submitted,

Daniel J. Long

Daniel J. Long, Reg. No. 29,404

BAE SYSTEMS
PO Box 868, NHQ1-719
Nashua, NH 03061-0868
Tel. No. (603) 885-2643
Fax No. (603) 885-2167

I hereby certify that this correspondence is being transmitted by facsimile (571) 273-6500 to Commissioner of Patents, Box 1450, Alexandria, VA 22313-1450 on December 17, 2008.

Nancy A. Young

Nancy A. Young

12/17/08

Date of Signature

Nancy A. Young

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.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/264,546	09/11/2007	7269127	20070007	5338

22500 7590 08/22/2007

BAE SYSTEMS INFORMATION AND
ELECTRONIC SYSTEMS INTEGRATION INC.
65 SPIT BROOK ROAD
P.O. BOX 868 NHQ1-719
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 970 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 Customer Service Center of the Office of Patent Publication at (571)-272-4200.

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

Apurva N. Mody, Atlanta, GA;
Gordon L. Stuber, Atlanta, GA;

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

BIBDATASHEET

Bib Data Sheet

CONFIRMATION NO. 5338

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/264,546	10/04/2002 RULE	370	2616	20070007

APPLICANTS

Apurva N. Mody, Atlanta, GA;
Gordon L. Stuber, Atlanta, GA;

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

This appln claims benefit of 60/327,145 10/04/2001

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

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY **
** 11/04/2002

		STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
Foreign Priority claimed	☐ yes ☐ no	GA	7	40	5
35 USC 119 (a-d) conditions met	☐ yes ☐ no ☐ Met after Allowance				
Verified and Acknowledged	Examiner's Signature Initials				

ADDRESS
22500

TITLE
PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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www.uspto.gov

APPLICATION NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/264,546	10/04/2002	Apurva N. Mody	062020-1120

CONFIRMATION NO. 5338

OC000000025363423

OC000000025363423

24504
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

Date Mailed: 08/14/2007

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/06/2007.

- 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).

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199
OFFICE COPY

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 NUMBER	FILING OR 371 (c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
10/264,546	10/04/2002	Apurva N. Mody	20070007

CONFIRMATION NO. 5338

OC000000025363449

OC000000025363449

22500
BAE SYSTEMS INFORMATION AND
ELECTRONIC SYSTEMS INTEGRATION INC.
65 SPIT BROOK ROAD
P.O. BOX 868 NHQ1-719
NASHUA, NH 03061-0868

Date Mailed: 08/14/2007

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 08/06/2007.

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.

Tan Carlson

Office of Initial Patent Examination (571) 272-4000, or 1-800-PTO-9199
OFFICE COPY

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24504 7590 06/19/2007

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

Maureen Miles	(Depositor's name)
Maureen Miles	(Signature)
8.6.07	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/264,546	10/04/2002	Apurva N. Mody	062020-1120	5338

TITLE OF INVENTION: PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$700	$300	$0	$1000	09/19/2007

08/09/2007 CNEGA2 00000035 190130 10264546
01 FC:2501 700.00 DA
02 FC:1504 300.00 DA
03 FC:8001 [illegible] DA

EXAMINER	ART UNIT	CLASS-SUBCLASS
PEZZLO, JOHN	2616	370-210000

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 Thomas, Kayden, Horstemeyer & Risley LLP
2 Daniel J. Long
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: 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 4

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ 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 7/31/07

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Mody, et al.	Serial No.:	10/264,546
Filed:	04-Oct-2002	Docket No:	20070007
For:	Preamble Structures For Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems		

CERTIFICATE OF FACSIMILE 37 CFR 1.6(d): I certify that this correspondence is being faxed to 571-273-8300 on the below date addressed to: Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450.

Date: 8-6-07 Maureen Miles

Maureen Miles

Dear Examiner:

LETTER OF TRANSMITTAL

Transmitted herewith is the following:

☒ 1 page form PTO/SB/96 Statement Under 37 CFR 3.73(b),

☒ 1 page form PTO/SB/82 Revocation Of Power Of Attorney And Change of Correspondence Address

PAYMENT: Authorization is hereby given to charge filing fee to Deposit Account 190130. All necessary fees relating to the attached submittal, if any, are intended to be included. However, the Office is hereby authorized to charge any deficiency or credit any overpayment in the fees to deposit account 190130.

Please communicate, through our customer number 22500, with the undersigned attorney if there are any questions.

Respectfully submitted,

Daniel J. Long

Daniel J. Long, Reg. No. 29,404

BAE Systems
PO Box 868
Nashua, NH 03061-0868
Tel. No. (603) 885-2643; Fax. No. (603) 885-2167

PTO/SB/96 (04-07)
Approved for use through 09/30/2007. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Mody, Apurva N. and Stuber, Gordon L.

Application No./Patent No.: 10/264,546 Filed/Issue Date: 10/04/2002

Entitled: Preamble Structures for Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems

BAE Systems Information and Electronic Systems Integration Inc., a corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.)

states that it is:

1. [X] 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/patent identified above by virtue of either:

A. [ ] An assignment from the inventor(s) of the patent application/patent identified above. The assignment was recorded in the United States Patent and Trademark Office at Reel _____, Frame _____, or for which a copy thereof is attached.

OR

B. [X] A chain of title from the inventor(s), of the patent application/patent identified above, to the current assignee as follows:

1. From: Mody, Apurva N. Stuber, Gordon L. To: Georgia Tech Research Corporation
The document was recorded in the United States Patent and Trademark Office at
Reel 013590, Frame 0021, or for which a copy thereof is attached.

2. From: Georgia Tech Research Corporation To: BAE Systems Information and Electronic Systems Integration Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 019183, Frame 0640, or for which a copy thereof is attached.

3. From: _____ To: _____
The document was recorded in the United States Patent and Trademark Office at
Reel _____, Frame _____, or for which a copy thereof is attached.

[ ] Additional documents in the chain of title are listed on a supplemental sheet.

[X] 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 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.

_____ 8/3/07
Signature Date

Kevin M. Perkins 603-885-3270
Printed or Typed Name Telephone Number

Vice President
Title

PTO/SB/82 (01-06)
Approved for use through 12/31/2006. OMB 0651-0035
U.S. Patent and Trademark Office, U.S. DEPARTMENT OF COMMERCE

REVOCATION OF POWER OF ATTORNEY WITH NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	10/264,546
Filing Date	10/04/2002
First Named Inventor	Mody, Apurva N.
Art Unit	2616
Examiner Name	Pezzlo, John
Attorney Docket Number	20070007

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint the practitioners associated with the Customer Number: 22500

☒ Please change the correspondence address for the above-identified application to:

☒ The address associated with Customer Number: 22500

OR

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

I am the:

☐ Applicant/Inventor.

☐ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) is enclosed. (Form PTO/SB/96)

SIGNATURE of Applicant or Assignee of Record

Signature	
Name	Kevin M. Perkins, Vice President
Date	8/3/07
Telephone	603-885-3270

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below*.

☐ *Total of _____ forms are submitted.

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

24504 7590 06/19/2007

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

EXAMINER	
PEZZLO, JOHN	
ART UNIT	PAPER NUMBER
2616	

DATE MAILED: 06/19/2007

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/264,546	10/04/2002	Apurva N. Mody	062020-1120	5338

TITLE OF INVENTION: PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$700	$300	$0	$1000	09/19/2007

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.

THE ISSUE FEE AND PUBLICATION FEE (IF REQUIRED) MUST BE PAID WITHIN THREE MONTHS FROM THE MAILING DATE OF THIS NOTICE OR THIS APPLICATION SHALL BE REGARDED AS ABANDONED. THIS STATUTORY PERIOD CANNOT BE EXTENDED. SEE 35 U.S.C. 151. THE ISSUE FEE DUE INDICATED ABOVE DOES NOT REFLECT A CREDIT FOR ANY PREVIOUSLY PAID ISSUE FEE IN THIS APPLICATION. IF AN ISSUE FEE HAS PREVIOUSLY BEEN PAID IN THIS APPLICATION (AS SHOWN ABOVE), THE RETURN OF PART B OF THIS FORM WILL BE CONSIDERED A REQUEST TO REAPPLY THE PREVIOUSLY PAID ISSUE FEE TOWARD THE ISSUE FEE NOW DUE.

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

If the SMALL ENTITY is shown as YES, verify your current SMALL ENTITY status:

A. If the status is the same, pay the TOTAL FEE(S) DUE shown above.

B. If the status above is to be removed, check box 5b on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and twice the amount of the ISSUE FEE shown above, or

If the SMALL ENTITY is shown as NO:

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

B. If applicant claimed SMALL ENTITY status before, or is now claiming SMALL ENTITY status, check box 5a on Part B - Fee(s) Transmittal and pay the PUBLICATION FEE (if required) and 1/2 the ISSUE FEE shown above.

II. PART B - FEE(S) TRANSMITTAL, or its equivalent, must be completed and returned to the United States Patent and Trademark Office (USPTO) with your ISSUE FEE and PUBLICATION FEE (if required). If you are charging the fee(s) to your deposit account, section "4b" of Part B - Fee(s) Transmittal should be completed and an extra copy of the form should be submitted. If an equivalent of Part B is filed, a request to reapply a previously paid issue fee must be clearly made, and delays in processing may occur due to the difficulty in recognizing the paper as an equivalent of Part B.

III. All communications regarding this application must give the application number. Please direct all communications prior to issuance to Mail Stop ISSUE FEE unless advised to the contrary.

IMPORTANT REMINDER: Utility patents issuing on applications filed on or after Dec. 12, 1980 may require payment of maintenance fees. It is patentee's responsibility to ensure timely payment of maintenance fees when due.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), to: Mail **Mail Stop ISSUE FEE**
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450
or Fax (571)-273-2885

INSTRUCTIONS: This form should be used for transmitting the ISSUE FEE and PUBLICATION FEE (if required). Blocks 1 through 5 should be completed where appropriate. All further correspondence including the Patent, advance orders and notification of maintenance fees will be mailed to the current correspondence address as indicated unless corrected below or directed otherwise in Block 1, by (a) specifying a new correspondence address; and/or (b) indicating a separate "FEE ADDRESS" for maintenance fee notifications.

CURRENT CORRESPONDENCE ADDRESS (Note: Use Block 1 for any change of address)

24504 7590 06/19/2007

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

Note: A certificate of mailing can only be used for domestic mailings of the Fee(s) Transmittal. This certificate cannot be used for any other accompanying papers. Each additional paper, such as an assignment or formal drawing, must have its own certificate of mailing or transmission.

Certificate of Mailing or Transmission
I hereby certify that this Fee(s) Transmittal is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to the Mail Stop ISSUE FEE address above, or being facsimile transmitted to the USPTO (571) 273-2885, on the date indicated below.

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/264,546	10/04/2002	Apurva N. Mody	062020-1120	5338

TITLE OF INVENTION: PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	YES	$700	$300	$0	$1000	09/19/2007

EXAMINER	ART UNIT	CLASS-SUBCLASS
PEZZLO, JOHN	2616	370-210000

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 _____
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 _____

4b. Payment of Fee(s): **(Please first reapply any previously paid issue fee shown above)**
☐ 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. _____

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.

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.

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.
10/264,546	10/04/2002	Apurva N. Mody	062020-1120	5338

24504 7590 06/19/2007

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

EXAMINER	
PEZZLO, JOHN	
ART UNIT	PAPER NUMBER
2616	

DATE MAILED: 06/19/2007

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 970 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 970 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)	
	10/264,546	MODY ET AL.	
	Examiner	Art Unit	
	John Pezzlo	2616	

-- 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 4/19/07*.

2. ☒ The allowed claim(s) is/are *2, 4, 6-23, 25-29 renumbered 1-25 respectively*.

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 _____.

JOHN PEZZLO
PRIMARY EXAMINER

Notice of References Cited	Application/Control No. 10/264,546	Applicant(s)/Patent Under Reexamination MODY ET AL.	
	Examiner John Pezzlo	Art Unit 2616	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2003/0043887 A1	03-2003	Hudson, John E.	375/144
	B	US-			
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Issue Classification	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/264,546	MODY ET AL.	
	Examiner	Art Unit	
	John Pezzlo	2616	

ISSUE CLASSIFICATION

ORIGINAL			CROSS REFERENCE(S)							
CLASS	SUBCLASS	CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)							
370	210	370	430	482						
INTERNATIONAL CLASSIFICATION		375	144							
H04J	11/00									
	1									
	1									
	1									
	1									

(Assistant Examiner) (Date)

(Legal Instruments Examiner) (Date)

2/14/07
JOHN PEZZLO
PRIMARY EXAMINER
(Primary Examiner) (Date)

Total Claims Allowed: 25

O.G. Print Claim(s)	O.G. Print Fig.
1	3

☐ 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
	~~1~~		~~31~~		61		91		121		151		181
1	2		~~32~~		62		92		122		152		182
	~~3~~		~~33~~		63		93		123		153		183
2	4		~~34~~		64		94		124		154		184
	~~5~~		~~35~~		65		95		125		155		185
3	6		~~36~~		66		96		126		156		186
4	7		~~37~~		67		97		127		157		187
5	8		~~38~~		68		98		128		158		188
6	9		~~39~~		69		99		129		159		189
7	10		~~40~~		70		100		130		160		190
8	11		~~41~~		71		101		131		161		191
9	12		42		72		102		132		162		192
10	13		43		73		103		133		163		193
11	14		44		74		104		134		164		194
12	15		45		75		105		135		165		195
13	16		46		76		106		136		166		196
14	17		47		77		107		137		167		197
15	18		48		78		108		138		168		198
16	19		49		79		109		139		169		199
17	20		50		80		110		140		170		200
18	21		51		81		111		141		171		201
19	22		52		82		112		142		172		202
20	23		53		83		113		143		173		203
	~~24~~		54		84		114		144		174		204
21	25		55		85		115		145		175		205
22	26		56		86		116		146		176		206
23	27		57		87		117		147		177		207
24	28		58		88		118		148		178		208
25	29		59		89		119		149		179		209
	~~30~~		60		90		120		150		180		210

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
10/264,546	MODY ET AL.
Examiner	**Art Unit**
John Pezzlo	2616

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
=	Allowed	÷	Restricted	I	Interference	O	Objected

Claim		Date
Final	Original	2 May 07
	~~1~~	
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Claim		Date
Final	Original	
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Claim		Date
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Search Notes

Application/Control No.	Applicant(s)/Patent under Reexamination
10/264,546	MODY ET AL.
Examiner	**Art Unit**
John Pezzlo	2616

SEARCHED			
Class	Subclass	Date	Examiner
370	430	2MAY07 JP	
	210		
	329		
	480 482		
	512, 513		
375	144		
	178		

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner
370	210	2MAY07 JP	
	430		
	482		
375	144		

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
refer to updated EAST search	5/2/07	JP

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Alexandria, Virginia 22313-1450
www.uspto.gov

Bib Data Sheet

CONFIRMATION NO. 5338

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/264,546	10/04/2002 RULE	370	2616	062020-1120

APPLICANTS

Apurva N. Mody, Atlanta, GA;
Gordon L. Stuber, Atlanta, GA;

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

This appln claims benefit of 60/327,145 10/04/2001 OK/ JP 18Oct06

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

None/ JP 18Oct06

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY **
** 11/04/2002

Foreign Priority claimed	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☒ no	GA	7	40	5

35 USC 119 (a-d) conditions met: ☐ yes ☒ no ☐ Met after Allowance

Verified and Acknowledged: _____ Examiner's Signature _____ Initials

ADDRESS
24504

TITLE
Preamble structures for single-input, single-output (SISO) and multi-input, multi-output (MIMO) communication systems

FILING FEE RECEIVED	FEES: Authority has been given in Paper
699	No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:

☐ All Fees
☐ 1.16 Fees (Filing)
☐ 1.17 Fees (Processing Ext. of time)
☐ 1.18 Fees (Issue)
☐ Other _____
☐ Credit

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments
1	BRS	L1	16	encoder and transmitter and pilot and symbol and training and data and frame and (IDFT or IFFT) and modulator and preamble and antenna and (cyclic near prefix)	US-PGPUB; USPAT	2007/05/02 11:34	

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:
Apurva N. Mody

Examiner: John Pezzlo

Art Unit: 2616

Serial No: 10/264,546

Docket No. 20070007

Filed: 10/04/2002

For: PREAMBLE STRUCTURES FOR SINGLE INPUT, SINGLE OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATIONS SYSTEMS

April 19, 2007

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

AMENDMENT

In response to the office action of 10/24/2006, please amend the above captioned application as follows.

In the claims

Please amend the claims in the way shown on the attached sheets.

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APR 19 2007

Remarks

The application has been amended to more clearly define the invention. Reconsideration is respectively requested.

Applicants thank the examiner for his indication that claims 3, 5 – 22, and 24 – 29 contain allowable subject matter. The claims have been amended accordingly to put them in condition for allowance.

It is believed that the application is now in condition for allowance. If the examiner believes that any matters are still at issue, he is requested to contact applicant's undersigned attorney.

Respectfully submitted,

Daniel J. Long

Daniel J. Long
Attorney for Applicant
Registration No. 29,404

BAE SYSTEMS Information and Electronic Systems Integration Inc.
P.O. Box 868
Nashua, NH 03061-0868
Tel: 603- 885-2643

I hereby certify that this correspondence is being transmitted by facsimile (571) 273-8300 to Commissioner of Patents, Box 1450, Alexandria, VA 22313-1450 on April 19, 2007.

Gloria Abbasciano

Gloria Abbasciano

4.19.07

Date of Signature
Gloria Abbasciano

CLAIMS

1. (cancelled)

2. (currently amended) A ~~transistor~~ transmitter of a communication system, the transmitter comprising:

an encoder having a pilot/training symbol inserter, the pilot/training symbol inserter configured to insert pilot symbols into data blocks and to combine training symbols with the data blocks;

at least one modulator, each modulator having an inverse discrete Fourier transform (IDFT) stage and a cyclic prefix inserter, each modulator outputting a frame structure comprising a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol; and

at least one transmit antenna, each transmit antenna corresponding to a respective one or the at least one modulator, each transmit antenna transmitting the frame structure output from the corresponding modulator, wherein the enhanced training symbol is a single symbol.

3. (cancelled)

4. (currently amended) The transmitter of claim 2, wherein the data structure comprises a plurality of data symbols, each data symbol having a data block and a cyclic prefix, the cyclic prefix being inserted by the cyclic prefix inserter, and each of the at least one training symbol comprises a cyclic prefix and a training block, the cyclic prefix being inserted by the cyclic prefix inserter, the training block being inserted by the pilot/training symbol inserter.

5. (cancelled)

6. (currently amended) The transmitter of claim ~~5~~ 4 wherein the enhanced training symbol comprises a cyclic prefix and a training block, the cyclic prefix being inserted by the cyclic prefix inserter, the training block inserted by the pilot/training symbol inserter.

7. (previously presented) The transmitter of claim 6, wherein each data block has a number of samples N, each training block of the at lease one training symbol has a number of samples N_I, and the training block of the enhanced symbol has a number of samples N_I, whereby N_I = N/I, where I is an integer.

8. (previously presented) The transmitter of claim 6, wherein the training block of the enhanced training symbol is divided into a number of sections having a number of samples N_J such the N_J=N/J, where J is an integer.

9. (previously presented) The transmitter of claim 8, wherein J equals 4.

10. (previously presented) The transmitter of claim 6, wherein the cyclic prefixes have a number of samples such that G = N/I, where I is an integer.

11. (previously presented) The transmitter of claim 2, wherein the enhanced training symbol comprises a cyclic prefix and a training block, the cyclic prefix having a number of samples G,

the training block having a number of samples N_I, whereby $N_I = N/I$, where N is equal to the number of samples of data blocks of the data structure and I is an integer, and whereby $G = N_I/4$.

12. (previously presented) The transmitter of claim 11, wherein the training block is divided into four sections, each section having a number of samples $N_I/4$.

13. (previously presented) The transmitter of claim 12, wherein the cyclic prefix and each of the four sections comprises the same sequence.

14. (previously presented) The transmitter of claim 13, wherein the cyclic prefix and the first section provide time synchronization and coarse frequency offset estimation, the second and third sections provide channel estimation and noise variance estimation, and the cyclic preix and first, second, and third sections further provide fine frequency offset estimation.

15. (previously presented) The transmitter of claim 14, wherein the communication system is a single-input, single-output (SISO) communication system.

16. (previously presented) The transmitter of claim 11, wherein the cyclic prefix is divided into first and second sections having a number of samples $N_I/8$, the training block is divided into third, fourth, fifth, sixth, seventh, and eighth sections, the third, fourth, seventh, and eighth sections having a number of samples $N_I/8$, the fifth and sixth sections having a number of samples $N_I/4$.

17. (previously presented) The transmitter of claim 16, wherein the first, second, third, fourth, seventh, and eight sections comprise a first sequence, and the fifth and sixth sections comprise a second sequence.

18. (previously presented) The transmitter of claim 17, wherein the first, second, third, and fourth sections provide time synchronization and coarse frequency offset estimation, the fifth and sixth sections provide channel estimation and noise variance estimation, and the first through sixth sections further provide fine frequency offset estimation.

19. (previously presented) The transmitter of claim 18, wherein the communication system is a single-input, single-output (SISO) communication system.

20. (previously presented) The transmitter of claim 11, wherein the number of modulators and transmit antennas is two, a first training block corresponding to a first transmit antenna being divided into four sections, each section having a number of samples $N_t/4$, and a second training block corresponding to a second transmit antenna being divided into four sections, each section having a number of samples $N_t/4$.

21. (previously presented) The transmitter of claim 20, wherein the cyclic prefixes of each transmit antenna and the first and fourth sections of the first and second training blocks comprise a first, sequence, the second and third sections of the first training block comprising a second sequence that is the negative of the complex conjugate of the first sequence, and the second and

third sections of the second training block comprising a third sequence that is the complex conjugate of the first sequence.

22. (previously presented) The transmitter of claim 21, wherein the cyclic prefixes and first sections of the first and second training blocks providing time synchronization and coarse frequency offset estimation, the first, second, and third sections of the first and second training blocks providing channel estimation and noise variance estimation, and the cyclic prefixes and first, second, and third sections of the first and second training blocks further providing fine frequency offset estimation.

23. (currently amended) A method of forming a frame structure that is transmitted in a communication system, the method comprising the steps of:

providing data blocks;

providing training blocks;

combining the data blocks and training blocks in a parallel format to provide a parallel combination;

taking an inverse discrete Fourier transform (IDFT) of the parallel combination to form IDFT blocks;

inserting the cyclic prefixes between the IDFT blocks to form parallel symbols;

converting the parallel symbols to serial format to form a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol; the data structure comprising a plurality of data symbols; [.]

forming data symbols such that each data symbol comprises a cyclic prefix and a data block, the cyclic prefix having a number of samples G, the data block having a number of samples N; and

forming a preamble structure having an enhanced training symbol, the enhanced training symbol comprising a cyclic prefix and a training block, the cyclic prefix having a number of samples G, the training block having a number of samples N_I such that $N_I = N/I$, where I is an integer and $G = N_I/4$.

24. (cancelled)

25. (previously presented) The method of claim 23, wherein the step of taking an IDFT comprises receiving an input to an IDFT stage such that the enhanced training symbol is formed having five sections, each section having the same sequence.

26. (previously presented) The method of claim 23, wherein the step of taking an IDFT comprises receiving an input to an IDFT stage such that the enhanced training symbol is formed having eight sections, each of the first, second, third, fourth, seventh, and eight sections comprising a first sequence, each of the fifth and sixth sections having a second sequence.

27. (previously presented) The method of claim 23, wherein the step of combining further comprises dividing the data blocks and training blocks onto two transmit diversity brances (TDBs), and forming a frame structure further comprises forming two frame structures, each frame structure being formed on a respective TB.

28. (previously presented) The method of claim 27, wherein a first enhanced training symbol on a first TDB is formed having five sections, and a second enhanced training symbol on a second TDB is formed having five sections.

29. (previously presented) The method of claim 28, wherein the first, second, and fifth sections of each of the first and second enhanced training symbols are formed such that each comprises a first sequence, the third and fourth sections of the first enhanced training symbol are formed such that each comprises a second sequence that is the negative of a complex conjugate of the first sequence, and the third and fourth sections of the second enhanced training symbol are formed such that each comprises a third sequence that is the complex conjugate of the first sequence.

30. – 41. (cancelled)

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APR 19 2007

PTO/SB/22 (04-07)
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U.S. Patent and Trademark Office; U.S. DEPARMENT OF COMMERCE
Under the paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless if displays a valid OMB control number.

PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) **FY 2006** *(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)*	Docket Number (Optional) 20070007
Application Number 10/264,546	Filed 10/4/02
For Preamble structures for single input, single output (SISO), and multi-input, multi-output (MIMO) communications systems	
Art Unit 2616	Examiner John Pezzlo

This is a request under the provisions of 37 CFR 1.136(a) to extend the period for filing a reply in the above identified application.

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below):

		Fee	Small Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$120	$60	$
☐	Two months (37 CFR 1.17(a)(2))	$450	$225	$
☒	Three months (37 CFR 1.17(a)(3))	$1020	$510	$ 1020.00
☐	Four months (37 CFR 1.17(a)(4))	$1590	$795	$
☐	Five months (37 CFR 1.17(a)(5))	$2160	$1080	$

☐ Applicant claims small entity status. See 37 CFR 1.27.

☐ A check in the amount of the fee is enclosed.

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

☐ The Director has already been authorized to charge fees in this application to a Deposit Account.

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 190130. I have enclosed a duplicate copy of this sheet.

WARNING: Information on this form may become public. Credit card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

I am the

☐ applicant/inventor.

☐ assignee of record of the entire interest. See 37 CFR 3.71. Statement under 37 CFR 3.73(b) is enclosed (Form PTO/SB/96).

☐ attorney or agent of record. Registration Number _____

☒ attorney or agent under 37 CFR 1.34. Registration number if acting under 37 CFR 1.34 29,404

Daniel J. Long
Signature

4/19/2007
Date

Daniel J. Long
Typed or printed name

603-885-2643
Telephone Number

NOTE: Signatures of all the inventors or assignees of record of the entire interest or their representative(s) are required. Submit multiple forms if more than one signature is required, see below

☐ Total of _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). 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 6 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.

04/20/2007 TL0111 00000020 190130 10264546
01 FC:1253 1020.00 DA

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10264546

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	48	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	40 minus 20=	* 20
INDEPENDENT CLAIMS	5 minus 3 =	* 2
MULTIPLE DEPENDENT CLAIM PRESENT		☐

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

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=	180.00	OR	X$18=	
X42=	84.00	OR	X84=	
+140=		OR	+280=	
TOTAL	370	OR	TOTAL	

CLAIMS AS AMENDED - PART II

12-1702

AMENDMENT A

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 40	Minus	** 40	=
Independent	* 5	Minus	*** 5	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

4/19/02

AMENDMENT B

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 25	Minus	** 40	=
Independent	* 2	Minus	*** 5	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. 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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/264,546	10/04/2002	Apurva N. Mody	062020-1120	5338

24504 7590 10/24/2006

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

EXAMINER	
PEZZLO, JOHN	

ART UNIT	PAPER NUMBER
2616	

DATE MAILED: 10/24/2006

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

Office Action Summary	Application No.	Applicant(s)	
	10/264,546	MODY ET AL.	
	Examiner	Art Unit	
	John Pezzlo	2616	

-- 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 3 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 *17 December 2002*.

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) *2-41* is/are pending in the application.

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

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *2,4,23 and 30-41* is/are rejected.

7)☒ Claim(s) *3,5-22 and 24-29* 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 *04 October 2002* 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 *2/10/03*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ .
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 101

35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

I. Claims 31-41 are rejected under 35 U.S.C. 101 because the claimed invention is directed to non-statutory subject matter. Claims 31-33 are directed to a space-time signal structure and claims 34-41 are directed to a preamble structure. Structures are not statutory, a structure is not a device or machine or process.

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

II. Claims 2, 4, 23, and 30-34 are rejected under 35 U.S.C. 102(e) as being anticipated by Ma et al. (US 2002/0122382 A1) hereinafter Ma.

1. Regarding claims 2 and 23 and 30-34 – Ma discloses an encoder having a pilot/training symbol inserter, the pilot/training symbol inserter configured to insert pilot symbols into data blocks and to combine training symbols with the data blocks, refer to Figure 1 and paragraphs [0021], [0033], [0034], [0039], [0040], and [0042].

Ma discloses at least one modulator, each modulator having an inverse discrete Fourier transform (IDFT) stage and a cyclic prefix inserter, each modulator outputting a frame structure comprising a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol, refer to Figure 1 and paragraphs [0021], [0023], [0027], [0033], [0034], [0039], [0040], and [0042].

Ma discloses at least one transmit antenna, each transmit antenna corresponding to a respective one of the at least one modulator, each transmit antenna transmitting the frame structure output from the corresponding modulator, refer to Figure 1 and [0029] and [0031].

2. Regarding claim 4 – Ma discloses the data structure comprises a plurality of data symbols, each data symbol having a data block and a cyclic prefix, the cyclic prefix being inserted by the cyclic prefix inserter, refer to Figure 1 and paragraphs [0021], [0023], [0027], [0033], [0034], [0039], [0040], and [0042].

Allowable Subject Matter

Claims 3, 5-22, and 24-29 are objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Conclusion

The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

1. Wu et al. (US 2002/0122381 A1) discloses channel estimation for MIMO OFDM system.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Pezzlo whose telephone number is (571) 272-3090. The examiner can normally be reached on Monday to Friday from 8:30 AM to 4:30 PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wellington Chin, can be reached on (571) 272-3134. The fax phone number for the organization where this application or proceeding is assigned is (571) 273-8300.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is (571) 272-2600.

Any response to this action should be mailed to:

Commissioner of Patents and Trademarks

Washington, D.C.

or faxed to:

(571) 273-8300

For informal or draft communications, please label "PROPOSED" or "DRAFT"

Hand delivered responses should be brought to:

Receptionist (Sixth floor)

Crystal Park 2

2121 Crystal Drive

Arlington, VA.

John Pezzlo

20 October 2006

JOHN PEZZLO
PRIMARY EXAMINER

PTO/SB/17 (10-02)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for Form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet | | Of | |

Complete If Known	
Application Number	10/264,546
Filing Date	10/04/2002
First Named Inventor	Apurva N. Mody et al.
Group/Art Unit	~~2131~~ 2616
Examiner Name	To Be Assigned
Attorney Docket No.	062020-1120

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2]	Publication Date MM-DD-YY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	A	US-5,732,113	03/24/1998	Schmidl et al.	
	B	US-6,088,408	07/11/2000	Calderbank et al.	
	C	US-6,115,427	09/05/2000	Calderbank et al.	
	D	US-6,125,149	09/26/2000	Jafarkhani et al.	
	E	US-6,185,258 B1	02/06/2001	Alamouti et al.	
	F	US-6,188,736 B1	02/13/2001	Lo et al.	
	G	US-2001/0031019 A1	10/18/2001	Jafarkhani et al.	
	H	US-2001/0050964 A1	12/13/2001	Foschini et al.	
	I	US-2001/0053143 A1	12/20/2001	Li et al.	
	J	US-2002/0041635 A1	04/11/2002	Ma et al.	
	K	US-2002/0181390 A1	12/05/2002	Mody et al.	
	L	US-2002/0181509 A1	12/05/2002	Mody et al.	
		US-			
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375/347
375/267
375/267
370/344
375/267
370/208
370/480

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] – Number[4] – Kind Code[5] (*if known*)	Publication Date MM-DD-YY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
						☐
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Examiner Signature		Date Considered	18 Oct 06

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3]Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese paten documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols are indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washing, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

PTO/SB/17 (10-02)
Approved for use through 10/31/2002. OMB 0651-0031
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for Form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet		Of	

Complete If Known	
Application Number	10/264,546
Filing Date	10/04/2002
First Named Inventor	Apurva N. Mody et al.
Group/Art Unit	~~2131~~ 2616
Examiner Name	To Be Assigned
Attorney Docket No.	062020-1120

OTHER PRIOR ART – NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published	
	M	SIAVASH M. ALAMOUTI, "A Simple Transmit Diversity Technique for Wireless Communications," IEEE Journal on Select Areas in Communications, October 1998, pp. 1451-1458, Vol. 16, No. 8.	☐
	N	VAHID TAROKH, HAMID JAFARKHANI, A. R. CALDERBANK, "Space-Time Block Codes from Orthogonal Designs," IEEE Transaction on Information Theory, July 1999, pp. 1456-1467, Vol. 45, No. 5.	☐
	O	VAHID TAROKH, HAMID JAFARKHANI, A. R. CALDERBANK, "Space-Time Block Coding for Wireless Communications: Performance Results," IEEE Journal on Selected Areas in Communications, March 1999, pp. 451-460, Vol. 17, No. 3.	☐
	P	YE (GEOFFREY) LI, NAMBIRAJAN SESHADRI, SIRIKIAT ARIYAVISITAKUL, "Channel Estimation for OFDM Systems With Transmitter Diversity in Mobile Wireless Channels," IEEE Journal on Selected Areas in Communications, March 1999, pp. 461-471, Vol. 17, No. 3.	☐
	Q	APURVA N. MODY, GORDON L. STUBER, "Synchronization for MIMO OFDM Systems," 2001, pp. 509-513, Vol. 1, Proceedings of GLOBECOM 2001, San Antonio.	☐ ✓
	R	APURVA N. MODY, GORDON L. STUBER, "Parameter Estimation for OFDM With Transmit Receive Diversity," 2001, Proceedings of VTC Rhodes, Greece.	☐ ✓
	S	APURVA N. MODY, GORDON L. STUBER, "Efficient Training and Synchronization Sequence Structures for MIMO OFDM," 2001, Proceedings of 6th OFDM Workshop 2001, Paper 16, Hamburg, Germany.	☐ ✓
	T	TIMOTHY M. SCHMIDL, DONALD C. COX, "Robust Frequency and Timing Synchronization for OFDM," IEEE Transactions on Communications, December 1997, pp. 1613-1621, Vol. 45, No. 12.	☐ ✓
	U	APURVA N. MODY, GORDON L. STUBER, "Receiver Implementation for a MIMO OFDM System," November 2002, Proceedings of GLOBECOM 2002, Taipei, Taiwan.	☐ ✓

Examiner Signature		Date Considered	18 Oct 06

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.
[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.
Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washing, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

Notice of References Cited	Application/Control No. 10/264,546	Applicant(s)/Patent Under Reexamination MODY ET AL.	
	Examiner John Pezzlo	Art Unit 2616	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2002/0122381	09-2002	Wu et al.	370/208
*	B	US-2002/0122382	09-2002	Ma et al.	370/208
	C	US-			
	D	US-			
	E	US-			
	F	US-			
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	H	US-			
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	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
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	P					
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	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	
	V	
	W	
	X	

*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

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. 5338

SERIAL NUMBER	FILING OR 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
10/264,546	10/04/2002 RULE	370	2616	062020-1120

APPLICANTS

Apurva N. Mody, Atlanta, GA;
Gordon L. Stuber, Atlanta, GA;

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

This appln claims benefit of 60/327,145 10/04/2001

OK/ JP 18Oct06

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

None/ JP 18Oct06

IF REQUIRED, FOREIGN FILING LICENSE GRANTED ** SMALL ENTITY **
** 11/04/2002

Foreign Priority claimed	35 USC 119 (a-d) conditions met	Verified and Acknowledged	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☒ no	☐ yes ☒ no ☐ Met after Allowance	Examiner's Signature Initials	GA	7	40	5

ADDRESS
24504

TITLE
Preamble structures for single-input, single-output (SISO) and multi-input, multi-output (MIMO) communication systems

FILING FEE RECEIVED	FEES: Authority has been given in Paper
699	No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:

- ☐ All Fees
- ☐ 1.16 Fees (Filing)
- ☐ 1.17 Fees (Processing Ext. of time)
- ☐ 1.18 Fees (Issue)
- ☐ Other _____
- ☐ Credit

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
10/264,546	MODY ET AL.
Examiner	**Art Unit**
John Pezzlo	2616

√	Rejected	–	(Through numeral) Cancelled	N	Non-Elected	A	Appeal
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Claim		Date
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Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination	
	10/264,546	MODY ET AL.	
	Examiner	Art Unit	
	John Pezzlo	2616	

SEARCHED			
Class	Subclass	Date	Examiner
370	430, 460	20Oct06 JP	
	208		
	~~206~~		
	330		
342	375, 383		
375	146, 260		
	355, 267		

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
refer to EAST search	19Oct06 JP	

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

	Type	L #	Hits	Search Text	DBs	Time Stamp	Comments
1	BRS	L1	54	(modulator or transmitter) and pilot and training and symbol and data and (idft or ifft) and (cyclic near prefix) and frame and preamble	US-PGPUB; USPAT	2006/10/19 08:22	

STATUS INQUIRY	Docket Number (Optional) 062020-1120

First Named Inventor: **Mody, et al.**

Group Art Unit: **2131**

Application No.: **10/264,546**

Examiner: **TBA**

Filed: **10/04/2002**

Confirmation No.: **5338**

Title: **Preamble Structures for Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems**

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

WARNING: *Submission of a status letter after a Notice of Allowance may subject an application to a reduction in patent term adjustment under 37 C.F.R. 1.704(c)(10). See Notice of May 29, 2001, 1247 OG 111-112, June 26, 2001.*

1. More than **Forty (40)** months have passed since

☒ NEW APPLICATIONS
the filing of this application on .
No communication has been received from the Patent and Trademark Office indicating action on this application.
(Note: Do not file a status inquiry until at least 18 months has elapsed with no communication from the PTO)

☐ AMENDED APPLICATIONS
the filing of a response on .
No further communication has been received from the Patent and Trademark office.
(Note: Do not file a status inquiry until 6 months has elapsed with no response from the PTO)

☐ APPEALED APPLICATION

The Appeal Brief was filed on .

CERTIFICATE OF MAILING 37 CFR 1.8(a)

I hereby certify that this correspondence is being:

☐ deposited with the United States Postal Service on the date shown below with sufficient postage as first class mail in an envelope addressed to: Mail Stop Petition, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

☒ transmitted by facsimile on the date shown below to the United States Patent and Trademark Office at (571) 273-8300.

April 6, 2006 — Date

Julie Campbell — Signature

(check and complete applicable items below)

☐ An Examiner's Answer was mailed on

☐ A Reply to the Examiner's Answer was submitted on

☐ ALLOWED APPLICATIONS
the mailing of FORM POL-327 and/or Examiner's Amendment on

2. Kindly advise the undersigned of the present status of this application.

04/06/06
Date

Signature

Telephone Number: (770) 933-9500

Scott A. Horstemeyer, Reg. NO. 34,183

Typed or printed name

Thomas, Kayden, Horstemeyer & Risley LLP
100 Galleria Parkway
Suite 1750
Atlanta, GA 30339

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

#5

In Re Application of:

Apurva N. Mody et al.

Serial No.: 10/264,546

Filed: 10/04/2002

Group Art Unit: 2131

Examiner: To Be Assigned

Docket No.: 062020-1120

For: PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS

INFORMATION DISCLOSURE STATEMENT

Commissioner for Patents
Washington, D.C. 20231

Sir:

This information disclosure statement is filed in accordance with 37 C.F.R. §§ 1.56, 1.97, and 1.98, and specifically:

☒ under 37 CFR 1.97(b), or
(within Three months of filing national application; or date of entry of international application; or before mailing date of first office action on the merits; whichever occurs last)

☐ under 37 CFR 1.97(c) together with either a:
- ☐ Statement Under 37 C.F.R. 1.97(e), or
- ☐ a $180.00 fee under 37 CFR 1.17(p), or

(After the CFR 1.97(b) time period, but before the final office action or notice of allowance, whichever occurs first)

☐ under 37 CFR 1.97(d) together with a:
- ☐ Statement under 37 CFR 1.97(e), and
- ☐ a $180.00 petition fee set forth in 37 CFR 1.17(p).

(Filed after final office action or notice of allowance, whichever occurs first, but before payment of the issue fee)

Enclosed is a check in the amount of $. Please charge $ to deposit account . At any time during the pendency of this application, please charge any fees required to Deposit Account 20-0778 pursuant to 37 CFR 1.25. The Commissioner is hereby requested to credit any overpayment to Deposit Account No. 20-0778.

☒ Applicant(s) submit herewith *Form PTO 1449A - Information Disclosure Statement by Applicant* together with copies of patents, publications or other information of which applicant(s) are aware, which applicant(s) believe(s) may or may not be material to the examination of this application and for which there may be a duty to disclose in accordance with 37 CFR 1.56. As required by 37 C.F.R. §1.98(a), a legible copy of each document is provided.

☐ A concise explanation of the relevance of foreign language patents, foreign language publications and other foreign language information listed on PTO Form 1449, as presently understood by the individual(s) designated in 37 CFR 1.56(c) most knowledgeable about the content is given on the attached sheet, or where a foreign language patent is cited in a search report or other action by a foreign patent office in a counterpart foreign application, an English language version of the search report or action which indicates the degree of relevance found by the foreign office is listed on the form PTO 1449 and is enclosed herewith.

The following rights are reserved by the Applicant(s): the right to establish the patentability of the claimed invention over any of the listed documents should they be applied as reference, and/or the right to prove that some of these documents may not be prior art, and/or the right to prove that some of these documents may not be enabling for the teachings they purport to offer.

This statement should not be construed as a representation that an exhaustive search has been made, or that information more material to the examination of the present application does not exist. The Examiner is specifically requested not to rely solely on the materials submitted herewith. The Examiner is requested to conduct an independent and thorough review of the documents, and to form independent opinions as to their significance.

It is requested that the information disclosed herein be made of record in this application and that the Examiner initial and return a copy of the enclosed PTO-1449 to indicate the documents have been considered.

Respectfully Submitted,

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.

By: Glenn W. Brown
Glenn W. Brown, Reg. No. 51,310

100 Galleria Parkway, Suite 1750
Atlanta, Georgia 30339-5948
770-933-9500
TKHR Docket No. 062020-1120

CERTIFIED MAILING

I hereby certify that this correspondence is being deposited with the United States Postal Service as **"First Class Mail,"** in an envelope addressed to: Commissioner of Patents, Washington, D.C. 20231 on February 3, 2003

Evelyn Sanders
Signature

CERTIFICATE OF MAILING

I hereby certify that the below listed items are being deposited with the U.S. Postal Service as first class mail in an envelope addressed to:

Box:
Commissioner for Patents
Washington, D.C. 20231

on February 3, 2003.

Evelyn Sanders
Evelyn Sanders

In Re Application of:

Apurva N. Mody et al.

Serial No.: 10/264,546

Filed: 10/04/2002

Group Art Unit: 2131

Examiner: To Be Assigned

Docket No.: 062020-1120

For: **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS**

The following is a list of documents enclosed:

Return Postcard
Information Disclosure Statement
Form PTO-1449
Copies of Cited Prior Art References A-U

Further, the Commissioner is authorized to charge Deposit Account No. 20-0778 for any additional fees required. The Commissioner is requested to credit any excess fee paid to Deposit Account No. 20-0778.

PTO/SB/17 (10-02)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for Form 1449A/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet		Of	

Complete If Known	
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Group/Art Unit	2131
Examiner Name	To Be Assigned
Attorney Docket No.	062020-1120

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2]	Publication Date MM-DD-YY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
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	B	US-6,088,408	07/11/2000	Calderbank et al.	
	C	US-6,115,427	09/05/2000	Calderbank et al.	
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		US-			
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FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] – Number[4] – Kind Code[5] *(if known)*	Publication Date MM-DD-YY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
						☐
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						☐
						☐

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3]Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese paten documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols are indicated on the document under WIPO Standard ST. 16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washing, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

PTO/SB/17 (10-02)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Substitute for Form 1449B/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(use as many sheets as necessary)

Sheet | | Of |

Complete If Known	
Application Number	**10/264,546**
Filing Date	**10/04/2002**
First Named Inventor	**Apurva N. Mody et al.**
Group/Art Unit	**2131**
Examiner Name	**To Be Assigned**
Attorney Docket No.	**062020-1120**

OTHER PRIOR ART – NON PATENT LITERATURE DOCUMENTS

Examiner Initials*	Cite No.[1]	Include name of the author (in CAPITAL LETTERS), title of the article (when appropriate), title of the item (book, magazine, journal, serial, symposium, catalog, etc.) date, page(s), volume-issue number(s), publisher, city and/or country where published	
	M	SIAVASH M. ALAMOUTI, "A Simple Transmit Diversity Technique for Wireless Communications," IEEE Journal on Select Areas in Communications, October 1998, pp. 1451-1458, Vol. 16, No. 8.	☐
	N	VAHID TAROKH, HAMID JAFARKHANI, A. R. CALDERBANK, "Space-Time Block Codes from Orthogonal Designs," IEEE Transaction on Information Theory, July 1999, pp. 1456-1467, Vol. 45, No. 5.	☐
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	R	APURVA N. MODY, GORDON L. STUBER, "Parameter Estimation for OFDM With Transmit Receive Diversity," 2001, Proceedings of VTC Rhodes, Greece.	☐
	S	APURVA N. MODY, GORDON L. STUBER, "Efficient Training and Synchronization Sequence Structures for MIMO OFDM," 2001, Proceedings of 6th OFDM Workshop 2001, Paper 16, Hamburg, Germany.	☐
	T	TIMOTHY M. SCHMIDL, DONALD C. COX, "Robust Frequency and Timing Synchronization for OFDM," IEEE Transactions on Communications, December 1997, pp. 1613-1621, Vol. 45, No. 12.	☐
	U	APURVA N. MODY, GORDON L. STUBER, "Receiver Implementation for a MIMO OFDM System," November 2002, Proceedings of GLOBECOM 2002, Taipei, Taiwan.	☐

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.

[1]Applicant's unique citation designation number (optional). [2]Applicant is to place a check mark here if English language Translation is attached.

Burden Hour Statement: This form is estimated to take 2.0 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washing, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

#4

PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:

Mody et al.

Serial No.: 10/264,546

Filed: October 4, 2002

Group Art Unit: 2131

Examiner: To Be Assigned

Docket No. 062020-1120

For: **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS**

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, DC 20231

Sir:

In regard to the above-referenced application, the Applicants submit the following preliminary amendments and remarks to be respectively entered and considered prior to examination.

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 C.F.R. § 1.136(a), and any fees required therefor (including fees for net addition of claims) are hereby authorized to be charged to Deposit Account No. 20-0778.

AMENDMENTS

Please amend the application as indicated hereafter.

In the Claims

Please cancel claim 1 without prejudice, waiver, or disclaimer, and add the following new claims:

---

2. (Newly Added) A transistor of a communication system, the transmitter comprising:

an encoder having a pilot/training symbol inserter, the pilot/training symbol inserter configured to insert pilot symbols into data blocks and to combine training symbols with the data blocks;

at least one modulator, each modulator having an inverse discrete Fourier transform (IDFT) stage and a cyclic prefix inserter, each modulator outputting a frame structure comprising a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol; and

at least one transmit antenna, each transmit antenna corresponding to a respective one of the at least one modulator, each transmit antenna transmitting the frame structure output from the corresponding modulator.

A1 Cont.

3. (Newly Added) The transmitter of claim 2, wherein the enhanced training symbol is a single symbol.

4. (Newly Added) The transmitter of claim 2, wherein the data structure comprises a plurality of data symbols, each data symbol having a data block and a cyclic prefix, the cyclic prefix being inserted by the cyclic prefix inserter.

5. (Newly Added) The transmitter of claim 4, wherein each of the at least one training symbol comprises a cyclic prefix and a training block, the cyclic prefix being inserted by the cyclic prefix inserter, the training block being inserted by the pilot/training symbol inserter.

6. (Newly Added) The transmitter of claim 5, wherein the enhanced training symbol comprises a cyclic prefix and a training block, the cyclic prefix being inserted by the cyclic prefix inserter, the training block being inserted by the pilot/training symbol inserter.

A. Cont.

7. (Newly Added) The transmitter of claim 6, wherein each data block has a number of samples N, each training block of the at least one training symbol has a number of samples N_I, and the training block of the enhanced training symbol has a number of samples N_I, whereby $N_I = N/I$, where I is an integer.

8. (Newly Added) The transmitter of claim 6, wherein the training block of the enhanced training symbol is divided into a number of sections having a number of samples N_J such that $N_J = N/J$, where J is an integer.

9. (Newly Added) The transmitter of claim 8, wherein J equals 4.

10. (Newly Added) The transmitter of claim 6, wherein the cyclic prefixes have a number of samples G such that G = N/I, where I is an integer.

11. (Newly Added) The transmitter of claim 2, wherein the enhanced training symbol comprises a cyclic prefix and a training block, the cyclic prefix having a number of samples G, the training block having a number of samples N_I, whereby $N_I = N/I$, where N is equal to the number of samples of data blocks of the data structure and I is an integer, and whereby $G = N_I/4$.

12. (Newly Added) The transmitter of claim 11, wherein the training block is divided into four sections, each section having a number of samples $N_I/4$.

Cont.

13. (Newly Added) The transmitter of claim 12, wherein the cyclic prefix and each of the four sections comprises the same sequence.

14. (Newly Added) The transmitter of claim 13, wherein the cyclic prefix and the first section provide time synchronization and coarse frequency offset estimation, the second and third sections provide channel estimation and noise variance estimation, and the cyclic prefix and first, second, and third sections further provide fine frequency offset estimation.

15. (Newly Added) The transmitter of claim 14, wherein the communication system is a single-input, single-output (SISO) communication system.

16. (Newly Added) The transmitter of claim 11, wherein the cyclic prefix is divided into first and second sections having a number of samples $N_I/8$, the training block is divided into third, fourth, fifth, sixth, seventh, and eighth sections, the third, fourth, seventh, and eighth sections having a number of samples $N_I/8$, the fifth and sixth sections having a number of samples $N_I/4$.

17. (Newly Added) The transmitter of claim 16, wherein the first, second, third, fourth, seventh, and eighth sections comprise a first sequence, and the fifth and sixth sections comprise a second sequence.

A1 Cont.

18. (Newly Added) The transmitter of claim 17, wherein the first, second, third, and fourth sections provide time synchronization and coarse frequency offset estimation, the fifth and sixth sections provide channel estimation and noise variance estimation, and the first through sixth sections further provide fine frequency offset estimation.

19. (Newly Added) The transmitter of claim 18, wherein the communication system is a single-input, single output (SISO) communication system.

20. (Newly Added) The transmitter of claim 11, wherein the number of modulators and transmit antennas is two, a first training block corresponding to a first transmit antenna being divided into four sections, each section having a number of samples $N_I/4$, and a second training

block corresponding to a second transmit antenna being divided into four sections, each section having a number of samples $N_I/4$.

21. (Newly Added) The transmitter of claim 20, wherein the cyclic prefixes of each transmit antenna and the first and fourth sections of the first and second training blocks comprise a first sequence, the second and third sections of the first training block comprising a second sequence that is the negative of the complex conjugate of the first sequence, and the second and third sections of the second training block comprising a third sequence that is the complex conjugate of the first sequence.

A1 Cont.

22. (Newly Added) The transmitter of claim 21, wherein the cyclic prefixes and first sections of the first and second training blocks providing time synchronization and coarse frequency offset estimation, the first, second, and third sections of the first and second training blocks providing channel estimation and noise variance estimation, and the cyclic prefixes and first, second, and third sections of the first and second training blocks further providing fine frequency offset estimation.

23. (Newly Added) A method of forming a frame structure that is transmitted in a communication system, the method comprising the steps of:

providing data blocks;

providing training blocks;

combining the data blocks and training blocks in a parallel format to provide a parallel combination;

taking an inverse discrete Fourier transform (IDFT) of the parallel combination to form IDFT blocks;

inserting cyclic prefixes between the IDFT blocks to form parallel symbols;

converting the parallel symbols to serial format to form a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol, the data structure comprising a plurality of data symbols.

A1 Cont.

24. (Newly Added) The method of claim 23, further comprising the steps of:

forming data symbols such that each data symbol comprises a cyclic prefix and a data block, the cyclic prefix having a number of samples G, the data block having a number of samples N; and

forming a preamble structure having an enhanced training symbol, the enhanced training symbol comprising a cyclic prefix and a training block, the cyclic prefix having a number of samples G, the training block having a number of samples N_I such that $N_I = N/I$, where I is an integer and $G = N_I/4$.

25. (Newly Added) The method of claim 23, wherein the step of taking an IDFT comprises receiving an input to an IDFT stage such that the enhanced training symbol is formed having five sections, each section having the same sequence.

26. (Newly Added) The method of claim 23, wherein the step of taking an IDFT comprises receiving an input to an IDFT stage such that the enhanced training symbol is formed having eight sections, each of the first, second, third, fourth, seventh, and eighth sections comprising a first sequence, each of the fifth and sixth sections having a second sequence.

Cont.

27. (Newly Added) The method of claim 23, wherein the step of combining further comprises dividing the data blocks and training blocks onto two transmit diversity branches (TDBs), and forming a frame structure further comprises forming two frame structures, each frame structure being formed on a respective TDB.

28. (Newly Added) The method of claim 27, wherein a first enhanced training symbol on a first TDB is formed having five sections, and a second enhanced training symbol on a second TDB is formed having five sections.

29. (Newly Added) The method of claim 28, wherein the first, second, and fifth sections of each of the first and second enhanced training symbols are formed such that each comprises a first sequence, the third and fourth sections of the first enhanced training symbol are formed such that each comprises a second sequence that is the negative of a complex conjugate of the first sequence, and the third and fourth sections of the second enhanced training symbol are formed such that each comprises a third sequence that is the complex conjugate of the first sequence.

30. (Newly Added) A computer program stored on a computer-readable medium, the computer program comprising:

logic configured to combine data blocks and training blocks in a parallel format to provide a parallel combination;

logic configured to take an inverse discrete Fourier transform (IDFT) of the parallel combination to form IDFT blocks;

logic configured to insert cyclic prefixes between the IDFT blocks to form parallel symbols;

logic configured to convert the parallel symbols into a serial format to form a preamble structure and a data structure, the preamble structure comprising at least one training symbol and an enhanced training symbol, the data structure comprising a plurality of data symbols.

31. (Newly Added) A space-time signal structure transmitted in a communication system, the space-time signal structure comprising:

at least one frame structure, each frame structure comprising a preamble structure and a data structure;

the preamble structure comprising:

at least one training symbol and an enhanced training symbol, each training symbol comprising a cyclic prefix and a training block, the enhanced training symbol comprising a cyclic prefix and an enhanced training block; and

the data structure comprising:

a plurality of data symbols, each data symbol comprising a cyclic prefix and a data block.

A1 cont.

32. (Newly Added) The space-time signal structure of claim 31, wherein the communication system is a single-input, single-output (SISO) communication system, the space-time signal structure comprises one frame structure, and the preamble strucutre comprises one training symbol and one enhanced training symbol.

33. (Newly Added) The space-time signal structure of claim 31, wherein the communication system is a multi-input, multi-output (MIMO) communication system, and the space-time signal structure comprises a plurality of frame structures.

34. (Newly Added) A preamble structure transmitted along with data blocks in a communication system, the preamble structure comprising:

at least one training symbol, each training symbol comprising:

a cyclic prefix; and

a training block;

an enhanced training symbol, the enhanced training symbol comprising:

a cyclic prefix; and

an enhanced training block.

35. (Newly Added) The preamble structure of claim 34, wherein the training blocks of the at least one training symbol and the enhanced training block of the enhanced training symbol each comprise a number of samples N_I such that $N_I = N/I$, where N is the number of samples of each data block and I is a positive integer, and the cyclic prefixes of the at least one training symbol and the cyclic prefix of the enhanced training symbol each comprise a number of samples G such that $G = N_I/4$.

36. (Newly Added) The preamble structure of claim 35, wherein the enhanced training block is divided into four equal sections such that each section has a number of samples $N_I/4$.

37. (Newly Added) The preamble structure of claim 36, wherein the cyclic prefix of the enhanced training symbol and the four sections of the enhanced training block each comprise the same sequence.

38. (Newly Added) The preamble structure of claim 37, wherein the sequences have good correlation properties and low peak to average power ratio (PAPR).

39. (Newly Added) The preamble structure of claim 35, wherein the cyclic prefix of the enhanced training symbol is divided into two equal $N_I/8$ sections, and the enhanced training block is divided into six sections, the first, second, fifth and sixth sections having $N_I/8$ samples, and the third and fourth sections having $N_I/4$ samples.

40. (Newly Added) The preamble structure of claim 35, wherein the communication system is a 2 x 2 multi-input, multi-output (MIMO) communication system, the enhanced training block being divided into four equal sections each having $N_I/4$ samples, a second enhanced training block being divided into four equal sections each having $N_I/4$ samples.

41. (Newly Added) The preamble structure of claim 40, wherein each of the second and third sections of the enhanced training block comprise a sequence that is the negative of the complex conjugate of the sequence of the first and fourth sections, and each of the second and third sections of the second enhanced training block comprise a sequence that is the complex conjugate of the first and fourth sections.

REMARKS

Applicants respectfully request that the above amendment be entered before examination of this application. Upon entry of this Preliminary Amendment, Claim 1 has been canceled and claims 2-41 have been newly added. It is believed that the foregoing amendments and additions add no new matter to the present application.

Favorable action in regard to the application is earnestly solicited.

Respectfully submitted ,

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.

By: Glenn W. Brown
Glenn W. Brown, Reg. No. 51,310

100 Galleria Parkway
Suite 1750
Atlanta, Georgia 30339-5948
(770) 933-9500

Docket No. 062020-1120

#3

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application Of: Apurva N. Mody et al.

Group No.: 2131

Serial No.: 10/264,546

Docket No. 062020-1120

Filed: 10/04/2002

For: **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI OUTPUT (MIMO) COMMUNICATION SYSTEMS**

RESPONSE TO MISSING PARTS NOTICE

Box: Missing Parts
Commissioner for Patents
Washington, D.C. 20231

Sir:

In response to the Notice to File Missing Parts of Application, Filing Date Granted, dated 11/05/2002, please find enclosed:

1. Declaration for Patent Application (Executed);

2. a copy of the Notice to File Missing Parts of Application, Filing Date Granted; and

3. a check in the amount of $65.00 to cover the additional surcharge fee for filing this Response to the Missing Parts Notice.

The Commissioner is authorized to charge Deposit Account 20-0778 for any deficiencies or credit any over payments.

Respectfully Submitted,

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.

By: Glenn W. Brown
Glenn W. Brown, Reg. No. 51,310

Suite 1750, 100 Galleria Parkway
Atlanta, Georgia 30339-5948
(770) 933-9500

#3

In re **PATENT** application of: Mody et al.

Serial No: **10/264,546**

Filed: **October 4, 2002**

Examiner: To Be Assigned

Group No.: 2131

Docket No.: 062020-1120

Title: **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMI) COMMUNICATION SYSTEMS**

AMENDMENT TRANSMITTAL LETTER

Commissioner For Patents
Box: Missing Parts
Washington, D.C. 20231

Sir:

Transmitted herewith is an amendment in the above-identified application.

- ☐ Response/Amendment
- ☒ Fee as Calculated Below
- ☐ No additional fee is required.
- ☐ Small Entity status has been established.
- ☐ Terminal Disclaimer
- ☐ Corrected Drawings
- ☒ Other: Preliminary Amendment

CLAIMS AS AMENDED FOR SMALL ENTITY					
	Claims After Amendment	Highest Prev. Paid For	Extra	Rate	Additional Fee
Total Claims	40	- 20	20	x $9.00	= $180
Independent Claims	5	- 3	2	x $42.00	= $84.00
Total Additional Fee for this Amendment					**= $264.00**

- ☒ A check in the amount of $329.00 is enclosed.
- ☐ A Credit Card Payment Form PTO-2038 is attached in the amount of $.
- ☐ The Commissioner is hereby authorized to charge to our Deposit Account No. the amount of $ for the fee identified above. A duplicate of this Amendment Transmittal Letter is included herewith.
- ☒ The Commissioner is authorized to charge any insufficiencies, and the Commissioner is hereby requested to credit any overpayments to our Deposit Account No. 20-0778.

Customer No.: 24504

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.

Date: 12/12/02

Glenn W. Brown

Glenn W. Brown, Reg. No. 51, 310
Attorney for Applicant(s)

CERTIFICATE OF MAILING

I hereby certify that the below listed items are being deposited with the U.S. Postal Service as first class mail in an envelope addressed to:

Box: Missing Parts
Commissioner for Patents
Washington, D.C. 20231

on 12/12/2002.

Evelyn Sanders
Evelyn Sanders

In Re Application Of: Mody *et al.*

Group No.: 2131

Serial No.: 10/264,546

Docket No. 062020-1120

Filed: October 4, 2002

For: **Preamble Structures for Single-Input, Single Out-put (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems**

The following is a list of documents enclosed:

Return Postcard
Response to Missing Parts
Copy of Notice of Missing Parts – Filing Date Granted
Declaration for Patent Application (Executed)
Amendment Transmittal Letter
Preliminary Amendment
Fee Transmittal
Check for $329.00

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Approved for use through 10/31/2002. OMB 0651-0032
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FEE TRANSMITTAL for FY 2003

Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($)329.00

Complete If Known	
Application Number	10/264,546
Filing Date	October 4, 2002
First Named Inventor	Mody et al.
Examiner Name	To Be Assigned
Group Art Unit	2131
Attorney Docket No.	062020-1120

METHOD OF PAYMENT *(check all that apply)*

☒ Check ☐ Credit Card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account

Deposit Account Number: 20-0778

Deposit Account Name: Thomas, Kayden, Horstemeyer Risley

The Commissioner is authorized to: *(check all that apply)*

☐ Charge fee(s) indicated below ☒ Credit any overpayments

☒ Charge any additional fee(s) during the pendency of this application

☐ Charge fee(s) indicated below, **except for the filing fee** to the above-identified deposit account

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	740	2001	370	Utility Filing Fee	
1002	330	2002	165	Design Filing Fee	
1003	510	2003	255	Plant Filing Fee	
1004	740	2004	370	Reissue Filing Fee	
1005	160	2005	80	Provisional Filing Fee	
				SUBTOTAL (1)	($)

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee From Below		Fee Paid
Total Claims	40	-20**=	20	X	9.00	=	$180
Independent Claims	5	-3** =	2	X	42.00	=	$84
Multiple Dependent					140.00	=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	84	2201	42	Independent claims in excess of 3
1203	280	2203	140	Multiple dependent claim, if not paid
1204	84	2204	42	**Reissue independent claims over original patent
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent
				SUBTOTAL (2) ($)264

***or number previously paid, if greater; For Reissues, see above*

FEES CALCULATION *(continued)*

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge-late filing fee or oath	65.00
1052	50	2052	25	Surcharge-late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	400	2252	200	Extension for reply within second month	
1253	920	2253	460	Extension for reply within third month	
1254	1,440	2254	720	Extension for reply within fourth month	
1255	1,960	2255	980	Extension for reply within fifth month	
1401	320	2401	160	Notice of Appeal	
1402	320	2402	160	Filing a brief in support of an appeal	
1403	280	2403	140	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive-unavoidable	
1453	1,280	2453	640	Petition to revive-unintentional	
1501	1,280	2501	640	Utility issue fee (or reissue)	
1502	460	2502	230	Design issue fee	
1503	620	2503	310	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee for provisional application	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	740	2809	370	Filing a submission after final rejection (37 CFR § 1.129(a))	
1810	740	2810	370	For each additional invention to be examined (37 CFR § 1.129(b))	
1801	740	2801	370	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee	(specify)				
				SUBTOTAL (3)	($) 65.00

*Reduced by Basic Filing Fee Paid

Submitted by			Complete (if applicable)	
Name (Print/Type)	Glenn W. Brown	Registration No.: 51,310 (Attorney/Agent)	Telephone Number	(770) 933-9500
Signature	Glenn W. Brown		Date 12/11/02	

WARNING: Information on this form may become public. Credit Card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

#3 MP/H

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
Washington, DC 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/264,546	10/04/2002	Apurva N. Mody	062020-1120

CONFIRMATION NO. 5338

FORMALITIES LETTER

OC000000009065109

24504
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
STE 1750
ATLANTA, GA 30339-5948

Date Mailed: 11/05/2002

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

12/18/2002 SMINASS1 00000071 10264546
01 FC:2051 65.00 OP

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. 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 oath or declaration is unsigned.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$65** for a Small Entity

- **$65** Late oath or declaration Surcharge.

12/18/2002 SMINASS1 00000071 10264546
02 FC:2202 180.00 OP
03 FC:2201 84.00 OP

A copy of this notice MUST be returned with the reply.

H. Tornay

Customer Service Center
Initial Patent Examination Division (703) 308-1202
PART 2 - COPY TO BE RETURNED WITH RESPONSE

#3

DECLARATION FOR PATENT APPLICATION

Attorney Docket No: **062020-1120**

As the below named inventor(s), I/we hereby declare that:

Our residences, post office addresses and citizenships are as stated below next to our names.

We believe we are the original, first, and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled **Preamble Structures for Single-Input, Single-Output (SISO) and Multi-Input, Multi-Output (MIMO) Communication Systems**, the specification of which:

- ☐ is attached hereto.
- ☒ was filed on **October 4, 2002** as Application Serial No. **10/264,546**.
- ☐ was filed on _____ under U.S. Express Mail No. _____.
- ☐ is set forth in PCT International Application No. _____; filed on _____ and as amended Under PCT Article 19 on _____ (if any).

I/we hereby state that I/we have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT international filing date of the continuation-in-part application.

I/we hereby claim foreign priority benefits under Title 35, United States Code, 119(a)-(d) or (f), or 365(b) of any foreign application(s) for patent, inventor's or plant breeder's rights certificate(s), or 365(a) of any PCT international application which designated at least one country other than the United States of America listed below and have also identified below any foreign application for patent, inventor's or plant breeder's rights certificate(s), or any PCT international application having a filing date before that of the application on which priority is claimed: **NOT APPLICABLE.**

I/we hereby appoint all attorneys of Thomas, Kayden, Horstemeyer & Risley, LLP, who are listed under the USPTO Customer Number shown below as my/our attorneys to prosecute this application and to transact all business in the United States Patent and Trademark Office connected therewith, recognizing that the specific attorneys listed under that Customer Number may be changed from time to time at the sole discretion of Thomas, Kayden, Horstemeyer & Risley, LLP, and request that all correspondence be addressed to the address filed under the same USTPO Customer Number.

24504

Please address all telephone calls, in the first instance, to **Scott A. Horstemeyer,** at telephone number: **(770) 933-9500.**

Address all correspondence to:

Scott A. Horstemeyer
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.
100 Galleria Parkway, N.W., Suite 1750
Atlanta, Georgia 30339-5948

I/we hereby declare that all statements made herein of my/our 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 statement 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.

Inventor's Signature: Apurva Mody Date: Nov 25, 2002

Full Name of First or Sole Inventor: **Apurva N. Mody**
Residence: **327155 Georgia Tech Station, Atlanta, GA 30332**
Citizenship: **U.S.A.**
Post Office Address: **327155 Georgia Tech Station, Atlanta, GA 30332**

Inventor's Signature: Date: Nov 25, 2002

Full Name of Second Inventor: **Gordon L. Stuber**
Residence: **1052 Arbor Trace, Atlanta, GA 30318**
Citizenship: **U.S.A.**
Post Office Address: **1052 Arbor Trace, Atlanta, GA 30318**

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10264546

CLAIMS AS FILED - PART I

	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA
TOTAL CLAIMS	40	
FOR		
TOTAL CHARGEABLE CLAIMS	40 minus 20=	* 20
INDEPENDENT CLAIMS	5 minus 3 =	* 2
MULTIPLE DEPENDENT CLAIM PRESENT		☐

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

SMALL ENTITY TYPE ☐		OR	OTHER THAN SMALL ENTITY	
RATE	FEE		RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=	180	OR	X$18=	
X42=	84.00	OR	X84=	
+140=		OR	+280=	
TOTAL	370	OR	TOTAL	

CLAIMS AS AMENDED - PART II

10-1702

AMENDMENT A	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	* 40	Minus	** 40	=
Independent	* 5	Minus	*** 5	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY		OR	OTHER THAN SMALL ENTITY	
RATE	ADDITIONAL FEE		RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. 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.

UNITED STATES PATENT AND TRADEMARK OFFICE

Commissioner for Patents
Washington, DC 20231
www.uspto.gov

APPLICATION NUMBER	FILING/RECEIPT DATE	FIRST NAMED APPLICANT	ATTORNEY DOCKET NUMBER
10/264,546	10/04/2002	Apurva N. Mody	062020-1120

CONFIRMATION NO. 5338

24504
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, LLP
100 GALLERIA PARKWAY, NW
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ATLANTA, GA 30339-5948

FORMALITIES LETTER

OC000000009065109

Date Mailed: 11/05/2002

NOTICE TO FILE MISSING PARTS OF NONPROVISIONAL APPLICATION

FILED UNDER 37 CFR 1.53(b)

Filing Date Granted

Items Required To Avoid Abandonment:

An application number and filing date have been accorded to this application. The item(s) indicated below, however, are missing. Applicant is given **TWO MONTHS** from the date of this Notice within which to file all required items and pay any fees required below to avoid abandonment. 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 oath or declaration is unsigned.
- To avoid abandonment, a late filing fee or oath or declaration surcharge as set forth in 37 CFR 1.16(e) of $65 for a small entity in compliance with 37 CFR 1.27, must be submitted with the missing items identified in this letter.

SUMMARY OF FEES DUE:

Total additional fee(s) required for this application is **$65** for a Small Entity

- **$65** Late oath or declaration Surcharge.

A copy of this notice MUST be returned with the reply.

H. Tivong

Customer Service Center
Initial Patent Examination Division (703) 308-1202
PART 3 - OFFICE COPY

10-07-02

jc800 U.S. PTO 10/04/02

PTO/SB/05 (03-01)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Please type a plus sign (+) inside this box → [+]

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

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No	062020-1120
First Inventor	Mody et al.
Title	PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS
Express Mail Label No	EL891519381US

J1033 U.S. PTO 10/264546 10/04/02

APPLICATION ELEMENTS

See MPEP Chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

[ ] APPLICANT REQUESTS EARLY PUBLICATION UNDER 37 CFR 1.219 *(additional fee)*

1. [X] Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original, and a duplicate for fee processing)*
2. [X] Applicant claims small entity status. See CFR 1.27
3. [X] Specification *(preferred arrangement set forth below)* [Total Pages 34]
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed Sponsored R&D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [X] Drawing(s) *(35 USC 113)* [Total Sheets 7]
5. Oath or Declaration [Total Pages 2]
   a. [X] Unexecuted
   b. [ ] Copy from a prior application (37 CFR §1 63(d)) *(for continuation/divisional with Box 18 completed)*
      i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1 33(b)
6. [ ] Application Data Sheet. See 37 CFR 1 76

   Assignee Name and Address (if applicable)

7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   a. [ ] Computer Readable Copy (CRF)
   b. Specification Sequence Listing on
      i. [ ] CD-ROM or CD-R (2 copies), or
      ii. [ ] Paper
   c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [ ] Assignment Papers (cover sheet & Documents(s))
10. [ ] 37 CFR 3 73(b) Statement *(when there is an assignee)* [X] Power of Attorney
11. [ ] English Translation Document *(if applicable)*
12. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
13. [ ] Preliminary Amendment
14. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Nonpublication Request under 35 U S.C 122(b)(2)(B)(i) Applicant must attach form PTO/SB/35 or its equivalent
17. [ ] Other _____

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

[ ] Continuation [ ] Divisional [ ] Continuation-in-part (CIP) of prior application No: /

Prior application information: ***Examiner*** _____ ***Group / Art Unit:*** _____

For CONTINUATION OR DIVISIONAL APPS only the entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference This incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts

18. CORRESPONDENCE ADDRESS

[X] *Customer Number or Bar Code Label* **24504** *(Insert Customer No. or Attach bar code label here)* or [ ] *Correspondence address below*

NAME	Scott A. Horstemeyer Thomas, Kayden, Horstemeyer & Risley, L.L.P.				
ADDRESS	100 Galleria Parkway Suite 1750				
CITY	Atlanta	STATE	Georgia	ZIP CODE	30339-5948
COUNTRY	U.S.A.	TELEPHONE	770-933-9500	FAX	770-951-0933

Name (Print/Type)	Glenn W. Brown	Registration No. (Attorney/Agent)	51,310
Signature	Glenn W. Brown	Date	10/4/02

Burden Hour Statement: This form is estimated to take 0.2 hours to complete. Time will vary depending upon the needs of the individual case. Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office. Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents. Box Patent Application. Washington, DC 2023.

PTO/SB/17 (11-01)
Approved for use through 10/31/2002. OMB 0651-0032
U S Patent and Trademark Office U S DEPARTMENT OF COMMERCE
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FEE TRANSMITTAL for FY 2003

Patent fees are subject to annual revision

☒ Applicant claims small entity status See 37 CFR 1 27

TOTAL AMOUNT OF PAYMENT	($)370.00

Complete If Known	
Application Number	To Be Assigned
Filing Date	10/4/02
First Named Inventor	Mody et al.
Examiner Name	To Be Assigned
Group Art Unit	To Be Assigned
Attorney Docket No	62020-1120

METHOD OF PAYMENT *(check all that apply)*

☐ Check ☐ Credit Card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account

Deposit Account Number: 20-0778

Deposit Account Name: Thomas, Kayden, Horstemeyer Risley

The Commissioner is authorized to: *(check all that apply)*

☒ Charge fee(s) indicated below ☒ Credit any overpayments

☒ Charge any additional fee(s) during the pendency of this application

☐ Charge fee(s) indicated below, **except for the filing fee** to the above-identified deposit account

FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	740	2001	370	Utility Filing Fee	370
1002	330	2002	165	Design Filing Fee	
1003	510	2003	255	Plant Filing Fee	
1004	740	2004	370	Reissue Filing Fee	
1005	160	2005	80	Provisional Filing Fee	
				SUBTOTAL (1)	($)370

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee From Below		Fee Paid
Total Claims	1	-20**=	0	X	9.00	=	0
Independent Claims	1	-3** =	0	X	42.00	=	0
Multiple Dependent					140.00	=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	84	2201	42	Independent claims in excess of 3
1203	280	2203	140	Multiple dependent claim, if not paid
1204	84	2204	42	**Reissue independent claims over original patent
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent
				SUBTOTAL (2) ($)0

***or number previously paid, if greater; For Reissues, see above*

FEES CALCULATION *(continued)*

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge-late filing fee or oath	
1052	50	2052	25	Surcharge-late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	400	2252	200	Extension for reply within second month	
1253	920	2253	460	Extension for reply within third month	
1254	1,440	2254	720	Extension for reply within fourth month	
1255	1,960	2255	980	Extension for reply within fifth month	
1401	320	2401	160	Notice of Appeal	
1402	320	2402	160	Filing a brief in support of an appeal	
1403	280	2403	140	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive-unavoidable	
1453	1,280	2453	640	Petition to revive-unintentional	
1501	1,280	2501	640	Utility issue fee (or reissue)	
1502	460	2502	230	Design issue fee	
1503	620	2503	310	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee for provisional application	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	740	2809	370	Filing a submission after final rejection (37 CFR § 1 129(a))	
1810	740	2810	370	For each additional invention to be examined (37 CFR § 1 129(b))	
1801	740	2801	370	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee	(specify)				
				SUBTOTAL (3)	($)

*Reduced by Basic Filing Fee Paid

Submitted by			Complete (if applicable)	
Name (Print/Type)	Glenn W. Brown	Registration No. 51,310 (Attorney/Agent)	Telephone Number	(770) 933-9500
Signature	Glenn W. Brown		Date 10/4/02	

WARNING: Information on this form may become public. Credit Card information should not be included on this form. Provide credit card information and authorization on PTO-2038.

Burden Hour Statement This form is estimated to take 0 2 hours to complete Time will vary depending upon the needs of the individual case Any comments on the amount of time you are required to complete this form should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, Washington, DC 20231. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Assistant Commissioner for Patents, Washington, DC 20231.

PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: **Mody et al.**

For: **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS**

CERTIFICATE OF EXPRESS MAIL

BOX: Patent Application
Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed for filing in the above case are the following documents:

Return Postcard
Utility Patent Application Transmittal Page
Fee Transmittal Page
Filing fees in the amount of $370.00 (Deposit Account Authorization)
Utility Patent Application Consisting Of:
32 ~~27~~ Pages of Specification
1 Pages of Claims (Claim 1)
1 Page of Abstract
7 Pages of Formal Drawings (Figs. 1-9)
Declaration and Power of Attorney (Unexecuted)

Further, the Commissioner is authorized to charge Deposit Account No. 20-0778 for any additional fees required. The Commissioner is requested to credit any excess fee paid to Deposit Account No. 20-0778.

Respectfully submitted,

Glenn W. Brown, Reg. No. 51,310

Glenn W. Brown

THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.
100 Galleria Parkway, N.W.
Suite 1750
Atlanta, Georgia 30339-5948

Our Docket No: **062020-1120**

I hereby certify that all correspondence listed above are being deposited for delivery to the above addressee, with the United States Postal Service **"EXPRESS MAIL POST OFFICE TO ADDRESSEE"** service under 37 CFR §1.10 on the date indicated below:

The envelope has been given U.S. Postal Service "Express Mail Post Office To Addressee" Package **#EL891519381US**.

Date: 10-4-02

Evelyn Sanders
Evelyn Sanders

10-07-02

jc800 U.S. PTO 10/04/02

PTO/SB/05 (03-01)
Approved for use through 10/31/2002. OMB 0651-0032
U.S. Patent and Trademark Office: U.S. DEPARTMENT OF COMMERCE

Please type a plus sign (+) inside this box → [+]

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

UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Attorney Docket No	062020-1120
First Inventor	Mody et al.
Title	PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS
Express Mail Label No	EL891519381US

J1033 U.S. PTO 10/264546 10/04/02

APPLICATION ELEMENTS

See MPEP Chapter 600 concerning utility patent application contents

ADDRESS TO: Assistant Commissioner for Patents, Box Patent Application, Washington, DC 20231

☐ APPLICANT REQUESTS EARLY PUBLICATION UNDER 37 CFR 1.219 *(additional fee)*

1. [X] Fee Transmittal Form *(e.g., PTO/SB/17)* *(Submit an original, and a duplicate for fee processing)*
2. [X] Applicant claims small entity status. See CFR 1.27
3. [X] Specification *(preferred arrangement set forth below)* *[Total Pages* [34] *]*
   - Descriptive title of the invention
   - Cross Reference to Related Applications
   - Statement Regarding Fed Sponsored R&D
   - Reference to sequence listing, a table, or a computer program listing appendix
   - Background of the Invention
   - Brief Summary of the Invention
   - Brief Description of the Drawings *(if filed)*
   - Detailed Description
   - Claim(s)
   - Abstract of the Disclosure
4. [X] Drawing(s) *(35 USC 113)* *[Total Sheets* [7] *]*
5. Oath or Declaration *[Total Pages* [2] *]*
   - a. [X] Unexecuted
   - b. [ ] Copy from a prior application (37 CFR §1 63(d)) *(for continuation/divisional with Box 18 completed)*
     - i. [ ] DELETION OF INVENTOR(S) Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1 33(b)
6. [ ] Application Data Sheet. See 37 CFR 1 76

Assignee Name and Address (if applicable)

7. [ ] CD-ROM or CD-R in duplicate, large table or Computer Program (Appendix)
8. Nucleotide and/or Amino Acid Sequence Submission *(if applicable, all necessary)*
   - a. [ ] Computer Readable Copy (CRF)
   - b. Specification Sequence Listing on
     - i. [ ] CD-ROM or CD-R (2 copies), or
     - ii. [ ] Paper
   - c. [ ] Statements verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

9. [ ] Assignment Papers (cover sheet & Documents(s))
10. [ ] 37 CFR 3 73(b) Statement *(when there is an assignee)* [X] Power of Attorney
11. [ ] English Translation Document *(if applicable)*
12. [ ] Information Disclosure Statement (IDS)/PTO-1449 [ ] Copies of IDS Citations
13. [ ] Preliminary Amendment
14. [X] Return Receipt Postcard (MPEP 503) *(Should be specifically itemized)*
15. [ ] Certified Copy of Priority Document(s) *(if foreign priority is claimed)*
16. [ ] Nonpublication Request under 35 U S.C 122(b)(2)(B)(i) Applicant must attach form PTO/SB/35 or its equivalent
17. [ ] Other _____

18. If a CONTINUING APPLICATION, *check appropriate box, and supply the requisite information below and in a preliminary amendment, or in an Application Data Sheet under 37 CFR 1.76:*

☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP) of prior application No: /

Prior application information: *Examiner* _____ ***Group / Art Unit:*** _____

For CONTINUATION OR DIVISIONAL APPS only the entire disclosure of the prior application, from which an oath or declaration is supplied under Box 5b, is considered a part of the disclosure of the accompanying continuation or divisional application and is hereby incorporated by reference This incorporation can only be relied upon when a portion has been inadvertently omitted from the submitted application parts

18. CORRESPONDENCE ADDRESS

[X] *Customer Number or Bar Code Label* **24504** *(Insert Customer No. or Attach bar code label here)* *or* [ ] *Correspondence address below*

NAME	Scott A. Horstemeyer Thomas, Kayden, Horstemeyer & Risley, L.L.P.				
ADDRESS	100 Galleria Parkway Suite 1750				
CITY	Atlanta	STATE	Georgia	ZIP CODE	30339-5948
COUNTRY	U.S.A.	TELEPHONE	770-933-9500	FAX	770-951-0933

Name (Print/Type)	Glenn W. Brown	Registration No. (Attorney/Agent)	51,310
Signature	Glenn W. Brown	Date	10/4/02

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FEE TRANSMITTAL for FY 2003

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☒ Applicant claims small entity status See 37 CFR 1 27

TOTAL AMOUNT OF PAYMENT	($)370.00

Complete If Known	
Application Number	To Be Assigned
Filing Date	10/4/02
First Named Inventor	Mody et al.
Examiner Name	To Be Assigned
Group Art Unit	To Be Assigned
Attorney Docket No	62020-1120

METHOD OF PAYMENT *(check all that apply)*

☐ Check ☐ Credit Card ☐ Money Order ☐ Other ☐ None

☒ Deposit Account

Deposit Account Number: 20-0778

Deposit Account Name: Thomas, Kayden, Horstemeyer Risley

The Commissioner is authorized to: *(check all that apply)*

☒ Charge fee(s) indicated below ☒ Credit any overpayments

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	740	2001	370	Utility Filing Fee	370
1002	330	2002	165	Design Filing Fee	
1003	510	2003	255	Plant Filing Fee	
1004	740	2004	370	Reissue Filing Fee	
1005	160	2005	80	Provisional Filing Fee	
				SUBTOTAL (1)	($)370

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee From Below		Fee Paid
Total Claims	1	-20**=	0	X	9.00	=	0
Independent Claims	1	-3** =	0	X	42.00	=	0
Multiple Dependent					140.00	=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	84	2201	42	Independent claims in excess of 3
1203	280	2203	140	Multiple dependent claim, if not paid
1204	84	2204	42	**Reissue independent claims over original patent
1205	18	2205	9	**Reissue claims in excess of 20 and over original patent
				SUBTOTAL (2) ($)0

***or number previously paid, if greater; For Reissues, see above*

FEES CALCULATION *(continued)*

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge-late filing fee or oath	
1052	50	2052	25	Surcharge-late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	400	2252	200	Extension for reply within second month	
1253	920	2253	460	Extension for reply within third month	
1254	1,440	2254	720	Extension for reply within fourth month	
1255	1,960	2255	980	Extension for reply within fifth month	
1401	320	2401	160	Notice of Appeal	
1402	320	2402	160	Filing a brief in support of an appeal	
1403	280	2403	140	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive-unavoidable	
1453	1,280	2453	640	Petition to revive-unintentional	
1501	1,280	2501	640	Utility issue fee (or reissue)	
1502	460	2502	230	Design issue fee	
1503	620	2503	310	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee for provisional application	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	740	2809	370	Filing a submission after final rejection (37 CFR § 1 129(a))	
1810	740	2810	370	For each additional invention to be examined (37 CFR § 1 129(b))	
1801	740	2801	370	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	
Other fee	(specify)				
				SUBTOTAL (3)	($)

*Reduced by Basic Filing Fee Paid

Submitted by			Complete (if applicable)	
Name (Print/Type)	Glenn W. Brown	Registration No. 51,310 (Attorney/Agent)	Telephone Number	(770) 933-9500
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PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re: **Mody et al.**

For: **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS**

CERTIFICATE OF EXPRESS MAIL

BOX: Patent Application
Commissioner for Patents
Washington, D.C. 20231

Sir:

Enclosed for filing in the above case are the following documents:

Return Postcard
Utility Patent Application Transmittal Page
Fee Transmittal Page
Filing fees in the amount of $370.00 (Deposit Account Authorization)
Utility Patent Application Consisting Of:
37 ~~27~~ Pages of Specification
1 Pages of Claims (Claim 1)
1 Page of Abstract
7 Pages of Formal Drawings (Figs. 1-9)
Declaration and Power of Attorney (Unexecuted)

Further, the Commissioner is authorized to charge Deposit Account No. 20-0778 for any additional fees required. The Commissioner is requested to credit any excess fee paid to Deposit Account No. 20-0778.

Respectfully submitted,

Glenn W. Brown, Reg. No. 51,310

Glenn W. Brown

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Our Docket No: **062020-1120**

I hereby certify that all correspondence listed above are being deposited for delivery to the above addressee, with the United States Postal Service **"EXPRESS MAIL POST OFFICE TO ADDRESSEE"** service under 37 CFR §1.10 on the date indicated below:

The envelope has been given U.S. Postal Service "Express Mail Post Office To Addressee" Package **#EL891519381US**.

Date: 10-4-02

Evelyn Sanders
Evelyn Sanders

PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS

CROSS-REFERENCE TO RELATED APPLICATIONS

This application claims priority to co-pending U.S. provisional application entitled "Preamble Structures for SISO and MIMO OFDM Systems," having serial no. 60/327,145, filed on October 4, 2001, which is entirely incorporated herein by reference.

This application is related to U.S. provisional application entitled "Efficient Training and Synchronization Sequence Structures for MIMO OFDM," having serial no. 60/322,786, filed September 17, 2001, which is entirely incorporated herein by reference.

TECHNICAL FIELD OF THE INVENTION

The present invention is generally related to communication systems and, more particularly, to single-input, single-output (SISO) and multi-input, multi-output (MIMO) communication systems.

BACKGROUND OF THE INVENTION

Significant developments in communications have been made by the introduction of technologies that increase system operating efficiency (*i.e.*, system "throughput"). One example of these technologies is the use of two or more transmit antennas and two or more receive antennas (*i.e.*, multiple antennas) in a wireless communication system. Such systems are typically referred to as multi-input, multi-output (MIMO) communication systems. In contrast, traditional wireless communication systems typically employ one

transmit antenna and one receive antenna, and such systems are referred to accordingly as single-input, single-output (SISO) systems.

In addition, traditional communication systems typically use one of two types of signal carrier systems. One such system uses only one carrier for the transmission of information and is known as a single carrier (SC) system. A system that uses multiple carriers to transmit information in parallel is known as a multi-carrier (MC) system. MC systems divide the existing bandwidth into a number of sub-channel bandwidths and each bandwidth is modulated individually by a respective sub-carrier. The method of dividing the bandwidth into sub-channel bandwidths is referred to as frequency division multiplexing (FDM). Therefore, either SISO or MIMO communications may use a SC or an MC signal carrier system.

In a MIMO communication system, signals are typically transmitted over a common path (*i.e.*, channel) by multiple antennas. The signals are typically pre-processed to avoid interference from other signals in the common channel. There are several techniques that may be used to pre-process the signals in this regard, and some of these techniques may be combined to further improve system throughput. One such technique, known as space-time processing (STP), processes and combines "preamble structures" and "data structures" into groups referred to herein as "frame structures." Wireless communication systems typically transmit data, or information (*e.g.*, voice, video, audio, text, *etc.*), as formatted data symbols (or information symbols), which are typically organized into groups referred to herein as data structures. The preamble structure contains an overhead for providing synchronization and parameter estimation, allowing a receiver to decode signals received from a transmitter. In a MIMO communication system, multiple frame structures are transmitted by a

corresponding number of transmit antennas. The combination of the multiple frame structures is generally referred to space-time signal structures. Each frame structure generally includes a preamble structure followed by a data structure.

Training symbols are typically added as prefixes to the data structures (*e.g.*, at the beginning of frame structure) to enable training (*i.e.*, time and frequency synchronization) between the transmitter and receiver of a MIMO communication system. These training symbols can be referred to as preambles and are part of the preamble structures. Space-time signal structures are constructed using STP for training symbols and data symbols individually. Furthermore, pilot structures (or pilots) are symbols that are also constructed by STP and have the same structure as preambles. However, instead of being placed as a prefix to the data structure, the pilot structures are periodically arranged within groups of data symbols. Certain properties incorporated into space-time signal structures make it possible to recover the data structures by post-processing the space-time signal structures with a receiver. Moreover, the formation and processing of space-time signal structures in a wireless communication system may provide increased strength (*i.e.*, gain) in the recovered signal, which typically enhances the performance of the communication system.

Another technique that may be used to pre-process signals in a MIMO communication system is FDM as mentioned earlier. FDM involves dividing the frequency spectrum of a wireless communication system into sub-channels and transmitting modulated data, or information (*i.e.*, formatted signals for voice, video, audio, text, *etc.*), over these sub-channels at multiple signal carrier frequencies ("sub-carrier frequencies").

Communication systems involving orthogonal frequency division multiplexing (OFDM) have emerged as a popular form of FDM in which the sub-carrier frequencies are

spaced apart by precise frequency differences. The application of the OFDM technology in a SISO communication system (*i.e.*, a SISO OFDM system) provides the capability, among others, to efficiently transmit and receive relatively large amounts of information. The application of OFDM in a MIMO communication system (*i.e.*, a MIMO OFDM system) increases the system's capacity to transmit and receive information using approximately the same amount of bandwidth (*i.e.*, transmission line capacity) as used in a SISO OFDM systems. A MIMO OFDM communication system also offers improved performance to overcome some of the difficulties experienced in other FDM communication systems, such as performance degradation due to multiple versions of a transmitted signal being received over various transmission paths (*i.e.*, multi-path channel interference).

In SISO and MIMO wireless communication systems, synchronization of data symbols is typically required in both the time domain and the frequency domain. Estimation of parameters such as noise variance and other channel parameters is also typically required. Thus, an efficient preamble structure for use in wireless communication systems should provide both synchronization and parameter estimation. Furthermore, an efficient preamble structure should possess a low peak-to-average power ratio (PAPR) (*i.e.*, at or approaching unity) to facilitate efficient system operation.

In their application to SISO and MIMO communication systems, however, various shortcomings have been identified in existing preamble structures. For example, the IEEE Standard 802.11a preamble structure includes a short sequence, which provides time synchronization and coarse frequency offset estimation, followed by a long sequence, which provides fine frequency and channel estimation. Although this preamble has application to SISO communication systems, it is not directly applicable to a MIMO communication

system to provide the above mentioned functions, without the need for significant modifications. Moreover, there is considerable redundancy in the IEEE Standard 802.11a preamble structure, which reduces the system throughput and hence the system efficiency.

Therefore, there is a need for an efficient preamble structure that provides time and frequency synchronization, estimation of parameters such as noise variance and channel parameters, and low PAPR when used with SISO and MIMO communication systems.

SUMMARY OF THE INVENTION

The present invention provides a system for providing efficient preamble structures for use in single-input, single-output (SISO) and multi-input, multi-output (MIMO) communication systems. Briefly described, one embodiment of the present invention, among others, includes providing a communication system for transmitting space-time signal structures across a channel. The space-time signal structures may be transmitted using a SISO communication system and/or a MIMO communication system. One such space-time signal structure includes at least one training symbol, each training symbol having a cyclic prefix and a training block. The length of N_I samples of the training block is equal to a fraction of the length of N samples of a data block such that $N_I = N/I$, where I is a positive integer. Furthermore, the length of G samples of the cyclic prefix is a fraction of the length N_I. For example, G may be equal to $N_I/4$, or 25% of N_I. The training symbols provide coarse and fine time synchronization, coarse and fine frequency synchronization, channel estimation, and noise variance estimation.

The present invention can also be viewed as providing a method for providing efficient preamble structures for SISO and MIMO communication systems. In this regard,

one embodiment of such a method, among others, can be broadly summarized by the following: providing a space-time signal structure having at least one training symbol, each training symbol having a cyclic prefix and a training block. The length of N_I samples of the training block is equal to a fraction of the length of N samples of a data block, *i.e.*, $N_I = N/I$. Furthermore, the length of G samples of the cyclic prefix is a fraction of the length of N_I. For example, G may be equal to $N_I/4$, or 25% of N_I. The training symbols provide coarse and fine time synchronization, coarse and fine frequency synchronization, channel estimation, and noise variance estimation.

Other systems, methods, features and advantages of the present invention will be or become apparent to one with skill in the art upon examination of the following drawings and detailed description. It is intended that all such additional systems, methods, features, and advantages be included within this description, be within the scope of the present invention, and be protected by the accompanying claims.

BRIEF DESCRIPTION OF THE DRAWINGS

Many aspects of the invention can be better understood with reference to the following drawings. Moreover, in the drawings, like reference numerals designate corresponding parts throughout the several views.

FIG. 1 is a block diagram of an exemplary multi-input, multi-output (MIMO) communication system.

FIG. 2 is a block diagram of an exemplary encoder with respect to the communication system depicted in FIG. 1.

FIG. 3 is a block diagram of an exemplary modulator with respect to the communication system depicted in FIG. 1.

FIG. 4 is a diagram illustrating exemplary signal transmissions and associated signal sample matrices with respect to the communication system depicted in FIG. 1.

FIG. 5 is a three-dimensional graphical illustration of a version of the receive sample matrix shown in FIG. 4 that is applicable to the MIMO communication system of FIG. 1 when employing Orthogonal Frequency Division Multiplexing (OFDM).

FIG. 6 illustrates exemplary data frames that may be implemented in the MIMO communication system depicted in FIG. 1.

FIG. 7 illustrates an embodiment of a preamble structure that may be implemented in a SISO communication system.

FIG. 8 illustrates another embodiment of a preamble structure that may be implemented in a SISO communication system.

FIG. 9 illustrates an embodiment of a preamble structure that may be implemented in a MIMO communication system, *e.g.*, the system depicted in FIG. 1.

DETAILED DESCRIPTION

The invention now will be described more fully with reference to the accompanying drawings. The invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are intended to convey the scope of the invention to those skilled in the art. Furthermore, all "examples" given herein are intended to be non-limiting.

FIG. 1 shows a block diagram of an exemplary multi-input, multi-output (MIMO) communication system 10. The exemplary MIMO communication system 10 and its sub-components will be described below to facilitate the description of the present invention. In that regard, the exemplary MIMO communication system 10 may be implemented as a wireless system for the transmission and reception of data across a wireless channel 12. For example, the MIMO communication system 10 may be implemented as part of a wireless local area network (LAN) or metropolitan area network (MAN) system, a cellular telephone system, or another type of radio or microwave frequency system incorporating one-way or two-way communications over a range of distances.

The MIMO communication system 10 may transmit and receive signals at various frequencies. For example, the MIMO communication system 10 may transmit and receive signals in a frequency range from 2 to 11 GHz, such as in the unlicensed 5.8 GHz band, using a bandwidth of about 3 to 6 MHz. Further, the MIMO communication system 10 may employ various signal modulation and demodulation techniques, such as single-carrier frequency domain equalization (SCFDE) or orthogonal frequency division multiplexing (OFDM), for example. However, throughout this description, references will be made with respect to a MIMO OFDM communication system merely to facilitate the description of the invention.

The MIMO communication system 10 may also be implemented as part of a communication system (not shown) that includes an array of sub-channel communication links, which convey one or more signals transmitted by one or more transmitting elements to one or more receiving elements. The sub-channel communication links may include

wires (*e.g.*, in a wiring harness) or other forms of transmission medium that span between a data source and a receiver within the communication system.

The MIMO communication system 10 includes a transmitter 14 and a receiver 16. The transmitter 14 transmits signals across the channel 12 to the receiver 16. As depicted in FIG. 1, the transmitter 14 typically includes several components. In this regard, the transmitter 14 includes an encoder 18. The encoder 18 typically encodes data and/or other types of signals received, for example, from a data source 20. Such signals may alternatively be referred to collectively as "data," "signals," or "data signals." The data source 20 may be a device, system, *etc.* that outputs such signals. The encoder 18 may also perform functions such as employing a channel code on data for transmission and forming sequence structures by STP techniques. Further, the encoder 18 may separate the signals from data source 20 onto one or more signal paths, which are referred to as transmit diversity branches (TDBs) 22-1, 22-2, ..., 22-Q, where Q is the number of transmit antennas from which the signals are transmitted. The encoder 18 typically facilitates the transmission of signals across the channel 12 by bundling the signals into groups, which are typically referred to as space-time signal structures. Details of an exemplary space-time signal structure, with respect to the present invention, is discussed below with respect to FIG. 6.

Further shown in FIG. 1, the transmitter 14 also includes one or more modulators 24-1, 24-2, ..., 24-Q that are configured to modulate signals for transmission over the channel 12. In this regard, the modulators 24 may employ various modulation techniques, such as SCFDE or OFDM. The modulators 24 are typically connected to the encoder 18 by the TDBs 22. The transmitter 14 also includes one or more transmit antennas 26-1, 26-2,

..., 26-Q connected respectively to the one or more modulators 24-1, 24-2, ..., 24-Q. Thus, each TDB 22 directs signals from the encoder 18 to a corresponding modulator 24, and the modulator 24 modulates the signals for transmission by a respective transmit antenna 26. An embodiment of a space-time signal structure transmitted by the transmitter 14 is described below with reference to FIG. 6.

As discussed above, the exemplary MIMO communication system 10, shown in FIG. 1, also includes a receiver 16. The receiver 16 also typically includes several components. The receiver includes one or more receive antennas 28-1, 28-2, ..., 28-L, where L is the number of receive antennas used to receive the Q transmitted space-time signal structures. With Q transmit antennas 26 and L receive antennas 28, the MIMO communication system 10 can be referred to as a Q x L system. In a SISO communication system, the variables Q and L are both equal to one. In a MIMO system, Q and L are equal to a number greater than one and may be equal to each other or non-equal. For example, a 2 x 2 MIMO communication system comprises two transmit antennas, *i.e.*, Q=2, and two receive antennas, *i.e.*, L=2.

The receive antennas 28-1, 28-2, ..., 28-L are connected to one or more demodulators 30-1, 30-2, ..., 30-L, respectively. The receive antennas 28 typically receive modulated signals, *i.e.*, space-time signal structures, that are transmitted across the channel 12 from the transmit antennas 26. The received signals are typically directed to the demodulators 30 from the respective receive antennas 28. The demodulators 30 demodulate signals that are received by the respective receive antennas 28.

The receiver 16 also includes a decoder 32, which is connected to the demodulators 30-1, 30-2, ..., 30-L via corresponding lines 31-1, 31-2, ..., 31-L. The decoder 32 typically

combines and decodes the demodulated signals from the demodulators 30. In this regard, the decoder 32 typically recovers the original signals that were provided by the data source 20. As depicted in FIG. 1, the original signals recovered by the decoder 32 may be transmitted to a connected data sink 34, which may include one or more devices configured to utilize or process the recovered signals.

As discussed above, the transmitter 14 of the MIMO communication system 10 includes one or more modulators 24 that are connected to one or more transmit antennas 26, respectively. Further, the receiver 16 of the MIMO communication system 10 includes one or more demodulators 30 that are connected to one or more receive antennas 28, respectively. In this regard, the number of modulators 24 and respective transmit antennas 26 that are implemented in the transmitter 14 may be represented by a first variable, "Q." Similarly, the number of demodulators 30 and respective receive antennas 28 that are implemented in the receiver 16 may be represented by a second variable, "L." In the exemplary MIMO communication system 10, the number Q of modulators 24 and respective transmit antennas 26 may be equivalent or non-equivalent to the number L of demodulators 30 and respective receive antennas 28. In this regard, the MIMO communication system 10 may be said to have "Q x L" transmit-receive diversity.

FIG. 2 is a block diagram of an exemplary encoder 18 of the MIMO communication system 10 depicted in FIG. 1. The elements of the encoder 18 shown in FIG. 2 will be described below with respect to several elements that were described above for FIG. 1. The exemplary encoder 18 includes a channel encoder 36. The channel encoder 36 typically converts data and/or other types of signals to channel encoded versions of the signals, which may also be referred to collectively as "channel encoded data" or "channel encoded

signals." These signals may be received by the channel encoder 36 from a data source 20, for example. The channel encoder 36 is typically configured to encode signals using an encoding scheme that can be recognized and decoded by the decoder 32 of the receiver 16. In the process of encoding signals, the channel encoder 36 typically adds parity to the signals so that the decoder 32 can detect errors in the received channel encoded signals, which may occur, for example, due to environmental conditions that affect the channel 12 or noise inadvertently injected into the signals by the transmitter 14 and/or receiver 16.

The exemplary encoder 18 depicted in FIG. 2 also includes a symbol mapper 38, which receives channel encoded signals from the channel encoder 36. The symbol mapper 38 is typically configured to map channel encoded signals into data blocks. This mapping may be done by grouping a predetermined number of bits of the data so that each group of bits constitutes a specific data block that is selected from a pre-determined symbol alphabet. In this regard, a symbol alphabet typically includes a finite set of values. For example, a symbol alphabet of a binary phase shift keying (BPSK) system typically comprises the values +1 and -1, and a symbol alphabet for a quadrature phase shift keying (QPSK) system typically comprises the values 1+j, -1+j, 1-j, and -1-j. The symbol mapper 38 is also typically configured to structure a stream of data blocks into data structures, which will be discussed further below.

The exemplary encoder 18 also includes a space-time processor 40. The space-time processor 40 is typically configured to encode a stream of data blocks, received from the symbol mapper 38, through space-time processing to form the data block designated for different TDBs 22 such that the processed data blocks have properties that enhance the performance of the MIMO communication systems 10. The encoded data blocks are output

from the space-time processor 40 over Q lines 42-1, 42-2, ..., 42-Q, where Q represents the number of modulators 24 and respective transmit antennas 26 of the transmitter 14, as discussed above.

As further illustrated in FIG. 2, the Q lines 42-1, 42-2, ..., 42-Q from the space-time processor 40 input respectively to Q adders 44-1, 44-2, ..., 44-Q. The encoder 18 also includes a pilot/training symbol inserter 46, which also has Q output lines 48-1, 48-2, ..., 48-Q that input respectively to the Q adders 44-1, 44-2, ..., 44-Q. The Q adders 44-1, 44-2, ..., 44-Q combine, or mix, the inputs and provide an output to the Q TDBs 22-1, 22-2, ..., 22-Q, which input respectively to the Q modulators 24-1, 24-2, ...24-Q shown in FIG. 1. The pilot/training symbol inserter 46 typically provides pilot blocks and training blocks that are inserted into (or combined with) the data blocks by the adders 44.

The term pilot blocks, as used in this description, refers to symbols provided by the pilot/training symbol inserter 46, which are inserted periodically into the data blocks. Typically, pilot symbols may be inserted at any point in the data blocks. The term training blocks refers to one or more continuous sections of symbols provided by the pilot/training symbol inserter 46. Training blocks are preferably inserted into preamble structures at the beginning of the frame structures and transmitted once per frame structure. However, training blocks may also be inserted in other parts of the signal structures, such as the middle or end of the frame structures. Preambles (or preamble structures) are symbol structures formed of training blocks inserted at the beginning of the frame.

Pilot blocks are typically transmitted with data blocks to calibrate (*i.e.*, synchronize) the receiver 16 to the transmitter 14 on a small scale. This calibration, or synchronization, accounts for the time varying nature of the channel 12, for example. Training symbols,

however, are typically used to periodically calibrate the receiver 16 to the transmitter 14. The training symbols may be unique for each sub-channel. Moreover, different sets of training symbols and/or pilot blocks may be provided by the pilot/training symbol inserter 46, depending on the operating criteria of the communication system 10, which may be determined by the user.

FIG. 3 is a block diagram of an exemplary modulator 24 from one of the modulators 24-1, 24-2, ..., 24-Q of the communication system of FIG. 1. The exemplary modulator 24 may be configured to modulate signals by various techniques, such as SCFDE or OFDM. The input to the modulator 24 is from a corresponding TDB 22, which was discussed above. As shown, the TDB 22 couples to a serial-to-parallel converter 50, which is one of several components of the modulator 24. The serial-to-parallel converter 50 converts the training blocks and data blocks from a serial format to a parallel format for further processing by other components of the modulator 24. Typically, the serial-to-parallel converter 50 converts a number of samples "N" of each of the data blocks from a serial format to a parallel format. The serial-to-parallel converter 50 also converts a number of samples "N_I" of each of the training blocks from serial samples to parallel samples.

The modulator 24 also includes an inverse discrete Fourier transform (IDFT) stage 52 that receives the parallel format of the training blocks and data blocks from the series-to-parallel converter 50. The IDFT stage 52 converts these blocks from the frequency domain to the time domain, as is known in the art. Typically, the IDFT stage 52 receives N samples for each data block and N_I samples for each training block from the serial-to-parallel converter 50 and converts the samples in the frequency domain to N samples for each data block and N_I samples for each training block in the time domain. The time domain samples

from the IDFT stage 52 are input to a cyclic prefix inserter 54. The cyclic prefix inserter 54 inserts an additional number of samples "G" with each data block and training block to form data symbols and training symbols. The G samples are inserted into the data symbols and training symbols as guard intervals to reduce or eliminate inter-symbol interference (ISI) in the N or N_I samples.

The modulator 24 also includes a parallel-to-serial converter 56, which converts the G+N or G+N_I samples received from the cyclic prefix inserter 54 from a parallel format to a serial format for further processing by other components of the modulator 24. The modulator 24 further includes a digital-to-analog converter (DAC) 58. The DAC 58 converts the digital symbols to analog symbols and inputs the analog symbols to a mixer 60. A local oscillator 62 generates carrier signals, which are also input to the mixer 60. The mixer 60 mixes the analog symbols from the DAC 58 with the carrier signals from the local oscillator 62 to generate up-converted versions of the signals for transmission as radio-frequency (RF) signals. The mixer 60 inputs the up-converted signals to an amplifier 64 where the signals are amplified and then input to the transmit antenna 26, which transmits the signals across the channel 12.

FIG. 4 is a schematic diagram illustrating exemplary signal transmissions and associated signal sample matrices with respect to the modulator/demodulator configuration of the MIMO communication system 10 of FIG. 1. As shown in FIG. 4, the configuration includes one or more modulators 24 and one or more demodulators 30. Each modulator 24 is connected to one or more respective transmit antennas 26, and each demodulator 30 is connected to one or more respective receive antennas 28, as discussed above with respect to FIG. 1. Also discussed above, the transmit antennas 26 are typically configured to transmit

modulated signals across a channel 12, and the receive antennas 28 are typically configured to receive modulated signals via the channel 12. In this regard, exemplary signal transmissions are depicted in FIG. 4, which will be discussed further below.

Similar to the above discussion with respect to the MIMO communication system 10 of FIG. 1, the number of modulators 24 and respective transmit antennas 26 that are implemented in the modulator/demodulator configuration of FIG. 4 may be represented by the variable, "Q." Accordingly, the number of demodulators 30 and respective receive antennas 28 in the arrangement of FIG. 4 may be represented by the variable, "L." Thus the modulator/demodulator arrangement depicted in FIG. 4 may also be described as having "Q x L" transmit-receive diversity. Moreover, the variables, Q and L, may be equivalent or non-equivalent in various MIMO communication system configurations.

Exemplary signal transmissions from the Q transmit antennas 26 across the channel 12 to the L receive antennas 28 are depicted in FIG. 4. For example, the first receive antenna 28-1 receives each of the Q transmitted signals from the Q transmit antennas 26-1, 26-2, ..., 26-Q. These Q transmitted signals are typically transmitted over sub-channels having an impulse response characterized by h_{11}, h_{21}, h_{31}, . . ., h_{Q1} that are transmitted from the 1st to the Qth transmit antennas 26-1, 26-2, ..., 26-Q, respectively. In this regard, the term h_{ij} (where i = 1, 2, ..., Q and j = 1, 2, ..., L) is used to refer to the impulse response, in the time domain, of the sub-channels between the i^{th} transmit antenna 26 and the j^{th} receive antenna 28. Thus, as a further example, the L^{th} receive antenna 28-L receives each of the Q transmitted signals, over the sub-channels having impulse responses h_{1L}, h_{2L}, h_{3L}, ..., h_{QL}, from the 1st to the Qth transmit antennas 26-1, 26-2, ..., 26-Q, respectively. Although, for simplicity, exemplary signal transmissions are depicted in FIG. 4 from the Q transmit

antennas 26 to the 1st and the Lth receive antennas 28-1 and 28-L only. However, it should be understood that, in a typical MIMO communication system, all L receive antennas 28 receive the signal transmissions from the Q transmit antennas 26.

A transmit sample matrix **S** is illustrated in FIG. 4. The matrix **S** is associated with the signals that are modulated by the Q modulators 24 and transmitted over the channel 12 from the Q transmit antennas 26. In this regard, the sample matrix **S** may be associated with signals that are transmitted by the MIMO communication system 10. Thus, the elements of the transmit sample matrix **S** may represent Q space-time signal structures, which are simultaneously transmitted from the Q transmit antennas 26 during Q symbol periods ("T_S"). For example, the elements of the first row of the transmit sample matrix **S** may represent the frame structures S_1, S_2, . . ., S_Q, which are transmitted from the 1st through the Qth transmit antennas 26, respectively, at a first instantaneous time ("t"). Similarly, the elements of the second row of the transmit sample matrix **S** may represent the frame structures S_{Q+1}, S_{Q+2}, . . ., S_{2Q}, which are transmitted from the 1st through the Qth transmit antennas 26, respectively, at a second time ("t + T_S"). For the purpose of illustration, the transmission times, *e.g.*, t, t + T_S, *etc.*, are shown to the right of the transmit sample matrix **S**. The elements of the last row of the transmit sample matrix **S** may represent the final set of symbols, $S_{(Q-1)Q+1}$, $S_{(Q-1)Q+2}$, . . ., S_{QQ}, which are transmitted from the 1st through the Qth transmit antennas 26, respectively, at a final time ("t + (Q-1)T_S"). Additional transmission times may be needed if more frame structures are transmitted.

FIG. 4 also includes a receive sample matrix **R**, which is associated with the signals that are received over the channel 12 by the L receive antennas 28 and demodulated by the L demodulators 30. Similar to the elements of the transmit sample matrix **S**, the elements

of the receive sample matrix **R** may represent L received space-time signal structures, which are simultaneously received by the L receive antennas 28 during Q or more symbol periods ("T_S"). For example, the elements of the first row of the receive sample matrix **R** may represent the symbols R_1, R_{Q+1}, . . ., $R_{(L-1)Q+1}$, which are demodulated by the 1st through the L^{th} demodulators 30, respectively, at a first time ("t"). Similarly, the elements of the second row of the receive sample matrix R may represent the symbols R_2, R_{Q+2} . . ., $R_{(L-1)Q+2}$, which are demodulated by the 1st through the L^{th} demodulators 30, respectively, at a second time ("$t + T_S$"). The elements of the last row of the receive sample matrix **R** may represent the final set of symbols, R_Q, R_{2Q}, . . ., R_{QL}, which are demodulated by the 1st through the L^{th} demodulators 30, respectively, at a final time ("$t + (Q-1)T_S$"). It is noted that although references are made to the same time instances (*e.g.*, t, $t + T_S$, *etc.*) in the foregoing descriptions with respect to the transmit sample matrix **S** and the receive sample matrix **R**, there is typically a time delay between the transmission and reception of the space-time signal structures represented by these matrices.

In addition to the transmit sample matrix **S** and the receive sample matrix **R**, there are at least two other matrices that are relevant to represent the transmission and reception of signals in a MIMO communication system, such as the system depicted in FIG. 1. The channel matrix $\boldsymbol{\eta}$ typically includes elements that represent channel coefficients, which are determined based on characteristics of the channel 12. The channel matrix $\boldsymbol{\eta}$ typically has a dimension of Q x L. A noise matrix **W** typically includes elements that represent additive white Gaussian noise, which typically causes distortion and corruption of received signals that are represented, for example, by the receive sample matrix **R**. The noise matrix **W** typically has a dimension of Q x L.

The relationship between the receive sample matrix **R**, the transmit sample matrix **S**, the channel matrix **η**, and the noise matrix **W** can be expressed by the following equation:

$$\mathbf{R}_{k,T\times L} = \mathbf{S}_{k,T\times Q} \cdot \boldsymbol{\eta}_{k,Q\times L} + \mathbf{W}_{k,T\times L} \qquad \text{EQ. 1}$$

With respect to EQ. 1, k represents the sub-carrier or sub-channel of received demodulated signals and T represents a dimension variable that is typically equivalent to Q, although it may have other values. As discussed above, Q and L represent, respectively, the number of modulators 24 and respective transmit antennas 26 and the number of demodulators 30 and respective receive antennas 28 with respect to a typical MIMO communication system 10.

FIG. 5 is a graphical illustration of a version of the receive sample matrix **R'** shown in FIG. 4 that is applicable to the MIMO communication system of FIG. 1, when employing OFDM. As shown, the x-axis represents space, the y-axis represents time, and the z-axis represents frequency. Each receive sample matrix $\mathbf{R}_k$ that is depicted in the space-time dimensions is similar to the receive sample matrix **R** discussed above with respect to FIG. 4. However, each element of the receive sample matrix **R'** illustrated in FIG. 5 also has N frequency components that are each represented by an index, "k". As k varies from 0 to N-1 for the elements of each receive sample matrix $\mathbf{R}_k$ in FIG. 5, the frequency component of the received symbol varies accordingly. Thus, the three-dimensional receive sample matrix **R'** can be viewed as including N receive sample matrices $\mathbf{R}_k$ of dimensions Q x L or alternatively can be viewed as including (Q times L) vectors $R_{i,j}$ of length N. For example, with respect to the symbol received by the first antenna and demodulated by the first demodulator, there is a vector of elements $R_{1,0}, R_{1,1}, \ldots, R_{1,N-1}$, as depicted in FIG. 5.

FIG. 6 is a diagram illustrating an exemplary space-time signal structure 66 that may be implemented in a MIMO communication system that has Q transmit antennas, such as the MIMO communication system 10 depicted in FIG. 1. As depicted in FIG. 6, the space-time signal structure 66 typically includes Q frame structures 68. Each frame structure 68 corresponds to a respective TDB 22 and to a respective transmit antenna 26. Each frame structure 68 typically includes a preamble structure 70 and a data structure 72.

The training blocks of the preamble structure 70 are typically inserted into the frame structure 68 by the pilot/training symbol inserter 46. The preamble structure 70 typically includes one or more training symbols 74. Usually the number of training symbols 74 is equal to Q. Each training symbol 74 typically includes a cyclic prefix 76 of length G and a training block 78 of length N_I. The combination of a cyclic prefix 76 and a training block 78 forms the training symbol 74 that has a length of $G+N_I$ samples in the time domain. In addition, the preamble structure 70 contains one symbol referred to herein as an enhanced training symbol 79, located at the beginning of the preamble structure 70. The training block 78 of the enhanced training symbol 79 is divided into several sections. Certain sections are used for synchronization and other sections are used for channel parameter estimation, as will be discussed in more detail below. The sections typically have a length of N/4 or N/8, but other fractions of N may be used to form the sections of the enhanced training symbol 79. The length of each section of the enhanced training symbol 79 is given the value N_J, which is equal to N/J where J is an integer.

The cyclic prefix 76 may also be referred to as a guard interval, since the cyclic prefix 76 typically functions to guard the signal structures 68 from inter-symbol interference (ISI) during transmission of the space-time structure 66 across the channel 12. The time

length T_g of the cyclic prefix 76 having G samples is typically greater than the maximum time length of the channel impulse response $h_{i,j}$, which was discussed above for FIG. 4. In the example of an OFDM communication system in accordance with the present invention, the time length T_g is about 25% of the time length of one OFDM symbol. However, depending on the time length of the channel 12, G may be less than 25% of one OFDM symbol.

As also depicted in FIG. 6, the data structure 72 typically includes one or more data symbols 80. Typically, the number of data symbols 80 is equal to a multiple of Q. Each data symbol 80 includes a cyclic prefix 76 and a data block 82. The cyclic prefix 76 may have a length G equal to the length of the cyclic prefix of the preamble structure. Alternatively, the length of the cyclic prefix of the data structure 72 may be different from the length of the cyclic prefix of the preamble structure 70. The data block 82 has a length N. The relationship between N and N_I can be expressed by the equation $N_I = N/I$, where I is a positive integer.

The combination of a cyclic prefix 76 and a data block 82 forms the data symbol 80 that has a length of G+N samples in the time domain. Therefore, the data structure 72 of the frame structure 68 typically includes Q or more data symbols 80 that have an overall length of P*Q*(G+N) samples in the time domain, as depicted in FIG. 6, where P is some positive integer. Although omitted from FIG. 6 for simplicity, pilot symbols may also be intermittently inserted into the data symbols 80 by the pilot/training symbol inserter 46, as discussed above.

The time length N_I of a training block 78 may be shorter than the length N of a data block 82 in a frame structure 68. Typically, the length N_I of a training block 78 in the

preamble structure 70 is established as a fraction of the length N of a data block 82 in the data structure 72 to provide the relationship of N_I being equivalent to N/I, where I is a positive integer. For example, N_I may be equivalent to N/4 (*i.e.*, I = 4). If the length N_I of a training block 78 is not established in the communication system, the length N_I may be assumed to be equivalent to N (*i.e.*, I = 1). Typically, the length of a training symbol 74 (*i.e.*, $G+N_I$) in the prior art is equivalent to the length of a data symbol 80 (*i.e.*, G+N). However, according to the present invention, the training symbol 74 may be shorter than the data symbol 80 in the context of the frame structure 68.

The enhanced training symbol 79 of length $G+N_I$ can be further subdivided into smaller sections for efficient synchronization and to perform frequency offset estimation over a wider range. The sequences contained in these sections are also known by the receiver 16. When the receiver 16 receives a space-time signal structure 66, the known sequence is compared with the enhanced training symbol 79 of the preamble structure 70 using a technique such as correlation, as is described in U.S. patent application serial number 10/128,756, filed April 24, 2002, which is incorporated by reference in it entirety herein.

The preamble structure 70 enables the receiver 16 (FIG. 1) to identify the arrival of the frame structure 68. Thus, the preamble structure 70 may facilitate time synchronization, frequency synchronization, channel parameter estimation, and noise variance estimation. Efficient preamble structures 70, in accordance with the present invention, provide the functions of time synchronization, frequency synchronization, channel parameter estimation, and noise variance estimation through synchronization signals that have low peak-to-average power ratios (PAPR) (*e.g.*, at or approaching unity). These functions are

achieved by the shortened preamble structures described herein, which are more efficient than the longer prior art structures. The range of frequency offset estimation can be improved with the shortened preamble structures. By subdividing the length of the training symbols in the time domain into integer multiples N_J, the range is increased.

A signal transmission matrix $\mathbf{S_k}$ having an efficient preamble structure should be a unitary transmission matrix in the frequency domain and have a low PAPR in the time domain. In this regard, efficient preamble structures provide enhanced performance in a MIMO communication systems, requiring less overhead.

A unitary transmission matrix contains rows or columns that are orthogonal to each other, and the energy of the signals represented by each row or column is unity. In mathematical terms, a unitary transmission matrix has the properties represented by the following equations:

$$\sum_{j=1}^{Q} S_{i,j} S_{i',j}^{*} = \begin{cases} 1 & i = i' \\ 0 & i \neq i' \end{cases} \qquad \text{EQ. 2A}$$

$$\sum_{i=1}^{Q} S_{i,j} S_{i,j'}^{*} = \begin{cases} 1 & j = j' \\ 0 & j \neq j' \end{cases} \qquad \text{EQ. 2B}$$

where $S_{i,j}$ represents the constituent symbols of the unitary transmission matrix.

Providing a unitary signal transmission matrix $\mathbf{S_k}$ reduces or eliminates noise enhancement during channel estimation of the received signals. Moreover, providing a unitary signal transmission matrix $\mathbf{S_k}$ with an efficient preamble structure that possesses a

low PAPR reduces or eliminates signal non-linearities and spurious out-of-band signal transmissions.

Furthermore, the enhanced training symbols of the transmitted signal is a short sequence that includes periodically repeating patterns with good correlation properties. The definition of a sequence having good correlation properties according to the present disclosure refers to any sequence having a unique pattern that is compared with a corresponding pattern of another sequence. For instance, using auto-correlation, when the pattern is matched in time with a corresponding pattern in the receiver 16, the patterns provide a peak output indicating a synchronization of the received signal.

Another advantage of the preamble structures described herein is that the shortened length of the preamble structures can be maintained for both SISO and MIMO communication systems. With a length of one OFDM symbol period, the preamble structures use far less bandwidth than used the prior art. The short preamble structures with short periodic sequences can be contained within one symbol period to allow for a greater amount of bandwidth available to transmit useful data or information.

In FIGs. 7-9, examples of enhanced training symbols 79 of the preamble structures are shown in accordance with the embodiments of the present invention. The enhanced training symbols 79 have a length of $G+N_I$ in the time domain, as explained above with respect to FIG. 6. The overhead for the enhanced training symbols 79 includes the cyclic prefix 76 having time length G. The length G is typically a fraction and is preferably equal to one divided by an integer. The length G, for example, may be one-fourth, or 25%, of the length of the training block 78. Furthermore, the time length N_I of the training block 78 of the enhanced training symbol 79 is equal to the length of only one symbol period in an

OFDM or other space-time communication system. With the shortened overhead of the enhanced training symbol 79, the efficiency of the communication system is improved in that the transmission of training symbols requires minimal bandwidth, thereby allowing a larger portion of the bandwidth for the transmission of data structures 72. Thus, more useful data or information can be communicated in the available bandwidth. Moreover, with the efficient preamble structures, time synchronization, frequency offset estimation, channel estimation, and noise variance estimation is accomplished.

FIG. 7 illustrates an example of an enhanced training symbol 84 for a SISO system that may be employed in a modulation/demodulation system, such as, for example, a SCFDE or OFDM system. The enhanced training symbol 84 includes five sections 86-1, 86-2, 86-3, 86-4, 86-5 each having length NT/4 in the time domain, where T is the sample time at the input to the DAC 58. The training block 78 of the enhanced training symbol 84 includes four sections 86-2, 86-3, 86-4, 86-5, and may be referred to as a 4 x (NT/4) training symbol. For example, if N=256, then the training block 78 has 4 x 64T configuration. The entire length of the enhanced training symbol 84 is T_s. The length of the cyclic prefix 76 is T_g and the length of the training block 78 is NT, as represented in interval 94. Cyclic prefix 76 has length G. In this example, G=NT/4. The sequence S_1 in frequency domain represents any sequence such that its modulation in the time domain s_1 has good correlation properties and low PAPR. For instance, the sequence s_1 may include a sequence formed using the exemplary modulator 24 shown in FIG. 3. In this example, each section 86 of the enhanced training symbol 84 is represented with the same type of sequence s_1.

A first interval 88 of the enhanced training symbol 84 spans the first two sections 86-1, 86-2. In this interval 88, the enhanced training symbol 84 includes sequences for

performing time synchronization and coarse frequency offset estimation. These sequences may further be used for other functions. Coarse frequency offset estimation provides an estimation of the frequency offsets in a frequency range up to 4/NT. A second interval 90 begins at the start of the third section 86-3 and spans to the end of the fourth section 86-4 and includes sequences for providing parameter estimation, such as channel estimation and noise variance estimation. A third interval 92 spans the first four sections 86-1, 86-2, 86-3, 86-4. The portion of the enhanced training symbol 84 in the third interval 92 provides sequences for fine frequency offset estimation. Fine frequency offset estimation can be used to estimate the frequency offset up to a value of 1/NT. A fourth interval 94 spans over the entire training block 78. This length is preferably equal to NT, wherein NT refers to the time of the N samples of the N data block 82 shown in FIG. 6. The 4 x NT/4 training block 78 of the enhanced training symbol 84 may be used in a MIMO communication system as well. In MIMO, this enhanced training symbol 84 may perform all the functions as expressed above or may alternatively perform synchronization only.

FIG. 8 is another exemplary embodiment of an enhanced training symbol 96 for a SISO system in a SCFDE, OFDM, or other type of modulation/demodulation system. The enhanced training symbol 96 comprises eight sections 98-1, 98-2, ..., 98-8 in which the first four sections 98-1, 98-2, 98-3, 98-4 have sequences s_1'(NT/8) which are N/8-point IDFT of the sequence S_1' in the frequency domain. The first four sections are followed by two sections 98-5, 98-6 having sequences s_1(NT/4) the N/4 point IDFTs of sequence S_1 which are further followed by two more sections 98-7, 98-8 of s_1'(NT/8) sequences. The cyclic prefix 76 (first two sections 98-1, 98-2) and the remaining six sections 98-3, 98-4, ..., 98-8 (having length NT shown at the fourth interval 94) make up the enhanced training symbol

96. Again, G is equal to N/4. The sequence S_1' is any sequence in the frequency domain such that its N/8 point IDFT modulation in the time domain s_1' has good correlation properties and low PAPR. Again, a sequence with good correlation properties refers to having a unique periodically repeating pattern such that one portion of the repeating pattern is compared with another similar portion of the repeating pattern for determining an accurate starting of training symbols. The sequence S_1 is chosen such that its N/4 point IDFT in the time domain s_1 has good correlation properties and low PAPR.

In the embodiment shown in FIG. 8, the intervals 88, 90, 92, and 94 are substantially the same as the intervals shown in FIG. 7. However, it should be noted that the intervals are only shown for illustrated purposes and may be rearranged or extended if necessary. The first interval 88 of the enhanced training symbol 96 spans the first four S_1' sections 98-1, 98-2, 98-3, 98-4. In this interval 88, the enhanced training symbol 96 includes the sequences for performing time synchronization and coarse frequency offset estimation. Coarse frequency offset estimation provides a frequency offset estimation range up to 8/NT, which is a greater range than possible in the embodiment of FIG. 7. The second interval 90 begins at the start of the fifth section 98-5 and spans to the end of the sixth section 98-6. The second interval 90 includes sequences for providing parameter estimation, such as channel estimation and noise variance estimation. The third interval 92 spans the first six sections of the enhanced training symbol 96 providing sequences for fine frequency offset estimation. Fine frequency offset estimation in this embodiment can estimate the frequency offset up to 1/NT.

FIG. 9 illustrates an example of first and second enhanced training symbols 100 and 102 for a 2 x 2 MIMO system using OFDM or other type of modulation/demodulation

system. A first antenna (ANTENNA 1) transmits the first enhanced training symbol 100. The first enhanced training symbol 100 has five sections 104-1, 104-2, ..., 104-5 in which the s_1 sequence is included in the first, second, and fifth sections 104-1, 104-2, 104-5 where s_1 is the N/4 point IDFT of S_1. The third and fourth sections include a sequence $(-s_1^*)$ that is the IDFT of the N/4 point sequence $-S_1^*$ in the frequency domain. The sequence $-S_1^*$ is the negative of the complex conjugate of the sequence S_1 in the frequency domain. As is similar to the enhanced training symbol 84 shown in FIG. 7, the enhanced training symbol 100 includes five intervals each covering a NT/4 time period. The second antenna (ANTENNA 2) transmits the second enhanced training symbol 102, which includes the sequence s_1 in the first, second, and fifth sections 105-1, 105-2, 105-5 and the sequence s_1^* in the third and fourth sections 105-3, 105-4. The sequence s_1^* is the IDFT of the sequence S_1^* in the frequency domain. The sequence S_1^* is the complex conjugate of the sequence S_1.

In the example of FIG. 9 for use in a 2 x 2 MIMO communication system, time synchronization and coarse frequency offset estimation are performed using portions of the enhanced training symbols 100 and 102 within the interval 88. In this interval 88, coarse frequency offset is estimated up to a range of 4/NT. Parameter estimation is performed in a time interval 106 during the second, third, and fourth sections. Parameter estimation may include channel estimation, noise variance estimation, or both. Fine frequency offset estimation is performed using the sections of the enhanced training symbols 100 and 102 within interval 92 and can be estimated up to 1/NT.

A method of forming the enhanced training symbols in the time domain will now be described. The IDFT stage 52 includes a number of inputs N_J. Given that $N_J = N$ and

N=256, then the following sequence S_I may be input to the IDFT stage 52 to generate the enhanced training symbol 84:

$S_{1,256}$=sqrt(2)*{0 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1+j 0 ... 0 (55 0's) +1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1-j 0 0 0}

As can be seen from this example, every fourth sub-carrier of the IDFT input is excited whereas all the other inputs are set to zero. The output of IDFT will be an N-point sequence with a periodicity of N/4. A cyclic prefix is inserted in front of the sequence to form complete the enhanced training symbol.

Another method for generating the enhanced training symbol shown in FIG 7. is to have N_J = N/4. Given that N=256, a sequence S_I such as the one shown below is input to the IDFT stage 52 to generate the enhanced training symbol:

$S_{1,64}$={ 1 1 -1 1 -1 1 -1 1 1 -1 1 1 1 -1 -1 -1 -1 1 1 1 -1 1 -1 -1 1 0 0 0 0 0 0 0 0 0 0 0 0 0 -1 1 1 1 1 -1 1 1 1 -1 -1 1 1 -1 1 -1 -1 1 -1 1 -1 -1 -1 1 -1 }

The output of the IDFT is an N/4 point sequence which is repeated 4 times and a cyclic prefix is added to generate the enhanced training symbol having the form CP (cyclic

prefix) + 4 x 64. In a similar manner, all the other training symbols can be generated by generating the constituent subsections and then combining them together.

The enhanced training symbol shown in FIG 7 may be further modified to be used in the MIMO system such that the different sequences from different antennas are orthogonal to each other. This orthogonality is achieved by keeping the constituents of the sequence S_1 the same but altering the sub-carriers. For example, the sequence transmitted from antenna 1 has only its even sub-carriers excited as shown:

$S_{1,256,\text{ antenna }1}$=sqrt(2)*{0 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1+j 0 ... 0 (55 0's) +1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1-j 0 0 0}

The sequence used for antenna 2 is the same as the one used for antenna 1 except that its odd sub-carriers are excited as shown:

$S_{1,256,\text{ antenna }2}$=sqrt(2)*{0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1-j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1+j 0 ... 0 (55 0's) +1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 -1+j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 -1-j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1+j

0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 -1-j 0 0 0 +1-j 0 0 0 +1+j 0 0 0 -1+j 0 0 0 +1-j 0 0 0 0}

Thus, with the use of the enhanced training symbols 84 and 96 in a SISO communication system, the synchronization can be enhanced and the system throughput may be increased. Likewise, the use of the enhanced training symbols 100 and 102 in a MIMO communication system also provides enhanced synchronization and hence increased system throughput. These enhanced training symbols provide for more hierarchical frame structures in communication systems.

It is noted that embodiments of the present invention, such as those described above, may be implemented in hardware, software, firmware, or a combination thereof. For example, in some embodiments, the present invention may be implemented as a computer program or application in software or firmware that is stored in a memory and that is executed by a suitable instruction execution system. In other embodiments the present invention may be implemented, for example, with one or a combination of the following technologies, which may be known in the art: one or more discrete logic circuit(s) having logic gates for implementing logic functions upon data signals, an application specific integrated circuit (ASIC) having appropriate combinational logic gates, a programmable gate array(s) (PGA), a field programmable gate array (FPGA), *etc.*

Finally, it should be emphasized that the above-described embodiments of the present invention are merely possible examples of implementations set forth for a clear understanding of the principles of the invention. Many variations and modifications may be made to the above-described embodiment(s) of the invention without departing substantially from the spirit and principles of the invention. All such modifications and

variations are intended to be included herein within the scope of this disclosure and the invention, and protected by the following claims.

CLAIMS

We claim:

1. A frame transmitted in a communication system, the frame comprising:

at least one signal structure, each signal structure comprising a preamble structure having a first time length and a data structure having a second time length, each signal structure being transmitted by a corresponding transmit antenna;

each preamble structure comprising at least one training symbol, each of the at least one training symbol having a third time length, each of the at least one training symbol comprising a first cyclic prefix having a time length G and a training block having a time length N_I; and

each data structure comprising at least one data symbol, each of the at least one data symbol having a fourth time length, each of the at least one data symbol comprising a second cyclic prefix having time length G and a data block having a time length N;

wherein N_I is a first integer fraction of N, and G is a second integer fraction of N_I.

ABSTRACT OF THE DISCLOSURE

A communication system is provided herein for transmitting frames across a channel. The frames may be transmitted in single-input, single-output (SISO) and/or multi-input, multi-output (MIMO) communication systems. One such frame includes at least one training symbol, each having a cyclic prefix and a training block. The time length N_I of the training block is equal to an integer fraction I of the time length of a data block, *i.e.*, $N_I = N/I$. Furthermore, the time length G of the cyclic prefix is an integer fraction of the time length N_I. For example, G may be equal to $N_I/4$ or 25% of N_I. The training symbols provide coarse and fine time synchronization, coarse and fine frequency synchronization, channel estimation, and noise variance estimation.

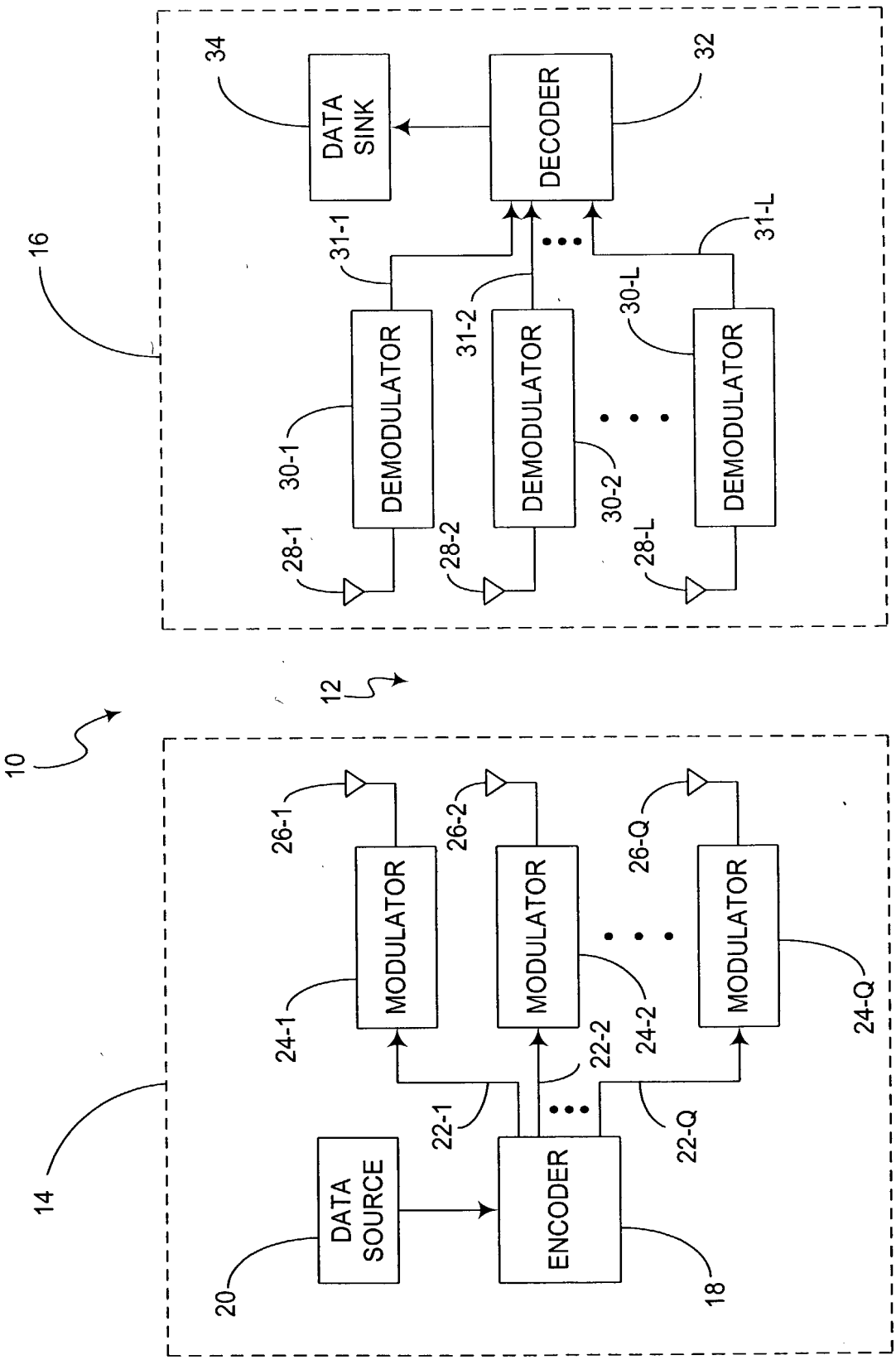

10
12
14
16
18
20
22-1
22-2
22-Q
24-1
24-2
24-Q
26-1
26-2
26-Q
28-1
28-2
28-L
30-1
30-2
30-L
31-1
31-2
31-L
32
34
DATA SOURCE
ENCODER
MODULATOR
MODULATOR
MODULATOR
DEMODULATOR
DEMODULATOR
DEMODULATOR
DECODER
DATA SINK

FIG. 1

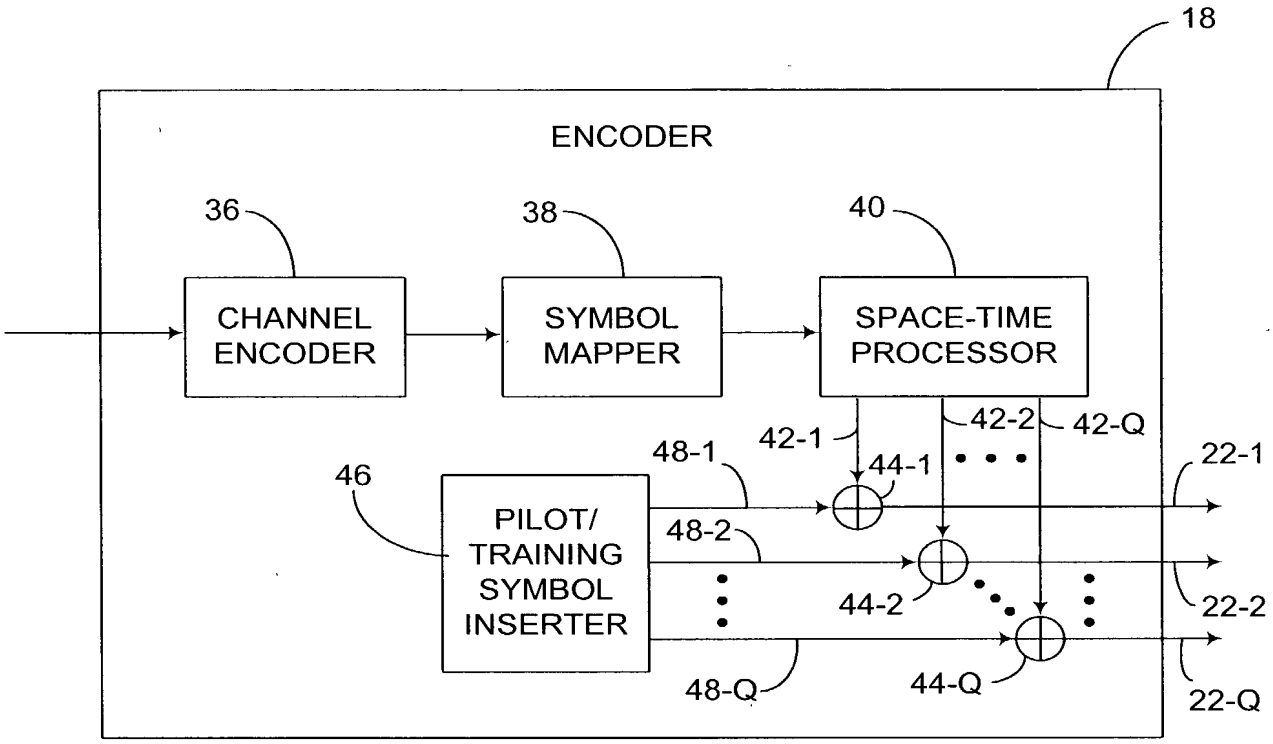

18
ENCODER
36
38
40
CHANNEL ENCODER
SYMBOL MAPPER
SPACE-TIME PROCESSOR
42-1
42-2
42-Q
48-1
44-1
46
PILOT/ TRAINING SYMBOL INSERTER
48-2
44-2
22-1
22-2
48-Q
44-Q
22-Q

FIG. 2

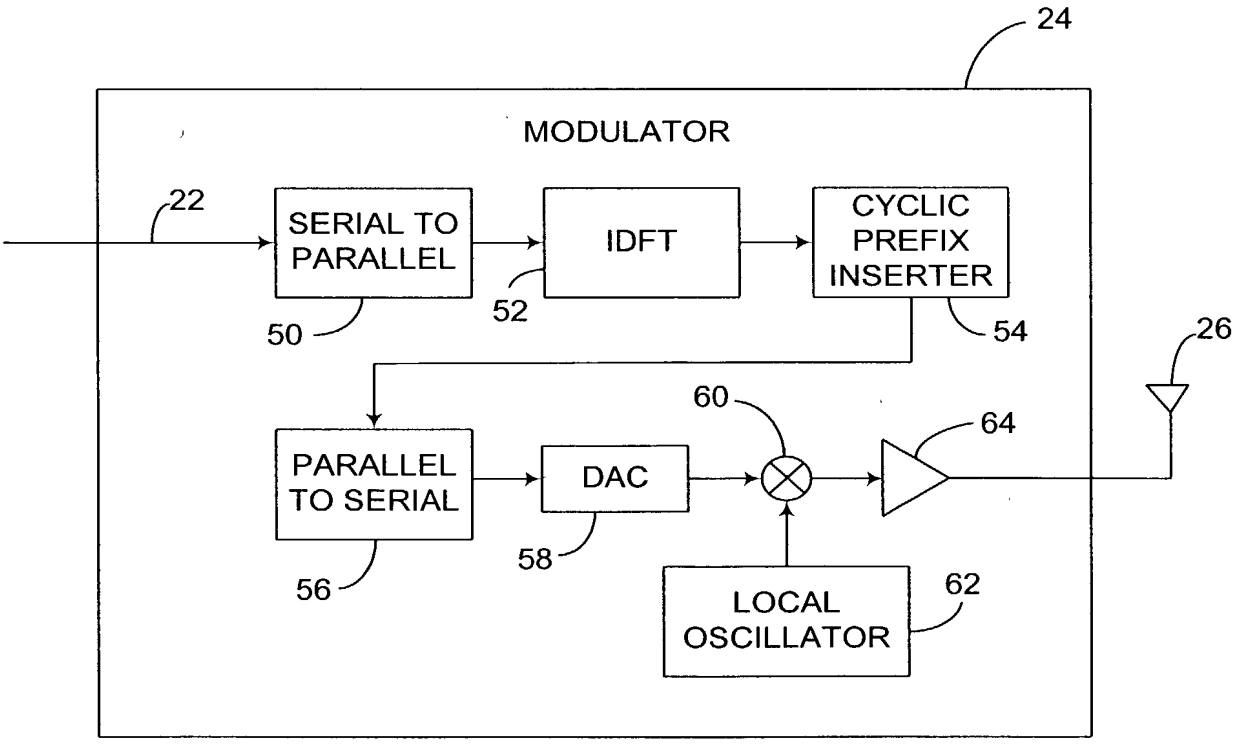

24
MODULATOR
22
SERIAL TO PARALLEL
IDFT
CYCLIC PREFIX INSERTER
50
52
54
26
60
64
PARALLEL TO SERIAL
DAC
58
56
LOCAL OSCILLATOR
62

FIG. 3

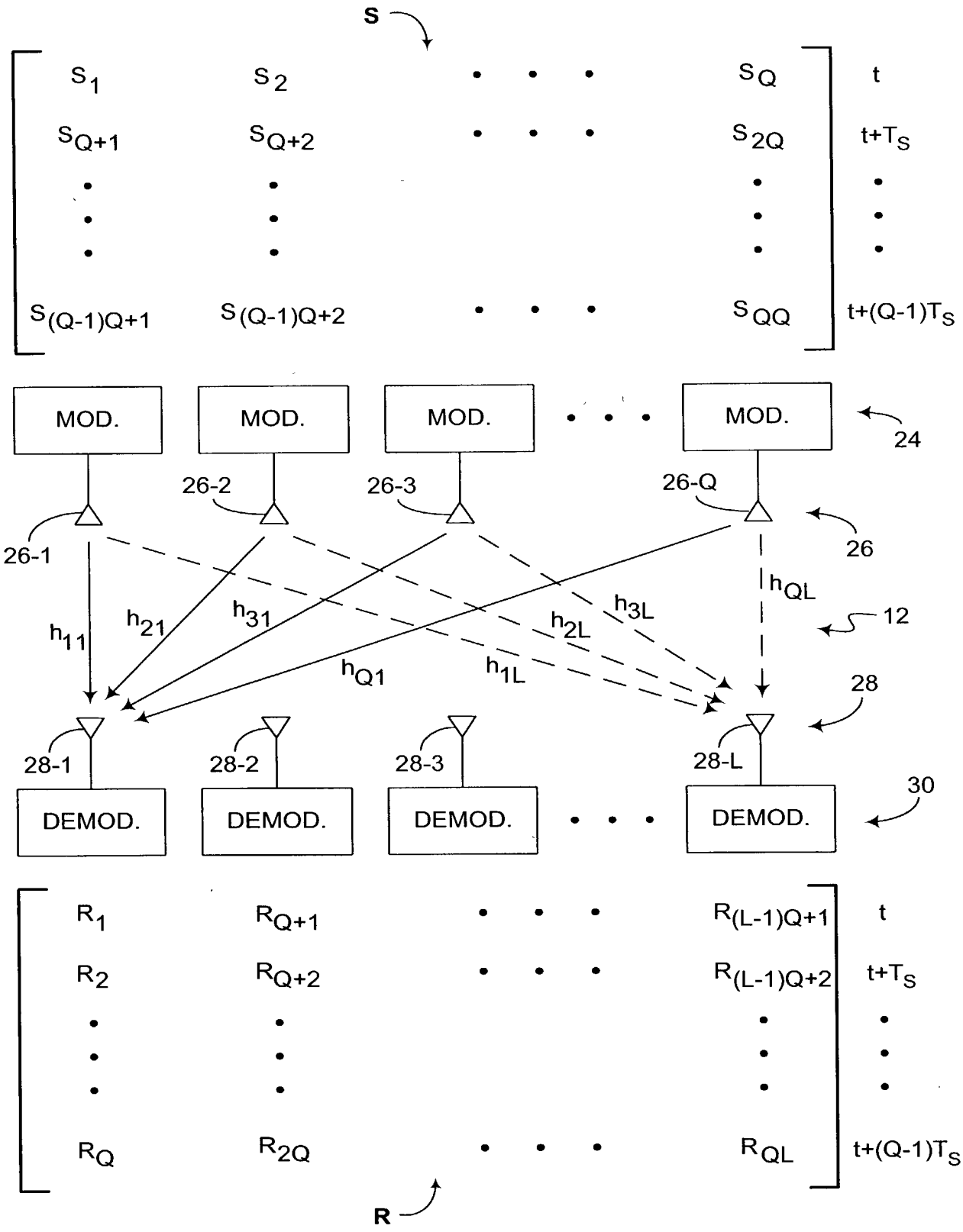
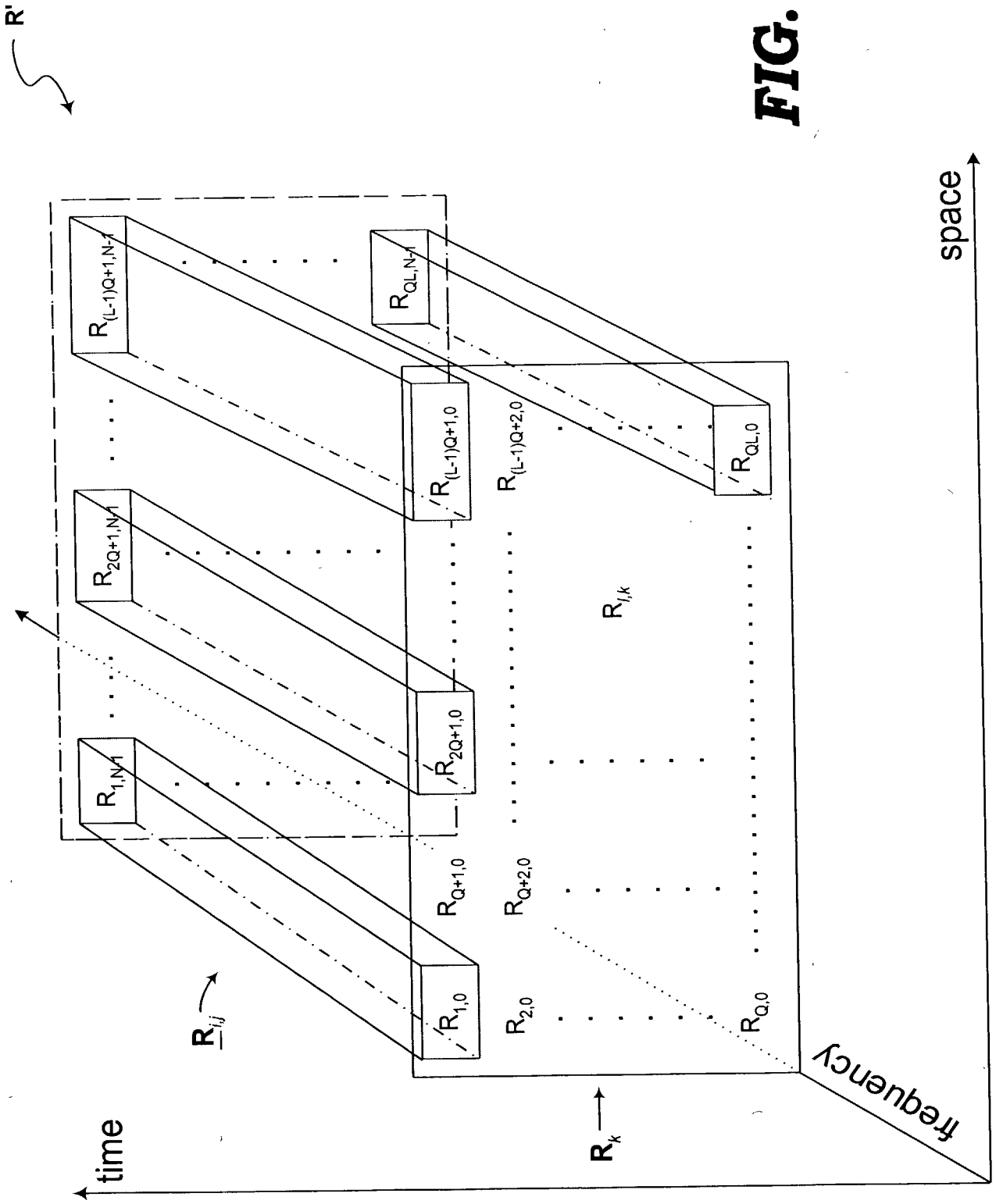

S
S_1 S_2 • • • S_Q t
S_{Q+1} S_{Q+2} • • • S_{2Q} t+T_S
$S_{(Q-1)Q+1}$ $S_{(Q-1)Q+2}$ • • • S_{QQ} t+(Q-1)T_S
MOD.
MOD.
MOD.
MOD.
24
26-1
26-2
26-3
26-Q
26
h_{11}
h_{21}
h_{31}
h_{3L}
h_{2L}
h_{QL}
h_{Q1}
h_{1L}
12
28
28-1
28-2
28-3
28-L
DEMOD.
DEMOD.
DEMOD.
DEMOD.
30
R_1 R_{Q+1} • • • $R_{(L-1)Q+1}$ t
R_2 R_{Q+2} • • • $R_{(L-1)Q+2}$ t+T_S
R_Q R_{2Q} • • • R_{QL} t+(Q-1)T_S
R

FIG. 4

FIG. 5


R'
space
time
frequency
$R_{(L-1)Q+1,N-1}$
$R_{QL,N-1}$
$R_{(L-1)Q+1,0}$
$R_{(L-1)Q+2,0}$
$R_{QL,0}$
$R_{2Q+1,N-1}$
$R_{2Q+1,0}$
$R_{1,N-1}$
$R_{1,0}$
$R_{Q+1,0}$
$R_{Q+2,0}$
$R_{2,0}$
$R_{Q,0}$
$R_{i,k}$
$R_{i,j}$
R_k

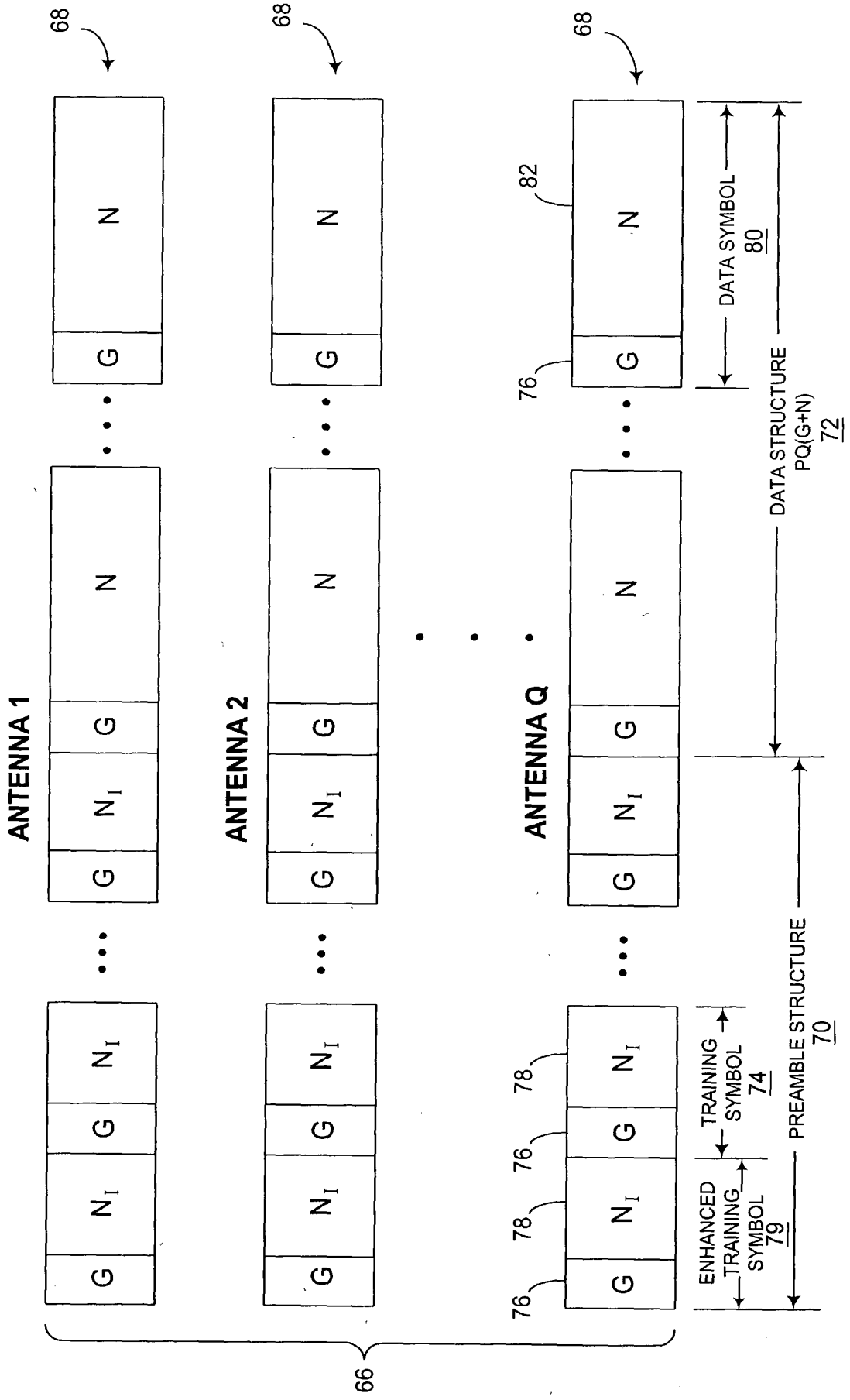

ANTENNA 1
ANTENNA 2
ANTENNA Q
68
82
76
78
66
N
G
N_I
DATA SYMBOL
80
DATA STRUCTURE
PQ(G+N)
72
PREAMBLE STRUCTURE
70
TRAINING
SYMBOL
74
ENHANCED
TRAINING
SYMBOL
79

FIG. 6

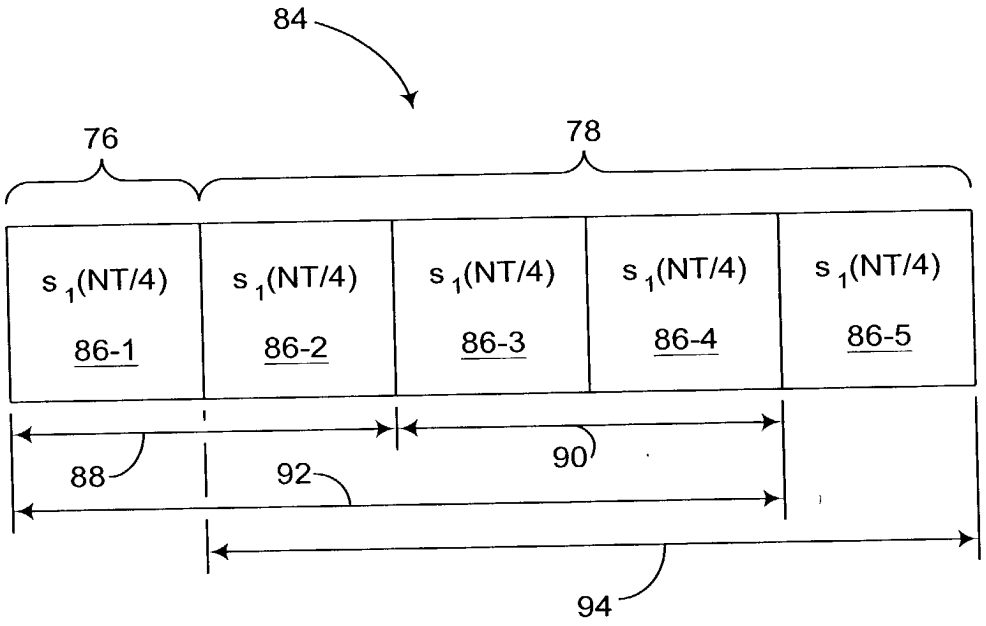

84
76
78
s 1(NT/4)
86-1
s 1(NT/4)
86-2
s 1(NT/4)
86-3
s 1(NT/4)
86-4
s 1(NT/4)
86-5
88
90
92
94

FIG. 7

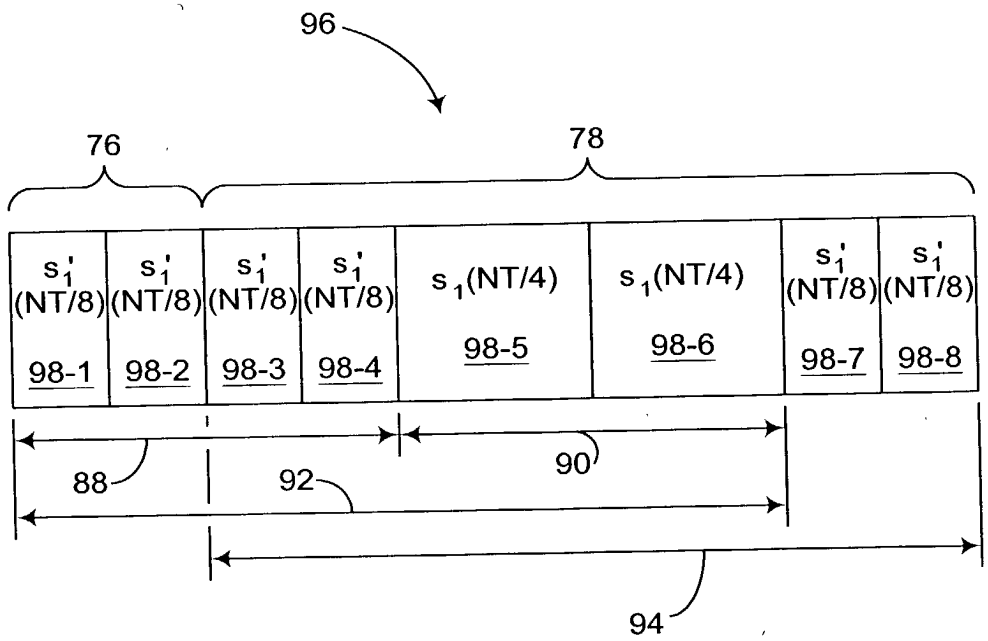

96
76
78
s'1 (NT/8)
98-1
s'1 (NT/8)
98-2
s'1 (NT/8)
98-3
s'1 (NT/8)
98-4
s 1(NT/4)
98-5
s 1(NT/4)
98-6
s'1 (NT/8)
98-7
s'1 (NT/8)
98-8
88
90
92
94

FIG. 8

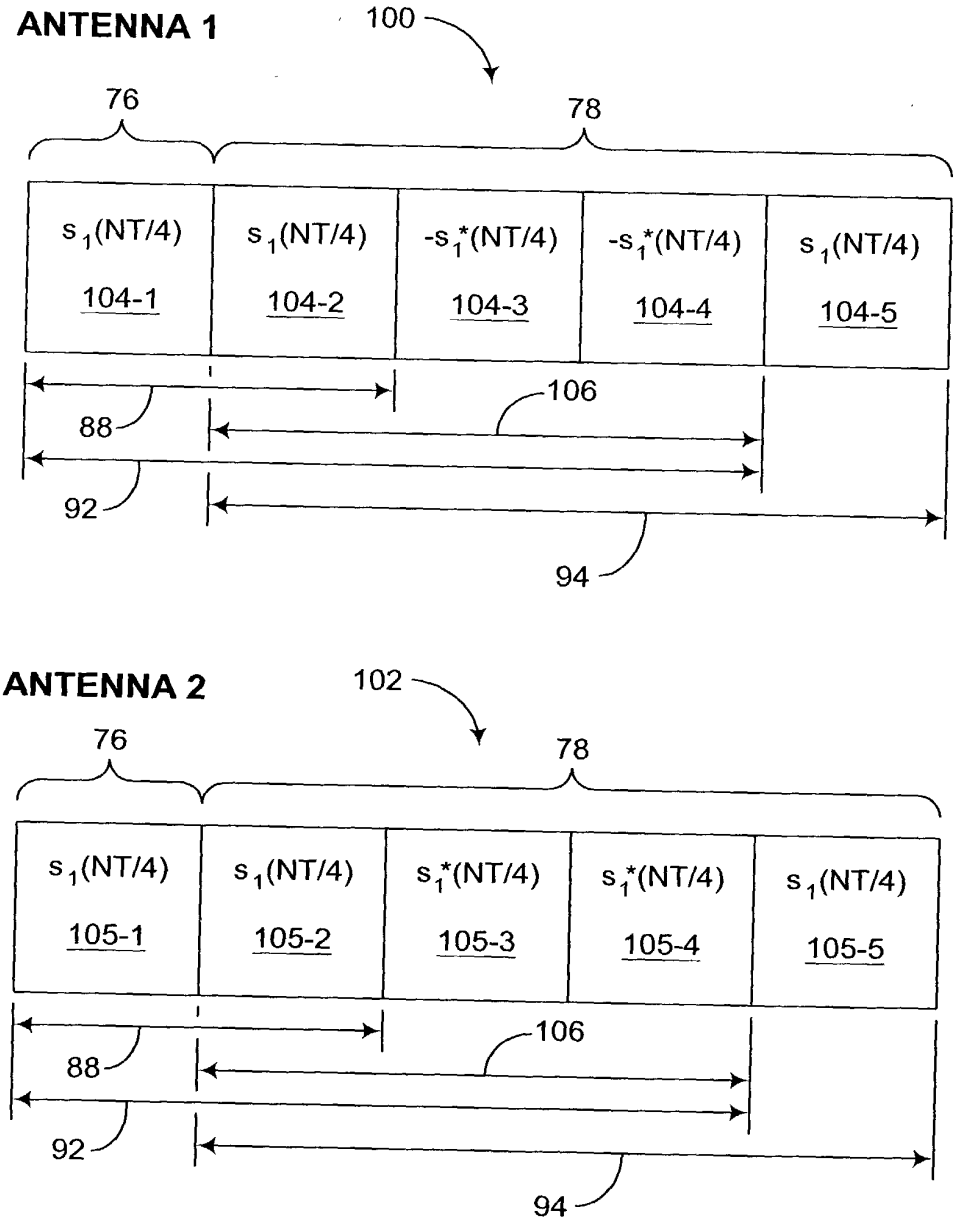

ANTENNA 1
100
76
78
s1(NT/4)
104-1
s1(NT/4)
104-2
-s1*(NT/4)
104-3
-s1*(NT/4)
104-4
s1(NT/4)
104-5
88
106
92
94
ANTENNA 2
102
76
78
s1(NT/4)
105-1
s1(NT/4)
105-2
s1*(NT/4)
105-3
s1*(NT/4)
105-4
s1(NT/4)
105-5
88
106
92
94

FIG. 9

DECLARATION FOR PATENT APPLICATION

Attorney Docket No: **062020-1120**

As the below named inventor(s), I/we hereby declare that:

Our residences, post office addresses and citizenships are as stated below next to our names.

We believe we are the original, first, and joint inventors of the subject matter which is claimed and for which a patent is sought on the invention entitled **PREAMBLE STRUCTURES FOR SINGLE-INPUT, SINGLE-OUTPUT (SISO) AND MULTI-INPUT, MULTI-OUTPUT (MIMO) COMMUNICATION SYSTEMS,** the specification of which:

- ☒ is attached hereto.
- ☐ was filed on _____ as Application Serial No. _____.
- ☐ was filed on _____ under U.S. Express Mail No. _____.
- ☐ is set forth in PCT International Application No. _____; filed on _____ and as amended Under PCT Article 19 on _____ (if any).

I/we hereby state that I/we have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I/we acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56.

I/we hereby claim the benefit under Title 35, United States Code, §119 of any United States provisional patent application, foreign application(s) for patent or inventor's certificate listed below and have also identified below any United States provisional patent application, foreign application for patent or inventor's certificate having a filing date before that of the above-identified application on which priority is claimed: **Provisional Patent Application Serial No. 60/327,145, filed October 4, 2001**

I/we hereby claim the benefit under Title 35, United States Code, §120 of any United States patent application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I/we acknowledge the duty to disclose material information as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application: **NOT APPLICABLE**

I/we hereby appoint the following attorneys/agents to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: **George M. Thomas, Reg. No. 22,260; James W. Kayden, Reg. No. 31,532; Scott A. Horstemeyer, Reg. No. 34,183; Stephen R. Risley, Reg. No. 35,659; Jeffrey R. Kuester, Reg. No. 34,367; Daniel R. McClure, Reg. No. 38,962; Daniel J. Santos, Reg. No. 40,158; Dan R. Gresham, Reg. No 41,805; J. Scott Culpepper, Reg. No. 41,692; Michael J. Tempel, Reg. No. 41,344; David R. Risley, Reg. No. 39,345; David L. Berdan, Reg. No. 41,614; Jon E. Holland, Reg. No. 41,077; Ann I. Dennen, Reg. No. 44,651; M. Paul Qualey, Reg. No 43,024; Robert P. Biddle, Reg. No. 35,826; Jennifer M. Gruber, Reg. No. 42,601; Peter A. Nieves, Reg. No. 48,173; William F. Heinze, Reg. No. 36,161; Raymond W. Armentrout, Reg. No. 45,866; Robert A. Blaha, Reg. No. 43,502; Cynthia J. Lee, Reg. No. 46,033; N. Andrew Crain, Reg. No. 45,442; Robert B. Dulaney III, Reg. No. 47,539; Christopher B. Linder, Ph.D., Reg. No. 47,751; Adam E. Crall, Reg. No. 46,646; Edwina T. Washington; Reg. No. 43,187; Scott M. Lohnes, Reg. No. 45,451; Sami O. Malas, Reg. No. 44,893; David Rodack, Reg. 47,034; Troy VanAacken, Reg. No. 50,847; Charles W. Griggers, Reg. No. 47,283; Robert E. Stachler II, Reg. No. 36,934; David P. Kelley, Reg. No. 17,420; Eric M. Ringer, Reg. No. 47,028; Charles E. Thorpe, Jr., Reg. No. 48,782; Harold L. Marquis, Reg. No. 20,594; Sam Han, Reg. No. P51,771; Kenneth C. Bruley, Reg. No. P51,504; Glenn W. Brown, Reg. No. 51,310; and Curtis W. Dodd, Reg. No. 37,314.**

Please address all telephone calls, in the first instance, to **Scott A. Horstemeyer,** at telephone number: **(770) 933-9500.**

Address all correspondence to:

Scott A. Horstemeyer
THOMAS, KAYDEN, HORSTEMEYER & RISLEY, L.L.P.
100 Galleria Parkway, N.W., Suite 1750
Atlanta, Georgia 30339-5948

I/we hereby declare that all statements made herein of my/our 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 statement 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.

Inventor's Signature: _____ Date: _____

Full Name of First or Sole Inventor: **Apurva N. Mody**
Residence: **327155 Georgia Tech Station, Atlanta, GA 30332** Citizenship: **U.S.A.**
Post Office Address: **327155 Georgia Tech Station, Atlanta, GA 30332**

Inventor's Signature: _____ Date: _____

Full Name of First or Sole Inventor: **Gordon L. Stuber**
Residence: **1052 Arbor Trace, Atlanta, GA 30318** Citizenship: **U.S.A.**
Post Office Address: **1052 Arbor Trace, Atlanta, GA 30318**

PATENT APPLICATION SERIAL NO. _____

U.S. DEPARTMENT OF COMMERCE
PATENT AND TRADEMARK OFFICE
FEE RECORD SHEET

10/08/2002 DTESSEM1 00000033 200778 10264546
01 FC:201 370.00 CH

PTO-1556
(5/87)

PATENT APPLICATION FEE DETERMINATION RECORD
Effective October 1, 2001

Application or Docket Number: 10264546

CLAIMS AS FILED - PART I

	(Column 1)	(Column 2)
TOTAL CLAIMS	49	
FOR	NUMBER FILED	NUMBER EXTRA
TOTAL CHARGEABLE CLAIMS	49 minus 20=	* 29
INDEPENDENT CLAIMS	5 minus 3 =	* 2
MULTIPLE DEPENDENT CLAIM PRESENT		☐

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

SMALL ENTITY TYPE ☐ OR OTHER THAN SMALL ENTITY

RATE	FEE	OR	RATE	FEE
BASIC FEE	370.00	OR	BASIC FEE	740.00
X$ 9=	1890	OR	X$18=	
X42=	84.00	OR	X84=	
+140=		OR	+280=	
TOTAL	370	OR	TOTAL	

CLAIMS AS AMENDED - PART II

AMENDMENT A

	(Column 1)		(Column 2)	(Column 3)
	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

SMALL ENTITY OR OTHER THAN SMALL ENTITY

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT B

	(Column 1)		(Column 2)	(Column 3)
	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. FEE	

AMENDMENT C

	(Column 1)		(Column 2)	(Column 3)
	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA
Total	*	Minus	**	=
Independent	*	Minus	***	=
FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM				☐

RATE	ADDITIONAL FEE	OR	RATE	ADDITIONAL FEE
X$ 9=		OR	X$18=	
X42=		OR	X84=	
+140=		OR	+280=	
TOTAL ADDIT. FEE		OR	TOTAL ADDIT. 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.