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THE UNITED STATES OF AMERICA

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UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

September 26, 2023

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APPLICATION NUMBER: ***17/587,462***
FILING DATE: ***January 28, 2022***
PATENT NUMBER: ***11399206***
ISSUE DATE: ***July 26, 2022***

UNITED STATES PATENT AND TRADEMARK OFFICE · DEPARTMENT OF COMMERCE

Certified by

Performing the Functions and Duties of the
Under Secretary of Commerce
for Intellectual Property
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Patent and Trademark Office

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Attorney Docket No. 28427US13

In the Application of: Madhukar Reddy Serial No.: Not yet assigned Filed: January 28, 2022 Title: METHOD FOR RECEIVING A TELEVISION SIGNAL Group Art Unit: Not yet assigned Confirmation No.: Not yet assigned Customer No.: 23466	**Electronically Filed:** **January 28, 2022**

PRELIMINARY AMENDMENT

Applicant submits this Preliminary Amendment in connection with the above-identified newly filed continuation application ("Instant Application").

CONTENTS OF THIS CORRESPONDENCE

General Statement on Filing of Amendments begins on page 2.

Amendments to the Specification begin on page 3.

Amendments to the Claims begin on page 4.

Remarks begin on page 9.

Filing Of Amendments

Title 37 USC, §1.125(a) states that "If the number or nature of the amendments or the legibility of the application papers renders it difficult to consider the application, or to arrange the papers for printing or copying, the Office may require the entire specification, including the claims, or any part thereof, be rewritten." The Applicant submits that this does not apply in the present situation because the preliminary amendment submitted was in the proper format, does not include an excessive number of amendments, and is perfectly legible. Accordingly, the Applicant respectfully submits that, in general, a preliminary amendment is a proper vehicle for effecting changes to the claims.

Amendments to the Specification

Please amend the title as follows:

METHOD FOR RECEIVING A TELEVISION SIGNAL ~~WIDEBAND TUNER ARCHITECTURE~~

Please amend paragraph [0001] as follows:

[0001] This application is a continuation of U.S. patent application 17/217,244 filed on March 30, 2021, which is a continuation of U.S. patent application 16/430,506 (now patent 10,972,781) filed on June 4, 2019, which is a continuation of U.S. patent application 15/792,318 (now patent 10,313,733) filed October 24, 2017, which is a continuation of U.S patent application 14/948,881 (now patent 9,819,992) filed November 23, 2015, which is a continuation of U.S. patent application 14/617,973 (now patent 9,210,363) filed on February 10, 2015, which is a continuation of U.S. patent application 13/962,871 (now patent 9,100,622) filed on August 08, 2013, which is a continuation of U.S. patent application 12/762,900 filed on April 19, 2010 (now U.S. Patent 8,526,898), which claims the benefit of priority to U.S. provisional application 61/170,526 filed April 17, 2009, now expired. Each of the above referenced documents is hereby incorporated by reference in its entirety.

Amendments to the Claims:

This listing of claims will replace all prior version and listings of claims in the application.

What is claimed is:

1-18 (Cancelled)

19. (New) A method for receiving a television (TV) signal comprising:
digitizing a contiguous band of frequencies in an input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises a plurality of desired channels and a plurality of undesired channels;
concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels; and
providing the plurality of desired channels.

20. (New) The method of claim 19, wherein the method comprises:
communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

21. (New) The method of claim 19, wherein the method comprises:
generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

22. (New) The method of claim 21, wherein:
the I and Q components of each corresponding complex signal are at baseband.

23. (New) The method of claim 21, wherein the method comprises:
filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

24. (New) The method of claim 21, wherein the method comprises:
demodulating, via each demodulator of a plurality of demodulators, the corresponding complex signal to generate a demodulated signal as a desired channel output.

25. (New) The method of claim 19, wherein the method comprises:
demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

26. (New) The method of claim 25, wherein the method comprises:
providing a plurality of demodulated desired channels via a parallel interface.

27. (New) The method of claim 19, wherein the method comprises:
providing the plurality of desired channels via a parallel interface.

28. (New) The method of claim 19, wherein the method comprises:
providing the plurality of desired channels via a serial interface.

29. (New) The method of claim 19, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

30. (New) The method of claim 19, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

31. (New) The method of claim 19, wherein:

the method is performed by a device comprising a digital video recorder (DVR).

32. (New) The method of claim 19, wherein the method comprises:

configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

33. (New) The method of claim 19, wherein:

the contiguous band of frequencies comprises a portion of a frequency spectrum of the input signal.

34. (New) A method comprising:

digitizing an input signal via a wideband analog-to-digital converter (ADC), wherein the input signal comprises a plurality of desired channels and a plurality of undesired channels; and

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs.

35. (New) The method of claim 34, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

36. (New) The method of claim 34, wherein:

digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

37. (New) The method of claim 36, wherein:

the I and Q components of each corresponding complex signal are at baseband.

38. (New) The method of claim 36, wherein the method comprises:
a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

39. (New) The method of claim 36, wherein the method comprises:
demodulating the corresponding complex signal to provide a demodulated channel as a digital channel output.

40. (New) The method of claim 34, wherein the method comprises:
demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

41. (New) The method of claim 40, wherein the method comprises:
providing the plurality of demodulated channels via a parallel interface.

42. (New) The method of claim 34, wherein the method comprises:
providing the plurality of digital channel outputs via a parallel interface.

43. (New) The method of claim 34, wherein the method comprises:
providing the plurality of digital channel outputs via a serial interface.

44. (New) The method of claim 34, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

45. (New) The method of claim 34, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

46. (New) The method of claim 34, wherein:

the method is performed by a device comprising a digital video recorder (DVR).

47. (New) The method of claim 34, wherein the method comprises:

providing a picture-in-picture display signal according to the plurality of digital channel outputs.

48. (New) The method of claim 34, wherein:

the plurality of desired channels and the plurality of undesired channels comprise a portion of a frequency spectrum of the input signal.

REMARKS

The Applicant requests entry of this preliminary amendment prior to prosecution on the merits. No new matter has been added.

With respect to the present application, Applicant hereby rescinds any disclaimer of claim scope made in the parent application or any predecessor or related application. The Examiner is advised that any previous disclaimer of claim scope, if any, and the alleged prior art that it was made to allegedly avoid, may need to be revisited. Nor should a disclaimer of claim scope, if any, in the present application be read back into any predecessor or related application.

The Commissioner is hereby authorized to charge any fees required by this submission including any extra claims fees, to the deposit account of McAndrews, Held & Malloy, Ltd., Account No. 13-0017.

Respectfully submitted,

Date: January 28, 2022

/Wayne H. Bradley /
Wayne H. Bradley
Reg. No. 39,916

McAndrews, Held & Malloy, Ltd.
500 W. Madison Street - Suite 3400
Chicago, Illinois 60661
(312)-775-8000

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Filer:	Wayne Bradley/Laura Foley
Attorney Docket Number:	28427US13

Filed as Large Entity

Filing Fees for Track I Prioritized Examination - Nonprovisional Application under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
UTILITY APPLICATION FILING	1011	1	320	320
UTILITY SEARCH FEE	1111	1	700	700
UTILITY EXAMINATION FEE	1311	1	800	800
REQUEST FOR PRIORITIZED EXAMINATION	1817	1	4200	4200
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	10	100	1000
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
PUBL. FEE- EARLY, VOLUNTARY, OR NORMAL	1504	1	0	0
PROCESSING FEE, EXCEPT PROV. APPLS.	1830	1	140	140
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**7160**

Electronic Acknowledgement Receipt	
EFS ID:	44865449
Application Number:	17587462
International Application Number:	
Confirmation Number:	9515
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Customer Number:	23446
Filer:	Wayne Bradley/Laura Foley
Filer Authorized By:	Wayne Bradley
Attorney Docket Number:	28427US13
Receipt Date:	28-JAN-2022
Filing Date:	
Time Stamp:	15:22:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$7160
RAM confirmation Number	E20221RF23142128
Deposit Account	130017
Authorized User	Laura Foley
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	TrackOne Request	28427US13_Track_1_Certification_AIA-424.pdf	124021 72baa00f8234e451b4b45b9acb12ec25af130dbc	no	2
Warnings:					
Information:					
2	Application Data Sheet	28427US13_ADS.pdf	1226907 143beb7e9290ad3b84982e6918da00c53d9b9d41	no	9
Warnings:					
Information:					
3	Oath or Declaration filed	28427US06_Declarations_executed.pdf	336661 44750254e8ce14db07258504c15bc9b027a9eb02	no	3
Warnings:					
Information:					
4	Drawings-only black and white line drawings	28427US06_Figures.pdf	4419764 3146aa711b9cb4885113ed88fc4c2537ca051c59	no	10
Warnings:					
Information:					
5		28427US08_CON_Specification.pdf	135177 db8ad20ff9549a1be835281e273d2302ebf25b23	yes	27

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	21
Claims	22	26
Abstract	27	27

Warnings:					
Information:					
6	Power of Attorney	Entropic_MxL_PostAIA_POA_New_Address.pdf	131987 2ee5ce460a08dc9682966d71c044bb94c8837026	no	2
Warnings:					
Information:					
7	Information Disclosure Statement (IDS) Form (SB08)	28427US13_IDS_sb08a_EFS-WEB.pdf	1008356 a273f4e21c66a0d3205fbd8dd724e9fbb2271f25	no	9
Warnings:					
Information:					
8	Foreign Reference	EP2087623A2.pdf	112213 112c7af198fa095a19b1da28e1827b7e61c79aef	no	2
Warnings:					
Information:					
9	Non Patent Literature	NPL_1.pdf	603163 5088d48613579b3d2816d5522ec4dd7a0ecca16f	no	14
Warnings:					
Information:					
10	Non Patent Literature	NPL_2.pdf	443966 4bfc54746c564f3cb9b7cd840dd98df22fb2fe7a	no	8
Warnings:					
Information:					
11	Foreign Reference	NPL_3.pdf	413840 d2b4d3610b34404f76c07a733fd5e032965754d1	no	7
Warnings:					
Information:					
12		28427US13_FINAL_Prelim_Amendment_.pdf	41498 33cf1927dca3531ecd18f1849b8cb804bd206971	yes	9

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Preliminary Amendment	1	2
	Specification	3	3
	Claims	4	8
	Applicant Arguments/Remarks Made in an Amendment	9	9

Warnings:					
Information:					
13	Fee Worksheet (SB06)	fee-info.pdf	52864 dd0ee99ab02fe9d431f2ba16e10c148d170eddb8	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	9050417		

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

New Applications Under 35 U.S.C. 111
If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.
National Stage of an International Application under 35 U.S.C. 371
If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.
New International Application Filed with the USPTO as a Receiving Office
If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

PTO/AIA/80 (07-12)
Approved for use through 11/30/2014. OMB 0651-0035
U.S. Patent and Trademark Office; U.S DEPARTMENT OF COMMERCE
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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(c).

I hereby appoint:

☒ Practitioners associated with Customer Number: 23,446

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 assignments documents attached to this form in accordance with 37 CFR 3.73(c).

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

☒ The address associated with Customer Number: 23,446

OR

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

Assignee Name and Address: Entropic Communications LLC
5966 La Place Court
Suite 100
Carlsbad, CA 92008

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

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

Signature		Date	10/10/16
Name	Adam Spice	Telephone	949-330-0092
Title	Chief Financial Officer		

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.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Doc Code: TRACK1.REQ
Document Description: TrackOne Request

PTO/AIA/424 (04-14)

CERTIFICATION AND REQUEST FOR PRIORITIZED EXAMINATION UNDER 37 CFR 1.102(e) (Page 1 of 1)

First Named Inventor:	Madhukar Reddy	Nonprovisional Application Number (if known):	
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL		

APPLICANT HEREBY CERTIFIES THE FOLLOWING AND REQUESTS PRIORITIZED EXAMINATION FOR THE ABOVE-IDENTIFIED APPLICATION.

1. The processing fee set forth in 37 CFR 1.17(i)(1) and the prioritized examination fee set forth in 37 CFR 1.17(c) have been filed with the request. The publication fee requirement is met because that fee, set forth in 37 CFR 1.18(d), is currently $0. The basic filing fee, search fee, and examination fee are filed with the request or have been already been paid. I understand that any required excess claims fees or application size fee must be paid for the application.

2. I understand that the application may not contain, or be amended to contain, more than four independent claims, more than thirty total claims, or any multiple dependent claims, and that any request for an extension of time will cause an outstanding Track I request to be dismissed.

3. The applicable box is checked below:

I. ☑ Original Application (Track One) - Prioritized Examination under § 1.102(e)(1)

i. (a) The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a). This certification and request is being filed with the utility application via EFS-Web.

---OR---

(b) The application is an original nonprovisional plant application filed under 35 U.S.C. 111(a). This certification and request is being filed with the plant application in paper.

ii. An executed inventor's oath or declaration under 37 CFR 1.63 or 37 CFR 1.64 for each inventor, **or** the application data sheet meeting the conditions specified in 37 CFR 1.53(f)(3)(i) is filed with the application.

II. ☐ Request for Continued Examination - Prioritized Examination under § 1.102(e)(2)

i. A request for continued examination has been filed with, or prior to, this form.
ii. If the application is a utility application, this certification and request is being filed via EFS-Web.
iii. The application is an original nonprovisional utility application filed under 35 U.S.C. 111(a), or is a national stage entry under 35 U.S.C. 371.
iv. This certification and request is being filed prior to the mailing of a first Office action responsive to the request for continued examination.
v. No prior request for continued examination has been granted prioritized examination status under 37 CFR 1.102(e)(2).

Signature /Wayne H. Bradley/	Date January 28, 2022
Name (Print/Typed) Wayne H. Bradley	Practitioner Registration Number 39,916

Note: *This form must be signed in accordance with 37 CFR 1.33. See 37 CFR 1.4(d) for signature requirements and certifications. Submit multiple forms if more than one signature is required.**

☑ *Total of 1 forms are submitted.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).
5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).
7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (*i.e.*, GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspection or an issued patent.
9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

PTO/AIA/14 (02-18)
Approved for use through 11/30/2020. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

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

Secrecy Order 37 CFR 5.2:

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

Inventor Information:

Inventor 1 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Madhukar		Reddy	

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

City	Carlsbad	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	5966 La Place Court
Address 2	Ste. 100

City	Carlsbad	State/Province	CA
Postal Code	92008	Country	US

Inventor 2 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Curtis		Ling	

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

City	Carlsbad	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	5966 La Place Court
Address 2	Ste. 100

City	Carlsbad	State/Province	CA
Postal Code	92008	Country	US

Inventor 3 Remove

Legal Name

Prefix	Given Name	Middle Name	Family Name	Suffix
	Tim		Gallagher	

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

City	Carlsbad	State/Province	CA	Country of Residence	US

Mailing Address of Inventor:

Address 1	6966 La Place Court		
Address 2	Ste. 100		
City	Carlsbad	State/Province	CA
Postal Code	92008	Country	US

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

Correspondence Information:

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

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

Customer Number	23446		
Email Address	mhmpto@mcandrews-ip.com	Add Email	Remove Email

Application Information:

Title of the Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL		
Attorney Docket Number	28427US13	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Total Number of Drawing Sheets (if any)	10	Suggested Figure for Publication (if any)	

Filing By Reference:

Only complete this section when filing an application by reference under 35 U.S.C. 111(c) and 37 CFR 1.57(a). Do not complete this section if application papers including a specification and any drawings are being filed. Any domestic benefit or foreign priority information must be provided in the appropriate section(s) below (i.e., "Domestic Benefit/National Stage Information" and "Foreign Priority Information").

For the purposes of a filing date under 37 CFR 1.53(b), the description and any drawings of the present application are replaced by this reference to the previously filed application, subject to conditions and requirements of 37 CFR 1.57(a).

Application number of the previously filed application	Filing date (YYYY-MM-DD)	Intellectual Property Authority or Country

Publication Information:

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

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

Representative Information:

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

Please Select One:	● Customer Number	US Patent Practitioner	◯ Limited Recognition (37 CFR 11.9)
Customer Number	23446		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, 365(c), or 386(c) or indicate National Stage entry from a PCT application. Providing benefit claim information in the Application Data Sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78.
When referring to the current application, please leave the "Application Number" field blank.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)
	Continuation of	17217244	2021-03-30

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
17217244	Continuation of	16430506	2019-06-04	10972781	2021-04-06

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
16430506	Continuation of	15792318	2017-10-24	10313733	2019-06-04

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
15792318	Continuation of	14948881	2015-11-23	9819992	2017-11-14

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14948881	Continuation of	14617973	2015-02-10	9210363	2015-12-08

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
14617973	Continuation of	13962871	2013-08-08	9100622	2015-08-04
Prior Application Status	Patented				Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)	Patent Number	Issue Date (YYYY-MM-DD)
13962871	Continuation of	12762900	2010-04-19	8526898	2013-09-03
Prior Application Status	Expired				Remove
Application Number	Continuity Type	Prior Application Number	Filing or 371(c) Date (YYYY-MM-DD)		
12762900	Claims benefit of provisional	61170526	2009-04-17		

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

Foreign Priority Information:

This section allows for the applicant to claim priority to a foreign application. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55. When priority is claimed to a foreign application that is eligible for retrieval under the priority document exchange program (PDX)[i] the information will be used by the Office to automatically attempt retrieval pursuant to 37 CFR 1.55(i)(1) and (2). Under the PDX program, applicant bears the ultimate responsibility for ensuring that a copy of the foreign application is received by the Office from the participating foreign intellectual property office, or a certified copy of the foreign priority application is filed, within the time period specified in 37 CFR 1.55(g)(1).

Remove

Application Number	Country[i]	Filing Date (YYYY-MM-DD)	Access Code[i] (if applicable)

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

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications

☐ This application (1) claims priority to or the benefit of an application filed before March 16, 2013 and (2) also contains, or contained at any time, a claim to a claimed invention that has an effective filing date on or after March 16, 2013.
NOTE: By providing this statement under 37 CFR 1.55 or 1.78, this application, with a filing date on or after March 16, 2013, will be examined under the first inventor to file provisions of the AIA.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

Authorization or Opt-Out of Authorization to Permit Access:

When this Application Data Sheet is properly signed and filed with the application, applicant has provided written authority to permit a participating foreign intellectual property (IP) office access to the instant application-as-filed (see paragraph A in subsection 1 below) and the European Patent Office (EPO) access to any search results from the instant application (see paragraph B in subsection 1 below).

Should applicant choose not to provide an authorization identified in subsection 1 below, applicant **must opt-out** of the authorization by checking the corresponding box A or B or both in subsection 2 below.

NOTE: This section of the Application Data Sheet is **ONLY** reviewed and processed with the **INITIAL** filing of an application. After the initial filing of an application, an Application Data Sheet cannot be used to provide or rescind authorization for access by a foreign IP office(s). Instead, Form PTO/SB/39 or PTO/SB/69 must be used as appropriate.

1. Authorization to Permit Access by a Foreign Intellectual Property Office(s)

A. Priority Document Exchange (PDX) - Unless box A in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the European Patent Office (EPO), the Japan Patent Office (JPO), the Korean Intellectual Property Office (KIPO), the State Intellectual Property Office of the People's Republic of China (SIPO), the World Intellectual Property Organization (WIPO), and any other foreign intellectual property office participating with the USPTO in a bilateral or multilateral priority document exchange agreement in which a foreign application claiming priority to the instant patent application is filed, access to: (1) the instant patent application-as-filed and its related bibliographic data, (2) any foreign or domestic application to which priority or benefit is claimed by the instant application and its related bibliographic data, and (3) the date of filing of this Authorization. See 37 CFR 1.14(h)(1).

B. Search Results from U.S. Application to EPO - Unless box B in subsection 2 (opt-out of authorization) is checked, the undersigned hereby **grants the USPTO authority** to provide the EPO access to the bibliographic data and search results from the instant patent application when a European patent application claiming priority to the instant patent application is filed. See 37 CFR 1.14(h)(2).

The applicant is reminded that the EPO's Rule 141(1) EPC (European Patent Convention) requires applicants to submit a copy of search results from the instant application without delay in a European patent application that claims priority to the instant application.

2. Opt-Out of Authorizations to Permit Access by a Foreign Intellectual Property Office(s)

☐ A. Applicant **DOES NOT** authorize the USPTO to permit a participating foreign IP office access to the instant application-as-filed. If this box is checked, the USPTO will not be providing a participating foreign IP office with any documents and information identified in subsection 1A above.

☐ B. Applicant **DOES NOT** authorize the USPTO to transmit to the EPO any search results from the instant patent application. If this box is checked, the USPTO will not be providing the EPO with search results from the instant application.

NOTE: Once the application has published or is otherwise publicly available, the USPTO may provide access to the application in accordance with 37 CFR 1.14.

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

Applicant Information:

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

Applicant 1 — Remove

If the applicant is the inventor (or the remaining joint inventor or inventors under 37 CFR 1.45), this section should not be completed. The information to be provided in this section is the name and address of the legal representative who is the applicant under 37 CFR 1.43; or the name and address of the assignee, person to whom the inventor is under an obligation to assign the invention, or person who otherwise shows sufficient proprietary interest in the matter who is the applicant under 37 CFR 1.46. If the applicant is an applicant under 37 CFR 1.46 (assignee, person to whom the inventor is obligated to assign, or person who otherwise shows sufficient proprietary interest) together with one or more joint inventors, then the joint inventor or inventors who are also the applicant should be identified in this section.

Clear

● Assignee	Legal Representative under 35 U.S.C. 117	Joint Inventor
Person to whom the inventor is obligated to assign.	Person who shows sufficient proprietary interest	

If applicant is the legal representative, indicate the authority to file the patent application, the inventor is:

Name of the Deceased or Legally Incapacitated Inventor:

If the Applicant is an Organization check here. ☒

Organization Name	Entropic Communications, LLC		
Mailing Address Information For Applicant:			
Address 1	5966 La Place Court		
Address 2	Ste. 100		
City	Carlsbad	**State/Province**	CA
Country	US	Postal Code	92008
Phone Number		Fax Number	
Email Address			

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

Assignee Information including Non-Applicant Assignee Information:

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

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

Assignee 1

Complete this section if assignee information, including non-applicant assignee information, is desired to be included on the patent application publication. An assignee-applicant identified in the "Applicant Information" section will appear on the patent application publication as an applicant. For an assignee-applicant, complete this section only if identification as an assignee is also desired on the patent application publication.

Remove

If the Assignee or Non-Applicant Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information For Assignee including Non-Applicant Assignee:

Address 1			
Address 2			
City		**State/Province**	
Country i		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee or Non-Applicant Assignee Data may be generated within this form by selecting the Add button. Add

Signature:

Remove

NOTE: This Application Data Sheet must be signed in accordance with 37 CFR 1.33(b). **However, if this Application Data Sheet is submitted with the INITIAL filing of the application and either box A or B is not checked in subsection 2 of the "Authorization or Opt-Out of Authorization to Permit Access" section, then this form must also be signed in accordance with 37 CFR 1.14(c).**

This Application Data Sheet **must** be signed by a patent practitioner if one or more of the applicants is a **juristic entity** (e.g., corporation or association). If the applicant is two or more joint inventors, this form must be signed by a patent practitioner, **all** joint inventors who are the applicant, or one or more joint inventor-applicants who have been given power of attorney (e.g., see USPTO Form PTO/AIA/81) on behalf of **all** joint inventor-applicants.

See 37 CFR 1.4(d) for the manner of making signatures and certifications.

Signature	/Wayne H. Bradley/			Date (YYYY-MM-DD)	2022-01-28
First Name	Wayne H.	Last Name	Bradley	Registration Number	39916

Additional Signature may be generated within this form by selecting the Add button. Add

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	28427US13
	Application Number	
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL	

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

Privacy Act Statement

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

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

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

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

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

4. A record in this system of records may be disclosed, as a routine use, to a contractor of the Agency having need for the information in order to perform a contract. Recipients of information shall be required to comply with the requirements of the Privacy Act of 1974, as amended, pursuant to 5 U.S.C. 552a(m).

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

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Attorney Docket No. 89194-002720US-883946

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	WIDEBAND TUNER ARCHITECTURE

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 13/962,871 filed on August 8, 2013.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Madhukar Reddy Date (Optional) : _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.

Attorney Docket No. 89194-002720US-883946

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DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	WIDEBAND TUNER ARCHITECTURE

As the below named inventor, I hereby declare that:

This declaration is directed to:

☐ The attached application, or

☒ United States application or PCT international application number 13/962,871

filed on August 8, 2013.

The above-identified application was made or authorized to be made by me.

I believe that I am the original inventor or an original joint inventor of a claimed invention in the application.

I hereby acknowledge that any willful false statement made in this declaration is punishable under 18 U.S.C. 1001 by fine or imprisonment of not more than five (5) years, or both.

WARNING:

Petitioner/applicant is cautioned to avoid submitting personal information in documents filed in a patent application that may contribute to identity theft. Personal information such as social security numbers, bank account numbers, or credit card numbers (other than a check or credit card authorization form PTO-2038 submitted for payment purposes) is never required by the USPTO to support a petition or an application. If this type of personal information is included in documents submitted to the USPTO, petitioners/applicants should consider redacting such personal information from the documents before submitting them to the USPTO. Petitioner/applicant is advised that the record of a patent application is available to the public after publication of the application (unless a non-publication request in compliance with 37 CFR 1.213(a) is made in the application) or issuance of a patent. Furthermore, the record from an abandoned application may also be available to the public if the application is referenced in a published application or an issued patent (see 37 CFR 1.14). Checks and credit card authorization forms PTO-2038 submitted for payment purposes are not retained in the application file and therefore are not publicly available.

LEGAL NAME OF INVENTOR

Inventor: Curtis Ling Date (Optional) : _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

This collection of information is required by 35 U.S.C. 115 and 37 CFR 1.63. 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 1 minute 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.**

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Title of Invention	WIDEBAND TUNER ARCHITECTURE

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LEGAL NAME OF INVENTOR

Inventor: Tim Gallagher Date (Optional): _____

Signature: _____

Note: An application data sheet (PTO/SB/14 or equivalent), including naming the entire inventive entity, must accompany this form or must have been previously filed. Use an additional PTO/AIA/01 form for each additional inventor.

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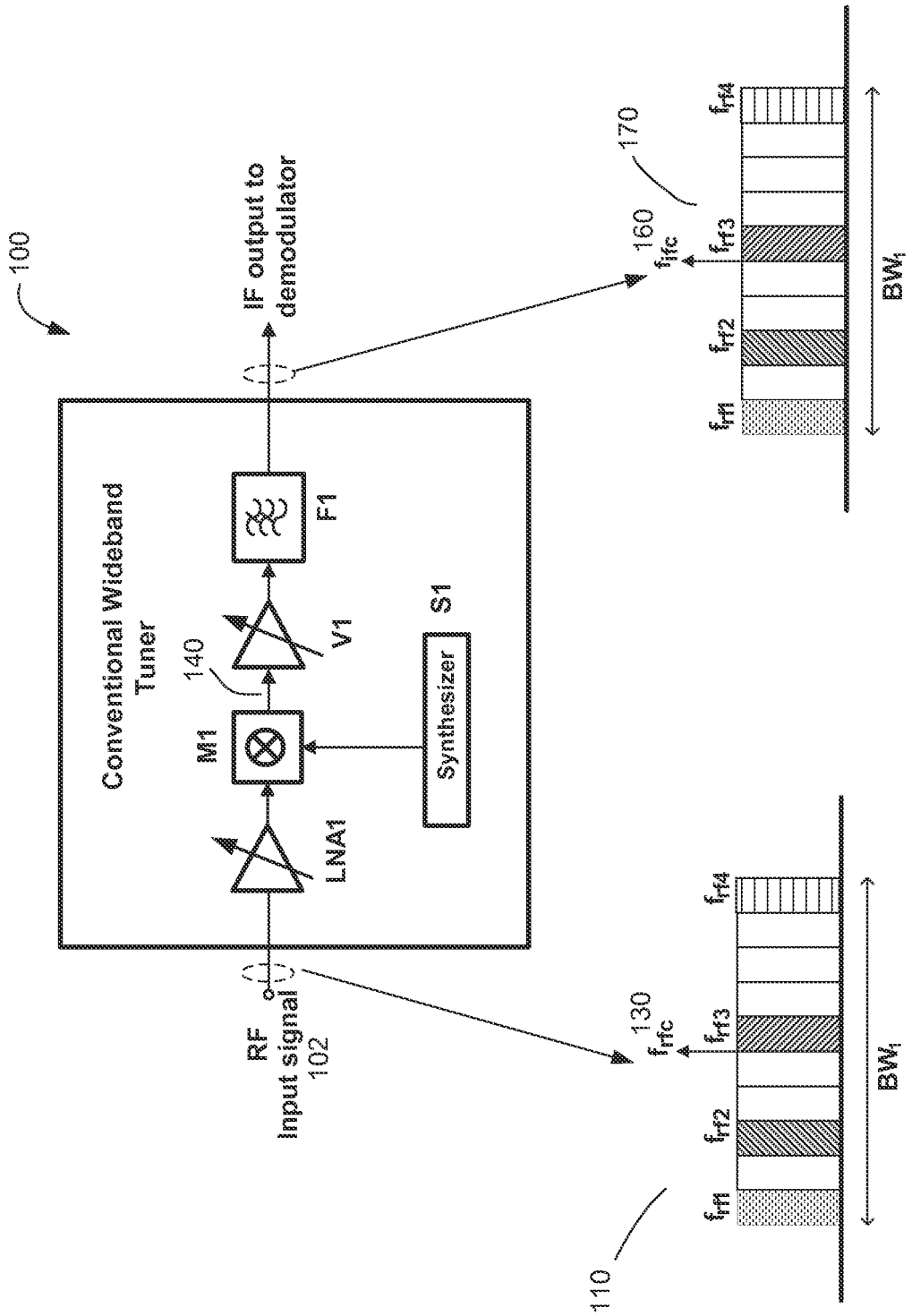


FIG. 1
(Prior Art)

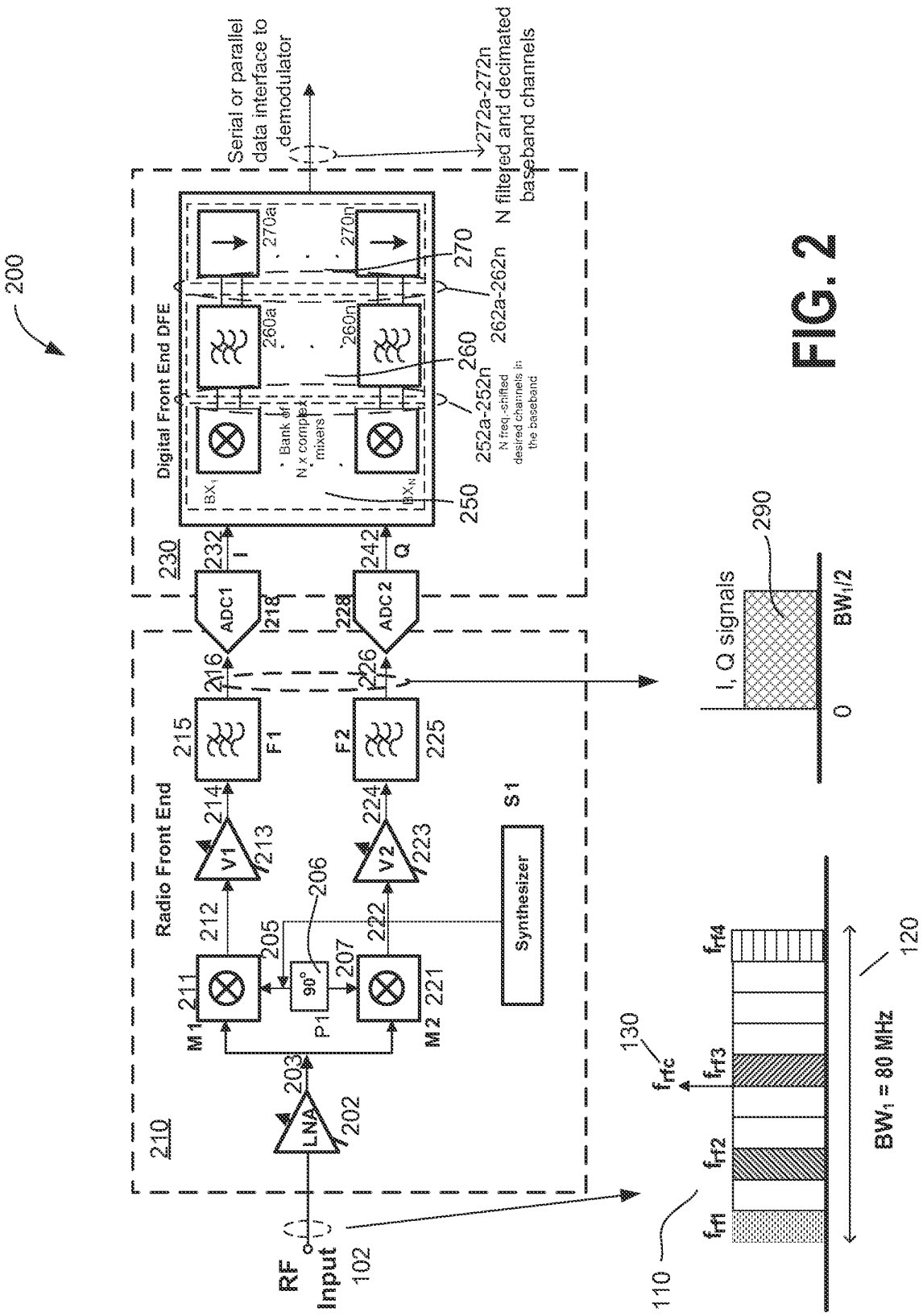

200
210
Radio Front End
Digital Front End DFE
230
RF Input
102
LNA
202
203
M1
211
M2
221
P1
90°
205
206
207
212
222
V1
213
V2
223
214
224
215
225
F1
F2
216
226
ADC1
218
ADC2
228
232
242
I
Q
Synthesizer
S1
250
260
260a
260n
270
270a
270n
252a-252n
N freq.-shifted desired channels in the baseband
262a-262n
N x complex mixers
Bank of
N filtered and decimated baseband channels
272a-272n
Serial or parallel data interface to demodulator
I, Q signals
290
0
BW1/2
110
130
120
BW1 = 80 MHz
frf1
frf2
frfc
frf3
frf4

FIG. 2

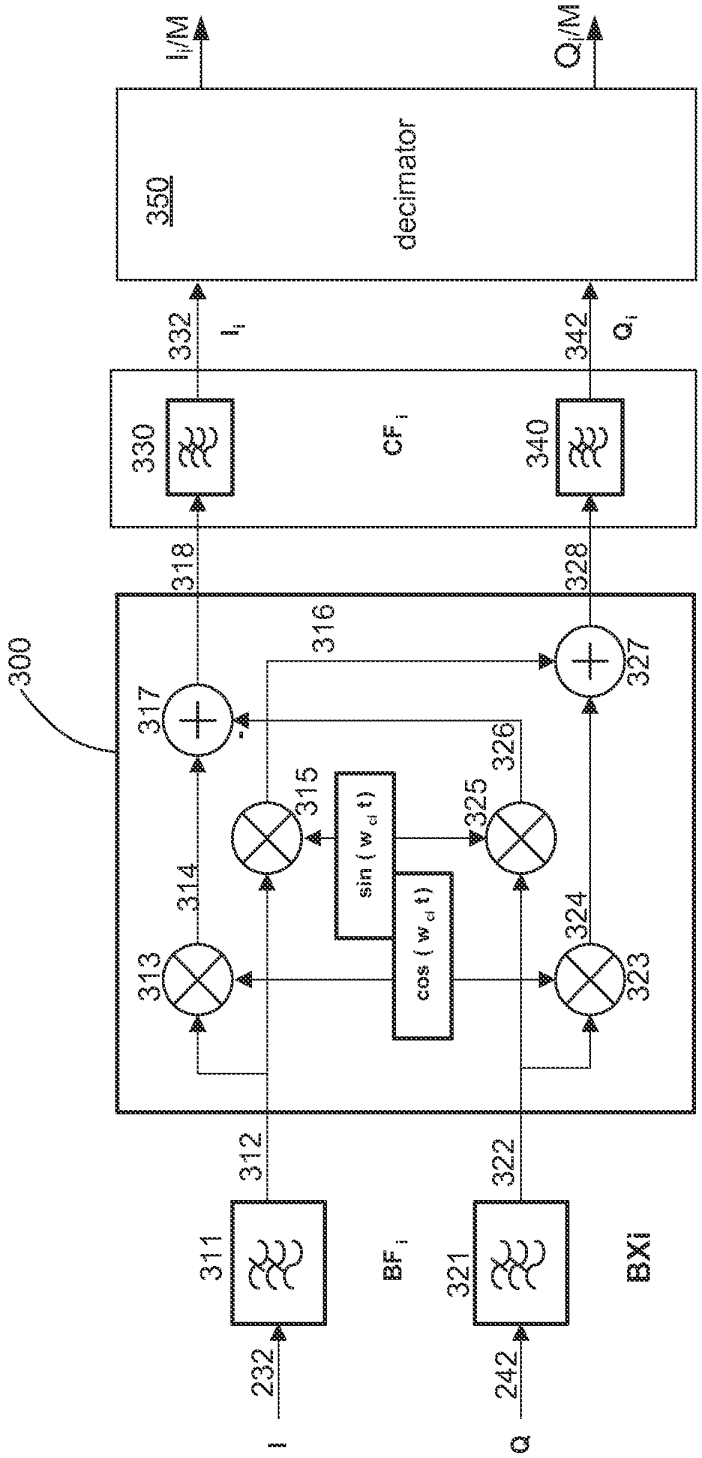

I
232
311
312
BF i
313
314
315
316
317
318
sin (w ct)
cos (w ct)
300
Q
242
321
322
BXi
323
324
325
326
327
328
330
332
CF i
I i
340
342
Q i
350
decimator
I i/M
Q i/M

FIG. 3

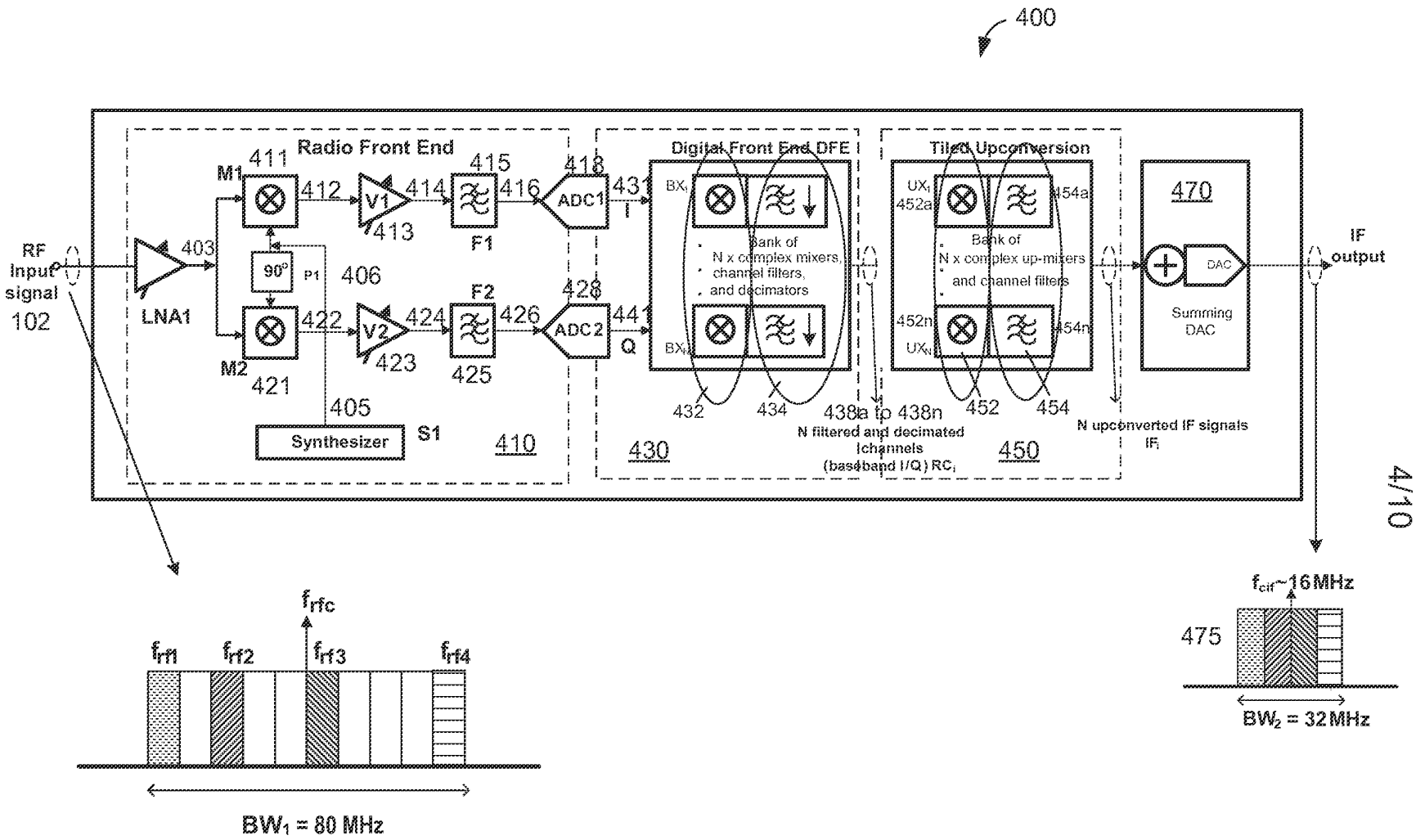

400
Radio Front End
Digital Front End DFE
Tiled Upconversion
RF input signal 102
LNA1
403
M1
M2
411
412
V1
413
414
415
F1
416
ADC1
418
431
I
90°
P1
406
F2
422
V2
423
424
425
426
ADC2
428
441
Q
405
Synthesizer
S1
410
BX1
BXN
Bank of N x complex mixers, channel filters, and decimators
432
434
438a to 438n
N filtered and decimated channels (baseband I/Q) RC1
430
UX1
452a
454a
452n
UXN
454n
Bank of N x complex up-mixers and channel filters
452
454
450
N upconverted IF signals IF1
470
DAC
Summing DAC
IF output
4/10
frfc
frf1
frf2
frf3
frf4
BW1 = 80 MHz
fcif~16MHz
475
BW2 = 32MHz

FIG. 4

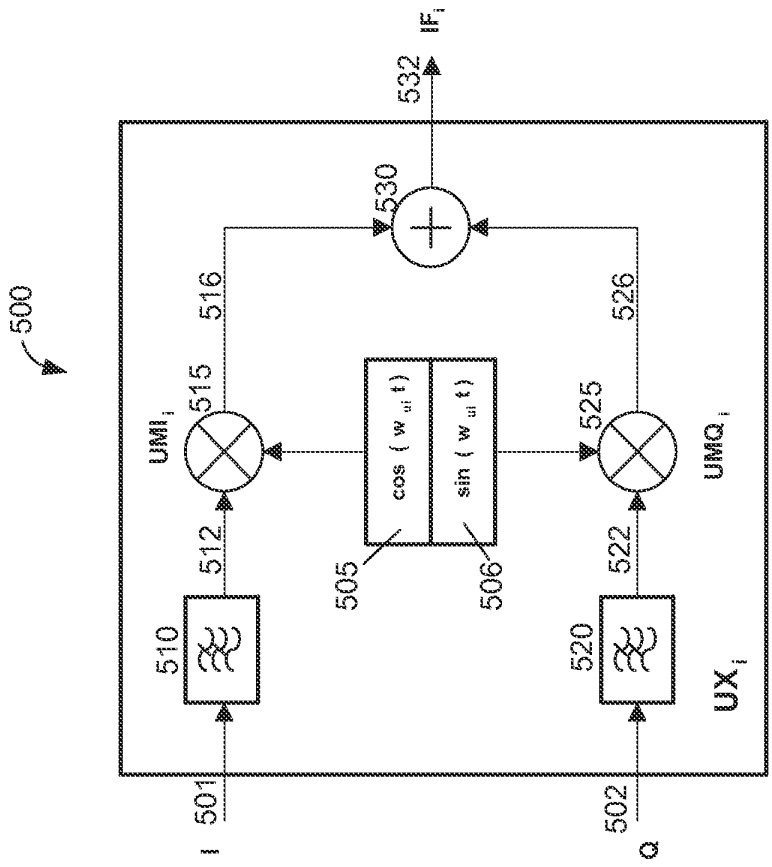

500
532
IF_i
530
516
526
UMI_i
515
525
UMQ_i
cos (w_ui t)
sin (w_ui t)
505
506
512
522
510
520
UX_i
501
502
I
Q

FIG. 5

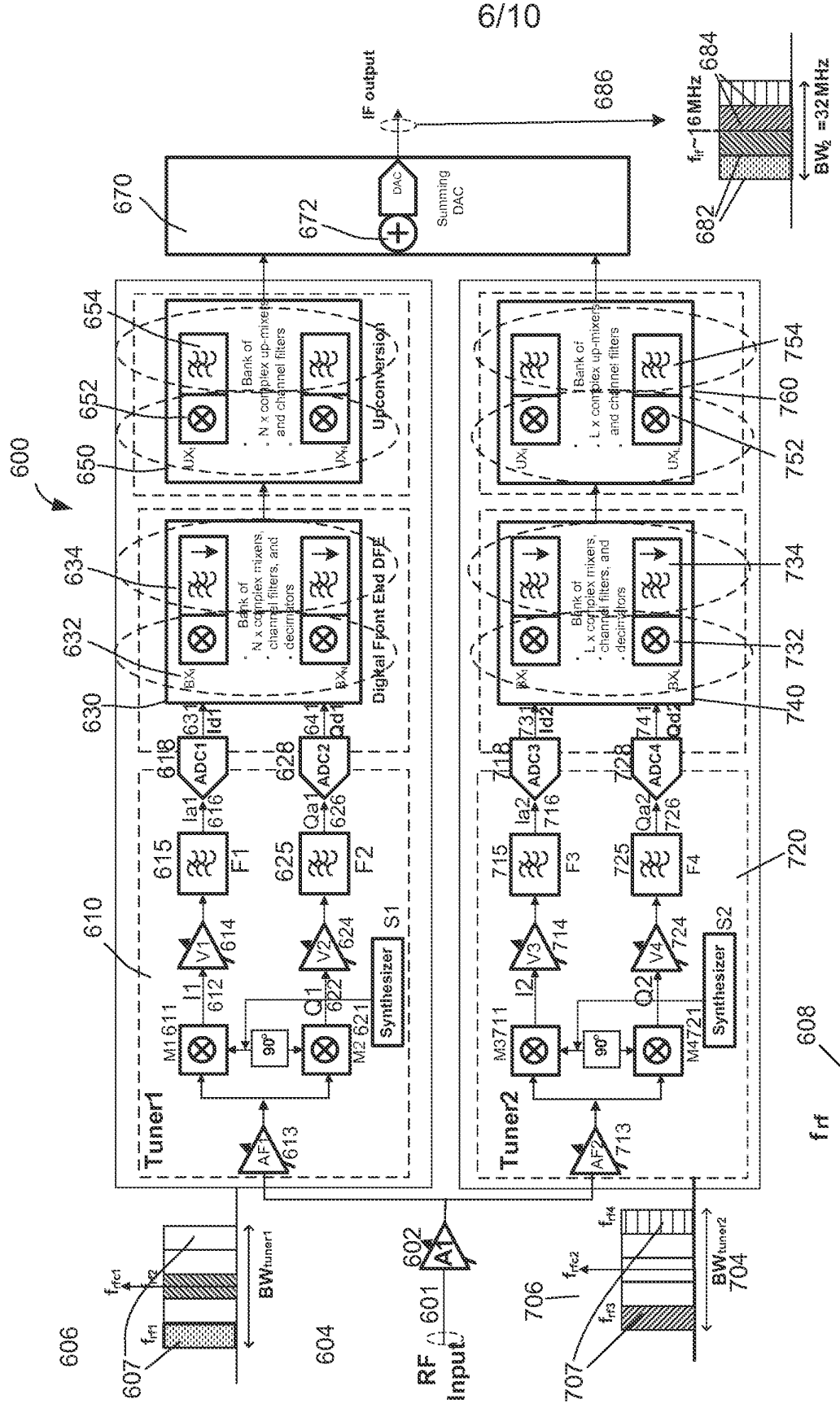

600
606
604
610
Tuner1
Tuner2
720
607
f_{rf1}
f_{rf2}
BW_{tuner1}
602
A1
601
RF input
706
707
f_{rf3}
f_{rf4}
f_{rfc2}
BW_{tuner2}
704
AF1
613
AF2
713
M1 611
M2 621
M3 711
M4 721
90°
I1 612
Q1 622
I2
Q2
V1 614
V2 624
V3 714
V4 724
Synthesizer S1
Synthesizer S2
615
F1
625
F2
715
F3
725
F4
Ia1 616
Qa1 626
Ia2 716
Qa2 726
ADC1 618
ADC2 628
ADC3 718
ADC4 728
Id1 63
Qd1 64
Id2 731
Qd2 741
Digital Front End DFE
Upconversion
Bank of
. N x complex mixers,
. channel filters, and
. decimators
. N x complex up-mixers
. and channel filters
. L x complex mixers,
. channel filters, and
. decimators
. L x complex up-mixers
. and channel filters
630
632
634
650
652
654
740
732
734
752
760
754
670
672
Summing DAC
IF output
686
682
684
f_{if}~16 MHz
BW_2 =32 MHz
608
f_{rf}
f_{rfc}
f_{rf1}
f_{rf2}
f_{rf3}
f_{rf4}
BW_{tuner1}
BW_{tuner2}
BW= 80 MHz

FIG. 6

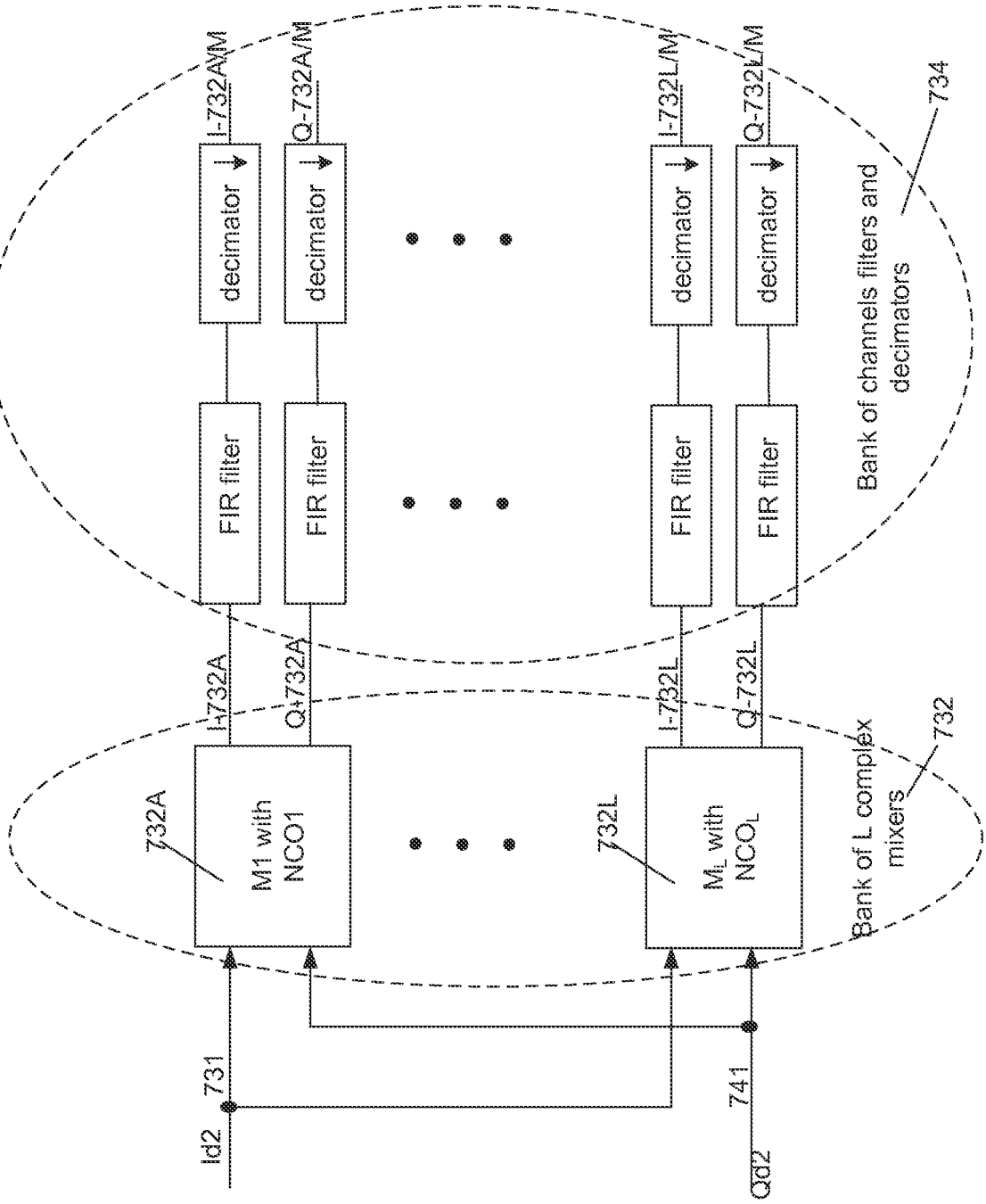

Id2
731
Qd2
741
732A
M1 with NCO1
732L
M_L with NCO_L
Bank of L complex mixers
732
I-732A
Q-732A
I-732L
Q-732L
FIR filter
decimator
I-732A/M
Q-732A/M
I-732L/M
Q-732L/M
Bank of channels filters and decimators
734

FIG. 7

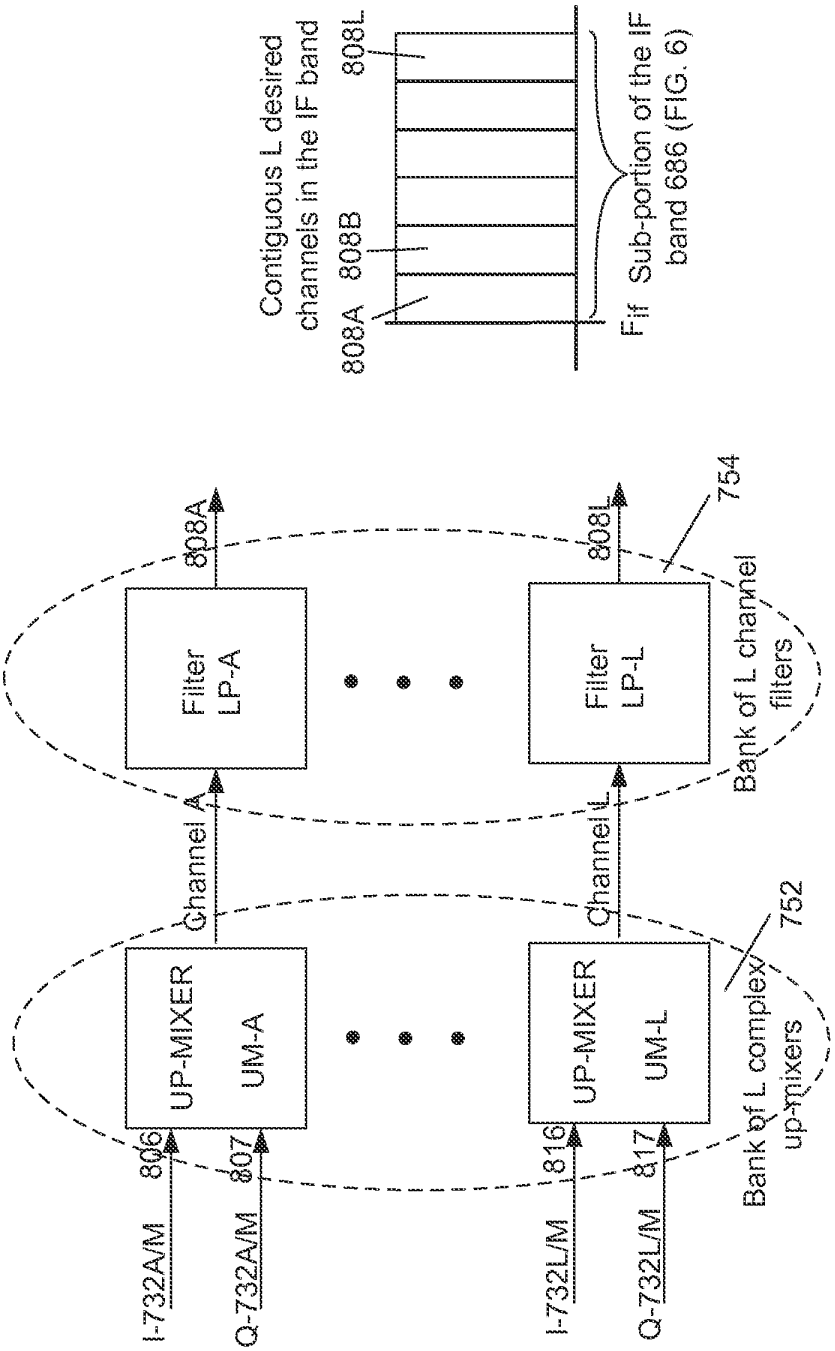

Contiguous L desired channels in the IF band
808A
808B
808L
Fif
Sub-portion of the IF band 686 (FIG. 6)
I-732A/M
Q-732A/M
I-732L/M
Q-732L/M
806
807
816
817
UP-MIXER
UM-A
UP-MIXER
UM-L
Bank of L complex up-mixers
752
Channel A
Channel L
Filter LP-A
Filter LP-L
808A
808L
Bank of L channel filters
754

FIG. 8

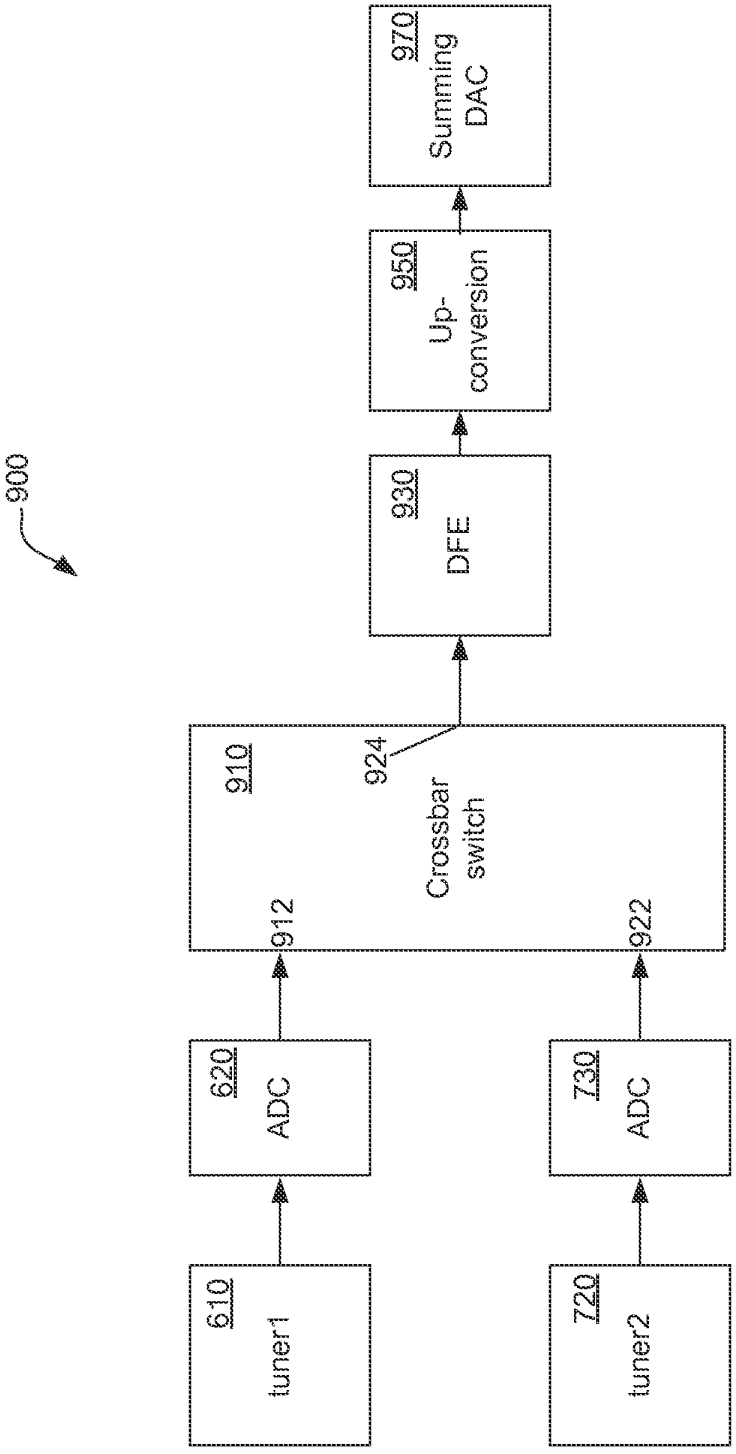

900
610
tuner1
620
ADC
730
ADC
720
tuner2
910
912
922
924
Crossbar switch
930
DFE
950
Up-conversion
970
Summing DAC

FIG. 9

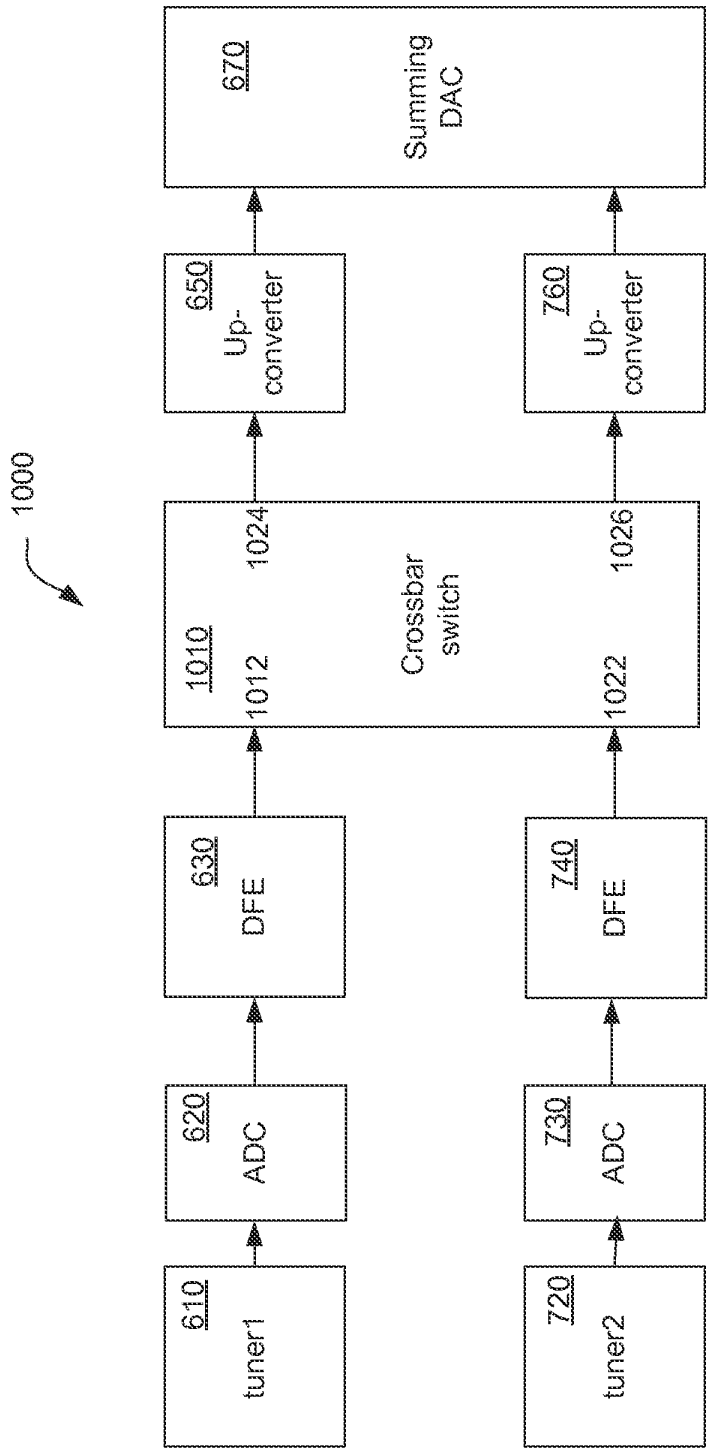

1000
610
tuner1
620
ADC
630
DFE
1010
1012
1022
Crossbar switch
1024
1026
650
Up-converter
670
Summing DAC
720
tuner2
730
ADC
740
DFE
760
Up-converter

FIG. 10

WIDEBAND TUNER ARCHITECTURE

PRIORITY CLAIM

[0001] This application is a continuation of U.S. patent application 14/617,973 (now patent 9,210,363) filed on February 10, 2015, which is a continuation of U.S. patent application 13/962,871 (now patent 9,100,622) filed on August 08, 2013, which is a continuation of U.S. patent application 12/762,900 filed on April 19, 2010 (now U.S. Patent 8,526,898), which claims the benefit of priority to U.S. provisional application 61/170,526 filed April 17, 2009, now expired. Each of the above referenced documents is hereby incorporated by reference in its entirety.

BACKGROUND

[0002] This invention relates to wideband receiver systems and methods having a wideband receiver that is capable of receiving multiple radio frequency channels located in a broad radio frequency spectrum. In particular, the invention relates to wideband receiver systems that are capable of receiving multiple desired television channels that extend over multiple non-contiguous portions of the broad frequency spectrum and grouping them into a contiguous, or substantially-contiguous, frequency spectrum.

[0003] Receivers used to down-convert and selectively filter TV channels are referred to as tuners, and tuners designed to concurrently receive several TV channels are referred to as wideband tuners. Existing tuners for these applications down-convert a swath of channels to an intermediate frequency, which are then sent to a demodulator. Because the swath of channels is not contiguous, this swath includes the desired channels as well as undesired channels. The demodulator employs a high-speed data converter to capture this swath of desired and undesired channels in the digital domain and subsequently filters out the desired channels.

[0004] In general, television channels broadcasted over the air or over cable networks are distributed across a broad frequency spectrum. That is, the channel frequencies may not be adjacent to each other. In certain applications such as DVR and picture-in-picture, the receiver system may have to concurrently receive several desired channels that may or may not be contiguous. The wideband receiver requirement poses a trade-off to the system to limit either the dynamic range of the wideband tuner or reduce the bandwidth covered by the tuner so that fewer channels may be received and processed by the demodulator.

[0005] FIG. 1 shows a conventional wideband tuner 100. Tuner 100 may be a direct conversion tuner and includes a low noise amplifier LNA1 having an input terminal coupled to a radio frequency (RF) input signal 102 and an output terminal coupled to a mixer M1. The RF signal may include one or more television channels receiving from a cable network via an RF connector or wirelessly via an antenna. The RF input signal may include the VHF and UHF television channels in a terrestrial television broadcasting system or the CATV channels in cable networks. In order to receive all broadcasted channels present in the RF input signal, LNA1 must necessarily have a wide tuning range, high linearity, and low noise. Mixer M1 is coupled to a synthesizer S1 that can generate an oscillator frequency located around the center of the RF signal. Mixer M1 frequency down-converts the received RF input signal to a more convenient intermediate frequency (IF) band. Tuner 100 includes an amplifier V1 having a programmable gain for amplifying the IF signal, which is then band-pass filtered by a filter F1 before outputting to a demodulator.

[0006] In general, the RF signal includes multiple desired channels that are located in non-contiguous portions of a radio frequency spectrum. As shown in FIG. 1, the swath of channels 110 occupies a bandwidth BW1 120 at an RF center frequency f_{rfc} 130. Synthesizer S1 may be tuned to a frequency around the center frequency f_{rfc} 130 for

mixing channels 110 to an intermediate frequency f_{ifc} 160, the frequency down-mixed channels 140 are amplified by amplifier V1 and then filtered by F1 to produce a swath of channels 170 centered around frequency f_{ifc} 160. In an exemplary application shown in FIG. 1, bandwidth BW1 contains 10 channels. In the case where channels are TV channels that are spaced at either 6 MHz or 8 MHz in most parts of the world, bandwidth BW1 120 would span from 60-80 MHz, i.e., the down-converted bandwidth at the intermediate frequency would require a bandwidth equal to at least BW1, or at least 80 MHz when such architecture is used. It is noted that in other applications where the desired RF channels are located in the low band such as channels numbers 2 to 6 (VHF in the terrestrial TV broadcast or CATV) and in the high band such as channels numbers 14 to 83 of the UHF TV broadcast or channel numbers 63-158 of the CATV's ultra band, the bandwidth BW1 can be 800 MHz or higher. This wide bandwidth of 800 MHz would require a very expensive digital processing circuitry such as very high-speed analog to digital conversion and high-speed processor in the demodulator.

[0007] It is desirable to have wideband receiver systems that can increase the dynamic range without requiring expensive data conversion, filtering and channel selection at the demodulator.

BRIEF SUMMARY

[0008] An embodiment of the present invention includes a wideband receiver system that is configured to concurrently receive multiple radio frequency (RF) channels including a number of desired channels that are located in non-contiguous portions of a frequency spectrum and group the desired channels in a contiguous or substantially-contiguous frequency band at an intermediate frequency spectrum, where the term "substantially-contiguous" includes spacing the desired channels close to each other (e.g. as a fraction of the total system bandwidth, or relative to a channel bandwidth) but with a spacing that can be variable to accommodate the needs of overall system. The term "contiguous" heretofore encompasses "substantially-contiguous." The term "spacing" is referred to as the frequency difference between adjacent channels. The system includes a wideband receiver having a complex mixer module for down-shifting the multiple RF channels and transforming them to an in-phase signal and a quadrature signal in the baseband or low intermediate frequency (IF) band. The system further includes a wideband analog-to-digital converter module that digitizes the in-phase and quadrature signals. The digital in-phase and quadrature signals are provided to a digital frontend module that contains a bank of complex mixers that frequency-shift the number of desired channels to a baseband where the desired channels are individually filtered.

[0009] The digital frontend module may also include a decimator module that decimates the desired RF channels by a factor M before demodulating them to a digital data stream.

[0010] In certain embodiments of the present invention, the wideband receiver system additionally includes an up-converter module having multiple complex up-mixers, each of the complex up-mixers is configured to frequency up-shift each one of the desired RF channels to a sub-portion of an IF spectrum, wherein all sub-portions of the desired channels are adjacent to each another and form a contiguous frequency band in the IF

spectrum. The act of frequency shifting the desired channels to the IF spectrum allows the wideband receiver system to directly interface with commercially available demodulators. Allowing the spacing of the desired channels in the contiguous spectrum to be variable allows a system to optimize placement of these desired channels for the purposes of avoiding sensitive portions of the spectrum which may either be vulnerable to spurious signals and interference; or which may generate interference directly or as a harmonic product, to other systems.

[0011] In another embodiment of the present invention, a multi-tuner receiver system having two or more tuners is provided to receive multiple desired RF channels that extend over several non-contiguous sub-portions of a broad frequency spectrum and group them into a contiguous frequency spectrum. The multi-tuner system includes at least a first tuner that processes a first sub-portion of the broad frequency spectrum into a first in-phase signal and a first quadrature signal and a second tuner that processes a second sub-portion of the broad frequency spectrum into a second in-phase signal and a second quadrature signal. The multi-tuner receiver system further includes a first analog-to-digital converter module that digitizes the first in-phase and quadrature signals and a second analog-to-digital converter module that digitizes the second in-phase and quadrature signals. In addition, the multi-tuner system includes a first digital frontend module having a first number of complex mixers corresponding to a first number of the desired RF channels located in the first sub-portion of the broad frequency spectrum and a second digital frontend module having a second number of complex mixers corresponding to a second number of the desired RF channels located in the second sub-portion of the broad frequency spectrum. The first digital frontend module frequency shifts the first number of the desired RF channels to a first plurality of baseband signals and the second digital frontend module frequency shifts the second number of the desired RF channels to a second plurality of baseband signals.

[0012] The multi-tuner system further includes a first up-converter module having a plurality of N complex mixers, wherein N is an integer value equal to the number of desired channel. The first up-converter module frequency up-shifts the first plurality of the baseband signals to a first portion of an intermediate frequency. In addition, the multi-tuner system includes a second up-converter module that frequency up-shifts the second plurality of the baseband signals to a second portion of an intermediate frequency. The first and the second portions of the intermediate frequency are non-overlapping and located adjacent to each other to form a contiguous intermediate frequency (IF) band. The multi-tuner system further includes a digital-to-analog converter that converts the contiguous IF band to an analog waveform signal.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a schematic block diagram of a conventional wideband tuner;

[0014] FIG. 2 is a schematic block diagram of a wideband receiver system according to an embodiment of the present invention;

[0015] FIG. 3 is a simplified circuit diagram of a complex down-mixer according to an embodiment of the present invention;

[0016] FIG. 4 is a simplified schematic block diagram of a wideband receiver system according to another embodiment of the present invention;

[0017] FIG. 5 is a simplified circuit diagram of a complex up-mixer according to an embodiment of the present invention;

[0018] FIG. 6 is a simplified schematic block diagram of a wideband multi-tuner receiver system according to an embodiment of the present invention;

[0019] FIG. 7 is a block diagram illustrating an exemplary digital front end according to an embodiment of the present invention in more detail;

[0020] FIG. 8 is a block diagram illustrating an exemplary tiled up-converter module according to an embodiment of the present invention in more detail;

[0021] FIG. 9 is a simplified block diagram of a wideband multi-tuner receiver system 900 according to an embodiment of the present invention; and

[0022] FIG. 10 is a simplified block diagram of a wideband multi-tuner receiver system 1000 according to another embodiment of the present invention.

DETAILED DESCRIPTION

[0023] FIG. 2 is a schematic block diagram of a wideband receiver system 200 according to an embodiment of the present invention. Wideband receiver system 200 includes a radio front end 210 and a digital front end 230. Radio front end 210 may be a single very wide-band tuner receiver that captures the desired swath of channels located in non-contiguous portions of the spectrum having a frequency bandwidth BW1 120. In this example, the number of available channels in BW1 120 is assumed to be 10 with each channel occupying an 8 MHz bandwidth for a total of 80 MHz. Radio front end 210 is shown as including a low noise amplifier LNA 202 having an input terminal configured to receive an RF input signal 102. In the example shown, RF signal 102 includes four desired RF channels having the respective carrier frequency f_{rf1}, f_{rf2}, f_{rf3}, and f_{rf4} that are located in non-contiguous portions of the wide frequency spectrum BW1. It is understood, however, that spectrum BW1 120 may have any other number of desired frequencies that are not contiguous. LNA 202 has a very low noise figure and very high linearity and a wide tuning range (i.e., very high IIP2 and IIP3 intercept points) to maximize a signal-to-noise-and distortion ratio (SNDR) at the amplifier output. LNA 202 may have a programmable gain to amplify RF signal 102 to adequate voltage levels for mixers M1 211 and M2 221.

[0024] Mixers M1 211 and M2 221 may be conventional mixers formed using, for example, differential Gilbert cells. Each of the mixers 211 and 221 multiplies (mixes) an amplified RF signal 203 with a respective first oscillator frequency signal 205 and a second oscillator frequency signal 207 to generate an in-phase signal 212 and a quadrature signal 222 that have a phase shift of 90° degree between them. Mixers 211 and 221 are identical so that the amplitude of the in-phase signal 212 and quadrature signal 222 are the same. The first and second oscillator frequencies 205 and 207 are identical and have a 90° degree phase shift generated through a 90° degree phase shifter P1 206. Synthesizer S1 may be a single local oscillator operable to generate the oscillator

frequency 205 for converting the receive RF signal 102 to a zero-IF or low-IF band. Synthesizer S1 can be a coarse (large step) phase locked loop. Synthesizer S1 can also be programmable to cover the wideband frequency of the analog and digital terrestrial broadcast and/or the cable television system. The RF signal 102 may have relatively uniform signal strength in a cable network. However, its signal strength may extend in several orders of magnitude in a terrestrial broadcast system, thus, LNA 202 and/or mixers M1 211, M2 221 are required to have a relatively high dynamic range to handle the large variations in the signal strength.

[0025] In-phase signal 212 and quadrature signal 222 are further amplified and filtered by respective amplifiers V1 213, V2 223 and filters F1 215, F2 225 to generate a filtered in-phase signal 216 and a filtered quadrature signal 226. Filters F1 215 and F2 225 may be passive or active low-pass filters to filter out any unwanted frequency components of the signals 214 and 224 before digitizing them for further processing in digital front end 230. It is understood that the in-phase path 216 and the quadrature path 226 must have the same amplitude spectrum and maintain a fixed phase relationship, i.e., amplifiers V1 213, V2 223 and filters F1 215, F2 225 must be substantially identical. Because the two paths 216 and 226 are in quadrature, the spectral components from both positive and negative frequencies can be overlaid so that the bandwidth (cutoff frequency) of filters F1 215 and F2 225 can be one half of the BW1 bandwidth 120.

[0026] Analog-to-digital converters ADC1 218 and ADC2 228 are high-speed (i.e., high sampling rate) converters to maximize the dynamic range. In an exemplary application, radio front end 210 operates as a nominal zero-IF down-mixer so that signals 216 and 226 have a nominal bandwidth 290 equal to one half of the RF signal bandwidth BW1 thanks to the complex down-mixer architecture. In other embodiment, radio front end 210 operates as a low-IF down-mixer so that the nominal bandwidth 290 of signals 216 and 226 is greater than one half of the bandwidth BW1. In practice, the sampling rate

of ADC1 218 and ADC2 228 is chosen to be higher than the Nyquist sampling requirement, i.e., the filtered analog quadrature signals 216 and 226 may be over-sampled in order to reduce or avoid aliasing of undesired signals into the digitized I and Q signals.

[0027] ADC1 218 generates a digital signal I 232 that is a digital representation of the analog filtered signal 216; ADC2 228 generates a digital signal Q 242 that is a digital representation of the analog filtered signal 226. Digital signals I 232 and Q 242 are then applied to a bank of N complex mixers 250, wherein N is an integer value corresponding to the number of desired RF channels located in the non-contiguous portions of the frequency spectrum BW1. It is understood that the number N can be any integer value. In one embodiment, N can be equal to the number of all available channels that exist in the licensed frequency spectrum to provide system flexibility. In other embodiments, N can be equal to the number of all receivable channels within a geographic area. In yet another embodiment, N can be an integer value less than the number of receivable channels with the geographic area to reduce system costs. In the exemplary embodiment shown in FIG. 2, the number of desired channels is 4. That is, each of the 4 complex mixers 250 mixes in-phase and quadrature signals 232 and 242 with an associated frequency to generate a corresponding baseband, which is then individually filtered, decimated and provided to an associated demodulator.

[0028] Each of the N complex mixers 250 receives the digital signals I 232 and Q 242 from ADCs 218 and 228 to extract a different one of the desired channels and frequency-shifts the extracted signals to the baseband frequency. Each of the frequency shifted desired channels 252 is filtered by an associated filter module (identified as 260a to 260n). In an embodiment, each of the filtered signals 260a to 260n may be sent directly to an associated demodulator (identified as 270a to 270n) for extracting the original information transmitted in the associated desired channel. In another embodiment, each

of the filtered signals 262a to 262n is further decimated before providing to a demodulator. A path of digital front end 230 is described in more detail below.

[0029] FIG. 3 is a simplified circuit diagram of one of the signal paths 272a to 272n of digital front end 230 shown in FIG. 2 according to an embodiment of the present invention. In an embodiment, digital signal I 232 may be further filtered by a filter 311 to obtain a filtered signal 312. Similarly, digital signal Q 242 may be further filtered by a filter 321 to obtain a filtered signal 322. Thus, digital signals 312 and 322 only contain low-frequency components with undesired high-frequency components being eliminated by respective filters 311 and 321. It is noted that filtered signals 312 and 322 are interposed between the respective ADCs 218, 228 and the bank of N complex mixers 250.

[0030] Mixer 300, which represents one of the N complex mixers 250, includes four multipliers 313, 315, 323, and 325. Multipliers 313 and 315 multiply the filtered signal 312 with respective $\cos(\omega_{ci}t)$ and $\sin(\omega_{ci}t)$ signals and generate respective products 314 and 316. Similarly, multipliers 323 and 325 multiply the filtered Q signal 322 with respective $\cos(\omega_{ci}t)$ and $\sin(\omega_{ci}t)$ signals and generate respective products 324 and 326. An adder 317 sums the products 314 and 326 to generate a frequency-shifted signal I 318. An adder 327 sums the products 324 and 316 to generate a frequency-shifted signal Q 328. Basically, complex mixer 300 causes a frequency shift of the filtered components 312 and 322 to respective baseband signals 318 and 328 in the digital domain according to the operation:

$$Y(t) = X(t) * e^{-j\omega_c t} \quad (1)$$

or taken the Fourier transform, we obtain:

$$Y(\omega)=X(\omega-\omega_c) \quad (2)$$

[0031] Multipliers 313, 315, 323, and 325 are identical digital multipliers. In an embodiment, a numerically controlled oscillator with quadrature output generates the $\cos(\omega_{ci}t)$ and $\sin(\omega_{ci}t)$ signals. Numerically controlled oscillators (NCO) can be implemented using a phase accumulator and a look-up table. NCOs are known to those of skill in the art and will not be described herein. The frequency ω_{ci} is so chosen that each one of the desired channels embedded in the digital signals I 232 and Q 242 will be downshifted to the baseband. In the given example shown in FIG. 2, the bank of N complex mixers will have four complex mixers, each one of the N (i.e., four) complex mixers is coupled to an individual NCO having a distinct frequency ω_{ci} so that when mixing the filtered digital I and Q signals 312 and 322 with that frequency, each one of the complex mixers will generate the signals I (318) and Q (328) of a corresponding one of the desired channels at the baseband.

[0032] In an embodiment, baseband signals 318 and 328 are further individually filtered by respective filters 330 and 340 that are identified as one of the filters 260a-n in FIG. 2. Filters 330 and 340 may be band-pass or low-pass filters having a narrow bandwidth equal to the bandwidth of a desired channel. In certain embodiments, filters 330 and 340 can be analog passive or active low-pass or complex band-pass filters such as polyphase filters. In another embodiment, filters 330 and 340 can be digital low-pass filters, such as finite impulse response (FIR) filters to eliminate high frequency components that may be aliased back to the baseband signals Ii (332) and Qi (342) when decimated by subsequent decimator 350.

[0033] The reduced sampling rate of the N desired baseband channels will be sent as a serial or parallel digital data stream to a demodulator using a serial or parallel data interface according to commonly known methods, as shown in FIG. 2. This approach provides several advantages over conventional tuner architectures. First, it eliminates the need of expensive data conversion, filtering and channel selection on the demodulator

side. Second, it removes undesired channels from the signal path at an early stage, thus relieves the large dynamic range requirement in the demodulator.

[0034] FIG. 4 shows a simplified schematic block diagram of a wideband receiver system 400 according to another embodiment of the present invention. Wideband receiver system 400 includes a radio front end 410, a digital front end 430, a tiled up-conversion module 450, and a summing digital-to-analog converter module DAC 470. Radio front end 410 includes a low noise amplifier LNA1 that receives an RF input signal 102 and provides an amplified RF signal 403 to mixers M1 411 and M2 421. Mixer M1 411 is coupled to an oscillator frequency 405 of a synthesizer S1 whereas mixer M2 421 is coupled with the oscillator frequency 405 via a phase shifter P1 406 that generates a 90° degree phase-shift to the oscillator frequency 405. Mixers M1 411 and M2 421 generate respective in-phase signal 412 and quadrature signal 422 that are further amplified by respective amplifiers V1 413 and V2 423. The amplified in-phase and quadrature signals 414, 424 are then filtered by filters F1 415 and F2 425 to eliminate undesired frequency components that would be aliased back to the in-phase and quadrature signals when digitally sampled by subsequent analog-to-digital converters ADC1 418 and ADC2 428. Digital signals I 422 and Q 442 at the input of digital front end 430 are digital representations of the filtered analog in-phase and quadrature signals 416, 426 before the ADCs. Digital front end 430 include a bank of N complex mixers 432 comprising 432a to 432n identical mixers, where N is an integer value corresponding to the number of the desired channels located in non-contiguous portions of the frequency spectrum. Each of the N complex mixers 432a to 432n frequency down-converts signals I 432 and Q 442 to an associated baseband. Each of the frequency down-converted I and Q signals are coupled to respective low-pass, band-pass, or decimating filters 434. In this regard, the radio front end 410 and the digital front end 430 are similar to respective radio front end 210 and digital front end 230 of FIG. 2 that have been described in detail above.

[0035] In an alternative embodiment of the present invention, the N filtered and decimated channels 438a to 438n (where indices a to n correspond to the associated number of desired channels) are not provided to a demodulator for demodulation. Instead, the N filtered and decimated channels 438a to 438n are further frequency up-converted to an intermediate frequency (IF) spectrum. In order to achieve that, the N filtered and decimated channels are coupled to a tiled up-conversion module 450 that includes a bank of N complex up-mixers, where N is an integer value correspond to the number of desired received channels. The N complex up-mixers include identical digital mixers 452a to 452n that will be described further in detail below with reference to FIG. 5. The N up-shifted channels are then filtered by a subsequent bank of channel filters 454 that, in an embodiment, comprises N individual finite impulse response (FIR) filters. The N filtered channels are then digitally combined and converted to the analog domain by a summing digital-to-analog converter module DAC 470. The N up-shifted channels are adjacent to each other and form a contiguous or substantially-contiguous set of channels 475 in the IF spectrum centered around f_{if} as illustrated in FIG. 4. In an embodiment, the spectra of the mixed products are spaced in such a way so as to avoid overlap with known frequency bands containing potential or actual interferers. In another embodiment, the spectra of the mixed products are spaced in such a way so as to avoid overlap with frequency bands that might introduce interference to other systems. In general, because the bandwidth BW_2 is substantially lower than BW_1, the IF frequency f_{if} can be set proportionally lower, e.g., typically about 16 MHz to accommodate the spectrum of BW2 of up to 32 MHz (corresponding to the total bandwidth of the four desired channels, each having a bandwidth of 8 MHz in this example).

[0036] The up-conversion approach of FIG. 4 provides several advantages over conventional tuner architectures. First, it allows the demodulator to operate the data converter at a lower data rate and with lower resolution (fewer bits) due to the fact that the contiguous channels have a narrower bandwidth. Second, the up-conversion approach

provides full compatibility with existing demodulators that require an analog IF signal. Third, it removes undesired channels from the signal path at an early stage, thus relieves the requirement of a high dynamic range requirement of the demodulator's analog-to-digital converter and the demodulator itself.

[0037] FIG. 5 shows a simplified exemplary circuit diagram of a complex up-mixer 500 according to an embodiment of the present invention. Up-mixer 500 is one of the N complex up-mixers 452a to 452n in tiled up-conversion module 450 shown in FIG. 4. Up-mixer 500 includes filter 510 and 520 configured to eliminate unwanted frequency components present in respective input signals I 501 and Q 502. Filtered signals 512 and 522 are provided to up-mixers UMI 515 and UMQ 525 that multiply the filtered signals 512 and 522 with respective $\cos(\omega_u t)$ and $\sin(\omega_u t)$. The products 516 and 526 are summed in an adder 530 to generate an IF signal 532 according to the following equation:

$$IF(t)=I(t)*\cos(\omega_u t)+Q(t)*\sin(\omega_u t) \qquad (3)$$

[0038] Up-mixers UMI 515 and UMQ 525 are identical digital multipliers that multiply the respective filtered signal 512 and 522 with a cosine function 505 and a sine function 506 that can be generated from a NCO using a digital phase accumulator and a look-up table.

[0039] As described above, TV channels are grouped into multiple frequency bands in North America. For example, channels 2 through 6 are grouped in VHF-low band (aka band I in Europe), channels 7 through 13 in VHF-high band (band III), and channels 14 through 69 in UHF band (bands IV and V). In order to receive such a wide frequency spectrum, the low noise amplifier and mixer must have very low noise, wide tuning range and high linearity as described above in the wideband receiver systems 200 and 400. However, a wideband receiver having a single tuner with high sensitivity may have a high power consumption. For certain applications, it may be advantageous to use multiple tuners that are optimized for a given frequency band, such as a dedicated tuner

for the low VHF band, another dedicated tuner for the high VHF band and the UHF band, and yet other dedicated tuners for receiving the digital video broadcasting (DVB) via satellite (DVB-S), via cable (DVB-C), or terrestrial digital video broadcasting (DVB-T). The multi-tuner approach may also be advantageously applied to cable networks that carry TV programs on an 88 MHz to 860 MHz according to the Data Over Cable Service Interface Specification (DOCSIS) protocol.

[0040] FIG. 6 shows a simplified schematic block diagram of a wideband multi-tuner receiver system 600 according to an embodiment of the present invention. In an embodiment, multi-tuner system 600 includes low noise amplifier A1 602 for receiving an RF input signal 601. Amplifier A1 602 is coupled to at least a tuner1 610 and a tuner2 720. In another embodiment, multi-tuner system 600 may not include amplifier 602 so that RF input signal 601 can be received directly at each tuner 610 and 720.

[0041] Tuner1 610 includes an amplifying filter AF1 613 that filters and amplifies a first portion BWtuner1 604 of a broad frequency spectrum 608 that contains a first plurality of RF channels 606 including desired channels 607 having respective channel frequencies f_{rf1} and f_{rf2}. The first portion of the broad frequency spectrum BWtuner1 604 is then frequency down-converted to a low-IF or zero-IF in-phase signal I1 612 and a quadrature signal Q1 622 through respective mixer M1 611 and M2 621. Signals I1 612 and Q1 622 are further amplified and low-pass filtered before applying to respective analog-to-digital converters ADC1 618 and ADC2 628 that convert analog signals Ia1 616 and Qa1 626 to respective digital in-phase signal Id1 631 and digital quadrature signal Qd1 641. Because tuner1 610 only covers a portion BWtuner1 604 of the entire frequency spectrum 608 having fewer channels, the ADC1 618 and ADC2 628 can be slower-speed analog-to-digital converters with a large number of bits, i.e., large dynamic range.

[0042] Digital signals Id1 631 and Qd1 641 are then provided to a digital front end DFE 630 that includes a first bank of N complex mixers 632 and channel and decimating filters 634. The first bank of N complex filters 632 has N identical complex mixers, where N is an integer value equal to the number of desired channels located in the first portion BWtuner1 604 of the broad frequency spectrum 608. In an embodiment, each one of the first bank of N complex mixers includes four digital mixers that multiply digital stream Id1 631 and Qd1 641 with respective digitized cosine function and sine function to generate the sum and difference frequency components, as shown in FIG. 3. The digitized cosine and sine frequency, i.e., the mixer frequency is so chosen so that when mixing signals Id1 631 and Qd1 641 will move them to a baseband or a low-IF band. In an embodiment, channel and decimating filters have similar structures as filters 330 and 340 and demodulator 350 as shown in FIG. 3. That is, channel and decimating filters include digital low-pass filters 330 and 340 that eliminates unwanted high frequency components of the baseband signals I and Q prior to applying them to a decimator 350 (FIG. 3) that reduces the sample frequency without any loss of information since Id1 631 and Qd1 641 are sampled at a much higher frequency by the respective ADC1 618 and ADC2 628.

[0043] The decimated desired channels are then provided to an up-converter module 650 that includes a bank of N up-mixers. The bank of N up-mixers includes N identical up-mixers whose structure is shown in FIG. 5. In an embodiment, N is an integer value equal to the number of desired channels present in BWtuner1 604. Each one of the up-mixer frequency-shifts the baseband signals I and Q of each one of the desired channels to an appropriate portion of the intermediate frequency band according to Equation (3). In other words, the bank of N up-mixers is "frequency multiplexing" the desired channels onto a first portion 682 of an IF band 686.

[0044] Similarly, tuner2 720 includes an amplifying filter AF2 713 that is configured to receive a second portion BWtuner2 704 of the broad frequency spectrum 608. The second portion 704 contains a second plurality of RF channels 706 including a second number of desired channels. In the exemplary illustration of FIG. 6, the second portion 704 has a frequency bandwidth of BWtuner2 that contains desired channels 707 having respective channel frequencies f_{rf3} and f_{rf4}. Tuner2 720 includes elements such as mixers M3 711, M4 721, amplifiers V3 714, V4 724, filters F3 715, F4 725 and analog-to-digital converters ADC3 731 and ADC4 741 that are substantially the same as the like-named elements of the signal path of tuner1 610. Thus, redundant description is omitted herein.

[0045] Digital in-phase signal Id2 731 and digital quadrature signal Qd2 741 are then provided to digital front end 740. Digital front end 740 includes a bank of L complex filters, where L is an integer value equal to the number of desired channels in the second portion BWtuner2 704 of the broad frequency spectrum 608. Each one of the bank of L complex filters is a digital complex mixer configured to transform the signals Id2 731 and Qd2 741 to baseband signals that are further filtered by individual digital low-pass filters such as FIR filters before decimated by a subsequent decimator. The elements of digital front end 740 are substantially similar to those described in digital front end 630. Thus, redundant description is omitted herein.

[0046] The decimated baseband I and Q channels are further provided to a subsequent up-conversion module 760 that performs a function substantially similar to that of the up-conversion module 650 already described above. The outputs of up-conversion module 650 and 760 can be tiled to generate a contiguous set of IF frequencies 682, 684 centered at f_{if} 686. In an embodiment, the outputs of up-conversion module 650 and 760 are digitally summed and converted to an analog signal by summing DAC 670. In another embodiment, the up-conversion modules 650 and 760 and the

digital summing function 672 can be performed using an inverse discrete Fourier transform or an inverse Fast Fourier transform operation.

[0047] The multi-tuner architecture provides the flexibility that multiple commercially available tuners can be used without the need of designing a wideband tuner. For example, a tuner designed for a terrestrial broadcast digital TV can be used together with a tuner dedicated to receiving a cable signal and/or a tuner for receiving a satellite broadcast signal. The multi-tuner receiver system provides an additional advantage that other tuners can be added quickly to the system to accommodate any future applications. Additionally, the multi-tuner architecture allows the use of slower speed (i.e., lower cost) analog-to-digital converters with a larger number of bits for achieving large dynamic range.

[0048] FIG. 7 shows a block diagram of an exemplary digital front end of the invention in more detail. In an embodiment, in-phase signal Id2 731 and quadrature signal Qd2 741 at the output of respective ADC converters 718 and 728 are provided to each of the L complex mixers 732 comprising mixers 732A to 732L. A more detailed description of each of L complex mixers is shown in FIG. 3. Mixer 732A multiplies Id2 731 and Qd2 741 with a cosine signal and a sine signal that are generated from an NCO1 and produces an I-732A signal and a Q-732A signal that are further individually filtered by an FIR filter before decimating. The bank of L complex mixers corresponds to the block 732 in FIG. 6; and the set of FIR filters and decimator corresponds to the block 734 in FIG. 6. Each decimated pair of I-732i/M in the baseband, where the index "i" is from A to L, is further provided to a subsequent up-mixer for frequency-shifting to an intermediate frequency as shown in FIG. 8.

[0049] FIG. 8 shows an exemplary embodiment of a bank of L complex up-mixers according to the present invention. Each decimated pair of complex signals I-732i/M and Q-732i/M is provided to an associated complex up-mixer, whose frequency is so chosen

that when mixing with the pair of complex signals I-732i/M and Q-732i/M will generate an associated channel at a predetermined sub-portion of the intermediate frequency band 686 (FIG. 6). A more detailed schematic block of one of the L up-mixers is described above together with FIG. 5.

[0050] FIG. 9 is a simplified block diagram of a wideband multi-tuner receiver system 900 according to an embodiment of the present invention. In an embodiment, system 900 includes a crossbar switch 910 having at least an input terminal 912 configured to receive signals from an analog-to-digital converter (ADC) 912 and an input terminal 922 configured to receive signals from an ADC 922. Crossbar switch 910 also includes an output terminal 924 that is coupled to a digital front end 930. In an embodiment, input terminals 912 and 922 of crossbar switch 910 have P inputs, where P is an integer value that is equal to the total number of desired channels received by tuner1 610 and tuner2 720. Output terminal 924 of crossbar switch 910 have Q outputs, where Q is an integer value that is equal to the total number of desired channels received by tuner1 610 and tuner2 720.

[0051] In an embodiment, digital front end 930 may include a bank of R complex mixers that frequency shifts the received channels to a baseband. Digital front end 930 may combine digital front end 630 and 740 shown in FIG. 6. Similarly, a tiled up-conversion module 950 may include up-converter modules 650 and 760 of FIG. 6.

[0052] System 900 further includes a summing DAC that operates similarly as summing DAC 470 and 670 that have been described in detail in relation with respective FIG. 4 and FIG. 6 above. Thus, redundant description is omitted herein.

[0053] FIG. 10 is a simplified block diagram of a wideband multi-tuner receiver system 1000 according to another embodiment of the present invention. System 1000 includes at least tuner1 610 coupled with digital front end 630 through an analog-to-digital converter 620 and tuner2 720 coupled with digital front end 740 through an

analog-to-digital converter 730. System 1000 further includes a crossbar switch 1010 that is interposed between digital front ends 630, 740 and up-conversion modules 650, 760. Crossbar switch 1010 includes an input terminal 1012 having S inputs coupled with DFE 630 and an input terminal 1022 having T inputs coupled with DFE 740. In an embodiment, S is an integer value equal to the number of desired channels processed in DFE 630 and T is an integer value equal to the number of desired channels processed in DFE 740. Crossbar switch 1010 further includes an output terminal 1024 having U outputs coupled with up-converter module 650 and an output terminal 1024 having V outputs coupled with up-converter module 760. In an embodiment, the total number of the outputs U and V is equal to the sum of the inputs S and T. Thus, crossbar switch 1010 allows the routing of any channel from either DFE 630 or DFE 740 to up-converters 650 or 760. It is understood that system 1000 is not as flexible as system 900 because DFE 630 and DFE 740 are already pre-assigned to respective tuner1 (610) and tuner2 (720). However, this pre-assigned arrangement allows a simpler implementation of crossbar switch 1010 that operates at lower speeds.

[0054] While several embodiments in accordance with the present invention have been described, it is to be understood that the above description is intended to be illustrative and not restrictive. Many embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined not with reference to the above description, but instead should be determined with reference to the appended claims along with their full scope of equivalents.

CLAIMS

What is claimed is:

1. A system comprising:

a first analog-to-digital converter (ADC) configured to digitize a first frequency band comprising a first plurality of channels;

a second ADC configured to digitize a second frequency band comprising a second plurality of channels; and

a digital frontend (DFE) circuit operatively coupled to the first ADC and the second ADC, the DFE being configured to:

frequency shift one or more channels from the first plurality of channels; and

frequency shift one or more channels from the second plurality of channels, wherein the frequency-shifted one or more channels from the first plurality of channels and the frequency-shifted one or more channels from the second plurality of channels are combined into an intermediate frequency (IF) signal.

2. The system of claim 1, wherein the IF signal is a digital signal and the DFE is configured to output the IF signal via a serial interface.

3. The system of claim 1, wherein the IF signal is a digital signal and the DFE is configured to output the IF signal via a parallel interface.

4. The system of claim 1, wherein:

prior to the frequency shift of the one or more channels from the first plurality of channels and the frequency shift of the one or more channels from the second plurality of channels, there is a first, greater amount of separation in frequency between the one or more channels from the first plurality of

channels and the one or more channels from the second plurality of channels; and

after the frequency shift of the one or more channels from the first plurality of channels and the frequency shift of the one or more channels from the second plurality of channels, there is a second, lesser amount of separation in frequency between the frequency-shifted one or more channels from the first plurality of channels and the frequency-shifted one or more channels from the second plurality of channels.

5. The system of claim 1, wherein the DFE comprises a plurality of channel filters configured to perform selection of the one or more channels from the first plurality of channels and the one or more channels from the second plurality of channels.

6. The system of claim 5, wherein each one of the plurality of channel filters is a finite impulse response filter.

7. The system of claim 1, wherein the DFE is configured to:

adjust a sample rate of the frequency-shifted one or more channels from the first plurality of channels; and

adjust a sample rate of the frequency-shifted one or more channels from the second plurality of channels.

8. The system of claim 1, wherein each of the frequency shift of the one or more channels from the first plurality of channels and the frequency shift of the one or more channels from the second plurality of channels comprises a down-shift and an up-shift.

9. The system of claim 1, wherein the first plurality of channels and second plurality of channels are satellite broadcast television channels.

10. A method comprising:

digitizing, by a first analog-to-digital converter (ADC), a first frequency band comprising a first plurality of channels;

digitizing, by a second ADC, a second frequency band comprising a second plurality of channels;

frequency shifting, by a digital frontend (DFE) circuit operatively coupled to the first ADC and the second ADC, one or more channels from the first plurality of channels; and

frequency shifting, by the DFE, one or more channels from the second plurality of channels, wherein the frequency-shifted one or more channels from the first plurality of channels and the frequency-shifted one or more channels from the second plurality of channels are combined into an intermediate frequency (IF) signal.

11. The method of claim 10, comprising outputting, by the DFE, the IF signal via a serial interface.

12. The method of claim 10, comprising outputting, by the DFE, the IF signal via a parallel interface.

13. The method of claim 10, wherein:

prior to the frequency shifting of the one or more channels from the first plurality of channels and the frequency shifting of the one or more channels from the second plurality of channels, there is a first, greater amount of separation in frequency between the one or more channels from the first plurality of

channels and the one or more channels from the second plurality of channels; and

after the frequency shifting of the one or more channels from the first plurality of channels and the frequency shifting of the one or more channels from the second plurality of channels, there is a second, lesser amount of separation in frequency between the frequency-shifted one or more channels from the first plurality of channels and the frequency-shifted one or more channels from the second plurality of channels.

14. The method of claim 10, comprising selecting, by a plurality of channel filters of the DFE, the one or more channels from the first plurality of channels and the one or more channels from the second plurality of channels.

15. The method of claim 14, wherein each one of the plurality of channel filters is a finite impulse response filter.

16. The method of claim 10, comprising:

adjusting, by the DFE, a sample rate of the frequency-shifted one or more channels from the first plurality of channels; and

adjusting, by the DFE, a sample rate of the frequency-shifted one or more channels from the second plurality of channels.

17. The method of claim 10, wherein each of the frequency shifting of the one or more channels from the first plurality of channels and the frequency shifting of the one or more channels from the second plurality of channels comprises down-shifting and up-shifting.

18. The method of claim 10, wherein the first plurality of channels and second plurality of channels are satellite broadcast television channels.

ABSTRACT

A wideband receiver system comprises a wideband analog-to-digital converter (ADC) module and a digital frontend (DFE) module. The wideband ADC is configured to concurrently digitize a band of frequencies comprising a plurality of desired channels and a plurality of undesired channels. The DFE module is coupled to the digital in-phase and quadrature signals. The DFE module is configured to select the plurality of desired channels from the digitized band of frequencies, and generate an intermediate frequency (IF) signal comprising the selected plurality of desired channels and having a bandwidth that is less than a bandwidth of the band of frequencies, where the generation comprises frequency shifting of the selected plurality of desired channels. The IF signal may be a digital signal and the DFE is configured to output the IF signal via a serial or parallel interface.

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (**Not for submission under 37 CFR 1.99)**		
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	First Named Inventor	Madhukar Reddy
	Art Unit	
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	1	JEFFREY A. WELDON, et al. "A 1.75-GHz Highly Integrated Narrow-Band CMOS Transmitter With Harmonic-Rejection Mixers, IEEE Journal of Solid-State Circuits, December 2001, pages: 2003-2015, Vol. 36, No. 12, Seattle, Washington.	
	2	Int'l Search Report and Written Opinion Appln No. PCT/2010/031631 mailed June 17, 2010.	
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Applicant(s): R F MAGIC INC [US] ± (R.F. MAGIC INC, ; RF MAGIC, INC)

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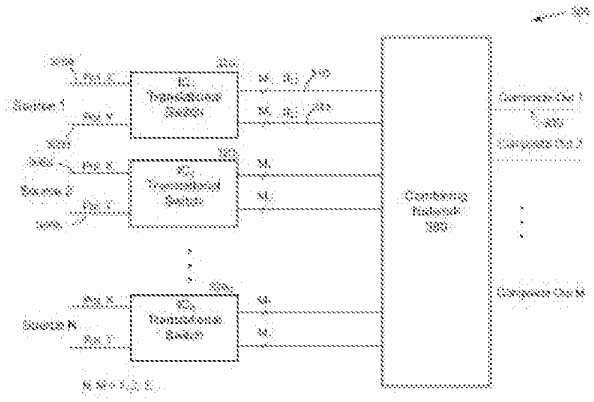
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Abstract not available for EP2087623 (A2)
Abstract of corresponding document: US2008112385 (A1)

Circuits, systems, and methods for assembling a composite signal include a frequency translation circuit coupled to receive an input signal and operable to generate a plurality of frequency-translated versions of the input signal at a respective plurality of different frequencies, the plurality of frequency-translated input signals defining a group of frequency translated signals. The plurality of frequency translated signals may each be processed to provide a composite signal.



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A 1.75-GHz Highly Integrated Narrow-Band CMOS Transmitter With Harmonic-Rejection Mixers

Jeffrey A. Weldon, R. Sekhar Narayanaswami, Jacques C. Rudell, *Member, IEEE*, Li Lin, Masanori Otsuka, Sebastien Dedieu, Luns Tee, *Student Member, IEEE*, King-Chun Tsai, *Student Member, IEEE*, Cheol-Woong Lee, and Paul R. Gray, *Fellow, IEEE*

***Abstract*—A highly integrated 1.75-GHz 0.35-μm CMOS transmitter is described. The I/Q modulator-based transmitter facilitates integration through the use of a unique mixer, termed a harmonic-rejection mixer, and a wide loop bandwidth phase-locked loop (PLL) for the RF synthesizer. The harmonic-rejection mixers are used to eliminate the need for a discrete IF filter and the use of a wide loop bandwidth PLL allowed for the complete integration of the synthesizers using low-Q components while achieving low phase noise. The entire transmit signal path from the digital-to-analog converters to the power amplifier, including two fully integrated frequency synthesizers, is integrated into a single-chip solution. The transmitter was tested with a testing buffer before the power amplifier (PA) and achieved less than 1.3° rms phase error when modulating a DCS-1800 GMSK signal. The prototype consumed 151 mA from a 3-V supply. A class-C PA, capable of driving 25 dBm off-chip, was included and the output was compared to the testing buffer with little change in the transmitter performance.**

***Index Terms*—Class-C power amplifier, CMOS RF, digital-to-analog converter, frequency synthesizer, harmonic-rejection mixer, harmonic-rejection transmitter, image-rejection mixer, low-pass filter, phase-locked loop, power amplifier, quadrature generation, radio architectures, radio transmitter, wireless communications.**

I. Introduction

THE DEMAND for wireless connectivity supporting both voice and data has dramatically increased in recent years. Advancements in wireless technology have largely been driven by the desire for lower cost solutions. One method of achieving this price reduction is through increased levels of integration in both the transmitter and the receiver. In addition to reducing the number of ICs needed, eliminating the need for costly discrete components can also lower the overall cost. Consequently, methods of integration have received considerable attention over the last few years [1], with the goal of complete integration of both the digital and analog circuits onto a single chip. CMOS is amenable to high integration due to the fact that the vast majority of digital integrated circuits as well as many analog integrated circuits [2] are implemented in CMOS technologies. However, maintaining high performance in a wireless system, with an integrated CMOS solution, requires advances at both the architectural and circuit level because many current implementations are not amenable to integration in CMOS.

Recently, significant effort has been directed toward the implementation of integrated CMOS receivers [3], [4]. The focus of this work is to demonstrate techniques that would allow for a highly integrated high-performance CMOS transmitter and eliminate the need for costly discrete components. The challenge was to maintain the high performance needed by cellular communications systems while using low-Q on-chip components inherent to standard CMOS. A prototype was fabricated using a 0.35-μm double-poly five-layer metal CMOS technology. The transmitter operated at 1.75 GHz and was designed for a narrow-band cellular standard, DCS-1800, an up-banded version of GSM. Although the prototype was only tested with one standard, the architecture was chosen to facilitate multistandard operation. The transmitter integrated the entire signal path from the digital-to-analog converters (DACs) to the power amplifier (PA) including two frequency synthesizers. The full integration of the transmitter was facilitated by a number of techniques including the harmonic-rejection mixer (HRM) and a wide-loop-bandwidth phase-locked loop (PLL).

Section II discusses relevant transmitter architectures and their potential for integration in CMOS and multistandard operation. Section III focuses on the harmonic-rejection transmitter in more detail while addressing a few of the key concepts and circuit blocks. Section IV examines the CMOS prototype transmitter used to demonstrate the previously discussed concepts, and Section V presents the measured results from this transmitter. Finally, some conclusions are made in Section VI.

II. Transmitter Architectures

Transmitter implementations to date have used a variety of architectures, each of which exhibits features making them well suited for implementing a specific standard. However, if the goal is multistandard operation, a transmitter architecture with high flexibility is desired. Furthermore, high performance is required if a difficult standard is among the targeted applications. In particular, RF systems with large cell sizes, such as cellular communication systems, generally require higher performance than short-range systems such as Bluetooth. The issue is further complicated by the fact that CMOS integration using low-Q components limits the performance of many circuit techniques. As

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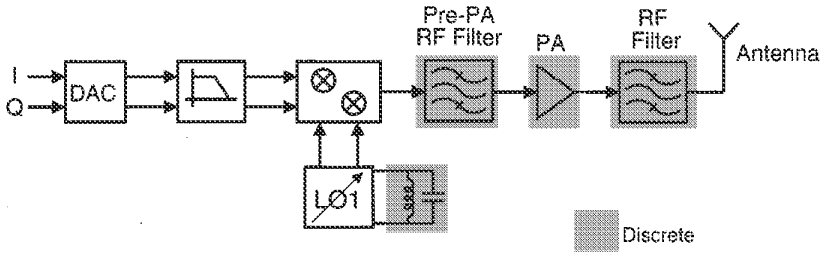


Fig. 1. Direct upconversion transmitter block diagram.

a result, new architectures and circuit techniques must be investigated if the goal is high-performance multistandard operation using CMOS and its inherently low-Q devices.

The vast majority of transmitters fall into two classes: I/Q modulator-based transmitters and voltage-controlled oscillator (VCO)-based transmitters. Although VCO-based transmitters have shown promise with respect to the elimination of discrete components [5], [6], they are fundamentally limited to constant-envelope modulation schemes. In contrast, I/Q modulator-based transmitters can operate with both constant and nonconstant envelope modulation, making them well suited for multistandard operation. To begin the discussion of I/Q modulator-based transmitters, a homodyne or direct upconversion transmitter is evaluated, followed by a discussion of the traditional heterodyne or indirect upconversion transmitter. Finally, a modified heterodyne transmitter is presented called the harmonic-rejection transmitter.

A. Direct-Upconversion Transmitter (Homodyne)

The direct-upconversion transmitter, shown in Fig. 1, is attractive because of the simplicity of the signal path. The in-phase (I) and quadrature (Q) baseband digital signals pass through a DAC and a baseband filter before the signal is upconverted to RF in a single step. The I and Q signals are then combined before passing through a pre-PA RF filter, a PA, and a second RF filter. Channel tuning is typically performed with a single RF channel-select frequency synthesizer. The shaded components in Fig. 1 would likely remain discrete if CMOS integration with low-Q components was attempted for a number of reasons. In particular, integrating a low-phase noise RF channel-select frequency synthesizer using low-Q components would be particularly difficult for narrow-band cellular standards such as GSM. This would lead to the use of a discrete VCO tank circuit to meet the required phase-noise performance with reasonable power consumption. Aside from the tank circuit, a discrete pre-PA RF filter is needed for two reasons. First, the filter reduces potential third-order intermodulation in the PA that could degrade modulation accuracy. This can be seen in Fig. 2 when the third harmonic of the desired signal intermodulates with the desired signal to produce an unwanted third harmonic of the baseband signal. The pre-PA RF filter is also needed to attenuate transmitted noise that in turn reduces the filtering requirement after the PA. This allows the use of a single filter after the PA with potentially lower loss than if a pre-PA filter was not used. Aside from the need for discrete components, the direct upconversion transmitter suffers from some well-known problems. First, the

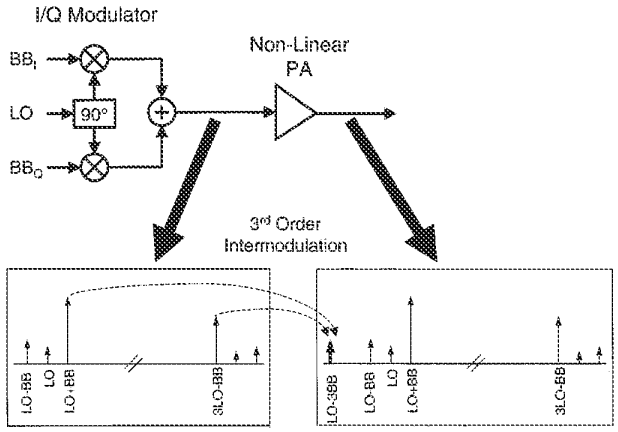


Fig. 2. Third-order intermodulation in PA.

local oscillator (LO) feedthrough is relatively large because of the high frequency used in the I/Q modulator. The second, and potentially more severe, problem is LO pulling which occurs because the transmitted signal is running at the same frequency as the LO. This condition would only get worse with PA integration. One method to reduce LO pulling is offset mixing [7], [8], but this technique does not address any of the other integration issues. To further improve transmitter performance, an indirect upconversion transmitter is often used.

B. Indirect Upconversion Transmitter (Heterodyne)

The indirect upconversion transmitter, shown in Fig. 3, can be viewed as the transmitter version of the superheterodyne receiver. Like the homodyne transmitter, an I/Q modulator is used; however, now the baseband signal is frequency translated to a fixed IF. The signal is then typically filtered to remove unwanted IF harmonics. The IF signal is then upconverted to RF before it passes through a pre-PA RF filter, the PA, and a final RF filter. Like the direct upconversion transmitter, channel tuning is performed with a single RF channel-select frequency synthesizer, and again, the shaded components would likely remain discrete if CMOS integration with low-Q components was attempted. In addition, yet another discrete component, the IF filter, has been added. Furthermore, little has been done to ease the requirements of the RF VCO tank circuit or the pre-PA RF filter. However, this transmitter does have a number of performance advantages. First, LO feedthrough is reduced because of the lower frequency used in the I/Q modulator, and second, LO pulling is reduced because neither oscillator is operating at the transmitted frequency. To further improve performance a modi-

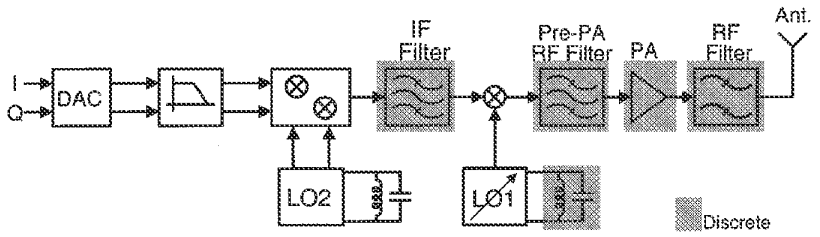


Fig. 3. Indirect upconversion transmitter block diagram.

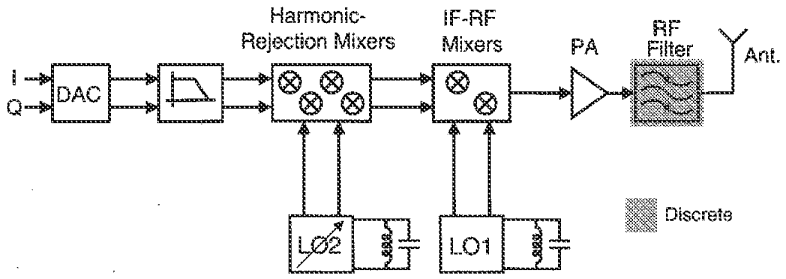


Fig. 4. Harmonic-rejection transmitter block diagram.

fied indirect-upconversion transmitter was used, called the harmonic-rejection transmitter.

C. Harmonic-Rejection Transmitter

The two-step transmitter shown in Fig. 4 is called the harmonic-rejection transmitter (HRT) because of the unique mixers used in the baseband to IF upconversion. This transmitter maintains the performance advantages of the traditional indirect upconversion transmitter in that both LO pulling and LO feedthrough are reduced. In addition, for reasons shown later, the dependency on discrete components has been reduced. For a given performance metric, removal of the IF filter and pre-PA filter may now be possible, as well as complete integration of the RF VCO tank circuit. Integration of the tank circuit is achieved by switching the roles of the synthesizers as compared to a conventional heterodyne transmitter. Channel tuning is now performed with the IF synthesizer while the RF synthesizer is fixed in frequency. By reversing the roles of the two synthesizers, the total phase noise of both synthesizers can be reduced when using low-Q on-chip components for the VCO tank circuitry.

The IF filtering requirement is relaxed by the use of HRMs for the baseband to IF upconversion. As previously mentioned, conventional switching mixers introduce relatively large harmonics at multiples of the IF frequency that require the use of a high-Q filter not amenable to CMOS integration. In contrast, the HRM not only frequency translates the baseband signal to IF but also avoids the need for a discrete filter by attenuating the third and fifth IF harmonics. This attenuation is achieved by effectively multiplying the baseband signal by a 3-bit, amplitude-quantized sinusoid. The details of the HRM will be discussed in more detail in Section III.

In addition to the relaxation of the IF filtering requirement, the requirements on the pre-PA RF filter have also been relaxed. The pre-PA filter is needed to reduce potential third-order intermodulation and to attenuate transmitted noise and spurs. Since the transmitted noise is typically dominated by the phase noise of the synthesizers, switching the roles of the synthesizers potentially allows for low-phase-noise integrated synthesizers which in turn reduce the pre-PA filtering requirement. Also, as previously mentioned, energy located at three times the carrier frequency can intermodulate and degrade the modulation accuracy. In an indirect upconversion transmitter, energy is generated at three times the carrier frequency from the 3LO2 × 3LO1 mixing product. However, due to the rejection of the third IF harmonic, third-order intermodulation is a less significant problem in the HRT. Consequently, the pre-PA RF filter is no longer needed to prevent significant third-order intermodulation. As a result, PA integration is now possible, because the RF filtering can be performed with one RF filter after the PA.

The next section will discuss some of the important details of the HRT, focusing on the HRM and frequency synthesizers.

III. Transmitter Details

A. Harmonic-Rejection Mixer

A key building block in the HRT is the harmonic-rejection mixer (HRM). Switching mixers are commonly used in RF transceivers because of their numerous advantages compared to other mixer topologies [9]. However, these mixers generate harmonics of the local oscillator frequency, which consequently need filtering. The top half of Fig. 5(a) shows a conventional switching mixer in which the baseband signal is effectively multiplied by a square-wave LO2 signal. The resulting upconverted signal now has relatively large copies of the baseband signal located at odd multiples of the LO frequency. Typically, a high-Q filter is needed to attenuate these copies. Alternatively, an HRM could be used to attenuate the third and fifth LO harmonics, reducing the IF filtering requirement. The fundamental concept of the HRM, shown in Fig. 5(b), is to multiply the baseband signal by a 3-bit, amplitude-quantized sinusoid, $f_{\mathrm{LO2h}}(t)$. Because the first harmonic of $f_{\mathrm{LO2h}}(t)$ is located

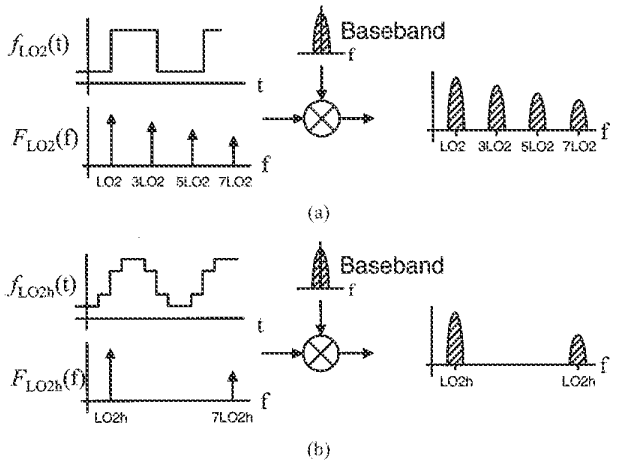


Fig. 5. (a) Conventional switching mixer. (b) Harmonic-rejection fundamentals.

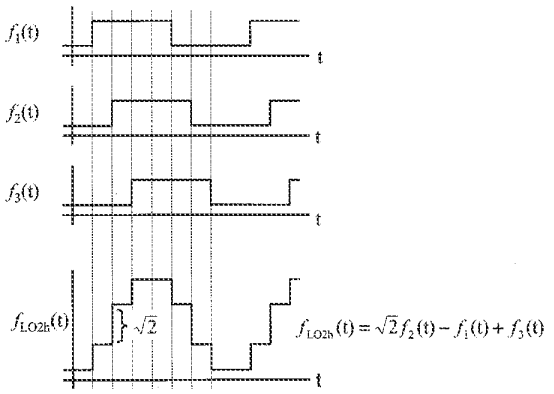


Fig. 6. Harmonic-rejection signal generation.

at seven times the fundamental frequency, the first significant copy of the upconverted baseband signal is also located at seven times the fundamental frequency. Consequently, the IF filtering requirement is greatly relaxed, leading to removal of the IF filter. The next challenge was to generate $f_{LO2h}(t)$ while maintaining the advantages of using a current-commutating switching mixer. Current-commutating switching mixers allow for a relatively low LO swing, which is critical for integration using low-Q components.

To generate $f_{LO2h}(t)$, three square waves are summed as shown in Fig. 6. To accurately represent a quantized sinusoid, the magnitude of $f_2(t)$ is scaled by $\sqrt{2}$. To better understand the rejection of the third and fifth harmonics, it is instructive to expand the three square waves using a Fourier series. The Fourier series representation of the three square waves up to the fifth-order component is given by

$$f_1(t) = \frac{\sqrt{2}}{\pi}\left[(\cos(\omega t) - \sin(\omega t)) + \frac{1}{3}(\cos(3\omega t) + \sin(3\omega t)) - \frac{1}{5}(\cos(5\omega t) - \sin(5\omega t))\ldots\right] \quad (1)$$

$$f_2(t) = \frac{2}{\pi}\left[\cos(\omega t) - \frac{1}{3}\cos(3\omega t) + \frac{1}{5}\cos(5\omega t)\ldots\right] \quad (2)$$

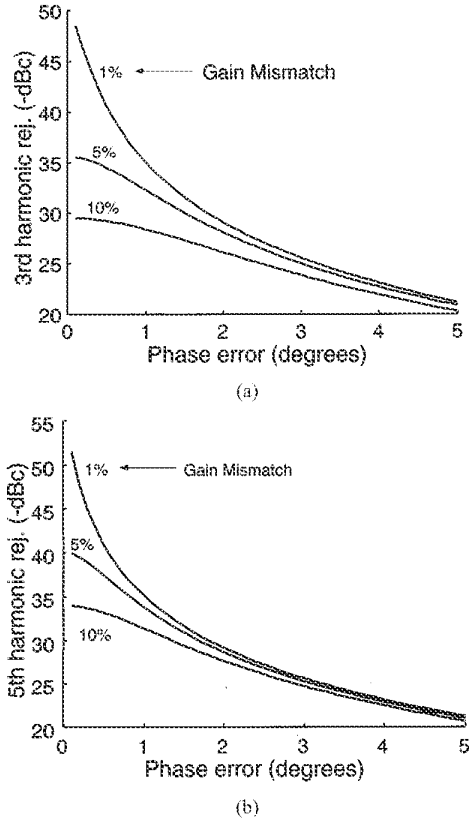


Fig. 7. Harmonic-rejection with mismatch. (a) For third harmonic. (b) For fifth harmonic.

$$f_3(t) = \frac{\sqrt{2}}{\pi}\left[(\cos(\omega t) + \sin(\omega t)) + \frac{1}{3}(\cos(3\omega t) - \sin(3\omega t)) - \frac{1}{5}(\cos(5\omega t) + \sin(5\omega))\ldots\right]. \quad (3)$$

Summing the three ideal square waves with $f_2(t)$ scaled by $\sqrt{2}$ results in the total rejection of the third and fifth harmonics. However, similar to a single-sideband mixer, gain and phase mismatch result in nonideal cancellation of the third and fifth harmonics. The rejection of the third and fifth harmonic are given by

$$\mathrm{HRM}_3 = \left(\frac{1}{9}\right)((1 - \cos(3\theta)(1+\Delta))^2 + ((1+\Delta)\sin(3\theta))) \quad (4)$$

$$\mathrm{HRM}_5 = \left(\frac{1}{25}\right)((1 - \cos(5\theta)(1+\Delta))^2 + ((1+\Delta)\sin(5\theta))) \quad (5)$$

where Δ is the gain mismatch and θ is the phase mismatch. The rejection depends strongly on the phase error in the original signal. Shown in Fig. 7 is the harmonic rejection plotted as a function of phase error for different gain errors. Fig. 7(a) shows the rejection of the third harmonic while Fig. 7(b) shows the rejection of the fifth harmonic. Note that as the phase and gain error increase the rejection of the third harmonic approaches 9.5 dBc while the rejection of the fifth harmonic approaches 14 dBc, which are the levels of an ideal square wave. For one-

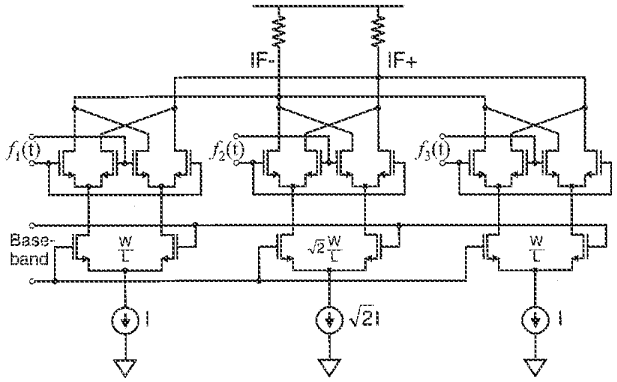


Fig. 8. Harmonic-rejection mixer circuit diagram.

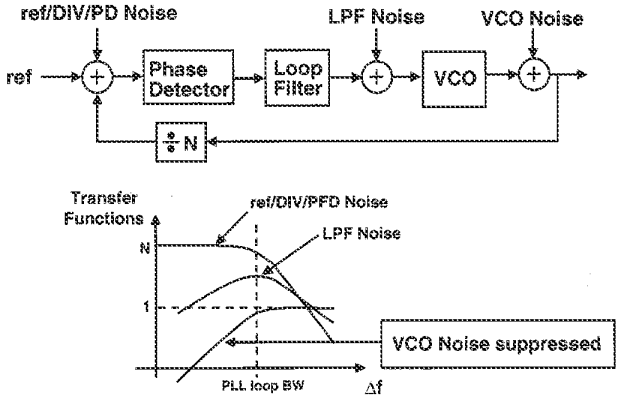


Fig. 9. VCO phase-noise suppression in wide-loop-bandwidth PLL.

degree phase error and 1% matching, approximately 35 dB of rejection is achieved for both the third and fifth harmonics.

To implement the HRM, each square wave, $f_1(t)$, $f_2(t)$, and $f_3(t)$, is mixed with the baseband signal and then the three outputs are summed. The advantage of this approach is that a low-noise switching mixer can now be used. However, a potential disadvantage is that scaling the LO voltage, by $\sqrt{2}$ in this case, will not proportionally scale the output voltage swing. The simplified circuit schematic for the HRM is shown in Fig. 8. The HRM consists of three current-commutating submixers. The transconductance stage of each submixer is driven with the identical baseband signal. However, the switches are driven by the three phase-shifted square waves. The current output of the three submixers is summed to generate the final output signal. Consequently, the baseband signal is effectively multiplied by a 3-bit amplitude-quantized sinusoid. To scale $f_2(t)$ by $\sqrt{2}$, the current switched in the middle submixer was increased by $\sqrt{2}$ by scaling the tail current source. Furthermore, to maintain an equivalent linearity performance in the three submixer transconductance stages, the input transistors were also scaled in the middle submixer to give a V_{dsat} that is equal in the three submixers.

B. Frequency Synthesizers

This transmitter architecture offers advantages with respect to full integration of the frequency synthesizer with on-chip low-Q VCOs. As previously mentioned, channel tuning is now performed with the low frequency synthesizer while the RF synthesizer is fixed in frequency. This achieves lower phase noise than the standard configuration because it allows for the use of a wide loop bandwidth for the RF synthesizer.

Performing channel-tuning with the lower frequency IF synthesizer allows the RF synthesizer to have an extended loop bandwidth, which has the effect of suppressing the close-to-carrier phase noise produced by the VCO. This may be better understood by evaluating the phase-noise transfer functions of the various components within a PLL to the output of the synthesizer, as illustrated in Fig. 9. Here, the phase-noise transfer function from the VCO to the PLL output has a high-pass characteristic relative to the carrier. Because the channel tuning is performed using the lower frequency IF synthesizer, the comparison frequency of the RF synthesizer can be significantly raised,

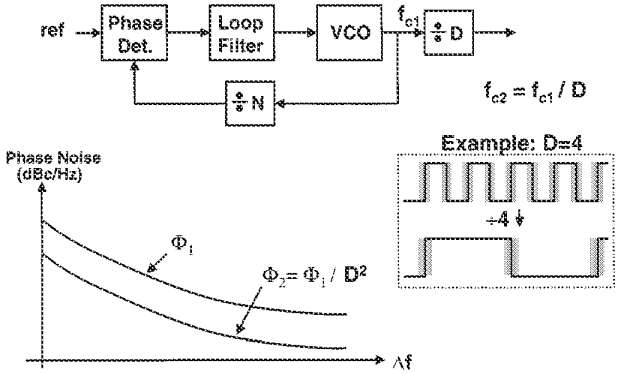


Fig. 10. Phase noise of low-frequency synthesizer.

by as much as a few orders of magnitude. Typically, for reasons related to the stability of a second-order PLL, the loop bandwidth must be anywhere from a fourth to a tenth of the comparison frequency. Therefore, the higher comparison frequency allows an increased loop bandwidth for the RF synthesizer, significantly extending the close-to-carrier bandwidth where VCO phase-noise suppression will occur. The overall RF synthesizer close-to-carrier phase-noise performance can then be designed such that the phase-noise performance is no longer dominated by a noisy integrated VCO using low-Q components in the tank circuit.

Although the lower frequency synthesizer must now perform channel tuning, lower phase noise, relative to the carrier power, can inherently be achieved due to the lower operating frequency. In this transmitter system, narrow channel tuning must be performed. Consequently, the maximum reference frequency and PLL loop bandwidth are limited, ultimately reducing the band of close-to-carrier VCO phase-noise suppression. The concept of inherently lower phase noise at lower frequencies may be understood with a time-domain interpretation, which is illustrated in Fig. 10. Assume for the moment that the PLL used to synthesize the channel spacing required by a narrow-band system produces an output at RF, instead of IF (again, the loop bandwidth would be small). If the output of this synthesizer is divided down to the IF frequency, there is an inherent lowering in both the rms jitter and phase noise as compared to the carrier.

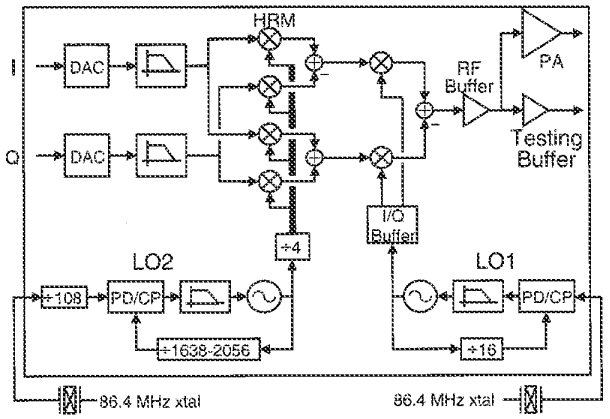


Fig. 11. CMOS prototype HRT block diagram.

This is illustrated in Fig. 10 for $D = 4$, where the time-domain waveform at the output of the synthesizer is shown at the bottom. Before the divider, each edge of the waveform contains jitter, resulting from noise generated inside the PLL. If it is assumed that an idealized noiseless divider is used to lower the frequency by a divider ratio D, then the divider will only capture the timing jitter from one of D edges, yet the period of the fundamental waveform increases by a factor of D. Stated differently, the rms timing jitter on the lower frequency LO, at the divider D output, will have the same timing jitter on each edge, however, the period of the waveform is increased by a factor of D. Thus, the jitter relative to the fundamental period has decreased by a factor D. For close-to-carrier phase noise, the timing error created from edge to edge is correlated at the output of the divider. Because of this correlation in timing error from edge to edge, the effect of a noiseless divider is to reduce the close-to-carrier phase noise by the square of the division ratio, in this case D. In the actual implementation of the IF synthesizer used in the transmitter prototype, the channel-tuning synthesizer produces an output in the range of 1.3104 to 1.4704 GHz, in 800-kHz steps. The IF synthesizer output is then divided down by a factor of 4; thus, the close-to-carrier phase noise produced at the output of the synthesizer is reduced by a factor of 16.

The RF synthesizer used by this prototype transmitter has been previously described in [10] and realizes a 1.3824-GHz oscillator with a loop bandwidth of 8 MHz. The IF synthesizer produces frequencies from 327.6 to 367.6 MHz in 200-kHz steps and has a 40-kHz loop bandwidth.

IV. CMOS Prototype

A CMOS prototype HRT was fabricated in a 0.35-μm double-poly five-layer metal process. A block diagram of the HRT is shown in Fig. 11. The HRT integrated the entire transmit signal path from the DACs to the PA, including two frequency synthesizers. Ten-bit digital I and Q baseband signals are brought on chip and passed through two 10-bit resistor string DACs and then filtered by two Sallen & Key third-order low-pass filters. The signals are then upconverted to a variable IF using four HRMs. Four mixers are used to provide image rejection for the baseband signal and to generate both I and Q IF signals. The IF signals are then upconverted to RF using

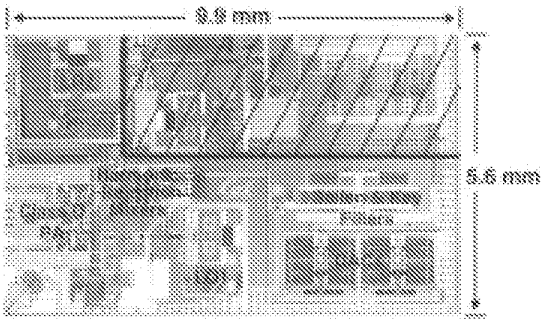


Fig. 12. Die photo.

two inductively loaded current-commutating mixers. The RF signal is then buffered before being driven off-chip with either a testing buffer or an integrated class-C PA. The testing buffer is capable of driving 0 dBm into 50 Ω, while the PA is capable of delivering 25 dBm. A die micrograph is shown in Fig. 12.

With the high level of integration implemented in this work, coupling between circuits and circuit blocks can severely degrade performance. The chip was fabricated in an epitaxial process; the epitaxial layer had a resistivity of 10 Ω-cm, while the substrate had a resistivity of 0.01 Ω-cm. With such a low substrate resistivity, it is quite possible that large signals injected into the substrate from the digital circuits or from the power amplifier (PA) can couple back into the sensitive analog sections. To reduce the effects of substrate coupling, three general techniques were used throughout the chip. First, a fully differential signal path was used from the output of the DACs through the output of both the PA and the testing buffer. Ideally, a differential circuit will see coupling from the substrate, due to other circuit blocks, as common-mode noise, and will reject those signals. Both frequency synthesizers were also implemented in a fully differential fashion, including the VCO control voltages. Differential control voltages were used to maximize the immunity of the frequency synthesizers to coupling through the substrate, from other blocks as well as each other. Second, independent supplies, which were heavily bypassed both on and off chip, were used for each of the circuit blocks. This was done so that the local supply and ground would move together; any voltage fluctuations on either the ground or supply nodes would ideally not impact the signals as they moved through the signal path. Third, multiple substrate contacts were placed around the transistors so that the body would move in unison with the local supply and ground. Therefore, any substrate coupling would also be coupled into the supply and ground local to a given circuit block, and would therefore minimize the effect of that coupling on the differential signal path.

To better understand the circuit implementation, a more detailed description of some of the key circuit blocks will follow. The blocks to be discussed include the DAC, the Sallen & Key filter, the RF quadrature generator, and the PA.

A. DAC

Fig. 13 shows the basic structure of the resistor string DAC used in the transmitter. The digital-to-analog conversion is made

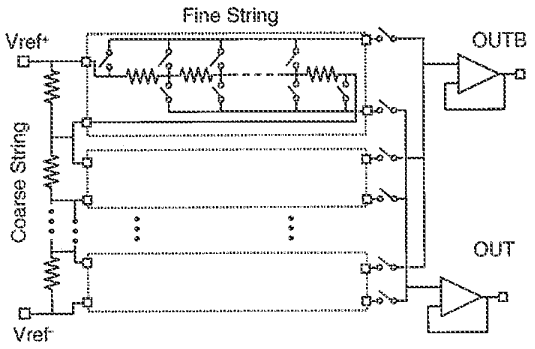


Fig. 13. Dual resistor string DAC schematic.

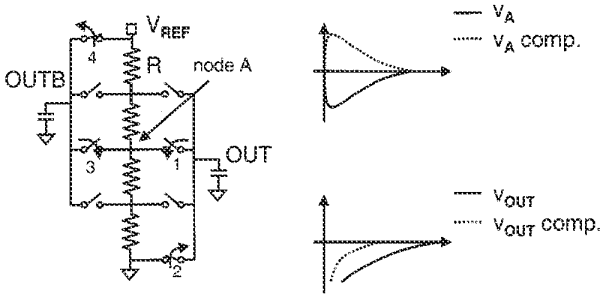


Fig. 14. Glitch reduction circuit technique for DAC.

in two steps using two 5-bit resistor strings that select the appropriate output analog level. In the design of a resistor-string DAC, there is usually a tradeoff between the maximum speed of the DAC and its power consumption. As the total value of the resistance in the resistor string increases, the overall power consumption is reduced, but the time needed for the output voltage to settle is also increased. A critical factor in the settling time is the issue of capacitive coupling between the output and the intermediate nodes in the resistor string. The intermediate nodes in the resistor string should stay at a fixed voltage at all times, but as switches close and open and different intermediate nodes are tied to the output, there is an instantaneous change on the intermediate nodes (for example, node A in Fig. 14) that causes an increase in the settling time of the output. This problem can be reduced through the use of a set of replica switches and a dummy capacitor, as shown in Fig. 14. Switches 3 and 4 switch in opposition to switches 1 and 2, respectively, and thereby induce an equal and opposite effect on the intermediate node voltage A. The uncompensated voltage at node A is summed with the glitch reduction due to the switches 3 and 4, resulting in a reduced fluctuation voltage at node A, as shown in Fig. 14. This allows the voltage at the output to settle more quickly to its desired value; furthermore, in simulation, the power consumption can be reduced as much as 30% for a given settling time. Moreover, the use of complementary switches performs the operation of single-ended to differential conversion. In the actual implementation, the function of the dummy capacitor was performed with the complementary output buffer.

B. Sallen & Key Filter

After the DACs, the I and Q baseband signals are filtered before upconversion. The filtering is performed with a third-order Sallen & Key low-pass filter. The filter uses a buffer in the feedback path to improve the rejection. Shown on the left side of Fig. 15 is a conventional Sallen & Key filter. The feedback capacitor C_1 introduces a zero in the transfer function which decreases the attenuation at higher frequencies. However, the wide-band noise is critical in transmitters, because it may corrupt the highly sensitive receivers nearby. One method of improving the attenuation, at the cost of increased power, is to increase the bandwidth of the forward buffer used in the filter. Alternatively, the effect of the zero may be reduced by adding a buffer in the feedback path as shown in the right side of the Fig. 15. The buffer blocks the zero introduced by the capacitor allowing for a lower bandwidth in the forward buffer. The plot shows the expected attenuation for the two configurations with equal power consumption. At higher frequencies, approximately a 30-dB improvement in the high-frequency attenuation is predicted by simulation with the feedback amplifier, as compared to a conventional Sallen & Key filter consuming equal power.

C. RF Quadrature Generator

The amount of sideband suppression obtained by an image-rejection mixer is highly dependent on the phase accuracy of the I and Q LO signals. For this transmitter system, the quadrature accuracy of the I and Q LO signals further relax the RF filtering requirement of the IF image. Additional and specific requirements of the quadrature generation circuitry used by this transmitter are that both the loading at the output of the synthesizer (or VCO) and the degradation in the VCO tank Q be minimized. Traditional methods of generating quadrature from a single phase include frequency dividers and passive filters realized with resistors and capacitors. The first LO (RF synthesizer) directly generates the frequency required for upconversion by the corresponding mixers, eliminating the possibility of using a frequency divider to generate quadrature LOs. Two common passive filter approaches include using an RC-CR filter or an asymmetric polyphase filter [11]. These passive methods for generating quadrature suffer from a variety of drawbacks, which can include both phase and amplitude frequency dependence, phase error from either component mismatch or process variations, and loss in LO carrier power.

Despite the well-known problems, polyphase filters are still an effective method for generating highly accurate quadrature signals from a single phase. However, there are several mechanisms of loss in this filter that typically require power-consuming buffers at the input and output of the filter. Polyphase filters generate quadrature from a single phase by passing the signal through multiple stages of an RC network when the signal frequency is near the 3-dB frequency of the RC network. Other contributing factors to loss in a polyphase filter include the parasitics associated with bottom plate capacitance used to create the capacitors. If the output is directly coupled to the mixer input, then an ac-coupling capacitor might be needed, which introduces additional parasitics and loss in LO carrier power.

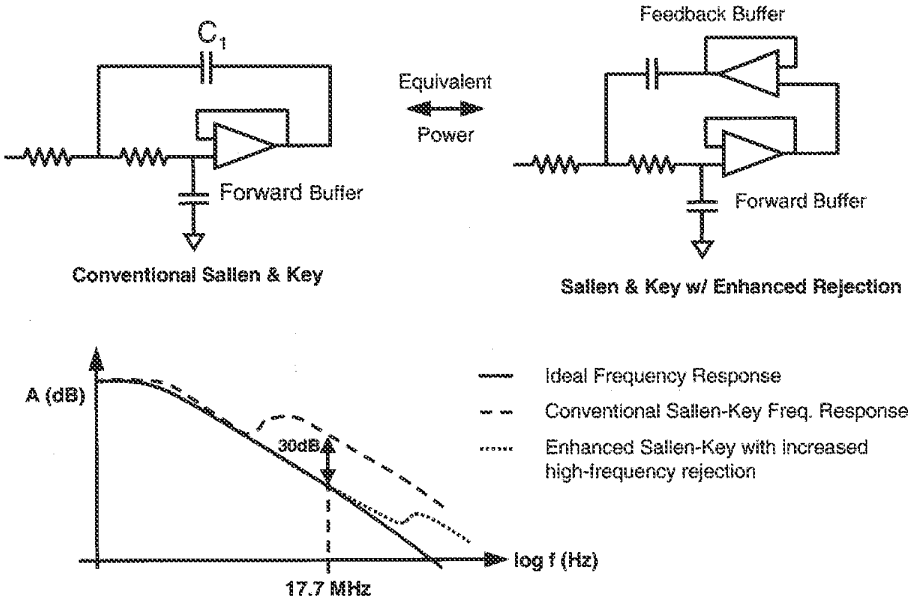


Fig. 15. Improved rejection from Sallen & Key filter.

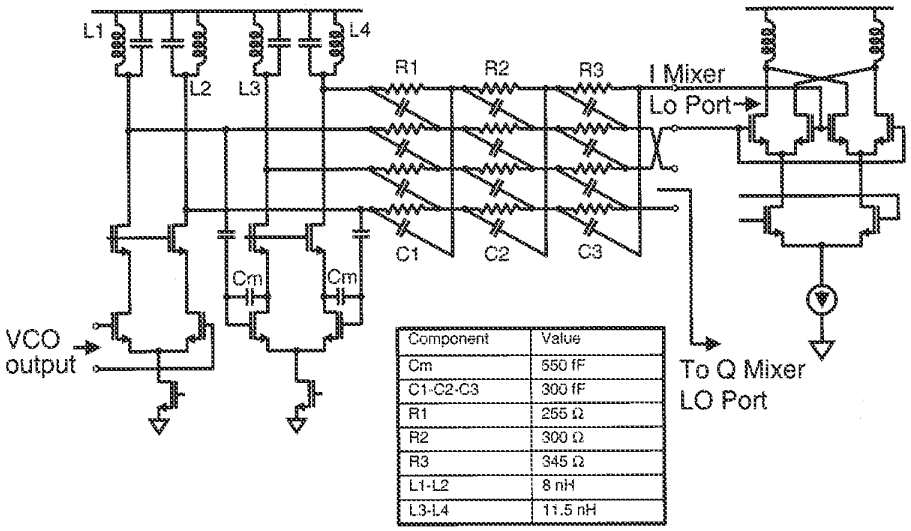


Fig. 16. High-frequency (LO1) VCO buffer quadrature generator circuit schematic.

The circuit shown in Fig. 16 reduces one mechanism of loss in the polyphase filter by using a buffer which drives the input of the filter with signals roughly in quadrature and thus eliminates the inherent 3-dB loss associated with converting a single phase to quadrature phases. Two common source buffers before the polyphase generate signals which are roughly 90° out of phase at the inductively loaded nodes when the operating frequency is near the g_m/C_m of the second buffer [12]. In addition, the input impedance looking into the buffer is capacitive with the exception of the gate resistance r_g, therefore minimizing the reduction in the VCO tank Q and loading. The Q of the LC tank at the buffer output, shown as L1-L4 in Fig. 16, is approximately 1.5 when loaded with the polyphase filter. The mixer LO input was designed to have a common mode at V_{dd} and thus the need for an ac-coupling capacitor has been eliminated as well as its associated loss.

D. Power Amplifier

Previous sections detailed the transmitter architecture, including the benefits of the harmonic rejection architecture with respect to the filtering required before the PA. These benefits allow for the use of an integrated highly nonlinear PA when a constant-envelope modulation scheme is used. Recent efforts that have investigated nonlinear PAs have focused primarily on switch-mode nonlinear PAs, such as class-D and class-E PAs [13], [14]. One drawback to switch-mode PAs, especially with respect to their potential for integration, is the need for a dc–dc converter in order to perform power control, which is

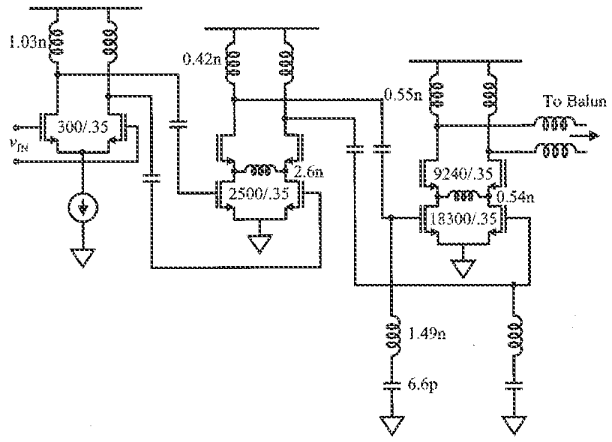


Fig. 17. Class-C power amplifier circuit schematic.

required in most cellular communications systems. In general, the only way to vary the output power level of a switch-mode PA is to vary the power supply; thus the need for the dc–dc converter, which can be difficult to integrate. Therefore, a different solution was explored.

In this work, a class-C architecture was used for the PA. The class-C architecture is an extension of the class-A and class-B architectures. In the class-C architecture, the angle of conduction (the portion of the cycle when the device is on) is less than 180°; the device is biased such that it is off for more than one-half the cycle by setting the dc bias below the threshold voltage of the device. Consequently, the input signal turns the device on for only a fraction of the period. This reduction in the period when the device conducts current serves to reduce the power consumed in the device and thus potentially raises the efficiency of the PA.

In the design of submicron CMOS PAs, a key limitation is the oxide breakdown voltage, which limits the available voltage swing at the drain of the transistor. As a result, the load impedance seen by the device needs to be extremely low in order to deliver the required amount of power without damaging the device. Furthermore, the current level must rise in proportion with the reduced voltage swing. Since CMOS generally has a poor transconductance when compared with silicon bipolar or Gallium Arsenide technologies, the device sizes required can be quite large in order to generate the required output power.

Fig. 17 shows the circuit diagram of the three-stage fully differential class-C PA used in this work. The stages are ac-coupled in order to allow the input device of each stage to be biased independent of the output of the previous stage. Since the PA was to be used in an integrated environment, the previous stages would likely not be able drive a heavy load; therefore, three stages were used in order that the first stage would not load down the output of the mixer. The first stage was biased in a class-A fashion, with a variable tail current source that controls the gain and thus the output power level. The final two stages are biased in a class-C fashion and use a cascode structure with the top devices biased at the supply in order to reduce the stress on the oxide due to voltage excursions at the outputs of those stages. At the input to the final stage, a different tuning technique was used to peak the gain at the desired frequency. Due to the high current drive required and the poor transconductance of CMOS, the output transistor size was extremely large (18 300 μm/0.35 μm); using a single spiral inductor to tune out all the capacitance between the second and third stages required an extremely small value inductor (on the order of 0.1 nH). That inductor was quite difficult to implement without parasitic trace inductance affecting the tuning at that node. Instead, a series LC was used in parallel with the gate capacitance of the final stage in order to provide a peaking of the impedance at that node. Furthermore, inductors were used across the differential cascode node in the second and third stages, in order to reduce the current required to charge and discharge the capacitors at those nodes and boost the efficiency. The inductors used at the output of the first and second stages as well as those at the cascode nodes were implemented as spiral inductors on chip; the other inductors used in this circuit were implemented as bond wires, in order to take advantage of their higher Q. The inputs of the second and third stages were biased at 0.35 V with a bias voltage generated on chip.

V. Results

Although the HRT was designed to facilitate multistandard operation, the performance of the transmitter was tested with the DCS 1800 specifications. This up-banded version of GSM was chosen for a number of reasons. First, it requires very high modulation accuracy from the transmitter. Second, DCS 1800 requires very low unwanted spurious transmission especially in the receive band. Finally, DCS 1800 uses a constant envelope modulation scheme making it well suited for use with a highly nonlinear class-C power amplifier.

A. Measured Results With Testing Buffer

The results in this section were measured using a testing buffer after the mixers, in parallel with the PA, as opposed to the PA itself. The next section will compare some of this data when the measurements were taken at the output of the PA instead of the testing buffer.

A critical test for all transmitters is the single-sideband test in which a single baseband tone is upconverted to RF. Although I/Q modulator-based transmitters are ideal for multistandard operation, gain mismatch and phase error in the modulator generally limit the modulation accuracy. Shown in Fig. 18 is the output of the transmitter when a 50-kHz baseband tone is upconverted to RF. The unwanted image suppression was measured at −56 dBc, implying that the gain and phase were matched very well throughout the transmitter. This was accomplished with careful layout techniques and the measurement transmitter has no external tuning. The carrier suppression was measured at −38 dBc while the third-order distortion was measured at −46 dBc. The third-order distortion was dominated by the baseband inputs of the HRMs.

Another key transmitter performance test is measuring the output when a modulated baseband signal is used as opposed to a single tone. Typically, different RF standards provide a spectral mask under which the transmitted signal must fall. Meeting

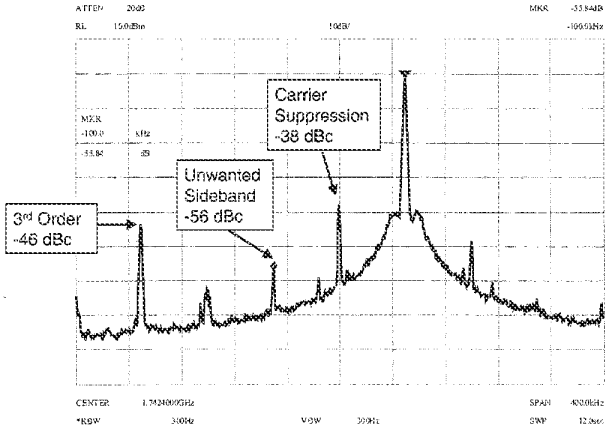


Fig. 18. Transmitter output with single-sideband test.

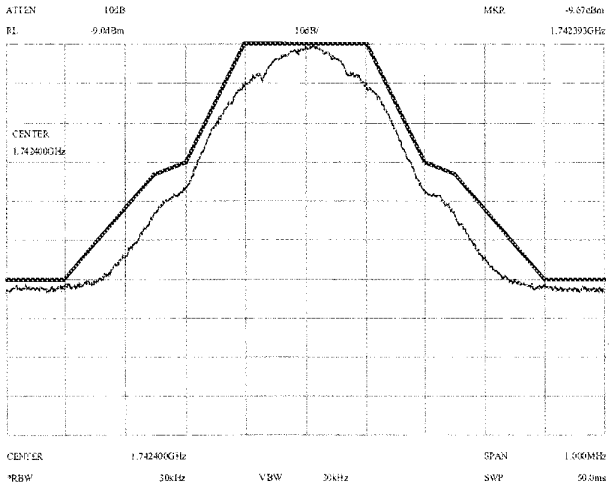


Fig. 19. Transmitter output with modulated baseband signal.

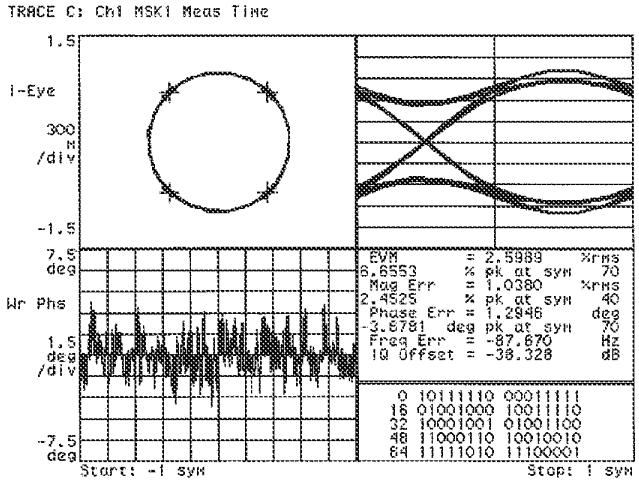


Fig. 20. Modulation accuracy of transmitter.

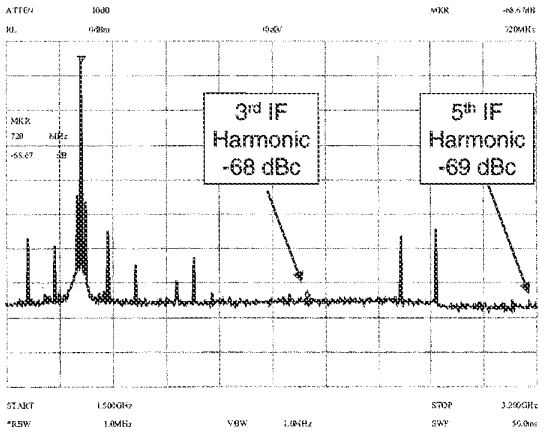


Fig. 21. Wide-band spectrum at transmitter output.

this specification requires low phase noise from the frequency synthesizer and high linearity in the baseband circuits. To test the HRT a DCS 1800 GMSK modulated baseband signal was used. Shown in Fig. 19 is the measured output spectrum along with the DCS-1800 spectral mask requirement. The measured results are limited by the phase noise of the frequency synthesizers.

Although the spectral mask limits the transmitted noise and unwanted spectral emissions, it does not measure the modulation accuracy. This test is typically performed using a modulated baseband signal and comparing the transmitted signal with the ideal signal. The DCS-1800 standard requires that the rms phase error is less than 5° with a peak phase error no larger than 20°. The measured results for the HRT are shown in Fig. 20 and the rms phase error is 1.3° while the peak phase error is 3.7°. This error was probably caused by the nonidealities in the I/Q modulator along with the phase noise of the synthesizers.

In addition to the close-in spectral mask requirements, DCS 1800 limits the unwanted transmissions that could potentially fall in the receive band. Consequently, the limit for the transmitted noise measured at 20-MHz offset from the carrier is -151 dBc/Hz. This transmitter was measured at -126 dBc/Hz. This noise was primarily caused by the phase noise of the frequency synthesizers. To meet the DCS 1800 specification, an RF filter is needed with 25 dB of attenuation at a 20-MHz offset. Such attenuation is achievable with a single RF filter allowing for a highly integrated transmitter requiring only one filter afterwards.

Finally, as a test of the HRM, a wide-band output spectrum was measured. The results are shown in Fig. 21. The suppression of the third IF harmonic was measured to be -68 dBc while the fifth IF harmonic suppression was measured to be -69 dBc. Although the third IF harmonic was further suppressed by the IF–RF image-reject mixer, the fifth IF harmonic was only suppressed by the HRM. The third IF harmonic on the low side of the carrier frequency was only suppressed by the HRM, and it was below the noise floor of the spectrum analyzer.

B. Measured Results With PA

The transmitter was also tested with the class-C PA. Shown in Fig. 22 are the results of a single-sideband test using the same 50-kHz signal. The test setup introduced approximately 2 dB of

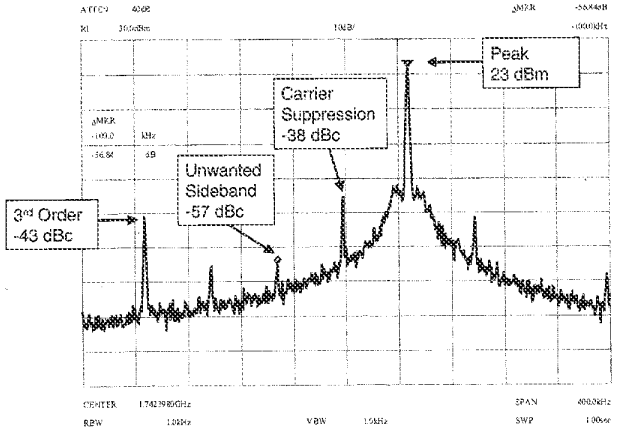


Fig. 22. Single-sideband test with PA output.

TABLE I
SUMMARY OF MEASURED RESULTS

VDD = 3 Volts Temp.= 25°C

	Testing Buffer	PA
Single Sideband Suppression	-56 dBc	-57 dBc
LO2 3rd Harmonic Spur	-68 dBc	-68 dBc
LO2 5th Harmonic Spur	-69 dBc	-69 dBc
IF Image Suppression	-60 dBc	-60 dBc
RF Carrier Suppression	-38 dBc	-38 dBc
RMS Phase Error	1.3°	N/A
Peak Phase Error	3.7°	N/A
20 MHz Carrier Offset Noise	-126 dBc/Hz	-121 dBc/Hz
3rd Order Distortion	-46 dBc	-43 dBc
Output Power	0 dBm	25 dBm
Active Chip Area	20 mm²	24 mm²
Technology	0.35 µm DP-5M CMOS	0.35 µm DP-5M CMOS

loss between the output of the PA and the measurement equipment. The differential to single-ended conversion was accomplished using a microstrip balun similar to the balun described in [14]. Comparing Fig. 22 with Fig. 18 shows very little difference. The integrated PA had little effect on the transmitter output when a single-sideband test was performed. Furthermore, although not shown here, the wide-band spectrum also showed little change compared to the wide-band output measured at the testing buffer. Although the integrated PA had little effect on the modulation performance, the noise at 20-MHz offset was affected by the PA. As previously mentioned, the noise measured with the testing buffer was −126 dBc/Hz while the noise measured with the PA was −121 dBc/Hz. Substrate coupling is the likely cause of the increased noise.

The integrated class-C PA was designed for 1.5-W peak power and was tested as standalone component. The peak measured power of the standalone PA was measured at 1.2 W. This power was not achieved in the integrated version because of the lower than expected gain in the transmitter. This was due to lower than expected Qs for the on-chip spiral inductors which are critical for gain.

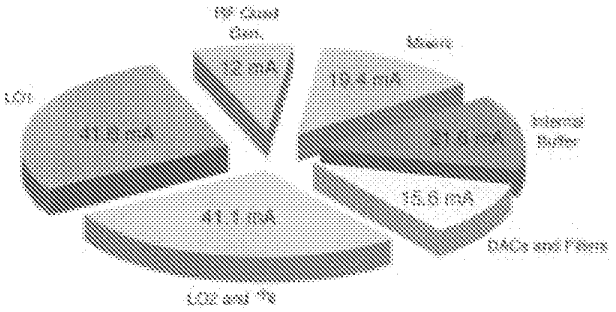


Fig. 23. Transmitter current consumption.

C. Results Summary

A summary of the measured results is shown in Table I. The table shows the results when measured with the testing buffer and the PA. Shown in Fig. 23 is the power consumption of the transmitter excluding the testing buffer and the PA. The lower than expected Qs negatively impacted the power consumption. The current for certain circuit blocks was increased to achieve the desired output power. Because the gain was lower than expected in the transmit path, the power output and the efficiency of the PA were significantly lower than expected.

VI. CONCLUSION

A fully integrated CMOS transmitter has been demonstrated. The entire transmit signal path including the PA and the frequency synthesizers were integrated in a 0.35-μm double-poly five-layer metal CMOS process. The transmitter demonstrated cellular performance requiring only a single RF filter after the PA. The need for pre-PA filtering was removed through the use of a harmonic-rejection transmitter and a wide-loop-bandwidth RF synthesizer. The performance met many of the key requirements of DCS 1800, an up-banded version of GSM. Furthermore, due to careful planning, the effect of on-chip coupling was minimized. This was evident by the fact that the chip incorporated two frequency synthesizers, two DACs, and a 25-dBm PA. Furthermore, the PA had a minimal effect on the performance when the PA output was compared to the output from a post-mixer testing buffer.

ACKNOWLEDGMENT

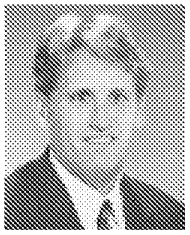
The authors would like to thank STMicroelectronics for their support and for chip fabrication services. Further, the authors are grateful to Agilent Technologies, Atmel, Conexant Systems, National Semiconductor, Nokia Mobile Phones, Nortel Networks, and Philips Research for their valued contributions.

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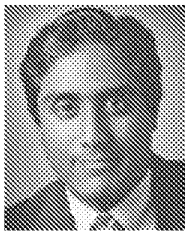
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Jeffrey A. Weldon received the B.S. degree from the University of California, Berkeley, in engineering physics in 1992. He is currently working toward the Ph.D. degree at the University of California, Berkeley, in the Electrical Engineering and Computer Science Department, where he is studying analog circuit design for RF applications.

His research focuses on wireless transmitter architectures well suited for high levels of integration in CMOS. In addition, he is investigating CMOS mixers for wireless applications.

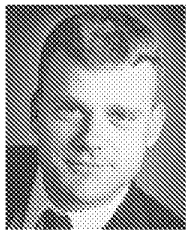
Mr. Weldon was a co-recipient of the 1998 ISSCC Jack Kilby Best Student Paper Award.



R. Sekhar Narayanaswami was born in Lubbock, TX, on November 5, 1971. He received the B.S. and M.S. degrees in electrical engineering and computer sciences in 1993 and 1998, respectively, both from the University of California, Berkeley. He is currently working toward the Ph.D. degree in the area of RF analog circuit design in CMOS technologies.

His research focuses on the implementation and integration of RF power amplifiers for mobile devices in CMOS technologies.

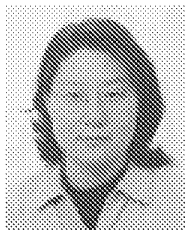
Mr. Narayanaswami is a member of Tau Beta Pi and Eta Kappa Nu.



Jacques C. Rudell (S'96–M'00) received the B.S. degree in electrical engineering from the University of Michigan, Ann Arbor. In his junior year, he was dedicated a James B. Angell Scholar. After graduation, he spent two years as an IC Designer and Project Manager at Delco Electronics, Kokomo, IN. While at Delco, his work focused mainly on bipolar analog circuits for automotive applications. In 1991, he returned to graduate school at the University of California, Berkeley. He received the M.S.E.E. degree in 1993, focusing on high-speed low-power digital adaptive equalization techniques for magnetic disk-drive channels employing class-IV partial response. Also at the University of California, Berkeley, he received the Ph.D. degree in 2000, focusing on wireless receiver architectures and systems suitable for high levels of integration in CMOS as well as multistandard/modal operation.

He worked as a Post-Doctoral Researcher at the University of California, Berkeley, in the spring of 2000. Currently, he is an Independent Consultant in Silicon Valley.

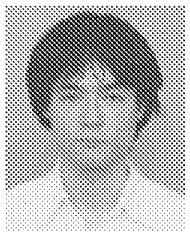
Dr. Rudell is a member of Tau Beta Pi and Eta Kappa Nu. He received the 1998 ISSCC Jack Kilby Best Student Paper Award. In 1999, he received the UC Berkeley EECS Demetri Angelakos Memorial Achievement Award.



Li Lin received the B.S. degree in electrical engineering from Portland State University, Portland, OR, in 1994, and the M.S. and Ph.D. degrees in electrical engineering from the University of California, Berkeley, in 1996 and 2000, respectively.

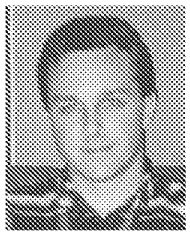
Since 2000, she has been with Broadcom Corporation, San Jose, CA, where she is a Staff Scientist working on RF integrated circuit design for wireless communication.

Dr. Lin is a member of Eta Kappa Nu and Tau Beta Pi.



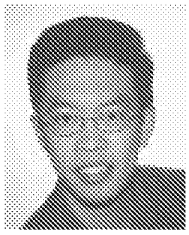
Masanori Otsuka was born in Saitama, Japan, in 1965. He received the B.S. and M.S. degrees in electrical engineering from the Science University of Tokyo, Tokyo, Japan, in 1989 and 1991, respectively.

In 1991, he joined Central Research Laboratory, Hitachi Ltd., Tokyo, and moved to Semiconductor and Integrated Circuits Division in 1995, where he has been engaged in developing CMOS D/A and A/D converters. From 1997 to 1998, he was a Visiting Industrial Fellow in Dr. P. Gray's research group at the University of California, Berkeley. During his stay, he investigated D/A converters for wireless systems.



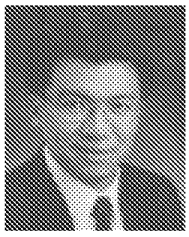
Sebastien Dedieu received the DESS of Microelectronic and the DEA of Electronic degrees from the University of Bordeaux, France, in 1993.

From 1993 until 1998, he was with STMicroelectronics Central R&D, France, as an Analog Design Engineer in the field of phase-locked loops and clock recovery for ATM (SDH/SONET) and GSM/DCS1800 applications. From 1998 to 1999, he was a Visiting Industrial Fellow in Dr. P. Gray's research group at the University of California, Berkeley. During his stay, he implemented a variable gain amplifier and active filters for a fully integrated RF transceiver. Since 1999, he worked at STMicroelectronics, Crolles, France, on phase quadrature locked loop for digital and cable TV receivers. He is currently developing synthesizers for HiperLAN/2 and 802.11applications. His research interests include mixed RF and analog VLSI circuit design in wireless and cable communications.



Lums Tee (S'93) received the B.A.Sc. degree in engineering science from the University of Toronto, Toronto, ON, Canada, in 1995. He is currently working toward the Ph.D. degree in electrical engineering at the University of California, Berkeley.

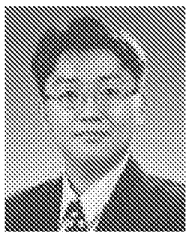
He is currently investigating transmitter linearization techniques for portable wireless applications.



King-Chun Tsai (S'95) received the B.S. degree in electrical engineering from Boston University, Boston, MA, in 1994. He is currently working toward the Ph.D. degree in electrical engineering at the University of California, Berkeley.

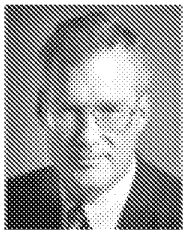
He has been a Teaching Assistant in a number of circuit design classes at the University of California, Berkeley. In the summer of 1998, he was with the Silicon Circuits Research Department at Bell Laboratories, Lucent Technologies, where he conducted research in microwave balun design. He joined Marvell Semiconductor Inc. in 2001, where he continued his work in designing RF ICs for wireless applications.

Mr. Tsai was recognized as an Outstanding Graduate Student Instructor at the University of California, Berkeley, in 1996.



Cheol-Woong Lee received the B.S. degree in electrical engineering from the Seoul National University, Seoul, Korea, in 1997. He is currently working toward the Ph.D. degree in electrical engineering at the University of California, Berkeley, where his interest is in RF and analog integrated circuits.

In 1996 and 1997, he investigated and developed a hardware system for 600-dpi color scanner with Thymedia Company Ltd., Seoul, Korea. In 1999, he designed a board to test the multistandard RF monolithic chip at RF research group in the department of electrical engineering at the University of California, Berkeley.



Paul R. Gray (M'69–SM'76–F'80) was born in Jonesboro, AR, on December 8, 1942. He received the B.S., M.S., and Ph.D. degrees from the University of Arizona, Tucson, in 1963, 1965, and 1969, respectively.

In 1969, he joined the Research and Development Laboratory, Fairchild Semiconductor, Palo Alto, CA, where he was involved in the application of new technologies for analog integrated circuits, including power integrated circuits and data conversion circuits. In 1971, he joined the faculty of the Department of Electrical Engineering and Computer Sciences, University of California, Berkeley. His research interests during this period have included bipolar and MOS circuit design, electrothermal interactions in integrated circuits, device modeling, telecommunications circuits, and analog–digital interfaces in VLSI systems. He is the co-author of a widely used college textbook on analog integrated circuits. During year-long industrial leaves of absence from the University of California, Berkeley, he served as Project Manager for Telecommunications Filters at Intel Corporation, Santa Clara, CA, during 1977–78, and as Director of CMOS Design Engineering at Microlinear Corporation, San Jose, CA, during 1984–1985. At the University of California, Berkeley, he has held several administrative posts, including Director of the Electronics Research Laboratory (1985–1986), Vice-Chairman of the EECS Department for Computer Resources (1988–1990), Chairman of the Department of Electrical Engineering and Computer Sciences (1990–1993), and Dean of the College of Engineering (1996–June 2000). He is currently the Executive Vice Chancellor and Provost and Roy W. Carlson Professor of Engineering.

Dr. Gray has been co-recipient of best paper awards at the IEEE International Solid-State Circuits Conference and the European Solid-State Circuits Conference, and was co-recipient of the IEEE R. W. G. Baker Prize in 1980, the IEEE Morris K. Liebman Award in 1983, and the IEEE Circuits and Systems Society Achievement Award in 1987. In 1994, he received the IEEE Solid-State Circuits Award. He served as editor of the IEEE JOURNAL OF SOLID-STATE CIRCUITS from 1977 through 1979, and as Program Chairman of the 1982 International Solid-State Circuits Conference. He served as President of the IEEE Solid-State Circuits Council from 1988 to 1990. He is a member of the National Academy of Engineering.

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: ARDESHIR TABIBI
TOWNSEND AND TOWNSEND AND CREW LLP
TWO EMBARCADERO CENTER
8TH FLOOR
SAN FRANCISCO, CA 94111-3834

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	17 JUN 2010
Applicant's or agent's file reference 22287-28-1PC	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US 10/31631	19 April 2010 (19.04.2010)	17 April 2009 (17.04.2009)

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - G06F 17/00 (2010.01)
USPC - 700/94

Applicant MAXLINEAR, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	31 May 2010 (31.05.2010)	Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No. PCT/US 10/31631

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing filed or furnished:

   a. (means)

   ☐ on paper

   ☐ in electronic form

   b. (time)

   ☐ in the international application as filed

   ☐ together with the international application in electronic form

   ☐ subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Form PCT/ISA/237 (Box No. I) (July 2009)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 10/31631

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	6, 15, 26	YES
	Claims	1-5, 7-14, 16-25, 27-43	NO
Inventive step (IS)	Claims	None.	YES
	Claims	1-43	NO
Industrial applicability (IA)	Claims	1-43	YES
	Claims	None.	NO

2. Citations and explanations:

Claims 1-5, 7-14, 16-25 and 27-43 lack novelty under PCT Article 33(2) as being anticipated by US 2003/0228855 A1 to Hertz et al. (hereinafter 'Hertz').

As per claim 1, Hertz teaches a wideband multimedia recorder for recording a plurality of radio channels (Abstract, para. [0012]) comprising: a wideband receiver (antenna, 100) configured to concurrently receive the plurality of radio channels (Fig. 2, para. [0013]); an analog-to-digital converter (ADC, 237) configured to digitize the plurality of radio channels (Fig. 2, [0066]); a digital front end module configured to frequency down-convert the digitalized plurality of radio channels to a number of radio channels in a baseband (para.[0045], [0069]); a demodulator module configured to demodulate the number of radio channels to a corresponding number of data streams (para. [0048], [0067]); a digital signal processing circuitry configured to process the demodulated number of data streams (para. [0049]); a storage unit (removable storage, 255) configured to store the processed number of data streams (Fig. 2, para.[0055], [0119]); and a control circuitry having a user interface for receiving control commands (para. [0053], [0108]).

As per claim 2, Hertz further teaches a first mixer and a second mixer, the first mixer is configured to generate an in-phase signal from the digitalized plurality of channels and a second mixer is configured to generate a quadrature signal from the digitized plurality of channels (para. [0087], [0093]).

As per claim 3, Hertz further teaches a pre-select filter that precedes the analog-to-digital converter and is configured to pass through the plurality of channels to the analog-to-digital converter (para. [0062], [0078]).

As per claim 4, Hertz further teaches wherein the radio front end module comprises: a wideband low noise amplifier configured to concurrently receive the plurality of radio channels (para. [0062], [0078]); a frequency synthesizer configured to generate an oscillator frequency (para. [0067]); a mixer module coupled to the low noise amplifier and the frequency synthesizer and configured to generate the in-phase and quadrature signals (para. [0093]); and a low-pass filter configured to eliminate unwanted frequency components in the in-phase and quadrature signals (para. [0062]).

As per claim 5, Hertz further teaches wherein the digital front end comprises a number of mixers, each one of the mixers is coupled to the digital in-phase and quadrature signals and configured to generate an associated radio channel in the baseband (para. [0069], [0093]).

As per claim 7, Hertz further teaches wherein the digital front end module further comprises a decimator module configured to decimate each one of the number of radio channels in the baseband (para. [0070], [0092]).

As per claim 8, Hertz further teaches wherein the demodulator module comprises a number of frequency modulation (FM) demodulators (para. [0067]).

As per claim 9, Hertz further teaches wherein the digital signal processing circuitry comprises a plurality of compression engines that are capable of encoding anyone of the demodulated number of data streams with one of a plurality of compression schemes (para. [0106]).

As per claim 10, Hertz further teaches wherein one of the plurality of compression schemes is one of the W AV, MP3, AC3, WMA, AAC audio formats (WMA, para. [0106]).

As per claim 11, Hertz further teaches wherein the digital processing circuitry comprises at least a decompression engine configured to decompress one of the stored encoded number of data streams (para. [0025]).

As per claim 12, Hertz further teaches wherein the storage unit comprises one of the optical compact disc, magnetic hard-disk, or flash memory (flash memory, para. [0055]).

As per claim 13, Hertz further teaches wherein the control circuitry manages playback and recording operations based on the user's control commands (Abstract, para. [0013], [0108]).

As per claim 14, Hertz further teaches wherein the playback is performed on a third-party device (para. [0013], [0052]).

---See Supplemental Sheet---

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 10/31631

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Box V.2 Citations and explanations:

As per claim 16, Hertz further teaches an RBDS decoder for parsing radio broadcast data service information embedded in the demodulated number of data streams (para. [0112], [0113]).

As per claim 17, Hertz further teaches wherein the act of parsing comprises determining an occupancy, a location, an identity, and/or content that is associated with at least one of the demodulated number of data streams (para. [0112], [0113]).

As per claim 18, Hertz further teaches wherein the RBDS decoder comprises a plurality of digital decoding circuits that operate in parallel (para. [0018]).

As per claim 19, Hertz further teaches wherein the parsed radio broadcast data service information is stored in a first section of the storage unit ([para. [0114]).

As per claim 20, Hertz further teaches an output unit configured to transmit wirelessly at least one of the number of data streams in response to a user's control commands (para. [0056], [0095]).

As per claim 21, Hertz teaches a wideband personal radio recorder system (Abstract, para. [0012]) comprising: at least a first tuner and a second tuner (para. [0076]), the first tuner configured to receive a first frequency spectrum (AM band) including a first plurality of radio channels (para. [0076]) and convert the first frequency spectrum to a first in-phase signal and a first quadrature signal (para. [0087], [0093]), the second tuner configured to receive a second frequency spectrum (FM band) including a second plurality of radio channels (para. [0076]) and convert the second frequency spectrum to a second in-phase signal and a second quadrature signal (para. [0087], [0093]); at least a first analog-to-digital converter module and a second analog-to- digital module (para. [0076]), the first analog-to-digital converter module (para. [0076]) configured to digitize the first in- phase and quadrature signals (para. [0087], [0093]) , the second analog-to-digital converter module (para. [0076]) configured to digitize the second in-phase and quadrature signals (para. [0087], [0093]); at least a first digital front end module (para. [0076]) having a first plurality of complex mixers configured to frequency down-convert the first digital in-phase and quadrature signals to a first number of radio channels in a baseband (para.[0045], [0069]), a second digital front end module (para. [0076]) having a second plurality of complex mixers configured to frequency down-convert the second digital in-phase and quadrature signals to a second number of radio channels in the baseband (para.[0045], [0069]); a demodulator module coupled to the first and second digital front end modules (para. [0076]) and configured to demodulate the first and second numbers of radio channels to obtain a plurality of data streams (para. [0048], [0067]); a digital signal processing circuitry coupled to the demodulator module and configured to encode the plurality of data streams (para. [0049]); a storage unit (removable storage, 255) coupled to the digital processing circuitry and configured to store the encoded plurality of data streams (Fig. 2, para.[0055], [0119]); and a control circuitry having a user interface for receiving control commands from a user (para. [0053], [0108]).

As per claim 22, Hertz further teaches wherein the first and second tuners, the first and second analog-to-digital converter modules, and the first and second digital front end modules are configured to operate concurrently)para. [0076]).

As per claim 23, Hertz further teaches wherein the digital signal processing circuitry further comprises an RBDS decoder for parsing radio broadcast data service (RBDS) information embedded in the demodulated number of data streams (para. [0112], [0113]).

As per claim 24, Hertz further teaches wherein the parsed RBDS information is stored in a first section of the storage unit (para. [0114]).

As per claim 25, Hertz further teaches wherein the digital signal processing circuitry further comprises at least a decoding engine configured to decode at least one of the stored plurality of data streams for playback (para. [0025]).

As per claim 27, Hertz teaches a method of recording a plurality of radio channels with a wideband receiver (Abstract, para. [0012]) comprising: receiving a radio signal including the plurality of radio channels (para. [0013]); converting the radio signal to an in-phase signal and a quadrature signal (para. [0093]); digitizing the in-phase and quadrature signals (para. [0066]); frequency-shifting the plurality of radio channels to a baseband by mixing the digital in-phase and quadrature signals concurrently with a plurality of complex mixers (para. [0045], [0069]); demodulating the plurality of radio channels in the baseband to obtain a corresponding plurality of data streams (para. [0048], [0067]); encoding the plurality of data streams (para. [0106]); and storing the encoded plurality of data streams (para. [0055], [0119]).

As per claim 28, Hertz further teaches filtering and decimating the frequency-shifted plurality of channels before demodulating (para. [0097]).

As per claim 29, Hertz further teaches retrieving the stored plurality of data streams (para. [0025]); and decoding at least one of the plurality of data streams for playback (para. [0025]).

As per claim 30, Hertz further teaches wherein the encoding comprises at least one of a plurality of audio compression schemes (para. [0106]).

As per claim 31, Hertz further teaches parsing radio broadcast data service (RBDS) information embedded in the plurality of demodulated data streams (para. [0012]-[0014]); storing the radio data service information (para. [0012]-[0014]); and building a directory based on the stored RBDS information (para. [0014]).

As per claim 32, Hertz further teaches wherein the parsing comprises determining an occupancy, a location, an identity, and/or content that is associated with at least one of the plurality of demodulated data streams (para. [0112], [0113]).

---See Supplemental Sheet---

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 10/31631

Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:
Box V.2 Citations and explanations:

As per claim 33, Hertz further teaches transmitting wirelessly, in response to user's control commands, at least one of the plurality of data streams (para. [0056]).

As per claim 34, Hertz teaches a method of recording a plurality of radio channels with a multi-tuner receiver (Abstract, para. [0012]) comprising: providing at least a first tuner and a second tuner (para. [0076]), the first and second tuners configured to operate concurrently (para. [0076]), the first tuner configured to receive a first frequency (AM band) spectrum including a first plurality of radio channels (para. [0076]), the second tuner configured to receive a second frequency spectrum (FM band) including a second plurality of radio channels (para. [0076]), the first tuner (para. [0076]) being configured to convert the first frequency spectrum to a first in-phase signal and a first quadrature signal (para. [0087], [0093]), and the second tuner (para. [0076]) configured to convert the second frequency spectrum to a second in-phase signal and a second quadrature signal (para. [0087], [0093]); converting the first frequency spectrum to a first in-phase and a first quadrature signal (para. [0076], [0087], [0093]); converting the second frequency spectrum to a second in-phase and a second quadrature signal (para. [0076], [0087], [0093]); digitizing the first and second in-phase and quadrature signals (para. [0076]); multiplying the first in-phase and quadrature signals with a first plurality of complex mixers to obtain a first plurality of in-phase and quadrature signals at a baseband (para.[0045], [0069]), wherein each one of the first number of in-phase and quadrature signals represents one of the first plurality of radio channels (para.[0045], [0069]); multiplying the second in-phase and quadrature signals with a second plurality of complex mixers to obtain a second plurality of in-phase and quadrature signals at the baseband, wherein each one of the second number of in-phase and quadrature signals represents one of the second plurality of radio channels (para.[0045], [0069]); demodulating the each one of the first and second pluralities of in-phase and quadrature signals to obtain a plurality of data streams (para. [0048], [0067]); encoding the plurality of data streams (para. [0049]); and storing the encoded plurality of data stream para.[0055], [0119]).

As per claim 35, Hertz further teaches filtering and then decimating the each one of the first and second pluralities of in-phase and quadrature signals before demodulating (para. [0097]).

As per claim 36, Hertz further teaches playing back at least one of the stored plurality of data streams (para. [0025]).

As per claim 37, Hertz further teaches wherein the encoding comprises at least one of the WAV, MP3, AC3, AAC, WMA audio compression formats (WMA, para. [0106]).

As per claim 38, Hertz further teaches wherein the digitizing the first and second inphase and quadrature signals is performed concurrently. (para. [0076]).

As per claim 39, Hertz further teaches wherein the demodulating the each one of the first and second pluralities of in-phase and quadrature signals is performed concurrently (para. [0095]).

As per claim 40, Hertz further teaches wherein the encoding is performed in parallel for each one of the plurality of data streams (para. [0020]).

As per claim 41, Hertz further teaches parsing radio broadcast data service (RBDS) information embedded in the plurality of demodulated data streams (para. [0012]-[0014]); storing the radio data service information (para. [0012]-[0014]); and building a directory based on the stored RBDS information (para. [0114]).

As per claim 42, Hertz further teaches wherein the parsing comprises determining an occupancy, a location, an identity, and/or content that is associated with at least one of the plurality of demodulated data streams (para. [0112], [0113]).

As per claim 43, Hertz further teaches transmitting wire1essly, in response to a user's control commands, at least one 3 of the plurality of data streams (para. [0056]).

Claims 15 and 26 lack an inventive step under PCT Article 33(3) as being obvious over Hertz in view of US 2003/0158614 A1 to Friel et al. (hereinafter 'Friel').

As per claim 15, Hertz does not teach a battery configured to supply power to the recorder for continual operation in the event that an external power supply is turned off. However, Friel does teach a battery configured to supply power to the recorder for continual operation in the event that an external power supply is turned off (para. [0002]). It would have been obvious to one of ordinary skill in the art to modify the recorder, as taught by Hertz, so as to include the use of a battery, as taught by Friel, because the battery ensures that the recorder will maintain tower, thus saving the memory storage and user controls.

As per claim 26, Hertz does not teach a battery configured to supply power to the recorder for continual operation in the event that an external power supply is turned off. However, Friel does teach a battery configured to supply power to the recorder for continual operation in the event that an external power supply is turned off (para. [0002]). It would have been obvious to one of ordinary skill in the art to modify the recorder, as taught by Hertz, so as to include the use of a battery, as taught by Friel, because the battery ensures that the recorder will maintain tower, thus saving the memory storage and user controls.

---See Supplemental Sheet---

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US 10/31631

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:
Box V.2 Citations and explanations:

Claim 6 lacks an inventive step under PCT Article 33(3) as being obvious over Hertz in view of US 5705949 A to Alelyunas et al. (hereinafter 'Alelyunas').

As per claim 6, Hertz does not teach wherein each one of the plurality of mixers is a digital complex mixer comprising four digital multipliers and two digital adders. However, Aleyunas does teach wherein each one of the plurality of mixers is a digital complex mixer comprising four digital multipliers and two digital adders (Fig. 1). It would have been obvious to one of ordinary skill in the art to modify the recorder, as taught by Hertz, so as to include a portion of the circuit to include 4 multipliers and 2 adders, as taught by Aleyunas, because they provide for compensation of phase error, thus reducing the potential of errors in the recorder (col. 3, ln 10-24).

Claims 1-43 have industrial applicability as defined by PCT Article 33(4) because the subject matter can be made or used in industry.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 22287-28-1PC	**FOR FURTHER ACTION**	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US 10/31631	International filing date *(day/month/year)* 19 April 2010 (19.04.2010)	(Earliest) Priority Date *(day/month/year)* 17 April 2009 (17.04.2009)
Applicant MAXLINEAR, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**
   a. With regard to the **language**, the international search was carried out on the basis of:
      ☒ the international application in the language in which it was filed.
      ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).
   b. ☐ This international search report has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43.6*bis*(a)).
   c. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II).

3. ☐ **Unity of invention is lacking** (see Box No. III).

4. With regard to the **title**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,
   ☒ the text is approved as submitted by the applicant.
   ☐ the text has been established, according to Rule 38.2, by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. With regard to the **drawings**,
   a. the figure of the **drawings** to be published with the abstract is Figure No. 1
      ☒ as suggested by the applicant.
      ☐ as selected by this Authority, because the applicant failed to suggest a figure.
      ☐ as selected by this Authority, because this figure better characterizes the invention.
   b. ☐ none of the figures is to be published with the abstract.

Form PCT/ISA/210 (first sheet) (July 2009)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US 10/31631

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - G06F 17/00 (2010.01)
USPC - 700/94
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
USPC - 700/94

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
USPC - 370/203, 206, 215, 297, 307, 310, 464, 546; 700/94; 704/500 (keyword limited; see terms below)

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
PubWEST(PGPB,USPT,EPAB,JPAB); Google Patents; Google. Search Terms Used: record, save, store, radio, channel, broadcast, program, frequency, RBDS, RDS, baseband, base, band, analog, digital, ADC, A/D, digitze, DSP, signal, processing, storage, disc, flash, memory, hard, disk, demodulate, user, owner, operator, human, control, interface, display, co

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 2003/0228855 A1 (Hertz et al.) 11 December 2003 (11.12.2003) entire document, especially: Fig. 2, Abstract, para. [0012]-[0014], [0018], [0025], [0045], [0048], [0049], [0053], [0055], [0056], [0062]-[0070], [0076],[0078], [0087], [0092], [0093], [0095], [0106]-[0108], [0112]-[0114], [0119]	1-5, 7-14, 16-25, 27-43 --- 6, 15, 26
Y	US 2003/0158614 A1 (Friel et al.) 21 August 2003 (21.08.2003) para. [0002]	15, 26
Y	US 5,705,949 A (Alelyunas et al.) 06 January 1998 (06.01.1998) Fig. 1, col. 3, ln 10-24	6
A	US 2007/0179649 A1 (Mitsuno) 02 August 2007 (02.08.2007) entire document	1-43

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
31 May 2010 (31.05.2010)	17 JUN 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Lee W. Young PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (July 2009)

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To:
ARDESHIR TABIBI
TOWNSEND AND TOWNSEND AND CREW LLP
8TH FLOOR
TWO EMBARCADERO CENTER
SAN FRANCISCO, CA 94111

PCT

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing *(day/month/year)*	18 JUN 2010
Applicant's or agent's file reference 22287-27-1PC	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date *(day/month/year)*	Priority date *(day/month/year)*
PCT/US2010/031627	19 April 2010	17 April 2009

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - H04B 1/06 (2010.01)
USPC - 455/260

Applicant MAXLINEAR, INC.

1. This opinion contains indications relating to the following items:

- ☒ Box No. I Basis of the opinion
- ☐ Box No. II Priority
- ☐ Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- ☐ Box No. IV Lack of unity of invention
- ☒ Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- ☐ Box No. VI Certain documents cited
- ☐ Box No. VII Certain defects in the international application
- ☐ Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

3. For further details, see notes to Form PCT/ISA/220.

Name and mailing address of the ISA/US	Date of completion of this opinion	Authorized officer:
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	26 May 2010	Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/237 (cover sheet) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/031627

Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:

   ☒ the international application in the language in which it was filed.

   ☐ a translation of the international application into _____ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. ☐ This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a))

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of:

   a. type of material

      ☐ a sequence listing

      ☐ table(s) related to the sequence listing

   b. format of material

      ☐ on paper

      ☐ in electronic form

   c. time of filing/furnishing

      ☐ contained in the international application as filed

      ☐ filed together with the international application in electronic form

      ☐ furnished subsequently to this Authority for the purposes of search

4. ☐ In addition, in the case that more than one version or copy of a sequence listing and/or table(s) relating thereto has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that in the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

Form PCT/ISA/237 (Box No. I) (April 2007)

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/031627

Box No. V **Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

Novelty (N)	Claims	4, 7-9 and 16-25	YES
	Claims	1-3, 5, 6, 10-15, 26 and 27	NO
Inventive step (IS)	Claims	None	YES
	Claims	1-27	NO
Industrial applicability (IA)	Claims	1-27	YES
	Claims	None	NO

2. Citations and explanations:

Claims 1-3, 5, 6, 10-15, 26 and 27 lack novelty under PCT Article 33(2) as being anticipated by Feher.

Regarding claim 1, Feher discloses a wideband receiver system (paragraph [0231]) comprising: a wideband receiver configured to concurrently receive a plurality of desired RF channels (in-phase and quadrature-phase baseband channels, paragraph [0276]); said wideband receiver comprising: a mixer module (multipliers also known as mixers, paragraphs [236] and [0243]) coupled to the plurality of desired RF channels and having a first mixer (mixer 11.13 of Fig. 17b) configured to generate an in-phase signal and a second mixer (mixer 11.16 of Fig. 17b) configured to generate a quadrature signal (an in-phase (I) and quadrature (Q) channels, Fig. 6 and paragraph [0237]); a wideband analog-to-digital converter (ADC) module (paragraph [0247]) having a first wideband ADC (19.15 of Fig. 19) coupled with the in-phase signal and configured to generate a digitalized in-phase signal and a second wideband ADC (19.8 of Fig. 19) coupled with the quadrature signal and configured to generate a digitalized quadrature signal (paragraph [0257]); and a digital frontend (DFE) module (5.17 and 5.5 of Fig. 5) having a plurality of complex mixers (5.8 and 5.20 of Fig. 5) coupled to the digital in-phase and quadrature signals, each one of the plurality of complex mixers frequency-shifting a different one of the plurality of the desired RF channels to a baseband signal (paragraph [0236]).

Regarding claim 2, Feher discloses a local oscillator (5.9 and 5.21 of Fig. 5) having an oscillator frequency centered around the plurality of the desired RF channels (paragraph [0236]).

Regarding claim 3, Feher discloses that the local oscillator comprises a phaselocked loop (paragraph [0247]).

Regarding claim 5, Feher discloses that each one of the plurality of complex mixers comprises a pair of digital multipliers (5.8 and 5.20 of Fig. 5), each pair of the digital multipliers is coupled to a numerically controlled oscillator (5.9 and 5.21 of Fig. 5) (multipliers 5.8 and 5.20 of Fig. 5 are coupled to oscillators 5.9 and 5.21 of Fig. 5, respectively, paragraph [0236]).

Regarding claim 6, Feher discloses that the DFE module (5.17 and 5.5 of Fig. 5) further comprises a plurality of channel filters (5.6 and 5.18 of Fig. 5), each one of the plurality of channel filters is coupled to each one of the plurality of complex mixers (5.8 and 5.20 of Fig. 5) and configured to filter one of the plurality of the desired channels (paragraph [0236]).

Regarding claim 10, Feher discloses an up-converter module (20.4b of Fig. 20) configured to frequency-shift the plurality of desired RF channels in the baseband to an intermediate frequency band (paragraph [0258]).

Regarding claim 11, Feher discloses that the up-converter module (20.4b of Fig. 20) comprises a plurality of N up-mixers (5.8 and 5.20 of Fig. 5) having a plurality of associated oscillator frequencies (5.9 and 5.21 of Fig. 5), wherein N is an integer value equal to the plurality of the desired RF channels (paragraph [0261]); wherein the plurality of associated oscillator frequencies are so chosen so that when mixing with the plurality of desired channels in the baseband, the mixed products occupy a contiguous frequency spectrum, or a substantially-contiguous frequency spectrum with one or more spacings between the desired channels (paragraphs [0246] and [0280]), wherein the one or more spacings are variable (inherent in a spread frequency spectrum), and wherein the one or more spacings are smaller than or comparable to a channel bandwidth, or small measured as a fraction of the bandwidth of the first and second wideband ADCs (paragraphs [0236], [0237] and [0257]).

Regarding claim 12, Feher discloses that the mixed products comprise spectra that are spaced in such a way so as to avoid overlap with known frequency bands containing potential or actual interferers (paragraph [0261]).

Regarding claim 13, Feher discloses that the mixed products comprise spectra that are spaced in such a way so as to avoid overlap with known frequency bands that introduce interference to other systems (paragraph [0261]).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/031627

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Regarding claim 14, Feher discloses that each one of the plurality of N up-mixers is a digital complex mixer (5.8 and 5.20 of Fig. 5) and each one of the plurality of associated oscillator frequencies (5.9 and 5.21 of Fig. 5) is generated by a numerically controlled oscillator (numerically controlled oscillator, paragraph [0247]).

Regarding claim 15, Feher discloses a digital-to-analog converter (paragraphs [0247] and [0254]) configured to convert the contiguous group of channels in the intermediate frequency spectrum to an analog waveform.

Regarding claim 26, Feher discloses a method of receiving a plurality of radio frequency (RF) channels including a number of desired channels (paragraphs [0221] and [0231]) that are located in non-contiguous portions of a frequency spectrum and grouping the desired channels in a contiguous frequency spectrum (paragraph [0261]), the method comprising: concurrently receiving the plurality of RF channels; producing an in-phase signal and a quadrature signal by mixing the plurality of RF channels (in-phase and quadrature-phase baseband channels, paragraph [0276]) with a first oscillator frequency 5.9 of Fig. 5) and a second local frequency (5.21 of Fig. 5); digitizing the in-phase and quadrature signals (19.10a of Fig. 19); and frequency down-shifting the digital in-phase and quadrature signals to a baseband signal using a number of complex mixers (mixers 11.13 and 11.16 of Fig. 17b, paragraphs [236] and [0243]), wherein the first and second oscillator frequencies are identical and have a phase shift of 90' degree between them, wherein the number of complex mixers correspond to the number of desired channels (Feher, paragraph [0243]).

Regarding claim 27, Feher discloses frequency up-shifting the baseband signal to an intermediate frequency; and converting the frequency up-shifted baseband signal to an analog waveform (paragraphs [0247] and [0254]).

Claims 4 and 16-25 lack an inventive step under PCT Article 33(3) as being obvious over Feher in view of Currivan.

Regarding claims 4 and 24, Feher discloses that the desired RF channels conform to Video over Internet Protocol (VilP) as well as Voice over Internet Protocol (VoIP) (paragraph [0236]). However, Feher fails to disclose that the plurality of desired RF channels conform to a Data Over Cable Service Interface Specification (DOCSIS) protocol. In the same field of endeavor, Currivan discloses that the plurality of desired RF channels conform to a Data Over Cable Service Interface Specification (DOCSIS) protocol (paragraphs [0027] and [0028]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Currivan to incorporate the above features into the invention of Feher for the benefit of providing an equivalent data throughput of N channels to a user, though the user perceives a single channel (Currivan, paragraph [0027]).

Regarding claim 16, Feher discloses a multi-tuner receiver system (paragraphs [0221] and [0231]) for receiving a plurality of desired radio frequency (RF) channels (in-phase and quadrature-phase baseband channels, paragraph [0276]) that extend over multiple non-contiguous portions of a broad frequency spectrum and grouping them in a contiguous frequency spectrum, the system comprising: a first tuner (multiple receiver, paragraph [0200]) configured to receive a first portion of the broad frequency spectrum, the first tuner includes a first mixer (mixer 11.13 of Fig. 17b) module coupled to a first oscillator (5.9 of Fig. 5) and is configured to generate a first in-phase signal and a first quadrature signal (an in-phase (I) and quadrature (Q) channels, Fig. 6 and paragraph [0237]); a second tuner (multiple receiver, paragraph [0200]) configured to receive a second portion of the broad frequency spectrum, the second tuner includes a second mixer module (mixer 11.16 of Fig. 17b) coupled to a second oscillator (5.21 of Fig. 5) and is configured to generate a second in-phase signal and a second quadrature signal (an in-phase (I) and quadrature (Q) channels, Fig. 6 and paragraph [0237]); a first analog-to-digital converter module (19.10a of Fig. 19) configured to digitize the first in-phase and quadrature signals; a second analog-to-digital converter module (19.2 of Fig. 19) configured to digitize the second in-phase and quadrature signals (paragraphs [0247] and [0254]). Feher fails to disclose first and second digital frontends. In the same field of endeavor, Currivan discloses a first digital frontend (DFE) module (112 sub 1 of Fig. 1) having a first bank of down-mixers coupled to the first digital in-phase and quadrature signals, each of the first bank of down-mixers is configured to frequency shift one of the desired RF channels in the first portion of the broad frequency spectrum (paragraphs [0019], [0031] and [0078]); and a second digital frontend (DFE) module (112 sub 2 of Fig. 1) having a second bank of down-mixers coupled to the second digital in-phase and quadrature signals, each of the second bank of down-mixers is configured to frequency shift one of the desired RF channels in the second portion of the broad frequency spectrum; wherein the first DFE module frequency-shifts the desired RF channels in the first portion of the broad frequency spectrum to a first portion of a baseband signal (paragraphs [0019], [0031] and [0078]); wherein the second DFE module frequency-shifts the desired RF channels in the second portion of the broad frequency spectrum to a second portion of the baseband signal (paragraphs [0018]-[0021]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Currivan to incorporate the above features into the invention of Feher for the benefit of selecting a first baseband signal corresponding to a first channel and for selecting a second baseband signal corresponding to a second channel, respectively (Currivan, paragraph [0019]).

Regarding claim 17, Currivan discloses a crossbar switch (a carrier adjustment module) interposed between the first and second analog-to-digital converter modules and the first and second DFE modules (paragraph [0019]).

Regarding claim 18, Feher discloses a first up-converter module (20.3b of Fig. 20) having a first bank of up-mixers (mixer 11.13 of Fig. 17b) coupled to the first portion of the baseband signal and configured to frequency shift the first portion of the baseband signal to a first portion of an intermediate frequency spectrum (5.9 of Fig. 5 and an in-phase (I) and quadrature (Q) channels, Fig. 6 and paragraph [0237]); a second up-converter module (20.4b of Fig. 20) having a second bank of up-mixers (mixer 11.16 of Fig. 17b) coupled to the second portion of the baseband signal and configured to frequency shift the second portion of the baseband signal to a second portion of the intermediate frequency spectrum (5.21 of Fig. 5 and an in-phase (I) and quadrature (Q) channels, Fig. 6 and paragraph [0237]); and a digital-to-analog converter (19.10a and 19.2 of Fig. 19) configured to convert the first and second portions of the intermediate frequency spectrum to an analog waveform signal (paragraphs [0247] and [0254]).

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

International application No.
PCT/US2010/031627

Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Regarding claim 19, Currivan discloses a crossbar switch interposed between the first and second DFE modules and the first and second up-converter modules (a carrier adjustment module).

Regarding claim 20, Feher discloses that the first and second portions are adjacent to each other and non-overlapping (paragraph [0261]).

Regarding claim 21, Feher discloses that each one of the first bank of down-mixers comprises a pair of digital multiplier having an input terminal coupled to a numerically controlled oscillator (multipliers also known as mixers, paragraphs [236] and [0243]).

Regarding claim 22, Feher discloses that the first DFE module (5.17 of Fig. 5) further comprises a plurality of channel filters (5.6 and 5.18 of Fig. 5), each one of the plurality of channel filters is coupled to each one of the first bank of down-mixers (5.8 and 5.20 of Fig. 5) and configured to filter one of the frequency down-shifted RF channels (paragraph [0236]).

Regarding claim 23, Feher discloses that the plurality of desired RF channels conform to one of a digital video broadcasting (DVB) standard (paragraph [0190]).

Regarding claim 25, Feher discloses that the plurality of RF channels conform to a television broadcasting standard (paragraph [0231]).

Claims 7-9 lack an inventive step under PCT Article 33(3) as being obvious over Feher in view of Hoctor.

Regarding claim 7, Feher discloses a plurality of channel filters (5.6 and 5.18 of Fig. 5). Feher fails to disclose that each one of the plurality of channel filters is a finite impulse response filter. In the same field of endeavor, Hoctor discloses that each one of the plurality of channel filters is a finite impulse response filter (paragraph [0061]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Hoctor to incorporate the above features into the invention of Feher for the benefit of processing signals processed by the decimation filter (Hoctor, paragraph [0061]).

Regarding claim 8, Feher discloses a plurality of channel filters (5.6 and 5.18 of Fig. 5). Feher fails to disclose that the DFE module further comprises a decimator module configured to decimate each one of the plurality of the desired channels in the baseband. In the same field of endeavor, Hoctor discloses that the DFE module (paragraph [0067]) further comprises a decimator module (paragraph [0061]) configured to decimate each one of the plurality of the desired channels in the baseband (paragraph [0059]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Hoctor to incorporate the above features into the invention of Feher for the benefit of eliminating undesirable signals and reduce the sampling rate to an appropriate frequency for baseband operation (Hoctor, paragraph [0059]).

Regarding claim 9, Feher discloses a plurality of channel filters (5.6 and 5.18 of Fig. 5). Feher fails to disclose that the DFE module further comprises a decimator module configured to decimate each one of the plurality of the desired channels to a demodulator. In the same field of endeavor, Hoctor discloses that the DFE module (paragraph [0067]) further comprises a decimator module (paragraph [0061]) configured to decimate each one of the plurality of the desired channels to a demodulator (paragraph [0064]). It would have been obvious to one of ordinary skill in the art at the time of the invention to use the teachings of Hoctor to incorporate the above features into the invention of Feher for the benefit of eliminating undesirable signals and reduce the sampling rate to an appropriate frequency for baseband operation (Hoctor, paragraph [0059]).

Claims 1-27 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

PATENT COOPERATION TREATY

PCT

INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference 22287-27-1PC	FOR FURTHER ACTION	see Form PCT/ISA/220 as well as, where applicable, item 5 below.
International application No. PCT/US2010/031627	International filing date *(day/month/year)* 19 April 2010	(Earliest) Priority Date *(day/month/year)* 17 April 2009
Applicant MAXLINEAR, INC.		

This international search report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This international search report consists of a total of 2 sheets.

☐ It is also accompanied by a copy of each prior art document cited in this report.

1. **Basis of the report**

a. With regard to the **language**, the international search was carried out on the basis of:

☒ the international application in the language in which it was filed

☐ a translation of the international application into _____ , which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b))

b. ☐ With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, see Box No. I.

2. ☐ **Certain claims were found unsearchable** (see Box No. II)

3. ☐ **Unity of invention is lacking** (see Box No. III)

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☒ the text is approved as submitted by the applicant

☐ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box No. IV. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority

6. With regard to the **drawings**,

a. the figure of the **drawings** to be published with the abstract is Figure No. 4

☒ as suggested by the applicant

☐ as selected by this Authority, because the applicant failed to suggest a figure

☐ as selected by this Authority, because this figure better characterizes the invention

b. ☐ none of the figures is to be published with the abstract

Form PCT/ISA/210 (first sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2010/031627

A. CLASSIFICATION OF SUBJECT MATTER
IPC(8) - H04B 1/06 (2010.01)
USPC - 455/260
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC(8) - H04B 1/06, 1/00 (2010.01)
USPC - 455/260, 209, 42, 180.1

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X — Y	US 2007/0032220 A1 (FEHER) 08 February 2007 (08.02.2007) entire document	1-3, 5, 6, 10-15, 26 and 27 ------ 4, 7-9 and 16-25
Y	US 2007/0263754 A1 (CURRIVAN et al) 15 November 2007 (15.11.2007) entire document	4 and 16-25
Y	US 2007/0002961 A1 (HOCTOR et al) 04 January 2007 (04.01.2007) entire document	7-9
A	US 5,590,156 A (CARNEY) 31 December 1996 (31.12.1996) entire document	1-27
A	US 5,768,260 A (KLINE et al) 16 June 1998 (16.06.1998) entire document	1-27

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

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier application or patent but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
26 May 2010	18 JUN 2010
Name and mailing address of the ISA/US Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-3201	Authorized officer: Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

Form PCT/ISA/210 (second sheet) (April 2005)

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
17/587,462	01/28/2022	2631	2820	28427US13	30	2

CONFIRMATION NO. 9515

FILING RECEIPT

23446
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

OC000000131613097

Date Mailed: 02/07/2022

Receipt is acknowledged of this non-provisional utility patent application. The application will be taken up for examination in due course. Applicant will be notified as to the results of the examination. Any correspondence concerning the application must include the following identification information: the U.S. APPLICATION NUMBER, FILING DATE, NAME OF FIRST INVENTOR, and TITLE OF INVENTION. Fees transmitted by check or draft are subject to collection.

Please verify the accuracy of the data presented on this receipt. If an error is noted on this Filing Receipt, please submit a written request for a corrected Filing Receipt, including a properly marked-up ADS showing the changes with strike-through for deletions and underlining for additions. If you received a "Notice to File Missing Parts" or other Notice requiring a response for this application, please submit any request for correction to this Filing Receipt with your reply to the Notice. When the USPTO processes the reply to the Notice, the USPTO will generate another Filing Receipt incorporating the requested corrections provided that the request is grantable.

Inventor(s)

Madhukar Reddy, Carlsbad, CA;
Curtis Ling, Carlsbad, CA;
Tim Gallagher, Carlsbad, CA;

Applicant(s)

Entropic Communications, LLC, Carlsbad, CA;

Power of Attorney: The patent practitioners associated with Customer Number 23446

Domestic Priority data as claimed by applicant

This application is a CON of 17/217,244 03/30/2021
which is a CON of 16/430,506 06/04/2019 PAT 10972781
which is a CON of 15/792,318 10/24/2017 PAT 10313733
which is a CON of 14/948,881 11/23/2015 PAT 9819992
which is a CON of 14/617,973 02/10/2015 PAT 9210363
which is a CON of 13/962,871 08/08/2013 PAT 9100622
which is a CON of 12/762,900 04/19/2010 PAT 8526898
which claims benefit of 61/170,526 04/17/2009

Foreign Applications for which priority is claimed (You may be eligible to benefit from the **Patent Prosecution Highway** program at the USPTO. Please see http://www.uspto.gov for more information.) - None.
Foreign application information must be provided in an Application Data Sheet in order to constitute a claim to foreign priority. See 37 CFR 1.55 and 1.76.

Permission to Access Application via Priority Document Exchange: Yes

Permission to Access Search Results: Yes

Applicant may provide or rescind an authorization for access using Form PTO/SB/39 or Form PTO/SB/69 as appropriate.

If Required, Foreign Filing License Granted: 02/03/2022

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 17/587,462**

Projected Publication Date: 05/19/2022

Non-Publication Request: No

Early Publication Request: No

Title

METHOD FOR RECEIVING A TELEVISION SIGNAL

Preliminary Class

375

Statement under 37 CFR 1.55 or 1.78 for AIA (First Inventor to File) Transition Applications: No

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

For information on preventing theft of your intellectual property (patents, trademarks and copyrights), you may wish to consult the U.S. Government website, http://www.stopfakes.gov. Part of a Department of Commerce initiative, this website includes self-help "toolkits" giving innovators guidance on how to protect intellectual property in specific countries such as China, Korea and Mexico. For questions regarding patent enforcement issues, applicants may call the U.S. Government hotline at 1-866-999-HALT (1-866-999-4258).

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

The applicant has been granted a license under 35 U.S.C. 184, if the phrase "IF REQUIRED, FOREIGN FILING LICENSE GRANTED" followed by a date appears on this form. Such licenses are issued in all applications where the conditions for issuance of a license have been met, regardless of whether or not a license may be required as set forth in 37 CFR 5.15. The scope and limitations of this license are set forth in 37 CFR 5.15(a) unless an earlier license has been issued under 37 CFR 5.15(b). The license is subject to revocation upon written notification. The date indicated is the effective date of the license, unless an earlier license of similar scope has been granted under 37 CFR 5.13 or 5.14.

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

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

NOT GRANTED

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

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The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The U.S. offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to promote and facilitate business investment. SelectUSA provides information assistance to the international investor

community; serves as an ombudsman for existing and potential investors; advocates on behalf of U.S. cities, states, and regions competing for global investment; and counsels U.S. economic development organizations on investment attraction best practices. To learn more about why the United States is the best country in the world to develop technology, manufacture products, deliver services, and grow your business, visit http://www.SelectUSA.gov or call +1-202-482-6800.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number: 17/587,462

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE($)	SMALL ENTITY FEE($)	OR	OTHER THAN SMALL ENTITY RATE($)	OTHER THAN SMALL ENTITY FEE($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	320
SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A	N/A			N/A	700
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	800
TOTAL CLAIMS (37 CFR 1.16(i))	30 minus 20 =	* 10			OR	x 100 =	1000
INDEPENDENT CLAIMS (37 CFR 1.16(h))	2 minus 3 =	*				x 480 =	0.00
APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						0.00
MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							0.00
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	2820

APPLICATION AS AMENDED - PART II

AMENDMENT A

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

AMENDMENT B

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

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

To: mhmpto@mcandrews-ip.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 23446

Feb 07, 2022 03:34:17 AM

Dear PAIR Customer:

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 23446 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

Disclaimer:
The list of documents shown below is provided as a courtesy and is not part of the official file wrapper. The content of the images shown in PAIR is the official record.

Application	Document	Mailroom Date	Attorney Docket No.
17587462	APP.FILE.REC	02/07/2022	28427US13

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

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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.
17/587,462	01/28/2022	Madhukar Reddy	28427US13	9515

23446 7590 03/15/2022

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER	
CENTRAL, DOCKET	

ART UNIT	PAPER NUMBER
OPAP	

NOTIFICATION DATE	DELIVERY MODE
03/15/2022	ELECTRONIC

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

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

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Decision Granting Request for Prioritized Examination (Track I)	**Application No.** 17/587,462	**Applicant(s)** Reddy et al.	
	Examiner CHERYL P GIBSON BAYLOR	**Art Unit** OPET	**AIA (FITF) Status** No

1. THE REQUEST FILED 28 January 2022 IS **GRANTED** .

The above-identified application has met the requirements for prioritized examination

A. ☑ for an original nonprovisional application (Track I).
B. ☐ for an application undergoing continued examination (RCE).

2. **The above-identified application will undergo prioritized examination**. The application will be accorded special status throughout its entire course of prosecution until one of the following occurs:

A. filing a **petition for extension of time** to extend the time period for filing a reply;

B. filing an **amendment to amend the application to contain more than four independent claims, more than thirty total claims** , or a multiple dependent claim;

C. filing a **request for continued examination** ;

D. filing a notice of appeal;

E. filing a request for suspension of action;

F. mailing of a notice of allowance;

G. mailing of a final Office action;

H. completion of examination as defined in 37 CFR 41.102; or

I. abandonment of the application.

Telephone inquiries with regard to this decision should be directed to CHERYL GIBSON BAYLOR at (571)272-3213. In his/her absence, calls may be directed to Petition Help Desk at (571) 272-3282.

/CHERYL GIBSON BAYLOR/ Paralegal Specialist, OPET	

To: mhmpto@mcandrews-ip.com,,
From: PAIR_eOfficeAction@uspto.gov
Cc: PAIR_eOfficeAction@uspto.gov
Subject: Private PAIR Correspondence Notification for Customer Number 23446

Mar 16, 2022 04:33:05 AM

Dear PAIR Customer:

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661
UNITED STATES

The following USPTO patent application(s) associated with your Customer Number, 23446 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

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Application	Document	Mailroom Date	Attorney Docket No.
17587462	TRACK1.GRANT	03/15/2022	28427US13

To view your correspondence online or update your email addresses, please visit us anytime at https://sportal.uspto.gov/secure/myportal/privatepair.

If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

Monday - Friday 6:00 a.m. to 12:00 a.m.

Thank you for prompt attention to this notice,

UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

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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.
17/587,462	01/28/2022	Madhukar Reddy	28427US13	9515

23446 7590 04/13/2022

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER	
JACKSON, BLANE J	

ART UNIT	PAPER NUMBER
2644	

NOTIFICATION DATE	DELIVERY MODE
04/13/2022	ELECTRONIC

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

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

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

mhmpto@mcandrews-ip.com

Office Action Summary	Application No. 17/587,462	Applicant(s) Reddy et al.	
	Examiner BLANE J JACKSON	Art Unit 2644	AIA (FITF) Status No

-- 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 MONTHS 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 28 January 2022.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

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

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

4)☐ 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*

5) ☑ Claim(s) 19-48 is/are pending in the application.

5a) Of the above claim(s) _____ is/are withdrawn from consideration.

6) ☐ Claim(s) _____ is/are allowed.

7) ☑ Claim(s) 19-27,29-30,33-42,44-45 and 48 is/are rejected.

8) ☑ Claim(s) 28,31-32,43 and 46-47 is/are objected to.

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

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to **PPHfeedback@uspto.gov.**

Application Papers

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

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

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

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

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).

Certified copies:

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)).

** 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) ☑ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date _____.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date _____.

4) ☐ Other: _____.

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Information Disclosure Statement

The Information Disclosure Statement filed 28 January 2022 is made of record.

Double Patenting

The nonstatutory double patenting rejection is based on a judicially created doctrine grounded in public policy (a policy reflected in the statute) so as to prevent the unjustified or improper timewise extension of the "right to exclude" granted by a patent and to prevent possible harassment by multiple assignees. A nonstatutory double patenting rejection is appropriate where the conflicting claims are not identical, but at least one examined application claim is not patentably distinct from the reference claim(s) because the examined application claim is either anticipated by, or would have been obvious over, the reference claim(s). See, e.g., *In re Berg*, 140 F.3d 1428, 46 USPQ2d 1226 (Fed. Cir. 1998); *In re Goodman*, 11 F.3d 1046, 29 USPQ2d 2010 (Fed. Cir. 1993); *In re Longi*, 759 F.2d 887, 225 USPQ 645 (Fed. Cir. 1985); *In re Van Ornum*, 686 F.2d 937, 214 USPQ 761 (CCPA 1982); *In re Vogel*, 422 F.2d 438, 164 USPQ 619 (CCPA 1970); *In re Thorington*, 418 F.2d 528, 163 USPQ 644 (CCPA 1969).

A timely filed terminal disclaimer in compliance with 37 CFR 1.321(c) or 1.321(d) may be used to overcome an actual or provisional rejection based on nonstatutory double patenting provided the reference application or patent either is shown to be commonly owned with the examined application, or claims an invention made as a result of activities undertaken within the

scope of a joint research agreement. See MPEP § 717.02 for applications subject to examination under the first inventor to file provisions of the AIA as explained in MPEP § 2159. See MPEP § 2146 *et seq.* for applications not subject to examination under the first inventor to file provisions of the AIA. A terminal disclaimer must be signed in compliance with 37 CFR 1.321(b).

The USPTO Internet website contains terminal disclaimer forms which may be used. Please visit www.uspto.gov/patent/patents-forms. The filing date of the application in which the form is filed determines what form (e.g., PTO/SB/25, PTO/SB/26, PTO/AIA/25, or PTO/AIA/26) should be used. A web-based eTerminal Disclaimer may be filled out completely online using web-screens. An eTerminal Disclaimer that meets all requirements is auto-processed and approved immediately upon submission. For more information about eTerminal Disclaimers, refer to www.uspto.gov/patents/process/file/efs/guidance/eTD-info-I.jsp.

Claims 19-48 are rejected on the ground of nonstatutory double patenting as being unpatentable over claims 1-27 of U.S. Patent No. 9,100,622. Although the claims at issue are not identical, they are not patentably distinct from each other because the claims of the instant application comprises the same but fewer or reorganized claim elements with respect to the parent patent.

Claim Rejections - 35 USC § 103

The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 19-27, 29, 30, 33-42, 44, 45 and 48 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Skones et al. US 6,760,342 in view of Uskall et al. WO 02/087230.

As to claim 19, Skones teaches a method for receiving a television (TV) signal comprising:

digitizing a contiguous band of frequencies in an input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises a plurality of desired channels and a plurality of undesired channels (figures 1 and 6, column 3, line 35 to column 4, line 18, receiver 10 comprising an LNA 16, frequency downconverter, an ADC 20 and a digital channelizer 22 that process the wideband received signals),

concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels (figures 1, 11 and 14, column 4, lines 53 to column 5, line 14 and column 11, line 51 to column 12, line 13, the digitally converted signal from the ADC 20 is applied to the digital channelizer 22, the channelizer comprising a plurality of digital sub-band tuners (DSBTs), each to digitally filter individual carrier signals from the digital multi carrier signals passed on a programmable center freqeny and bandwidth), and

providing the plurality of desired channels (figures 11 and 14, column 11, lines 51-65, each DSBT 274 provides a baseband channel coupled to a DSP to demodulate the channel).

Skones teaches a wideband receiver designed to process signals for many protocols and standards depending on the particular application, column 1, lines 43-49, but does not explicitly teach receiving a television (TV) signal.

Uskali teaches a broadband channelized cable television (CATV) communications network 100 comprising a broadband communications service provider 104 and a customer 106 for both television viewing and digital communications, page 4, lines 11-27.

Since Uskai teaches the CATV system could be part of any channelized system, it would have been obvious to one of ordinary skill in the art before the effective filing date of the instant application to utilize the wideband receiver of Skones to also process cable television as taught in the receiver of Uskali to provide audio/video services.

As to claim 20 with respect to claim 19, Skones of Skones modified teaches wherein the method comprises communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter (figure 1, column 3, lines 34-66, the multi-carrier receiver comprises an LNA 16, mixer 28, BPF 32, transformer 36 and ADC 20 to couple a multi-carrier wideband signal to channelizer 22).

As to claim 21 with respect to claim 19, Skones teaches generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels and wherein each corresponding complex signal comprises an in phase component and a quadrature component (figures 6, 10, 11 and 14, column 11, lines 51-64, the digitized quadrature output of the ADC 20 is provided to a plurality of digital sub-band tuners (DSBTs) with programmable bandwidth and center frequency use to channelize the desired signals).

As to claim 22 with respect to claim 21, Skones teaches the I and Q components of each corresponding complex signal are at baseband (column 11, line 51 to column 12, line 14, the output of each DSBT of channelizer 22 is at baseband).

As to claim 23 with respect to claim 1, Skones modified teaches filtering, via each filter of a plurality of filters, the corresponding complex singals and wherein each corresponding complex signal comprises a 6 MHz channel (column 11, line 51 to column 12, line 14, each DSBT 274 digitally filters individual signals from the multi carrier signals based on a programmable center frequency and bandwidth; the bandwidth with respect to a television channel as taught by chambers is 6 Mhz).

As to claim 24 with respect to claim 19, Skones teaches demodulating, via each demodulator of a plurality of demodulators, a desired channel, the corresponding complex signal to generate a demodulated signal as a desired signal (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 via each DSBT and then processed in the normal manner by subsequent DSP devices).

As to claim 25 with respect to claim 19, Skones teaches demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 via each of the plurality of DBT and then processed in the normal manner by subsequent DSP devices).

As to claim 25 with respect to claim 19, Skones teaches demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 and then processed in the normal manner by subsequent DSP devices).

As to claim 26 with respect to claim 25, Skones teaches providing a plurality of demodulated desired channels via a parallel interface (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 via each of the plurality of DBT and forming a parallel output, each processed in the normal manner by subsequent DSP devices).

As to claim 27 with respect to claim 19, Skones teaches wherein the method comprises providing the plurality of desired channels via a parallel interface (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 via each of the plurality of DBT and forming a parallel output, each processed in the normal manner by subsequent DSP devices).

As to claim 29 with respect to claim 19, Uskali of Skones modified teaches the plurality of desired channels comprises at least one cable broadcast channel (page 5, lines 18-31, the downstream spectrum 134 is divided into channels 136 of predetermined bandwidth which is 6 MHz in the United States).

As to claim 30 with respect to claim 19, Uskali of Skones modified teaches the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol (page 5, lines 18-31, the downstream spectrum 134 is divided into channels 136 of predetermined bandwidth which is 6 MHz in the United States).

As to claim 33 with respect to claim 19, Skones teaches the contiguous band of frequencies comprises a portion of a frequency spectrum of the input signal (figure 1, column 3, line 34 to column 4, line 36, the wideband receiver comprises frequency multiplier 48 to provide an IF signal limited by the BPF 32 to a particular frequency band).

As to claim 34, Skones teaches a method comprising:

digitizing an input signal via a wideband analog-to-digital converter (ADC), wherein the input signal comprises a plurality of desired channels and a plurality of undesired channels (figure 1, column 3, line 35 to column 4, line 18, receiver 10 comprising an LNA 16, frequency downconverter, an ADC 20 and a digital channelizer 22 that process the wideband received signals), and

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs (figures 11 and 14, column 11, lines 51-65, each DSBT 274 comprises a sub-band tuner and filter to output a desired digital channel at baseband).

Skones teaches a wideband receiver designed to process carrier signals for many protocols and standards depending on the particular application, column 1, lines 43-49, but does not explicitly teach the input signal comprises a plurality of channels (a television (TV) signal).

Uskali teaches a broadband channelized cable television (CATV) communications network 100 comprising a broadband communications service provider 104 and a customer 106 for both television viewing and digital communications, page 4, lines 11-27 and page 6, lines 1-31.

Since Uskai teaches the CATV system could be part of any channelized system, it would have been obvious to one of ordinary skill in the art before the effective filing date of the instant application to utilize the wideband receiver of Skones to also process cable television as taught in the receiver of Uskali to provide audio/video services.

As to claim 35 with respect to claim 34, Skones of Skones modified teaches communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter (figure 1, column 3, lines 34-66, the multi-carrier receiver comprises an LNA 16, mixer 28, BPF 32, transformer 36 and ADC 20 to couple a multi-carrier wideband signal to channelizer 22).

As to claim 36 with respect to claim 34, Skones teaches digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component (figures 6, 10, 11 and 14, column 11, lines 51-64, the digitized quadrature output of the ADC 20 is provided to a plurality of digital sub-band tuners (DSBTs) with programmable bandwidth and center frequency use to channelize the desired signals).

As to claim 37 with respect to claim 36, Skones teaches the I and Q components of each corresponding complex signal are at baseband (column 11, line 51 to column 12, line 14, the output of each DSBT of channelizer 22 is at baseband).

As to claim 38 with respect to claim 36, Skones teaches filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz (column 11, line 51 to column 12, line 14, each DSBT 274 digitally filters individual signals from the multi carrier signals based on a programmable center frequency and bandwidth; the bandwidth with respect to a television channel as taught by chambers is 6 Mhz).

As to claim 39 with respect to claim 36, Skones teaches demodulating the corresponding complex signal to provide a demodulated channel as a digital channel output (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 via each DSBT and then processed in the normal manner by subsequent DSP devices).

As to claim 40 with respect to claim 34, Skones teaches demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 and then processed in the normal manner by subsequent DSP devices).

As to claim 41 with respect to claim 40, Skones teaches providing the plurality of demodulated channels via a parallel interface (figure 1, column 4, lines 54-62, the desired signal

carrier or channels are selected by the channelizer 22 via each of the plurality of DBT and forming a parallel output, each processed in the normal manner by subsequent DSP devices).

As to claim 42 with respect to claim 34, Skones teaches wherein the method comprises providing the plurality of digital channel outputs via a parallel interface (figure 1, column 4, lines 54-62, the desired signal carrier or channels are selected by the channelizer 22 via each of the plurality of DBT and forming a parallel output, each processed in the normal manner by subsequent DSP devices).

As to claim 44 with respect to claim 34, Uskali of Skones modified teaches the plurality of desired channels comprises at least one cable broadcast channel (page 5, lines 18-31, the downstream spectrum 134 is divided into channels 136 of predetermined bandwidth which is 6 MHz in the United States).

As to claim 45 with respect to claim 34, Uskali of Skones modified teaches the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol (page 5, lines 18-31, the downstream spectrum 134 is divided into channels 136 of predetermined bandwidth which is 6 MHz in the United States).

As to claim 48 with respect to claim 34, Skones teaches

the plurality of desired channels and the plurality of undesired channels comprise a portion of a frequency spectrum of the input signal (figure 1, column 3, line 34 to column 4, line

36, the wideband receiver comprises frequency multiplier 48 to provide an IF signal limited by the BPF 32 to a particular frequency band).

Allowable Subject Matter

Claims 28, 31, 32 and 43, 46 and 47 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

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BLANE J JACKSON whose telephone number is (571)272-7890. The examiner can normally be reached 7:30-4:30 M-TH; 8-2 FRI.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kathy Wang-Hurst can be reached on 571 270 5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit:

https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BLANE J JACKSON/
Primary Examiner, Art Unit 2644

Notice of References Cited	Application/Control No. 17/587,462	Applicant(s)/Patent Under Reexamination Reddy et al.	
	Examiner BLANE J JACKSON	Art Unit 2644	Page 1 of 1

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*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	CPC Classification	US Classification
*	A	US-6760342-B1	07-2004	Skones; William M.	H04B1/28	370/437
*	B	US-7145972-B2	12-2006	Kumar; Rajendra	H04L5/06	375/349
	C					
	D					
	E					
	F					
	G					
	H					
	I					
	J					
	K					
	L					
	M					

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	O	WO-9748196-A1	12-1997	WO	BERGEN R S	H04B10/25753
	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.

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/587,462	Reddy et al.
	Examiner	Art Unit
	BLANE J JACKSON	2644

CPC - Searched*		
Symbol	Date	Examiner
H04N 5/455, 5/50, 21/4382, 21/4383, 21/454, 21/6143, 21/6193	04/07/2022	BJJ
H04B 1/16, 1/0014	04/07/2022	BJJ

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Review of parent patents & IDS, PE@E Search with DP to FAOM	04/07/2022	BJJ

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/587,462	Reddy et al.
	Examiner	Art Unit
	BLANE J JACKSON	2644

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

CLAIMS

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

CLAIM		DATE								
Final	Original	04/08/2022								
	19	✓								
	20	✓								
	21	✓								
	22	✓								
	23	✓								
	24	✓								
	25	✓								
	26	✓								
	27	✓								
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	43	O								
	44	✓								
	45	✓								
	46	O								
	47	O								
	48	✓								

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (02-18)
Approved for use through 11/30/2020. 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 contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	
Filing Date	2022-01-28
First Named Inventor	Madhukar Reddy
Art Unit	
Examiner Name	
Attorney Docket Number	28427US13

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.J.J/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2022-01-28
	First Named Inventor	Madhukar Reddy
	Art Unit	
	Examiner Name	
	Attorney Docket Number	28427US13

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	First Named Inventor	Madhukar Reddy
	Art Unit	
	Examiner Name	
	Attorney Docket Number	28427US13

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	Examiner Name	
	Attorney Docket Number	28427US13

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Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
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	First Named Inventor	Madhukar Reddy
	Art Unit	
	Examiner Name	
	Attorney Docket Number	28427US13

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Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1	2087623	EP	A2	2009-08-12	RF Magic Inc.		

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Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]

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	First Named Inventor	Madhukar Reddy
	Art Unit	
	Examiner Name	
	Attorney Docket Number	28427US13

	1	JEFFREY A. WELDON, et al. "A 1.75-GHz Highly Integrated Narrow-Band CMOS Transmitter With Harmonic-Rejection Mixers, IEEE Journal of Solid-State Circuits, December 2001, pages: 2003-2015, Vol. 36, No. 12, Seattle, Washington.	
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EXAMINER SIGNATURE

Examiner Signature	/BLANE J JACKSON/	Date Considered	04/06/2022

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

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.J.J/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	
	Filing Date	2022-01-28
	First Named Inventor	Madhukar Reddy
	Art Unit	
	Examiner Name	
	Attorney Docket Number	28427US13

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Wayne H. Bradley/	Date (YYYY-MM-DD)	2022-01-28
Name/Print	Wayne H. Bradley	Registration Number	39916

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PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	55	("10313733" OR "10972781" OR "20030158614" OR "20030228855" OR "20040058661" OR "20040110522" OR "20050040909" OR "20050286562" OR "20070002961" OR "20070032220" OR "20070042742" OR "20070111661" OR "20070179649" OR "20070263754" OR "20090075613" OR "20090258629" OR "20110105068" OR "5280636" OR "5590156" OR "5705949" OR "5768268" OR "6253094" OR "6262981" OR "6282184" OR "6735421" OR "6760342" OR "6906498" OR "6920185" OR "6992855" OR "7095454" OR "7145972" OR "7167694" OR "7362178" OR "7373125" OR "7421259" OR "7599673" OR "8107916" OR "8285240" OR "8300681" OR "8331886" OR "8374568" OR "8374569" OR "8374570" OR "8526898" OR "8577319" OR "8666350" OR "8892225" OR "8909187" OR "9059672" OR "9100622" OR "9210362" OR "9210363" OR "9225373" OR	(US-PGPUB; USPAT)	OR	ON	ON	2022/04/06 10:05 AM

		"9819992" OR "9942598").pn.					
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L3	1	"9100622".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2022/04/06 10:37 AM
L4	1	"9210363".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2022/04/06 10:43 AM
L5	1	"9819992".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2022/04/06 10:44 AM
L6	1	"10313733".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2022/04/06 10:46 AM
L7	1	"10972781".pn.	(US-PGPUB; USPAT)	OR	ON	ON	2022/04/06 10:47 AM
L8	3	("9100622").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/04/06 02:11 PM
L9	27	("5590156" | "5705949" | "5768268" | "6253094" | "6262981" | "6282184" | "6735421" | "6760342" | "6920185" | "8107916" | "8331886" | "8892225" | "20030158614" | "20030228855" | "20040058661" | "20040110522" | "20050286562" | "20070002961" | "20070032220" | "20070179649" | "20070263754" | "20090075613" | "20090258629" | "20110105068").pn. OR ("9100622").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/04/06 02:12 PM
L10	58	(H04B OR H04N) AND wideband SAME channelizer AND (TV OR television OR DOCSIS)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/04/06 02:43 PM
L11	39	(H04B OR H04N) AND (wideband adj5 receiver OR tuner) SAME channeliz$4 AND (TV OR television OR DOCSIS)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/04/06 02:45 PM
L12	76	(H04B OR H04N) AND (wideband adj5 receiver OR tuner) SAME channeliz$4 AND (TV OR television OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA,	OR	ON	ON	2022/04/06 02:45 PM

		DOCSIS)	EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L13	93	Reddy-Madhukar.in.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/06 02:53 PM
L14	36	Reddy-Madhukar.in. AND DOCSIS	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/06 02:53 PM
L15	918	Ling-Curtis.in.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO;	OR	ON	ON	2022/04/06 02:54 PM

			JPO; DERWENT; IBM_TDB)				
L16	44172	Ling-Curtis.in. AND television OR DOCSIS	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/06 02:55 PM
L17	587	Ling-Curtis.in. AND (television OR DOCSIS)	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/06 02:55 PM
L18	38	Ling-Curtis.in. AND contiguous adj5 frequencies	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/06 02:56 PM
L19	56	Gallagher-Tim.in.	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB,	OR	ON	ON	2022/04/06 03:01 PM

			HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L25	23070376	(H04N OR H04B) AND (DOCSIS OR headend) near$4 channeliz$4	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/07 11:56 AM
L26	59	(H04N OR H04B) AND (DOCSIS OR headend) SAME channel WITH channeliz$4	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/07 11:56 AM
L27	0	(H04N OR H04B) AND wideband adj6 tuner SAME (DOCSIS OR theadend) SAME channel WITH channeliz$4	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/07 12:03 PM
L28	0	(H04N OR H04B) AND wideband adj6 (tuner OR receiver) SAME (DOCSIS OR tv OR	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU,	OR	ON	ON	2022/04/07 12:03 PM

		television) SAME channel WITH channeliz$4	CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)				
L29	15	(H04N OR H04B) AND wideband adj6 (tuner OR receiver) AND (DOCSIS OR tv OR television) SAME channeliz$4	(US-PGPUB; USPAT; USOCR; FIT (AU, AP, AT, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, OA, RU, SU, WO, MC, MD, MY, NL, NO, NZ, PH, PL, PT, RO, RS, SE, SG, SI, SK, TH, TN, TR, TW, UA, VN); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/07 12:04 PM
L30	35	("5909435" | "6081215" | "6356569" | "6813320" | "6823169").pn. OR ("7145972").urpn. AND (PGPB | USPT | USOC).dbnm.	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/04/07 12:08 PM
L31	1	"7145972".pn. AND (televison OR docsis OR tv)	(US-PGPUB; USPAT; USOCR)	OR	ON	ON	2022/04/07 12:21 PM
L32	373	(H04N OR H04B) AND (DOCSIS OR tv OR television) SAME channeliz$4	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY, CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)	OR	ON	ON	2022/04/07 12:36 PM
L33	91	(H04N OR H04B) AND (DOCSIS OR headend) SAME channeliz$4	(US-PGPUB; USPAT; USOCR; FIT (AP, AT, AU, BE, BG, BR, BY,	OR	ON	ON	2022/04/07 12:42 PM

			CA, CH, CN, CS, CU, CZ, DD, DE, DK, EA, EE, EP, ES, FI, FR, GB, HR, HU, ID, IE, IL, IS, IT, JP, KR, LT, LU, LV, MA, MC, MD, MY, NL, NO, NZ, OA, PH, PL, PT, RO, RS, RU, SE, SG, SI, SK, SU, TH, TN, TR, TW, UA, VN, WO); FPRS; EPO; JPO; DERWENT; IBM_TDB)				

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

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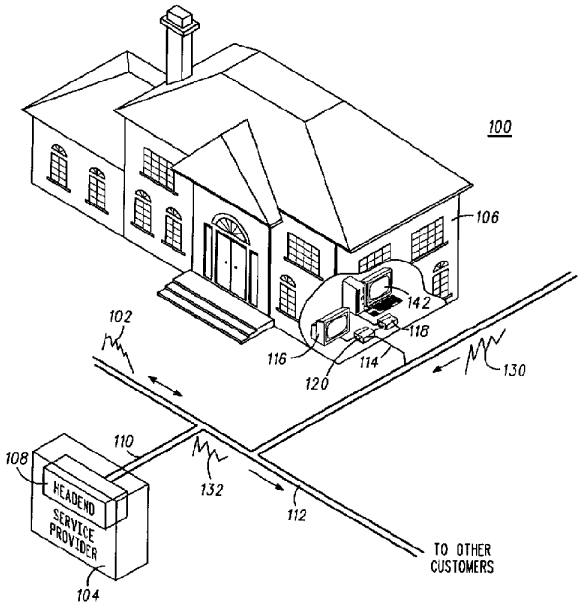
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT,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

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Published:
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[Continued on next page]

(54) Title: IMPROVED CABLE CHANNEL SEARCH SYSTEMS



(57) Abstract: A receiver system (118) rapidly selects a desired downstream receiver channel from the broad cable frequency bandwidth. The system (118) first makes a coarse scan (400) of the signal spectrum (122) to identify the most probable frequency zones, and subsequently makes a high resolution scan (404) of the selected frequency zones to identify the desired channel.

WO 02/087230 A1

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

TITLE OF THE INVENTION

IMPROVED CABLE CHANNEL SEARCH SYSTEMS

FIELD OF THE INVENTION

The present invention relates generally to receiver systems for channelized networks, and more particularly, to methods and apparatus for selecting a desired channel where the channel plan of the channelized network is unknown.

BACKGROUND OF THE INVENTION

Demand for high-speed Internet access has resulted in utilization of receivers such as cable modems to connect to broadband communications networks, such as cable television (CATV) systems, in various countries. The receiver must operate on broadband communications networks that deliver a multitude of services simultaneously. To keep these services from interfering with each other, the service provider allocates each service a distinct band of frequencies on the broadband network as a channel. A channel plan allocates the channels in the broadband frequency spectrum so that they do not interfere with each other.

Regulatory authorities in many countries and regions can, and do, regulate the channel plans of broadband communications networks. Further, even where differing regulatory authorities do not mandate different channel plans, because broadband communications services are typically using closed systems, broadband communications service providers have great flexibility in how they can allocate channels for their networks. The result is a worldwide multitude of channel plans.

Despite the use of a multitude of different channel plans, it is desirable for efficient and economical manufacture of receivers, to have only a minimal number of receiver designs. Such designs could be used throughout many of these countries and regions despite the differences in frequency allocation and utilization. In addition, it is desired that a limited number of receiver

models be manufactured that would work optimally independent of the system in which it is used.

Channel plans define channel allocations by usually defining the center frequency and bandwidth of each channel, and may define the modulation type for the spectrum associated with the upstream and downstream communication signal path. Unfortunately, these cable channel frequency allocations and designs are different in different countries of the international market. For instance, some services do not require an upstream signal path at all

When receivers are first installed, when a receiver is moved, or when there are problems with a previously operating downstream channel the receiver must establish a new valid connection. Without a known channel plan, a receiver may spend an excessive amount of time (many minutes or more) finding the desired communication channel using conventional search algorithms. If a lengthy channel initialization is encountered, the end-user or installation technician must wait for this operation to complete before continuing with use of the receiver. In addition, with an excessive initialization delay, the user may perceive the receiver to be malfunctioning or inoperable.

For example, under Euro-DOCSIS, if a 91 MHz (megahertz, or million cycles per second) to 860 MHz downstream spectrum is to be searched using a brute force method when the channel plan and desired channel is not known, more than 3000 channel possibilities may have to be tested for the desired channel. The time necessary for the receiver to tune and its demodulator to accurately "lock" on the amplitude and phase of the signal is typically 300-1200 or more milliseconds (msec). For a 1000 msec Quadrature Amplitude Modulation (QAM) lock time, the time necessary for a conventional receiver to step through and lock on each possible frequency position in the broadband cable spectrum is significant, and can require up to a 50 minute initial search time for the receiver to find an internet connection channel.

Accordingly, there is a need for methods to enhance the channel scan initialization procedure in order to significantly reduce the time required to

acquire the desired communication channel. Advantageously, such methods would enhance channel scan initialization procedures under both present and future channel plans.

BRIEF DESCRIPTION OF THE DRAWINGS

FIGURES 1a-c illustrates a cable television (CATV) signal distribution system, FIGURE 1a illustrates the signal transmission paths; FIGURE 1b illustrates a typical distribution of the a signal spectrum in a CATV signal distribution system, and FIGURE 1c illustrates some features of a channel in a CATV signal distribution system;

FIGURE 2 is a block diagram of an example of a receiver that can be utilized for channel selection in accordance with the present invention;

FIGURE 3 is a block diagram of an example of a dual conversion tuner that can be utilized as part of a receiver that can be utilized for channel selection in accordance with the present invention;

FIGURE 4 illustrates a flowchart diagram of a spectral loading characterization process in accordance with a preferred embodiment of the present invention;

FIGURE 5 illustrates how the combination of local oscillators, mixers and filters in a dual conversion tuner can be used to select a bandwidth of downstream signal;

FIGURE 6a illustrates selected signal types that can be present in a downstream spectrum while FIGURE 6b illustrates a possible constructed channel response of FIGURE 6a;

FIGURE 7 is a flowchart diagram of an example of a QAM channel check which may be used in a preferred embodiment of the present invention to; and

FIGURE 8 illustrates another embodiment of an example of a method to identify a desired channel that uses a fast Fourier transform (FFT).

DETAILED DESCRIPTION OF THE INVENTION

This invention provides receivers for broadband communications networks with improved channel search capabilities by evaluating the

downstream input spectrum to identify the most probable frequency regions of the input spectrum that may contain desired channels when the overall channel plan or the region of a desired channel are not known.

A method of the present invention locates a desired downstream channel in a broad frequency spectrum input signal. This is done by generating a constructed channel response (also constructed spectrum response) from the broad frequency spectrum input signal. The constructed channel response is then processed to generate a list of prospective channels. The channels in the prospective channel list are then checked until a desired downstream channel is identified.

Referring to the FIGURES 1a-c, and particularly to FIGURE 1a, a broadband communications network **100** transmits signals **102** between a broadband communications service provider (or "service provider" or "provider") **104** and a customer **106**. A common provider **104** of broadband communications networks **100** throughout the world are cable television companies, where the same cable transmits signals **102** for both television viewing and digital communications. For ease of explanation, the channels and the input spectrum are explained as part of a channelized cable television (CATV) system, but could be part of any channelized system.

The signals **102** from the service provider **104** to the customer **106** typically run from a headend **108** to a trunk line **110**, and from a trunk line **110** to a distribution line **112**. A drop line **114** typically connects the customer's **106** equipment (or hardware) to the distribution line **112**. The customer may connect equipment such as a television **116**, a receiver **118** such as a cable modem, set top box or telephony module to the drop line **114**. Frequently a splitter **120** is used so that the customer **106** can connect both a television **116** and a receiver **118** to the drop line **114**. The signals **102** from the customer to the service provider follow the opposite path. For simplicity of explanation, the different kinds of lines that can be present in the middle of the distribution chain between the headend **108** on the service provider's side,

and the customer's **106** equipment (such as a television **116** or cable modem) on the customer's side **106** are generally omitted hereinafter.

The broadband communications network **100** will carry signals **102** in a frequency spectrum (or spectrum) **122**. The spectrum **122** for a broadband network **100** typically has a frequency range from about 5 MHz or less at the lower end **124**, to about 860 MHz presently, and possibly 1 GHz or more in the future at the upper end **126**.

Referring in particular to FIGURES 1a-c, and in particular FIGURE 1b, an "upstream" signal frequency portion of the spectrum (or upstream portion, or upstream spectrum) **128** is reserved for upstream signals **130** sent from the customer **106** to the service provider **104**. Upstream signals **130** are transmitted from the customer's **106** equipment to the headend **108** in the upstream signal frequency portion **128** of the spectrum **122**. The upstream signal frequency portion **128** of the spectrum is usually about 5-70 MHz, but can be at any frequencies carried by the network **100**. The upstream signals **130** are typically both frequency and time division multiplexed to identify individual customers **106**, but do not have to be.

"Downstream" signals **132** from the service provider **104** are sent from its headend **108** to the customers **106**, typically in a downstream frequency portion of the spectrum (or downstream portion or downstream spectrum) **134** at frequencies above about 70 MHz, but the frequencies used can be any frequencies carried by the network **100**. The downstream spectrum **134** is typically divided into channels **136** of predetermined bandwidth, which in the United States are generally 6 MHz in width, and in Europe are generally 8 MHz in bandwidth. Referring to FIGURE 1c, channels **136** are usually defined, conventionally, by the center of the frequency range included in the channel (called the center frequency or channel center) **138** and the size of the frequency spectrum dedicated to the channel (called channel bandwidth) **140**. The present invention is not, however, limited to systems where all the channels **136** have the same channel bandwidth **140** or are designated by center frequencies **138**.

The channels **136** in the downstream spectrum **134** can carry a variety of signals of various modulation types, e.g., 64 QAM, 256 QAM, vestigial sideband (VSB)-amplitude modulation (AM), 8 VSB, 16 VSB, orthogonal frequency division multiplexing OFDM) or any other channelized modulation format, including, but not limited to 64 or 256 QAM, cable television channels, QPSK and QAM communication channels.

This invention characterizes the downstream spectrum **134**. Two embodiments are described in this disclosure, but the present invention can be present in a multitude of other embodiments, and the invention is not limited to the embodiments described herein. When the input spectrum characterization is complete, a detection algorithm is used to identify the desired downstream channel. An example of such a detection algorithm is a QAM detection algorithm used to detect QAM channels (the type of encoding used on cable modem networks currently), and the operation of the embodiments listed here are expressed in terms of detecting QAM channels, and channels on cable systems, but is not limited to such.

As illustrated in FIGURE 1a, a receiver **118** is connected to the service provider's **104** headend **108** and the customer's **106** computer system **142**. In a CATV system, the headend **108** and the receiver **118** are usually connected with a cable. For the cable any combination of coax, fiber, and fixed wireless links may be used, but typically fiber and coax both are used i.e. not just coaxial cable. The connection between the receiver **118** and the computer system **142** is via a variety of possible connections, but typically is a 10 base T or 100 base T Ethernet, firewire IEEE 1394, or USB connection. While those are the cablings typically used for such connections, the present invention can be used with other forms of wired or unwired networks **100** suitable for carrying a frequency spectrum **122** to a receiver **118**, including but not limited to coaxial cabling, twisted pair wiring, fiber optic cabling, hybrid, coaxial/fiberoptic cabling, infrared transmitters, and over the air transmission such as with wireless LAN transmitters, and other systems known to those skilled in the art.

Illustrated in FIGURE 2 is a block diagram useful in understanding some of the elements of a commercial receiver **118**. A receiver **118** having hardware suitable for the practice of this invention is sold by Motorola Corporation under its trademark CyberSURFR. As is known to those skilled in the art, diagrams such as FIGURE 2 serve to illustrate the functions of a piece of equipment, and do not necessarily represent how hardware is embodied to carry out the tasks. It will be apparent to those skilled in the art that the functionality of the present invention can be achieved with a variety of approaches and implemented in a number of substantially equivalent ways. The present invention is not limited to the particular implementations and embodiments disclosed.

The receiver **118** has a signal input **200**. The signal input **200** conducts downstream signals **132** from the headend **108** to a physical layer **202**, which has a downstream component called the downstream physical layer **204**. The downstream physical layer comprises a downstream tuner **205** and a demodulator **208**. The downstream physical layer **204** accepts downstream input signals **132** from the headend **108** and the downstream tuner **205** processes the downstream signals **132** before providing a tuned signal **206** to the demodulator **208**. A media access controller (MAC) **210** connects the modulator **212** and the demodulator **208** to a first memory **214** and a central processing unit **216**. The central processing unit **216** is connected to a second memory **218** and a host computer physical layer **220**, which is typically an Ethernet layer. The host computer physical layer **220** sends signals to and receives signals from the host **142.**

The downstream tuner **205** processes the downstream signal **132** before the tuned signal **206** is sent to the demodulator **208**. The tuning that the downstream tuner **205** performs can include, but is not limited to, selecting a frequency range of signals to be sent to the demodulator **208**, scaling the amplitude of the signals to make good use of the amplitude range of the demodulator **208**, and shifting the frequency of the signals to occupy a frequency spectrum that the demodulator **208** operates well with.

Referring to FIGURE 3, receivers **118** typically employ automatic gain control (AGC) systems in the downstream physical layer **204** to provide constant signal levels to the demodulator **208**. FIGURE 3 includes a dual conversion tuner suitable for the present invention, but those skilled in the art will appreciate that single or multiple conversion tuners can be used with the present invention. The downstream tuner **205** selects a fixed bandwidth of the downstream signals **132** to pass on as tuned signals **206**, the width of the frequency range of the signals being passed on being the bandpass of the downstream physical tuner **205**. Although present receivers currently use tuning electronics that select a fixed bandwidth, the present invention is not limited to such.

FIGURE 3 illustrates a simplified block diagram of an example of a downstream physical layer **300** according to a preferred embodiment of the present invention. The illustrated downstream physical layer **300** has at least one variable gain device and preferably comprises at least two variable gain devices **302, 304**, a power detector **306**, a control mechanism **308** and is connected to a microprocessor (CPU) **216** via an media access controller (MAC) **210**. Since the microprocessor **216** and MAC are not necessarily a part of the downstream physical layer, they are separated from the other components by a boundary line **324**. These components can reside in the receiver **118** as discrete components or combined components with any other compatible component of the receiver **118**. The variable gain devices **302, 304** may be attenuators or variable gain amplifiers

The downstream physical layer **300** illustrated in FIGURE 3 operates as a dual conversion receiver that has a first filter **312** and a second filter **314**, the first and second filters **312, 314** having respective associated tuning electronics, said respective associated tuning electronics being capable of being tuned independently of each other. The first and second filters **312, 314** are typically bandpass filters. In the illustrated embodiment, each filter **312, 314** is preceded by a respective mixer (first mixer and second mixer) **316 318** connected to a respective local oscillator (LO)(first local oscillator and second

local oscillator) **320, 322** that shift the frequency of the downstream signal **132** to place a desired portion of the downstream stream signal within the bandpass of the respective filters **312, 314.**

Usually, because of cost considerations, the first filter **312** has a bandpass that is substantially wider than the bandwidth allocated to the channels **140** on the broadband network **100.** A bandpass of 30-40 MHz is typical for the first filter of dual conversion tuner on a receiver **118** such as the CyberSURFR modem. The second filter **314** preferably has a bandpass of about the same bandwidth as the bandwidth of the channels **136** allocated to services on the broadband network **100.** The first and second filters **312, 314** in series have a combined bandpass that allows signals having frequencies in common with the two bandpasses to pass through. This combined bandpass is the bandwidth of the downstream tuner. If the channels **136** on the broadband network **100** vary in bandwidth, either the second filter **314** should be of adjustable width, or appropriate additional tuners should be supplied with the receiver. In the United States the bandpass of the second filter **312** is normally 6 MHz, and in Europe the bandpass is normally 8 MHz.

FIGURE 4 is a flowchart that illustrates the first spectral loading characterization method. In this algorithm, a first, coarse spectral loading scan (also coarse spectral scan, coarse loading scan or coarse scan) **400** is performed. This is accomplished by tuning the downstream physical layer **204** to sample the ranges of interest of the input signal **132** between a desired lower spectrum limit **144** to a desired upper spectral limit **146.** Currently, systems for which cable modems **118** are used would have a downstream spectrum **134** of about 50-1,000 MHz, but the invention will work with other downstream spectrum **134** ranges as well.

The coarse spectral loading scan **400** is preferably accomplished by defining a set of measurements to be taken that will measure the entire downstream spectrum **134** between the desired lower spectrum limit **144** and the desired upper spectrum limit **146.** One approach is to begin at one end of the downstream frequency spectrum **134** and serially step at a relatively

broad frequency increment up or down the downstream frequency spectrum **134** toward the other end of the spectrum **134**. Preferably, the coarse frequency step **size** will be in the range of from about 1/2 the bandwidth of the downstream tuner (which, in a dual conversion tuner, may be a combined bandpass or more commonly, the bandwidth of the second filter), to about twice the bandwidth of the downstream tuner, and most preferably corresponding to the downstream tuner's bandwidth. For each measurement of the set of measurements, the channel power is measured and can be stored in memory 218.

The channel power can be measured using the power measurement capabilities of the receiver **118** that are standard in such receivers currently. In the embodiment illustrated in FIGURE 3, the power detector (or detector) **306** and the control mechanism **308** reside in the demodulator **208**, but may be located elsewhere in the receiver **118**. The power detector **306** provides a means to measure the incoming signal level of the selected "coarse" or "fine" input frequency range to the detector **308** provided by the downstream physical layer **204**. The power level is also used as part of a feedback variable gain control mechanism to set a desired signal level into the demodulator **208** as part of an automatic gain control (AGC) system **300**.

It should be noted that the time required to measure channel power can be significantly less than the time required to determine whether a channel is a desired channel by other methods. In the case of a typical cable modem **118**, the time to perform a QAM lock test is substantially longer than the time required to do a power measurement. A typical power measurement using present hardware can take about 6ms while a QAM lock test using current QAM lock circuitry can take about 1000ms. This time difference provides significant improvement in channel search time in accordance with the present invention. The power measurement feature utilized in the present invention is typically included in conventional receivers **118** for other purposes such as diagnostics, network management, and automatic gain control feed back. To obtain the minimum time for channel power measurement, the

receiver may be optimally configured for this purpose. For example, the AGC loop bandwidth may be increased for the channel power measurement. In a receiver **118** such as the CyberSURFR modem the AGC loop bandwidth can be set by a register contained within the demodulator's "AGC Control Mechanism."

Another step in the first algorithm is to determine the power containing regions **402** of the downstream spectrum from the results of the coarse spectral loading scan **400**. This is done by identifying a number of regions, K, where power above a threshold standard is detected. The set of measurements to detect power constitutes a power spectrum, and the frequency spectrum covered by the set of measurements where power is detected are power containing regions of the power spectrum, or power containing regions for short. Either the power spectrum, or just the power containing regions, can be recorded in digital memory, and can be processed to select potential frequency ranges for the desired channel. For example, this coarse scan may determine that based on a predetermined threshold, for instance, -15dBmV, that no channels are present over one or more power lacking regions (regions not meeting the predetermined threshold) of the power spectrum (e.g., regions totaling, say, 550 MHz in a particular system). Ultimately, this information will reduce the search time for the desired downstream channel because these power lacking regions need not be searched.

Referring again to FIGURE 4, another step in the first spectral characterization approach is a finer spectrum scan **404** which is performed over the at least the power containing regions. The finer spectrum scan **404** has a finer resolution, that is more data points over the same spectral regions as the coarse scan **400**. While the finer spectrum scan can be done by performing measurements that have overlapping spectral ranges or by performing measurements that have narrower spectral ranges than the coarse scan or by performing scans that do both, the present invention can work with

a wide variety of methods for taking a finer spectrum scan that will be apparent to those skilled in the art.

The bandwidth covered by a measurement can be reduced **406** (or narrowed) if a dual or multiple conversion tuner is being used. . Reduction of the measurement bandwidth in a dual or multi conversion tuner can be easily accomplished without added circuitry in the unique manner as described below. However, this does not mean that such measurement bandwidth narrowing is exclusive to dual/multi tuners. It can be accomplished in a single conversion tuner by switching in a narrow bandwidth filter in place of filter 314, by switching in an additional bandpass filter, limiting amp 304 bandwidth, or by other methods known to those skilled in the art.

As described above, such tuners have at least a first filter **312** and second filter **314** that can be used in an unconventional way to narrow the frequency range for a signal power measurement. As illustrated in FIGURE 5a, the mixers **316, 318** and respective local oscillators **320, 322,** cooperate such that the signal frequencies passing through the second filter **502** are normally located entirely within the signal frequencies passing through the first filter **500** resulting in a first net bandpass **506** such that an entire channel's signal passes through both filters. Alternatively, as illustrated in FIGURE 5b, however, the frequencies passed through the pair of filters **312, 314** can be reduced by having the oscillators **316, 318** and mixers **320, 322** positioning the center of the bandpass **508** of the second filter **314** at the "edge" of the bandpass of the first filter **312.** The resultant second net bandpass **510** is narrower than the bandpass of either filter. Usually, this is accomplished by offsetting the second local oscillator frequency from its normal value. Although more precise results may be obtained with this offset technique, it is not required by this invention.

Returning to FIGURE 4, with or without the bandwidth reduction or narrowing, a fine spectral loading scan (or fine scan) **404** can be performed by scanning the power containing regions at a finer frequency increment than the original course scan increment. The downstream physical layer **204** is

methodically tuned to each test frequency range where the input power is measured and stored in memory.

For example, for a European DOCSIS cable system, the coarse scan **400** may be performed with 8 MHz intervals to determine power containing spectral regions **402** with power containing or power lacking channels. In another step, a higher frequency resolution (fine or relatively finer or finer resolution) scan **404** can be performed using a smaller frequency interval, which is less than one half, the frequency interval of the coarse scan, for example, about 2 MHz. In each case, channel power is measured and stored in memory for each measurement of the set of measurements. The set of measurements is a constructed channel response.

After the power levels of the power containing spectral regions have been quantified by the fine scan **404**, potential desired channels are identified via an off-line processing operation **408**. The input spectrum characterization may be performed by the microprocessor **216**. Referring to FIGURE 6, this offline processing operation **408** "views" the constructed channel response obtained during the fine resolution scan to identify features such as NTSC video carriers **600**, QAM signals **602**, and voids **604**.

By using pattern matching techniques, a large variety of which are known in the art, channel content can be tentatively identified without actually having to establish a lock on the signal. The offline processing operation **408** characterizes the constructed channel response. One way of conducting the offline processing operation determines the signal type, bandwidth, and center frequency, but many different techniques may be derived for this purpose. For example, a simple approach in determining the center frequency and bandwidth of the incoming signal involves an analysis of the minimum ("valley") and maximum ("peaks") values of the constructed spectrum response.

Referring to FIGURES 6 a-b, it can be seen that peaks **606** and valleys **608** are present. By cataloging these peaks **606** and valleys **608**, and calculating the frequency differences between peaks **610** as well as the

frequency differences between valleys **612**, it can be surmised that it is quite likely that 6 MHz bandwidth signals are present. In addition, the absolute frequency of the valleys **614** or peaks **616** give indications to the actual center frequency **618** of the measured channel **620**. Further analysis of the constructed spectrum response can give indications of the signal type.

For example, as can be seen in FIGURES 6a-b, a downstream QAM signal **602** compared to a NTSC analog video signal **600** has a much more uniform amplitude response. In the example of FIGURE 6b, the shape of the constructed signal within one 6 MHz wide region **618** defined by two valleys **614** tends to have an asymmetrical peaking response with more spectral energy in the leftmost area **626** of the assumed channel. It can be surmised that this response shape was generated from the corresponding analog video NTSC signal shown above it in FIGURE 6a.

In order to enable signal type determination, pattern matching and correction techniques are used. For example, a simple shape mask could be used to sort NTSC signals **600** from QAM signals **602**. A mask for each signal type must first be created representing the typical spectral properties of each signal. Next, the constructed spectrum response is divided into prospective channels by methods as previously described (including, but limited to peak and valley analysis). Each constructed channel response can be normalized to aid in comparison to the predefined signal mask. At this point, one of any number of standard or custom defined correlation methods known to those skilled in the art can be applied. Correlation to each mask is attempted resulting in "scored" responses. After completing a cross-correlation operation, a determination of the recovered signal type can be made based on the correlation results.

As a result of the pattern matching technique above, a list of prospective desired channels is generated. Preferably, this list is generated by identifying the center frequencies and bandwidths of the channels **136**. The number of prospective channels in this list can be very small compared to the total number of possible channels (5-100, versus 3000, for example) for

the desired channel's signal. With a channel power measurement time of 6 msec, all power measurements required in the algorithm of FIGURE 4 may be performed in less than 2 seconds.

FIGURE 7 illustrates a standard channel check algorithm that can be performed on each of the prospective desired channels until the desired downstream channel is located. For purposes of illustration, a QAM check algorithm has been illustrated because QAM encoding is the type used for cable modems. The invention is not, however, limited to QAM encoding. A prospective channel is selected and the downstream physical layer **204** is configured **700** to present that channel's tuned signal **206** to the demodulator **208**. In another step, the receiver **118,** usually through its demodulator **208,** checks if it can lock on to the desired channel **702**. If it can, then the receiver **118**, usually through its media access controller **210,** can check for a forward error correction (FEC) lock **704**. Further, the can check for MPEG packetization synchronization **706**. In another step, the receiver, usually through its media access controller, checks for recognized downstream MAC SYN messages, and if such messages are found, identifies the channel as a valid QAM channel. If the channel is valid, then procedures appropriate to having found a valid QAM channel are performed **708** which will depend on the system (with or without termination of the search), or if the channel was not a valid QAM channel, the next prospective channel in the list is checked **710**.

FIGURE 8 is a flowchart of an alternate QAM identification method that can be used in place of the method of FIGURE 4. As in the method of FIGURE 4, the same coarse spectral loading characterization **800** can be performed. The amount of processing required in the later steps of this procedure can be reduced by determining the power containing regions of the spectrum **802.** The receiver can then be configured **804** to perform a spectral analysis operation, preferably, as illustrated, a fast Fourier transform (FFT). The spectral analysis operation would usually be performed in the demodulator. Thereafter, for each power containing spectral region, a

constructed channel response is determined by means of a spectrum analysis operation **806** performed by the receiver, usually in the demodulator. Although the FFT method is illustrated and preferred, other spectrum analysis methods will be apparent to those skilled in the art and are also part of the present invention.

After each of the power containing spectral regions are characterized as described above, a more complete spectral response of the power containing regions of the spectrum can be constructed **808** by combining the individual spectrum analyses to make up a larger response. Reference amplitudes of the spectral analysis responses can be determined by the power measurements made in the coarse spectral scan operation. These reference amplitudes can be used to calibrate the spectral analyses so that adjacent spectrum analyses can be combined to form larger spectrum analyses. Preferably, all adjacent power containing regions are combined to construct contiguous power containing regions.

Although these spectral analyses are performed on contiguous, non-overlapping portions of the downstream spectrum, the measurements can also be performed by overlapping the regions covered by individual spectrum analysis operations. When the spectral analyses overlap in the downstream spectrum, the overlapping portions can be used to scale the regions relative to one another to calibrate the entire spectrum as will be apparent to those skilled in the art.

Within the fully constructed power containing portion of the spectrum, prospective desired channels are identified and a list of these channel centers and bandwidths is generated, and may be stored in the microprocessor memory. Optionally, the shape of the spectrum of channels identified as desired channels can be analyzed to determine if the prospective desired channel has the width and shape of the desired channel, and unsuitable channels removed from the list.

Like the process in FIGURE 4 **408**, after the channel power spectrum characterization data is collected, it is interpreted by an algorithm (preferably

implemented via a microprocessor) with embedded software that in turn identifies prospective cable channel frequencies for selective testing for specific desired channel identification. The algorithm identifies potential desired channels (in the illustrated embodiment, QAM channels) based on analyzing the reconstructed total spectrum response **808.**

EXAMPLES

Example 1 - Analysis By Fine Increment Power Scan

The broadband network provides a downstream signal in the downstream frequency spectrum of 46 MHz to 854 MHz. Within that downstream signal, at an unknown frequency, is a 64 QAM channel used for digital communication. The broadband network is connected to a receiver. The desired channel is a 64 QAM channel with a bandwidth of 8 MHz centered at 710 MHz.

The receiver can perform a coarse spectral loading scan by measuring the downstream frequency spectrum beginning with a series of power measurements that measure a bandwidth of 8 MHz each. A power detector in the receiver performs the power measurements. The first measurement can have a bandwidth of 8 MHz and a center at 50 MHz, and cover the spectrum from 46 MHz to 54 MHz. Successive measurements will have bandwidths of 8 MHz and centers with increments 8 MHz higher than the previous measurement. The one hundredth measurement will have a center at 850 MHz and cover the spectrum from 846 MHz to 854 MHz. The power measurements can be stored in memory.

A microprocessor can then determine whether the power measurements stored in memory surpass a power threshold of –15dBmV. The microprocessor then identifies contiguous regions containing power. For the purposes of this example, the regions from 46-454 MHz, 606-694 MHz, and 706-714 MHz are found to contain power.

The receiver then scans the first power containing region at a bandwidth of 8 MHz, with an increment of 2 MHz. The first measurement will be centered at 40 MHz, the second at 56 MHz, and so on until the last

measurement is centered at 460 MHz. An offline processing operation will then examine the result of the finer incremented power scan to identify regions where a 64 QAM channel can be found and generate a list of possible desired channel frequency centers and bandwidths. No possible channels are found.

The receiver then scans the second power containing region at a bandwidth of 8 MHz, with an increment of 2 MHz. The first measurement of the second set will be centered at 600 MHz, the second at 602 MHz until the last is centered at 700 MHz. An offline processing operation again examines the results to see if the shape of the power measurements could be consistent with a 64 QAM channel. The offline processing operation identifies three possible 64 QAM channels centered at 674 MHz, 682 MHz, and 690 MHz.

The receiver then scans the third power containing region at a bandwidth of 8MHz starting at 700 MHz and running to 720 MHz in increments of 2 MHz. The ensuing offline processing operation identifies the channel as a possible QAM channel.

A 64 QAM check algorithm is then performed. The downstream physical layer is configured to receive an 8 MHz wide channel at 674.5 MHz. The demodulator then attempts to establish a QAM lock, that is, whether it can identify signals located at the proper patterns of amplitude and phase for that kind of signal. The lock fails.

A 64 QAM check algorithm is also attempted on the channel at 682.5 MHz, and succeeds. The demodulator of the receiver then tries to establish a forward error correction (FEC) lock. The lock fails.

A 64 QAM check algorithm is then attempted on the channel at 690.5 MHz, and succeeds, and the FEC lock also succeeds. The demodulator checks for MPEG packetization synchronization and fails.

A 64 QAM check algorithm is then attempted on the channel at 710.5 MHz. The QAM lock, FEC lock, and MPEG packetization synchronization all succeed. The media access controller checks for MAC SYN messages. When the media access controller recognizes a MAC SYN message, the

channel at 710.5 MHz is identified as valid, and the desired channel has been found.

Example 2 - Analysis By Fine Increment Power Scan In 250 kHz Steps

To better identify each potential QAM channel's center, the search is done as in Example 1, except that the local oscillators of the downstream tuner are set so that only 250 kHz of downstream signal passes through both filters. Then each of the prospective channels at 674, 682, 690 and 710 MHz is scanned in steps of 250 kHz. The finer scan finds that the shape of the channel at 674 MHz is not as consistent with 64 QAM as the others and that channel is placed at the end of the prospective channel list. The number of potential QAM channels (L) is 4. Optionally, the channel at 674 MHz could just as easily be deleted from the prospective channel list, reducing L to 3.

Example 3 - Analysis by Fast Fourier Transform

Alternatively, the receiver can be provided with firmware or hardware fast Fourier transform (FFT) capability. To better identify each potential QAM channel's center and the shape of each signal, the search is done as in Example 1, except that the local oscillators of the downstream tuner are set so that the full bandwidth of the downstream tuner passes through. A fast Fourier transform is then performed on the signal received. The downstream tuner is then set to select another section of the downstream signal and another fast Fourier transform is performed on that section of the downstream signal. This is done for the full spectrum of interest, with the separate scans being scaled by the results of the coarse power scan measurements. These scaled results are combined to provide a complete picture of the power-containing portions of the downstream spectrum. This results in an even finer resolution than even the 250KHz bandwidth power scan, and finds that the shape of the channel at 674 MHz is not consistent with 64 QAM and deletes it from the prospective channel list, reducing L to 3.

Example 4 - Analysis by Fast Fourier Transform with Alternative Scaling

The fast Fourier channel scan of Example 3 can be performed by overlapping the scans by 1/4 of the bandwidth of the downstream tuner. The

overlapping sections can be compared and scaled against each other to provide a complete picture of the power containing portions of the downstream spectrum.

While the invention has been described in conjunction with a specific embodiment thereof, additional advantages and modifications will readily occur to those skilled in the art. The invention, in its broader aspects, is therefore not limited to the specific details, representative apparatus, and illustrative examples shown and described. Various alterations, modifications and variations will be apparent to those skilled in the art in light of the foregoing description. Thus, it should be understood that the invention is not limited by the foregoing description, but embraces all such alterations, modifications and variations in accordance with the spirit and scope of the appended claims.

CLAIMS

1. A method for locating a desired channel in a downstream signal comprising the steps of:

scanning the downstream signal to generate a constructed channel response;

processing the constructed channel response to generate a prospective channel list; and

checking the prospective channel list to find the desired channel.

2. The method of claim 1 comprising in addition the step of scanning the downstream signal with a coarse power spectrum scan to identify power containing regions of the downstream signal, wherein the step of scanning the downstream signal scans the power containing regions.

3. A method in accordance with Claim 1 wherein the coarse power spectrum scan has an increment that corresponds to a downstream physical layer bandwidth of about 6-8 MHz.

4. A method in accordance with Claim 1 wherein scanning the downstream signal comprises a relatively finer bandwidth power spectrum scan.

5. A method in accordance with Claim 1 wherein scanning the downstream signal comprises a relatively finer increment power spectrum scan.

6. A method in accordance with Claim 1 wherein scanning the downstream signal comprises performing at least one spectrum analysis operation.

7. A method in accordance with Claim 5, wherein the spectrum analysis operation comprises a fast Fourier transform.

8. A method in accordance with Claim 1, wherein the prospective channel list is checked with a QAM lock algorithm.

9. A method for locating a desired channel in a downstream signal comprising the steps of:

identifying power containing regions of the downstream signal with a relatively coarse power spectrum scan wherein each step of the scan covers about a 6-8 MHz portion of the downstream signal;

performing a relatively finer power spectrum scan on the power containing regions of the downstream signal to generate a constructed channel response of the power containing regions;

processing the constructed channel response of the power containing regions to generate a prospective channel list; and

checking the prospective channel list with a QAM lock algorithm until the desired channel is identified.

10. A method for locating a desired channel in a downstream signal comprising the steps of:

identifying power containing regions of the downstream signal with a relatively coarse power spectrum scan wherein each step of the scan covers about a 6-8 MHz portion of the downstream signal;

performing a Fourier analysis on the power containing regions of the downstream signal to generate a constructed channel response of the power containing regions;

processing the constructed channel response of the power containing regions to generate a prospective channel list; and

checking the prospective channel list with a QAM lock algorithm until the desired channel is identified.

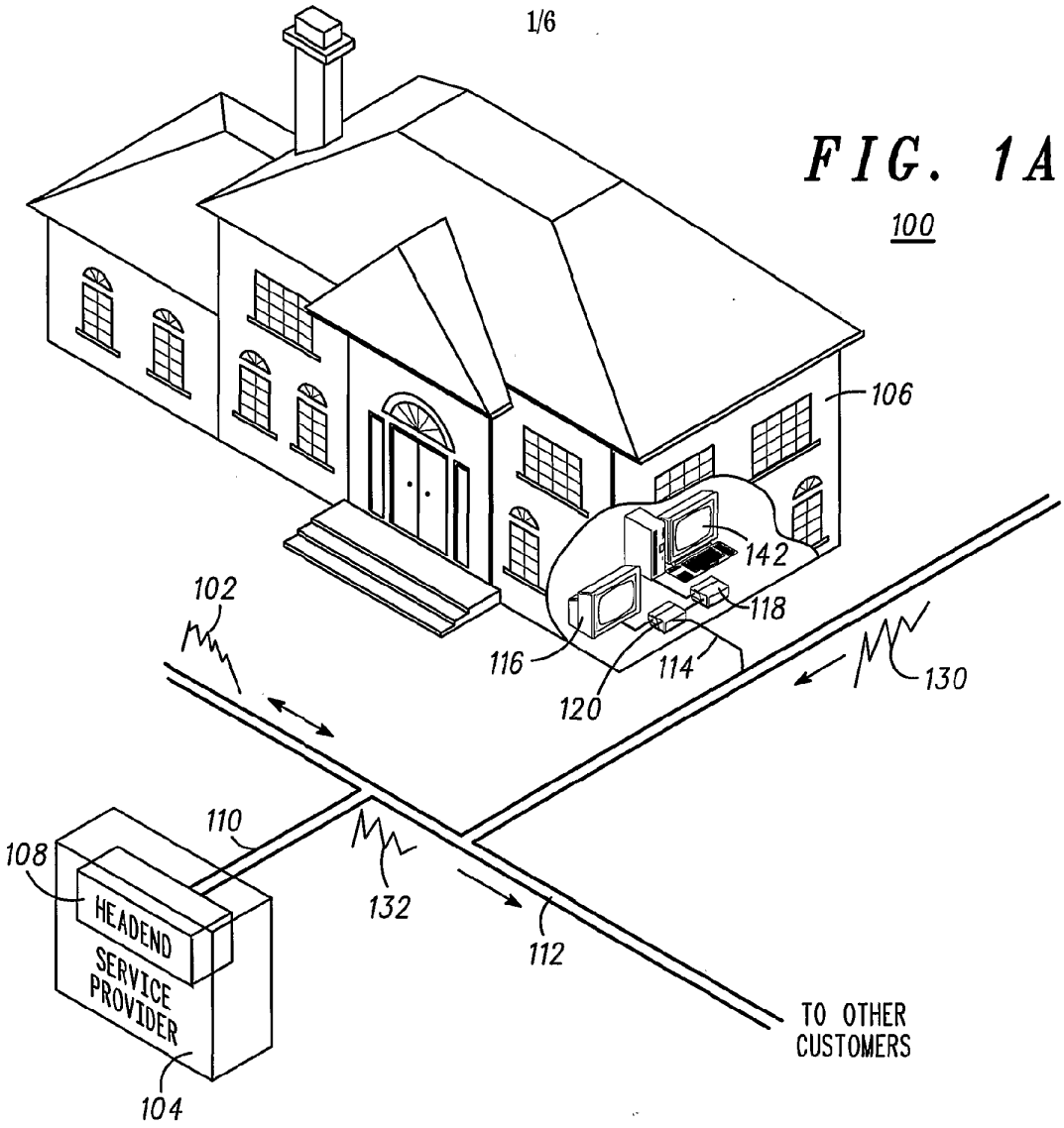


FIG. 1A

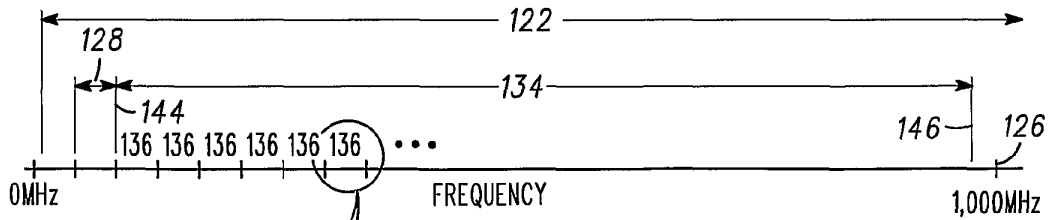


FIG. 1B

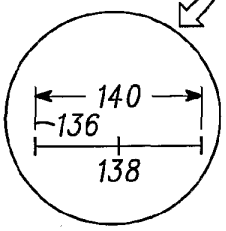


FIG. 1C

FIG. 2

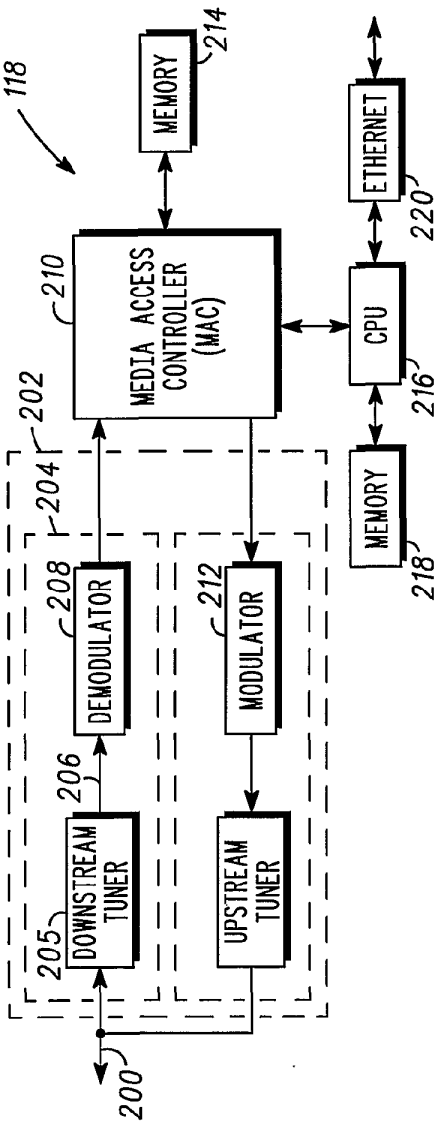
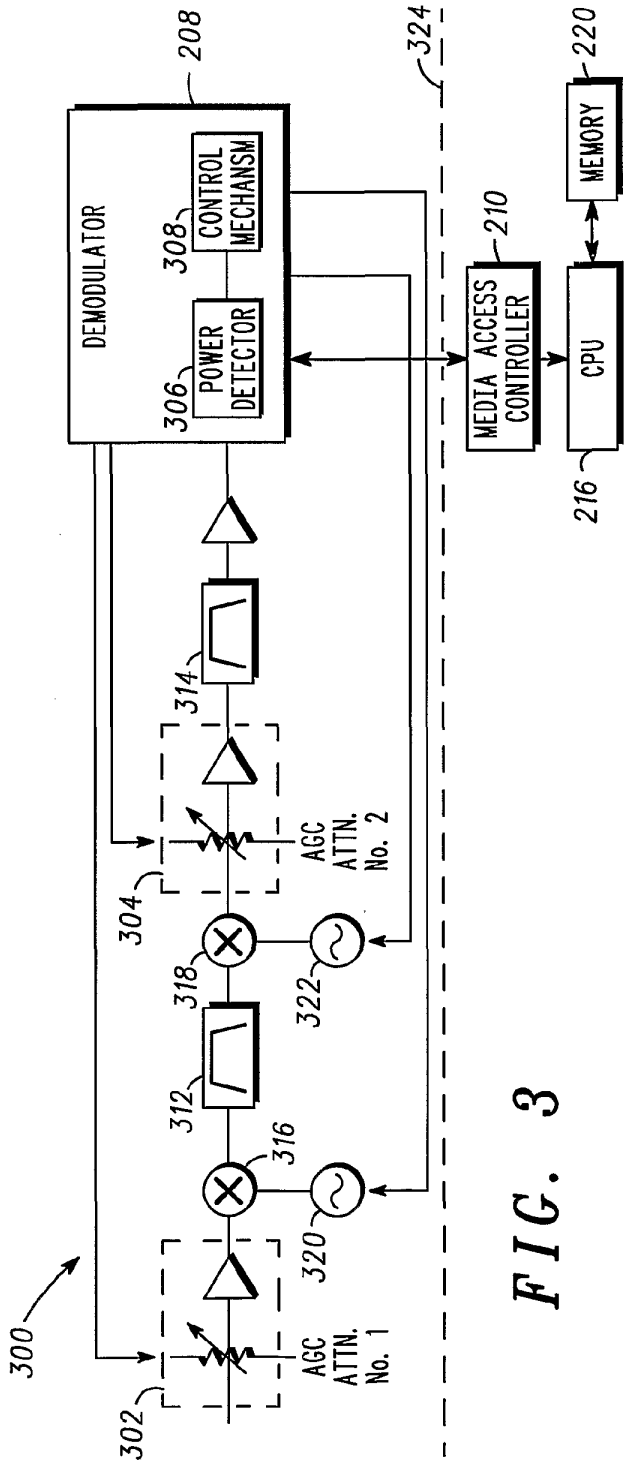

118
MEMORY
214
ETHERNET
220
210
MEDIA ACCESS CONTROLLER (MAC)
CPU
216
202
204
208
DEMODULATOR
212
MODULATOR
MEMORY
218
206
DOWNSTREAM TUNER
UPSTREAM TUNER
205
200

FIG. 3


208
DEMODULATOR
308
CONTROL MECHANSM
306
POWER DETECTOR
324
MEDIA ACCESS CONTROLLER
210
MEMORY
220
CPU
216
314
304
AGC ATTN. No. 2
318
322
312
316
320
300
AGC ATTN. No. 1
302

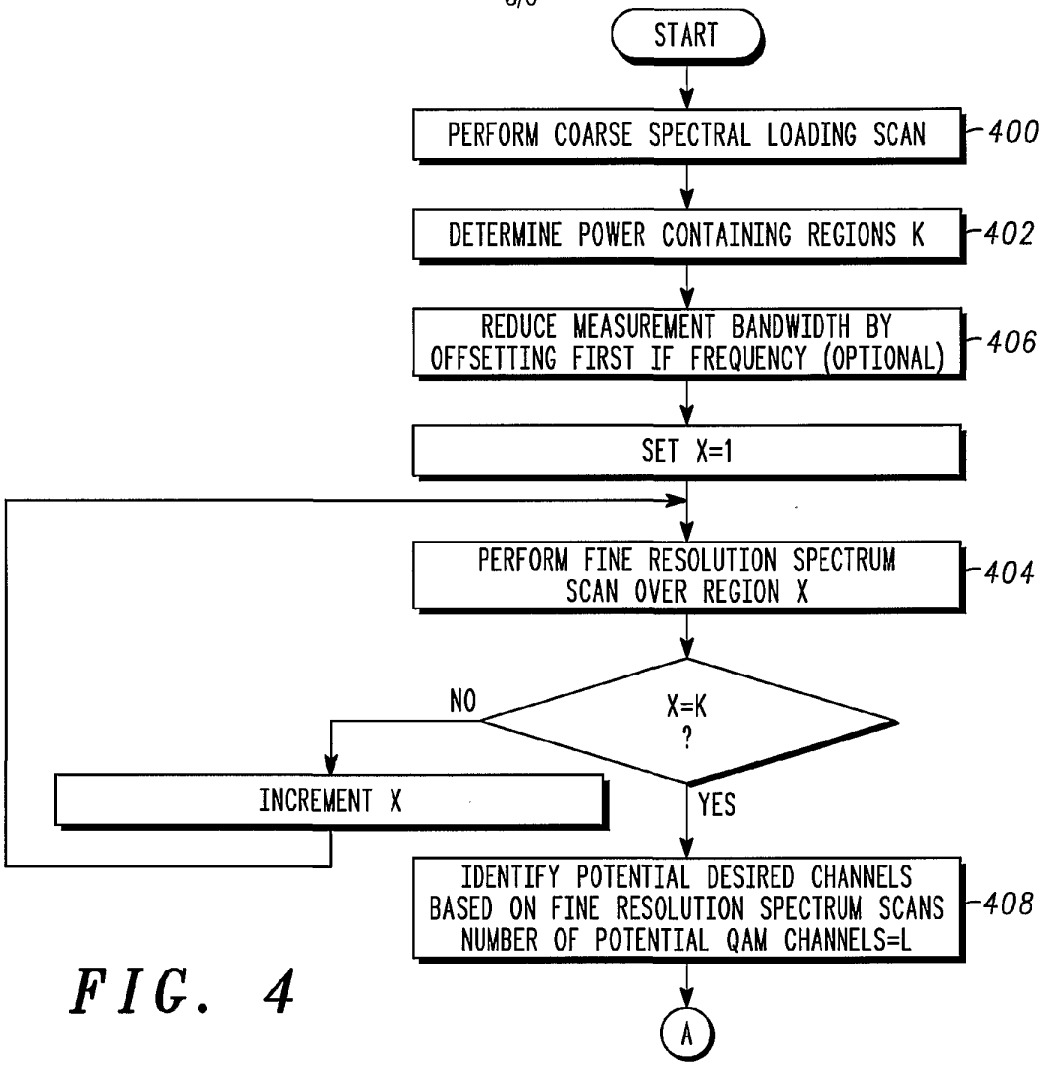

START
PERFORM COARSE SPECTRAL LOADING SCAN
400
DETERMINE POWER CONTAINING REGIONS K
402
REDUCE MEASUREMENT BANDWIDTH BY OFFSETTING FIRST IF FREQUENCY (OPTIONAL)
406
SET X=1
PERFORM FINE RESOLUTION SPECTRUM SCAN OVER REGION X
404
X=K ?
NO
YES
INCREMENT X
IDENTIFY POTENTIAL DESIRED CHANNELS BASED ON FINE RESOLUTION SPECTRUM SCANS NUMBER OF POTENTIAL QAM CHANNELS=L
408
A

FIG. 4

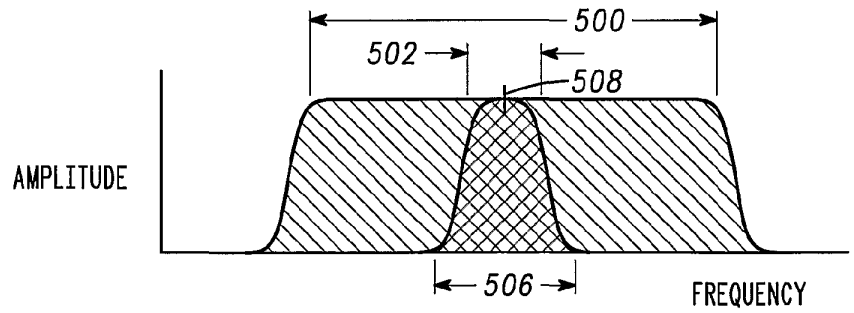

500
502
508
AMPLITUDE
506
FREQUENCY

FIG. 5A

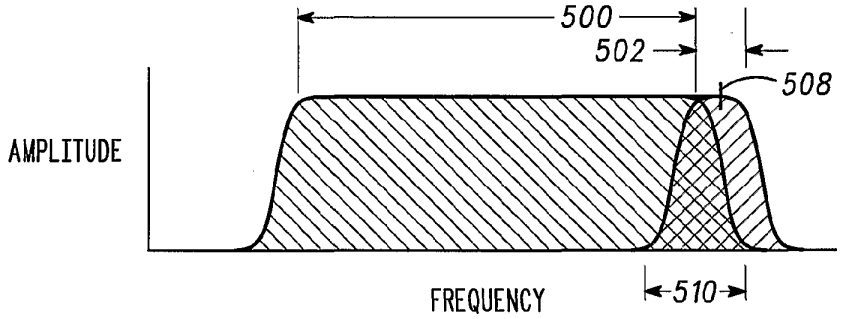


FIG. 5B

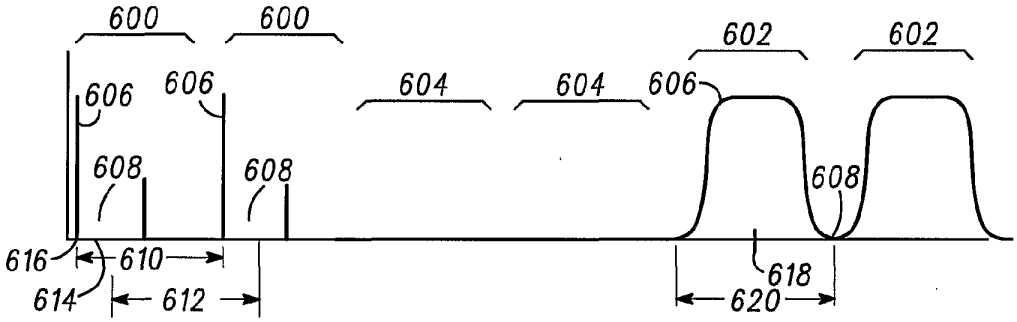


FIG. 6A

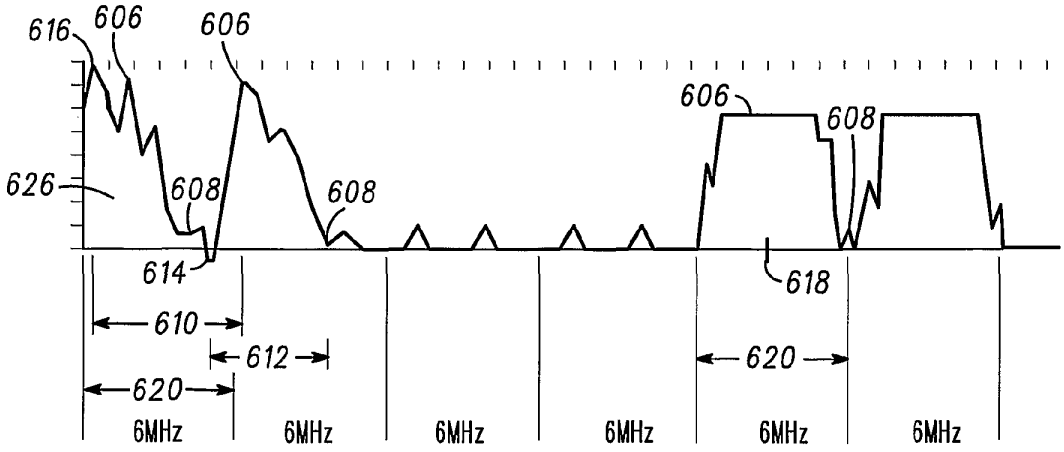


FIG. 6B

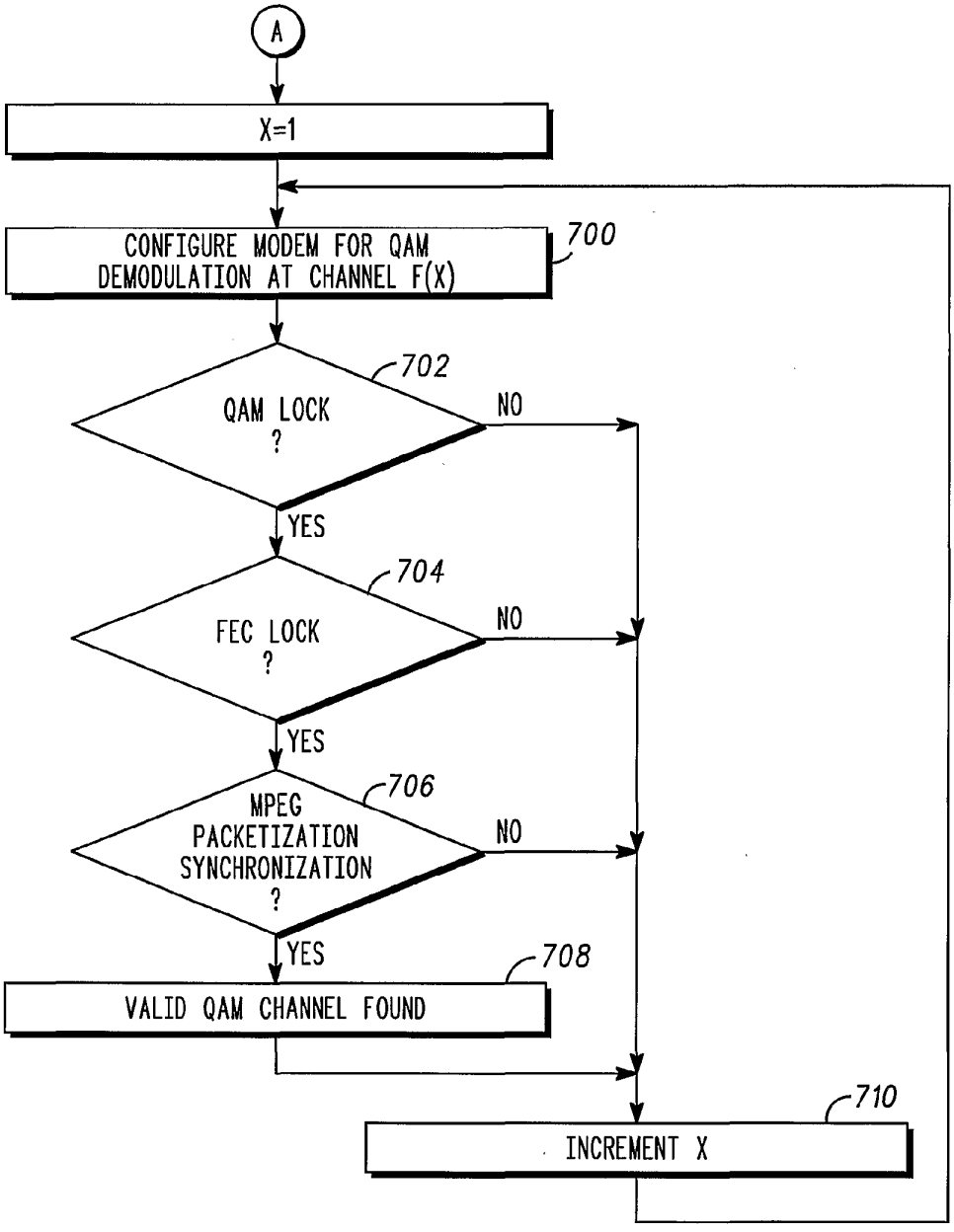

A
X=1
CONFIGURE MODEM FOR QAM DEMODULATION AT CHANNEL F(X)
700
QAM LOCK ?
702
NO
YES
FEC LOCK ?
704
NO
YES
MPEG PACKETIZATION SYNCHRONIZATION ?
706
NO
YES
VALID QAM CHANNEL FOUND
708
INCREMENT X
710

FIG. 7

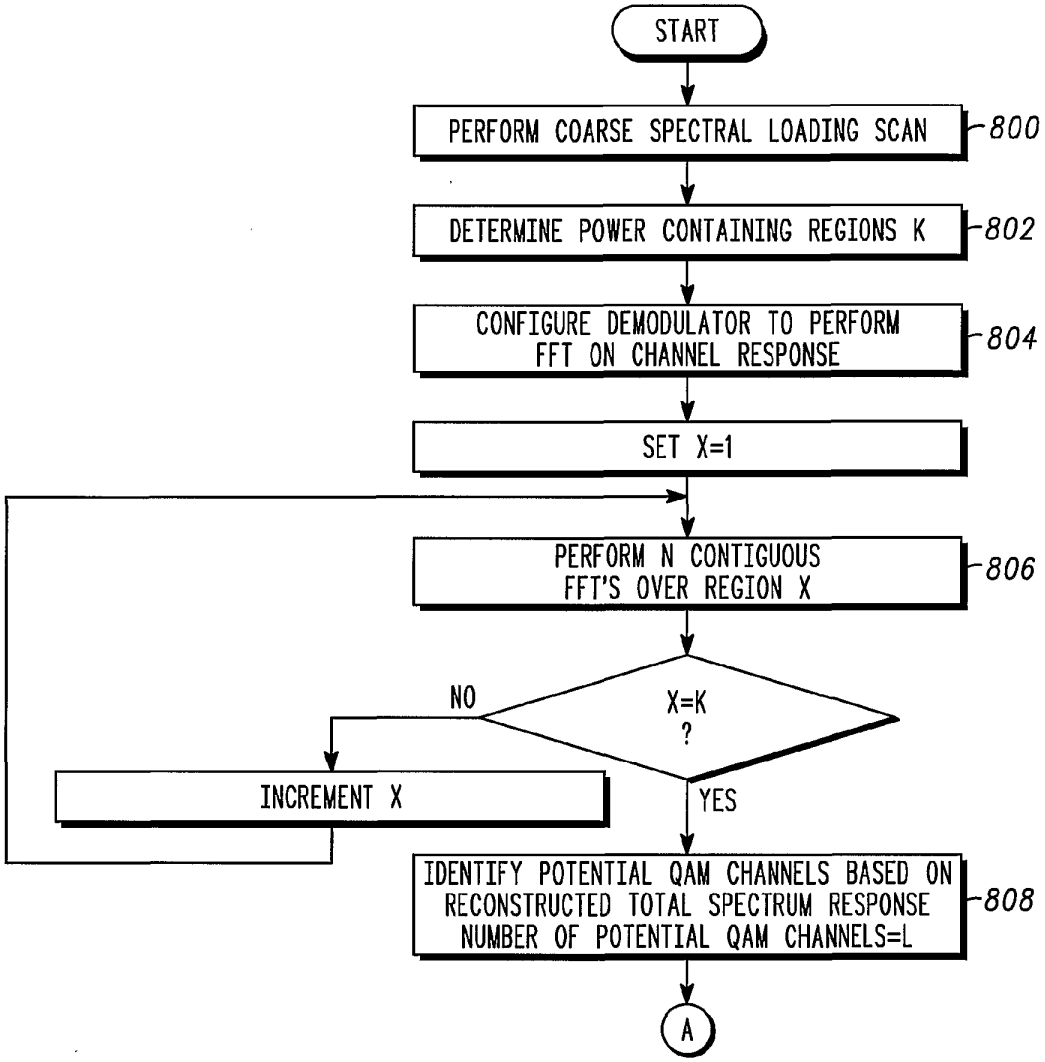

START
PERFORM COARSE SPECTRAL LOADING SCAN
800
DETERMINE POWER CONTAINING REGIONS K
802
CONFIGURE DEMODULATOR TO PERFORM FFT ON CHANNEL RESPONSE
804
SET X=1
PERFORM N CONTIGUOUS FFT'S OVER REGION X
806
X=K ?
NO
YES
INCREMENT X
IDENTIFY POTENTIAL QAM CHANNELS BASED ON RECONSTRUCTED TOTAL SPECTRUM RESPONSE NUMBER OF POTENTIAL QAM CHANNELS=L
808
A

FIG. 8

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US02/10601

A. CLASSIFICATION OF SUBJECT MATTER

IPC(7) :H04N 5/445, 7/173; G06F 3/00, 13/00
US CL :725/38, 56, 95; 370/431, 437; 455/434, 450, 464, 15.1
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 725/38, 56, 95; 370/431, 437; 455/434, 450, 464, 15.1

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

NONE

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

EAST - channel, frequency, listing, power, generate

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6,160,991 A (CHAPPELL et al) 12 December 2000, whole document	1-10
A	US 4,737,993 A (DEVILBISS) 12 April 1988, whole document	1-10
A	US 5,103,314 A (KEENAN) 07 April 1992, whole document	1-10

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

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Date of the actual completion of the international search 03 JUNE 2002	Date of mailing of the international search report 11 JUL 2002
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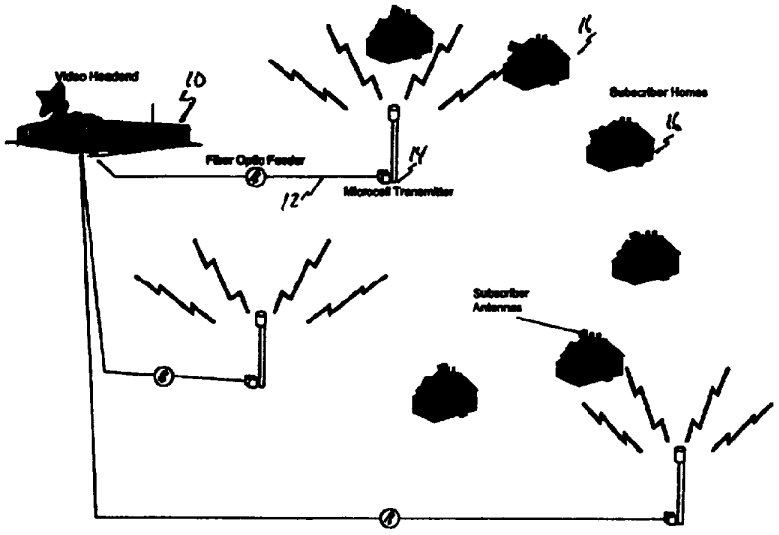
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(54) Title: LOW POWER MICROCELLULAR WIRELESS DROP INTERACTIVE NETWORK



(57) Abstract

Microcellular low power wireless networks for interactive, full duplex communication of video, data and telephony signals at microwave frequencies. Networks according to the present invention link a number of remote node transceivers to a central head office via fiber optic link. The remote node transceivers convert optical signals to radiofrequency energy in the microwave (preferably MMDS) range for robust and reliable communications that can, among other things, support basic lifeline telephone service. Low power and cross polarization techniques according to the present invention, together with modulation and multiplexing techniques, allow the limited bandwidth allotted in conventional microwave bands to accommodate analog and digital video, video on demand, data communications including graphics-rich Internet traffic, and voice and digital telephony, in a full duplex, bi-directional fashion.

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LOW POWER MICROCELLULAR WIRELESS DROP INTERACTIVE NETWORK

FIELD OF THE INVENTION

The present invention relates to the general field of telecommunications, and in particular to microcellular wireless networks for interactive television, data and telephony communications.

BACKGROUND OF THE INVENTION

A number of networks have been developed and are being developed for delivery of interactive television, data and telephony services. A variety of delivery architectures, structures and mechanisms permit a wide range of functionality. For example, some networks, which offer only limited interactivity, employ existing coaxial cable infrastructure plus existing telephone lines for return path communications (upstream). Other networks employ Asymmetrical Digital Subscriber-Line ("ADSL") technology which forwards compressed digital video signals over existing twisted pair telephone lines at up to two Mb/s. A third broad category, the hybrid network, employs fiber optic links between the headend and a number of nodes which service neighborhoods of approximately 500 homes, and which connect to subscribers via coaxial cable links. In a fourth broad category, known as fiber-to-the-curb, fiber optic links pass the subscribers more closely and connect to subscribers via twisted pair loops. Fiber-to-the-curb networks are more expensive than the hybrid and ADSL networks, but are generally considered more robust and capable of accommodating greater interactivity because they are capable of accommodating greater bandwidth.

All of these fiber/coaxial/twisted pair networks and various versions of them involve physical cable plant to the home and thus considerable infrastructure investment, installation lead time, community disruption and customer annoyance. In addition, the cost of serving a customer is primarily a capital intensive sunk cost up front, since customers must be passed to be served. As existing cable designs

demonstrate, systems without a substantial penetration and customer acceptance cannot be justified economically.

Such physical links also degrade over time due in part to moisture, temperature and flexure excursions, and the inherent environmental risks on the pole and in the ground. Such degradation can impose considerable efficiency losses over time, particularly as content suppliers require increasingly greater bandwidth capacity and efficiency.

Some see so-called "wireless cable" as a potential response to these issues presented by physical network infrastructures. Apart from the long lead time and expense required to pass hundreds of thousands of homes with wire line networks, wireless cable is impervious to physical degradation. In a conventional network topology, the "last mile" to the customer's home multiplied by the number of subscribers in the network comprises the vast proportion of the physical cable plant. Accordingly, replacement of that cable with wireless communications has received increasing attention in recent years.

One version of "wireless cable" networks is so called Multichannel Multipoint Distribution Service ("MMDS"). MMDS operates in the 2.1-2.7 Ghz microwave band, with a total of 33 analog 6-Mhz channels. Digital compression allows such MMDS networks with 33 analog channels to transport 100 to 180 digital programs. One entrant in the field has investigated combining MMDS with a telephone line return path for near video on demand capability. As a practical matter, it is apparent that with POTS return, full interactivity is probably not and never will be deployable due to the signaling logistics of TCP/IP networks.

Conventionally, however, MMDS has been viewed as providing insufficient bandwidth for full duplex interactive communications. Accordingly, certain entrants have investigated so called Local Multipoint Distribution Systems ("LMDS"). These operate at approximately 28 Ghz and follow the model of the cellular telephone. The high frequencies and concomitant greater bandwidth are tradeoffs for shorter transmission paths and thus smaller cell sizes. The higher frequencies also subject such networks to increased attenuation from foliage, weather, and other physical manifestations which obstruct the required line of sight path between the node and the subscriber station. In short, LMDS networks are viewed by some as lacking the robust

RF link necessary to support emerging residential interactive video, data and telephony communications requirements which customers are demanding and which are becoming part of the required suite of services offered by entrants in this field. In order to obtain critical mass for coverage, LMDS cell sites would, at least in many parts of the country, be entirely too close to each other to be commercially and economically justified.

SUMMARY OF THE INVENTION

Systems, methods and devices according to the present invention provide a practical implementation of wireless delivery of services including interactive video, data and voice-grade telephony. Network interfaces and delivery platforms according to the present invention replace the fiber / coaxial / twisted pair drop, or "last mile" of copper plant in the ADSL, coaxial, hybrid and fiber to the curb wireline networks mentioned above. Low power Microcellular Wireless Drop ("MWD") networks according to the present invention provide an economically attractive alternative to the high cost of coaxial distribution plant which is currently deployed en masse, as well as twisted pair and fiber links. Likewise, MWD architecture allows for service to be connected from a point further away from the customer, such that the target population does not need to be "passed" to be served. This transfers most of the capital intensive cost to serve a customer into a much more variable cost structure, so that it only requires a major capital investment once a subscriber is signed up for service. This is obviously very attractive in light of the major investment required to build the full service network. Unlike current MMDS networks, they use MMDS frequencies, but in a low power, microcellular way that allows for interactivity of the sort demanded by customers and content providers. Unlike LMDS networks, they allow for increased robustness in radiofrequency transmissions at lower frequencies, which permits more reliable telephony signaling and communication so as to approximate the basic lifeline requirements to which at least some of such signaling and communication must comply.

The present invention takes advantage of existing allocated frequency spectrum which is currently authorized and in use both domestically and internationally for broadcast video services, and specified as MMDS. The spectrum consists of two bands

that are spectrally separate in the frequency ranges of 2150-2162 MHz and 2500-2686 MHz. The bands are allocated for video broadcasting in 6 MHz channels (domestically) to be consistent with current NTSC compliant television channels. The present invention employs a different plan, however: That the lower frequency band of 2150-2162 be converted to an upstream back channel for full-duplex bi-directional capability, and that signals on the higher frequency bands be modulated and multiplexed in new ways to permit analog video, digital video, internet, analog voice, digital voice, and other signals of present and future existing formats and protocols to be handled with maximum flexibility, robustness and reliability.

Systems according to the present invention use networks of low power microwave transceivers in a point-to-multipoint configuration to connect a number of subscribers (preferably in the range of 10-100) to a broadband bi-directional service platform. Figure 1 shows, in schematic form, a network architecture according to a preferred embodiment of the invention. Such transceivers are connected to a fiber optic infrastructure which may be similar or identical to the fiber feeder layout of the conventional hybrid fiber / coaxial networks mentioned above. They are sufficiently small to mount on existing poles such as light poles, power poles, and utility poles. These remote node transceivers convert the modulated and channelized combined optical signal to an electrical radiofrequency ("RF") signal and broadcast that signal to a number of subscribers located within a defined coverage area of preferably 1000-2000 feet. The microcells are cross-polarized between adjacent cells, or if desirable, between adjacent sectors of a given cell, to mitigate harmful interference.

The subscriber station features an integrated antenna/transceiver that receives video, digital and telephony signals, downconverts them to an intermediate frequency, and feeds them via coax to a Home Distribution Terminal ("HDT") or Network Interface Unit ("NIU"). The transceiver equipment is preferably mounted at roof level to allow for best reception of signal from the remote node transceiver. The HDT is a component that is similar to current state-of-the-art digital set-top decoders, yet also allows termination / distribution in the subscriber's house of digital voice and data traffic. Likewise, the NIU demultiplexes and splits the incoming signals at a common point (i.e. the house entry point) and distributes those signals to the necessary equipment.

To accommodate full duplex bi-directional interactive communications, the subscriber station equipment, preferably but not necessarily the HDT or NIU, combines or multiplexes the upstream data and voice channels so that the information can be sent back upstream in the network. In addition to the remote node transceiver's downstream broadcast functionality, the transceiver also includes equipment for the reception of the upstream data and telephony traffic. The transceiver forwards this upstream traffic over fiber to the headend, where the signal is split into data and telephony components and routed to the proper path.

A band split plan according to a preferred embodiment of the present invention is outlined below in Table 1. This table shows how the video, data and telephony signals may be split up and modulated separately to obtain the required performance results for each service. The higher density modulation schemes (64, 256 QAM and 16, 64 VSB) allow much higher throughput of bits, although they lack the robustness from a propagation perspective of schemes such as QPSK and are substantially more susceptible to noise and interference. Lower density modulations such as BPSK and QPSK offer much more reliability under the same environmental parameters but accommodate much less data throughput capability. Thus, for video, where the number of video channels is a critical factor, higher level modulations are desirable. However, voice circuits that can approximate non-interruptible "life-line" service is achievable using lower level modulations that sacrifice capacity for reliability. With the broad 6 MHz bandwidth allowed, this capacity even at BPSK modulation would likely never be limiting due to the limited geographical coverage of the microcell. In fact, with QPSK modulation and Time Division Multiple Access (TDMA) for time slot assignment, and using 2 channels in each direction (i.e. 2674-2686 MHz down and 2150-2162 MHz up) in conjunction with currently available low-cost 32 kb/s ADPCM vocoder IC's, a total of 320 simultaneous voice grade circuits is achievable. Assuming two of those circuits are used for control and signaling, a total of 318 simultaneous voice grade circuits are available. Conservatively assuming a peak utilization of 50% (2 subs per circuit) a total of 636 subscriber lines are available. With 16 kbps vocoder technology quickly becoming available with perceptually the same voice quality, this number doubles to 1272 subscriber lines per microcell. The telephony circuits employ both Frequency Division Multiplexing (FDM) to separate upstream/downstream transmission paths and

TDMA between users to maximize efficiency and keep costs low. The low costs derive from the fact that both transceivers (node and subscriber) can use low-cost diplexer/filter circuitry that offer sufficient isolation between the incoming and outgoing signals.

Table 1. Example of Frequency Plan

Service Type	Modulation	Frequency
Video	64, 256 QAM	2500-2674
Voice\Telephony (Downstream)	QPSK	2674-2680
Data (Downstream)	64, 256 QAM	2680-2686
Voice\Telephony (Upstream)	QPSK	2150-2156
Data (Upstream)	QPSK	2156-2162

In addition, due to the close proximity of the spectrum to Personal Communication Systems ("PCS"), it is conceivable that the same type of transmission and receiver components could be easily modified for use with the present invention. This could lead to implementation of CDMA, OFDM, GSM or TDMA type transmission multiplexing of signals. Since standards are already agreed on for PCS implementation, such techniques appear logical and favorable for application in this case. This is especially true for the emerging wireless local loop equipment that is fixed vs. mobile.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic high level architectural diagram of a preferred form of wireless cable network according to the present invention.

FIG. 2 is a schematic view of a preferred embodiment of a headend control office according to the present invention.

FIG. 3 is a schematic view of a preferred embodiment of a remote node transceiver according to the present invention.

FIG. 4 is a schematic view of a preferred embodiment of a subscriber station according to the present invention.

FIG. 5 is a schematic view of a subscriber Network Interface Unit according to the present invention.

DETAILED DESCRIPTION

Figure 1 shows, in schematic form, a headend control office 10 connected via fiber optic links 12 to a plurality of remote node transceivers 14. Transceivers 14 convert optical energy into radiofrequency energy, in the microwave, and preferably the MMDS bands, for transmission to subscriber stations 16, each of which may correspond to a subscriber's home. Transceivers 14 also receive transmissions at microwave, preferably MMDS, frequencies from subscriber stations 16, and convert such energy to optical energy for forwarding to headend control office 10 via fiber optic links 12, thus allowing the network to provide full duplex bi-directional interactive video, data and telephone (voice or otherwise) communications.

Headend Control Office

With reference to FIG. 2, the Headend Control Office ("HCO") 10 includes all centrally located signal processing equipment in the network. Typically, the HCO includes all components in the video delivery chain such as satellite decoders and transcoders, off-air receivers, real-time digital encoders and other components conventionally found in a cable headend (shown using numeral 18 in Figure 2). It also includes internet and other network servers 20 as may be appropriate, and preferably includes public switched telecommunications network ("PSTN") interconnects 22 for telephony capability. Video servers 24 may be included to store and provide video on demand and other video content as required or requested by subscribers using the network. Routers 26, digital multiplexers 28, modulators 30, combiners 32, splitters 34 and other (or fewer) components are employed as may be necessary or appropriate to prepare the video signals 36, data signals 38 and telephony signals 40 for transmission to remote node transceivers 14 via fiber optic links 12 using fiber-optic transmitters 36. In addition, the HCO 10 may house components such as the channel management control computer 42, data routers 44 as desired, demultiplexers 46, demodulators 48 and return path fiber optic receivers 50 for processing subscriber data signals 52 and subscriber telephony signals 54.

Broadcast video signals 36 may be received through any of a number of sources as mentioned above, including satellite receivers and off the air receivers, MPEG II or otherwise digitally encoded (if analog), groomed and configured in the multiplexer 28, modulated and channelized onto an RF carrier, combined with other channels, split (for transmission to other node transceivers 14) and sent over fiber optic plant 12 to the remote node transceivers 14. The combining process after RF may be done on a non-adjacent carrier basis, as is currently the norm for a high power MMDS transmitter. If not combined on adjacent channels, dual fiber feeders are required. The fibers may be optically excited using state-of-the-art Externally Modulated Distributed Feedback (DFB) laser transmitters. DFB's allow extremely broadband RF signals to be optically modulated with the most efficiency, and hence allow for the entire spectrum of downstream voice, data and telephony to be carried on a single fiber. This ensures that low cost can be maintained throughout the network since the F/O transmitters are generally the most expensive single component in the transmission network.

To allow for interconnection to the Telephone Network in order that subscribers may be provided telephone service, a Node Radio Control Unit (NRCU) according to the present invention provides time slot management to the individual voice circuits and handle the contention management protocols such as slotted aloha. Communication between the Remote Node Transceiver and the individual subscriber terminals may be performed via an overhead channel within the downstream and upstream RF channels. These types of devices are readily available in most wireless digital voice networks such as PCS, PACS.

Remote Node Transceivers

The low-cost remote node transceiver 14 connects to the bi-directional fiber optic links 12 that originate at the headend control office 10. This fiber optic plant 12 or infrastructure carries the modulated and channelized RF carriers that contain the video, data and telephony signals (36, 38 and 40 respectively) in bit stream form. A simplified schematic of the low-cost low-power remote node transceivers is 14 shown in Figure 3. The remote node transceivers may be based on a single broadband booster amplifier that outputs approximately 20 mW of power per channel. This translates into 13 dBm/channel or equivalently -23 dBW /channel. Using a 16 dBi transmit antenna (either omni or sectored directional), an Effective Isotropic Radiated Power (EIRP) of

29 dBm/channel (or -1 dBW/channel) is broadcast. This varies dramatically from conventional LMDS architecture, which typically outputs 28-30 dBm/channel, or at least 50 times the required transmit power per channel as is required by the present invention. That conventional LMDS type of power is only available in Traveling Wave Tube (TWT) amplifiers for broadband transmissions or discrete channel solid state amplifiers. TWT's are renowned for their short life span and high cost, currently approximately $50K each. This seems likely not to improve much since the technology is World War II era and has been "tweaked" out in terms of cost/performance. Solid State amplifiers at 28 GHz are still very much in prototype stage for these kinds of power outputs. They are extremely limited in their bandwidth capability, have thermal dissipation problems and require a single amplifier for each RF channel. This implies 30+ solid state amplifiers (with expensive control circuitry) per LMDS node which affects cost, size, reliability and maintenance, all negatively when compared to the present invention's MWD equipment topography. Conventional LMDS in any event appears to be hard to justify economically, especially in regions of the country that have foliage and high rainfall rates.

With the MWD technology according to the present invention, implementation of the network is much simpler and cost effective since all signal processing is either performed at the headend or at subscriber locations. The small footprint of the remote node transceiver allows for a wide range of mounting alternatives and makes the concept feasible from both an economic and aesthetic perspective.

Power may be supplied to the remote mode transceiver 14 by commercial 120 VAC @ 60 Hz. Additional backup power can be battery backup or generator backup located at the transceiver site. The backup power may be configured to power only the voice channels for emergency lifeline service. In order to use the backup power most efficiently, it may be desirable to switch off the video carriers and transmit/receive only the voice carriers. This can be performed several ways. From a design perspective, the simpler approach is to transmit voice on a separate fiber and maintain a separate path through the transceiver amplification chain. This approach is obviously the more expensive one, given the additional electronics both at the headend and the node transceiver, in addition to the extra infrastructure. Another broad approach is to include intelligence in the transceiver itself that automatically shuts off the video and data

channels, passes the voice traffic and automatically adjusts the total broadband output power down to the level of the voice channel only. This may be performed by an automatic level control ("ALC") circuit in the transceiver architecture, although it adds extra cost and complexity to the transceiver.

The microcells preferably consist of at least three radiating sectors (120° each) and are cross polarized between adjacent cells to mitigate harmful interference due to the many transmitters in a given geographical area. The low power of the transmitters, the attenuation characteristics of foliage and building blockage, and the isolation gained by cross polarizing should prove adequate for reducing interfering signals in most cases. If desired, a four or more sector transceiver (90° each) could be implemented using cross polarization between adjacent sectors. The better isolation may be counteracted by increased cost and complexity, however.

Due to the potentially large number of transmitters deployed in the proposed scenarios, radio interference from adjacent nodes and multiple subscriber transceivers may substantially impact reliable operation. However, at the proposed frequency ranges foliage and terrain may be used advantageously when the system is being engineered to isolate the sources of interference. Additionally, due to the low power transmitters, directional receive antennas and the use of cross polarization discrimination for adjacent cells, it is conceivable that interference between node transceivers and subscribers may be negligible, allowing for frequency reuse factors of one. If so then the maximum efficiency in use of the spectrum can be obtained.

If interference does appear to be a problem in some areas, additional existing techniques can be employed that mitigate interference even further. For the downstream broadcast video portion of the spectrum, such techniques include simulcasting the broadcast signals by controlling the relative timing of signals at each transmitter and taking advantage of adaptive equalization in the set top to cancel out the interfering signals. S. Merrill Weiss, *Issues in Advanced Television Technology*, Focal Press, Boston (1996). This concept is new and was developed primarily for large cell multiple transmitter systems for Advanced Television (ATV) and Digital MMDS that are currently being built. In theory, the interference is canceled out since the interfering signal appears like multipath to the receiver. Use of the adaptive equalization techniques which are currently deployed in digital microwave systems makes this a

readily available implementation that should prove cost effective. The downstream and upstream data and voice should be somewhat immune to interference due to the more robust modulation schemes proposed (QPSK, BPSK, etc.) for these services. If more rejection is required, the use of frequency reuse factors greater than one can be engineered which offers much greater performance at a price of more limited capacity. At the small transmission ranges proposed in the architecture, the decrease in customer capacity does not impact the service sets too severely.

Subscriber Station

Subscriber stations according to the present invention, a preferred embodiment of which is shown in schematic form in Figure 4, include a small low profile antenna integrated with a subscriber transceiver 56 that includes a downconverter/upconverter 58 to convert the downstream video 36, data 38 and telephony 40 signals to a form which may be processed in the home, and to convert the upstream subscriber data 52 and voice 54 channels to the required RF. The antenna is relatively directional and may be of a type currently used with existing MMDS systems, being either a small planar array, corner reflecting dipole or parabolic reflector, among other designs. It is preferably high gain compared to an omni-directional monopole or "whip" antennae. The size of the antenna is directly related to the gain and sidelobe, and/or off-axis performance required. The up and downstream channels are preferably diplexed at both the front end and back end so that a single coaxial cable can feed a Network Interface Unit ("NIU") 60 which demultiplexes downstream signals, multiplexes upstream signals, and splits the signals to the proper interface or input/output device connections.

An example NIU 60 is illustrated in Figure 5. The NIU 60 is the component that exists outside the home (versus the HDT, which resides inside the set-top box) and connects the RF radio transport network to the respective individual service networks inside the home. The NIU 60 performs many functions that enable the subscriber to receive the various service sets (i.e. video, data and telephony) through the common network architecture. The NIU 60 takes advantage of lost-cost integrated circuitry to perform the functions of splitting and combining the bi-directional paths of the required signals both cost effectively and reliably. The NIU 60 also takes advantage of the existing in-house wiring for both video and telephony so that the logistics of re-wiring homes can be kept to a minimum.

Figure 5 shows a signal received at the CPE Transceiver that is downconverted and sent via coax to the NIU 60. The NIU 60 sends the signal through a diplexer where the upstream and downstream signals are isolated and combined on a single coax. The output of the diplexer (downstream) is coupled to a pre-amp (if necessary) and then into a splitter that breaks the signal into three equivalent full spectrum outputs. The outputs of the splitter feed individual IF band-pass filters that reject all but the desired signals for the given service. At this point, the video signals are once again sent through a diplexer (for upstream/downstream separation) and feed a digital set top box via existing coax distribution cable. Likewise the data traffic goes through a diplexer where it feeds a cable modem which in turn is connected to a PC for high speed data applications, i.e. internet, at home banking, etc.

The telephony traffic is routed to a demodulator/ADPCM decoder chipset which is connected to a Signaling Control Unit (SCU) for access control, phone ring generation etc. The SCU communicates with the Headend Telephony Control Unit (HCT) for time slot assignment and control via the overhead in the telephony channel. The SCU outputs an analog RJ-11 for in-home telephony distribution. The SCU may conversely contain a small transceiver similar to a cordless phone base station that would connect to all handsets in the home wirelessly. Contention management may be handled by a contention management protocol such as slotted aloha.

For the case where only interactive video and data services are required (no voice), a single coaxial feed may be employed to offer both services with distribution being performed at a single point with a bi-directional splitter and amplifier. Services may be separated in frequency as they are in existing and planned HFC networks. Another technique that can be used to simplify the NIU 60 even further is the use of telephony return cable modems so that the NIU 60 would only be required to process video and voice with the return path being a voice-like channel that uses the same interfaces as the voice path. Depending on capacity and traffic management concerns, this may be done using a single time shared telephone line or multiple lines.

Using a subscriber antenna of 18 dBi gain (a typical 15"x15" 16-element flat planar array) and assuming 64 QAM modulation and the EIRP referenced in the Remote Node Transceiver section, predicted link margins show reliability approaching 100% with propagation related outages less than 1 minute per year at a distance of 1

mile. This type of statistical reliability is difficult to achieve in an LMDS environment under normal rain conditions. Another advantage of the MWD according to the present invention is the fact that low-gain antennas can be employed as opposed to the very high-gain antennas (32+ dBi) required in an LMDS environment. This makes for much less stringent installation procedures. Also, the cost of a MMDS transceiver is substantially less than at 28 GHz due to the same reasons specified earlier for the remote node transceiver. Since the aggregate cost of subscriber equipment is the single highest cost of a wireless access network, even a savings of $10 per subscriber could negatively impact the capital costs by $10 million, assuming 1 million subscribers. Most likely, the cost of the subscriber transceiver alone may be on the order of several hundred dollars less than a comparatively equipped LMDS transceiver. This makes efficient provisioning of DS-0 POTS telephony to subscribers not only economically feasible but also extremely attractive when compared with the cost of doing likewise with LMDS technology

The video signals 36 are disseminated over coaxial cable for in-house distribution to set-top decoders that feed television sets 62 or other video input/output devices. Likewise, the digital signals 38 may use ethernet or other appropriate protocol to connect to a PC, internet compatible device, or any other desired input/output device 64 that may be adapted to interface in interactive network sessions. Voice/telephony signals 40 are distributed via RJ-11 twisted pair to telephone sets, telecopiers, answering machines and other telephony input/output devices 66. The upstream subscriber data signals 52 and telephony signals 54 are also combined and processed in the NIU 60 for transmission back to the subscriber transceiver 56. Alternatively, some cost may be saved if the downstream and upstream signals are on dual or siamese coax from the NIU 60 to the subscriber transceiver 56, but this obviously requires additional cable and installation effort and expense.

A DC voltage may be placed on the coaxial cable by the NIU 60 to feed the transceiver downconverter and upconverter stages 58. The DC voltage may be isolated from the subscriber side of the NIU 60. Battery backup may also be contained within the NIU 60 and used for powering the sections of the subscriber transceiver 56 needed for the voice transmission from the transceiver 56 to the remote node transceiver 14. The battery may be adapted to power the NIU 60 voice card and allow for ringing as

well as two-way voice communication. A solar panel at the antenna may be used to trickle charge the battery when not in use.

The foregoing is provided for purposes of explanation and illustration of a preferred form of the present invention. Modifications, deletions, additions and substitutions, such as, for instance, with respect to the frequencies used in accordance with the invention, may be made to the devices and processes disclosed in this document without departing from the scope or spirit of the invention.

What is claimed is:

1. A network for communicating a plurality of signals between a headend control office and a plurality of subscriber stations in full duplex, bi-directional fashion, comprising:

a. a headend control office containing signal processing circuitry for receiving a plurality of video signals from a plurality of video sources, and a plurality of digital signals from a plurality of digital sources, and transmitting said video and digital signals to a plurality of remote node transceivers via a network medium, and for receiving a plurality of subscriber signals from said remote node transceivers;

b. a plurality of remote node transceivers coupled to said headend control office via said network medium, each of said transceivers adapted to receive said video and digital signals, and transmit said signals, via radiofrequency carrier in a first band of microwave frequencies, and in a plurality of sectors, to a plurality of said subscriber stations, and to receive from said subscriber stations via radiofrequency carrier a plurality of subscriber signals in a second band of microwave frequencies, and transmit said subscriber signals to said headend control office via said network medium;

c. a plurality of subscriber stations, arranged in cells, each cell of subscriber stations corresponding to one of said remote node transceivers, each of said subscriber stations comprising:

1. a subscriber transceiver adapted to receive said radiofrequency-transmitted video and digital signals from its corresponding remote node transceiver and to transmit said subscriber signals to said remote node transceiver via radiofrequency carrier;

2. signal processing circuitry adapted to couple said video and digital signals to video and digital input/output devices, respectively, and to receive subscriber signals from said input/output devices and couple said subscriber signals to said subscriber transceiver; and

d. a plurality of said subscriber transceivers adapted to receive signals which are cross polarized with respect to radiofrequency signals which a plurality of other of said subscriber transceivers are adapted to receive.

2. A network according to claim 1 wherein said first band of microwave frequencies comprises a range of between substantially 2500 and 2686 Mhz and said second band of microwave frequencies comprises a range of between substantially 2150 to 2162 Mhz.

3. A network according to claim 1 wherein the network medium comprises fiber optic links.

4. A network according to claim 3 wherein the headend control office comprises a plurality of satellite receivers for receiving video signals from satellite video transmissions and a plurality of broadcast receivers for receiving video signals from terrestrial video transmissions, and multiplexing circuitry, modulation circuitry and at least one fiber optic transmitter for multiplexing, modulating and transmitting said video and digital signals to said remote node transceivers via said fiber optic links.

5. A network according to claim 4 wherein at least some of the remote node transceivers comprise fiber optic receiver circuitry for receiving said video and digital signals, radiofrequency transmitter circuitry for transmitting said video and digital signals to said subscriber stations, radiofrequency receiver circuitry for receiving subscriber signals from said subscriber stations, fiber optic transmitter circuitry for transmitting said subscriber signals to said headend control office via said fiber optic links.

6. A network according to claim 4 wherein said signal processing circuitry comprises a first diplexer circuitry adapted to separate said video and digital signals received from said subscriber transceiver from said subscriber signals, downconverter circuitry coupled to said first diplexer for downconverting said video and digital signals to a form adapted for transmission on coaxial cable, upconverter circuitry coupled to said first diplexer circuitry for upconverting said subscriber signals for coupling to said subscriber transceiver; and second diplexer circuitry for coupling said video and digital signals to said input/output devices and for coupling said subscriber signals to said upconverter.

7. A network for communicating a plurality of signals between a headend control office and a plurality of subscriber stations in full duplex, bi-directional fashion, comprising:

a. a headend control office containing signal processing circuitry for receiving a plurality of video signals from a plurality of video sources, a plurality of digital signals from a plurality of digital sources, and a plurality of telephony signals from a public switched telecommunications network, and transmitting said video, digital and telephony signals to a plurality of remote node transceivers via a network medium, and for receiving a plurality of subscriber data and telephony signals from said remote node transceivers;

b. a plurality of remote node transceivers coupled to said headend control office via said network medium, each of said transceivers adapted to receive said video, digital and telephony signals, and transmit said signals, via radiofrequency carrier in a frequency band of substantially 2500 to 2686 Mhz, and in a plurality of sectors, to a plurality of said subscriber stations, and to receive from said subscriber stations via radiofrequency carrier in a frequency band of substantially 2150 and 2162 Mhz a plurality of subscriber data and telephony signals and transmit said subscriber signals to said headend control office via said network medium;

c. a plurality of subscriber stations, arranged in cells, each cell of subscriber stations corresponding to one of said remote node transceivers, each of said subscriber stations comprising:

1. a subscriber transceiver adapted to receive said radiofrequency-transmitted video, digital and telephony signals from its corresponding remote node transceiver and to transmit subscriber data and telephony signals to said remote node transceiver via radiofrequency carrier;

2. signal processing circuitry adapted to couple said video, digital and telephony signals to video, digital and telephony input/output devices, respectively, and to receive subscriber data and telephony signals from said input/output devices and couple said subscriber data and telephony signals to said subscriber transceiver; and

d. a plurality of said subscriber transceivers adapted to receive signals which are cross polarized with respect to radiofrequency signals which a plurality of other of said subscriber transceivers are adapted to receive.

8. A network according to claim 7 wherein at least some of said remote node transceivers are adapted to receive said subscriber signals from said subscriber stations via frequencies in a band different from the band in which the remote node transceivers transmit said video, digital and telephony signals.

9. A network according to claim 7 wherein at least one subscriber station within a cell is adapted to transmit radiofrequency signals which are cross polarized with respect to radiofrequency signals which other subscriber stations within said cell are adapted to transmit.

10. A network according to claim 7 wherein all subscriber stations within at least one cell are adapted to transmit radiofrequency signals which are not cross polarized

with respect to one another, but which are cross polarized with respect to radiofrequency signals transmitted by subscriber stations in other cells.

11. A network according to claim 7 wherein the network medium comprises fiber optic links.

12. A network according to claim 11 wherein the headend control office comprises a plurality of satellite receivers for receiving video signals from satellite video transmissions, a plurality of broadcast receivers for receiving video signals from terrestrial video transmissions, interconnection circuitry coupled to a public switched telecommunications network coupling telephony signals to said headend control office, and multiplexing circuitry, modulation circuitry and at least one fiber optic transmitter for multiplexing, modulating and transmitting said video, digital and telephony signals to said remote node transceivers via said fiber optic links.

13. A network according to claim 11 wherein at least some of the remote node transceivers comprise fiber optic receiver circuitry for receiving said video, digital and telephony signals, radiofrequency transmitter circuitry for transmitting said video, digital signals and telephony signals to said subscriber stations, radiofrequency receiver circuitry for receiving subscriber data and telephony signals from said subscriber stations, and fiber optic transmitter circuitry for transmitting said subscriber signals to said headend control office via said fiber optic links.

14. A network according to claim 11 wherein said signal processing circuitry comprises first diplexer circuitry adapted to separate said video, digital and telephony signals received from said subscriber transceiver from said subscriber signals, downconverter circuitry coupled to said first diplexer for downconverting said video, digital and telephony signals to a form adapted for transmission on coaxial cable, upconverter circuitry coupled to said first diplexer circuitry for upconverting said subscriber signals for coupling to said subscriber transceiver; and second diplexer circuitry for coupling said video, digital and telephony signals to said input/output devices and for coupling said subscriber signals to said upconverter.

15. A network according to claim 7 in which the subscriber station further comprises interface circuitry coupled to said second diplexer via coaxial cable, and is adapted to separate and route to appropriate input/output devices said video, digital and telephony signals.

16. A network for communicating a plurality of signals between a headend control office and a plurality of subscriber stations in full duplex, bi-directional fashion, comprising:

a. a headend control office containing signal processing circuitry for receiving a plurality of video signals from a plurality of video sources, a plurality of digital signals from a plurality of digital sources, and a plurality of telephony signals from a public switched telecommunications network, and transmitting said video, digital and telephony signals to a plurality of remote node transceivers via a plurality of fiber optic links and for receiving a plurality of subscriber data and telephony signals from said remote node transceivers, said circuitry comprising a plurality of satellite receivers for receiving video signals from satellite video transmissions, a plurality of broadcast receivers for receiving video signals from terrestrial video transmissions, interconnection circuitry coupled to a public switched telecommunications network coupling telephony signals to said headend control office, and multiplexing circuitry, modulation circuitry and at least one fiber optic transmitter for multiplexing, modulating and transmitting said video, digital and telephony signals to said remote node transceivers via said fiber optic links;

b. a plurality of remote node transceivers coupled to said headend control office via said network medium, each of said transceivers adapted to receive said video, digital and telephony signals, and transmit said signals, via radiofrequency carrier in a frequency band of substantially 2500 to 2686 Mhz, and in a plurality of sectors, to a plurality of said subscriber stations, and to receive from said subscriber stations via radiofrequency carrier in a band of

substantially 2150 to 2162 Mhz a plurality of subscriber data and telephony signals and transmit said subscriber signals to said headend control office via said fiber optic links, said remote node transceivers comprising fiber optic receiver circuitry for receiving said video, digital and telephony signals, radiofrequency transmitter circuitry for transmitting said video, digital signals and telephony signals to said subscriber stations, radiofrequency receiver circuitry for receiving subscriber data and telephony signals from said subscriber stations, and fiber optic transmitter circuitry for transmitting said subscriber signals to said headend control office via said fiber optic links;

c. a plurality of subscriber stations, arranged in cells, each cell of subscriber stations corresponding to one of said remote node transceivers, each of said subscriber stations comprising:

1. a subscriber transceiver adapted to receive said radiofrequency-transmitted video, digital and telephony signals from its corresponding remote node transceiver and to transmit subscriber data and telephony signals to said remote node transceiver via radiofrequency carrier;

2. signal processing circuitry adapted to couple said video, digital and telephony signals to video, digital and telephony input/output devices, respectively, and to receive subscriber data and telephony signals from said input/output devices and couple said subscriber data and telephony signals to said subscriber transceiver, said signal processing circuitry comprising first diplexer circuitry adapted to separate said video, digital and telephony signals received from said subscriber transceiver from said subscriber signals, downconverter circuitry coupled to said first diplexer for downconverting said video, digital and telephony signals to a form adapted for transmission on coaxial cable, upconverter circuitry coupled to said first diplexer circuitry for upconverting said subscriber signals for coupling to said subscriber transceiver; and second diplexer circuitry for coupling said

video, digital and telephony signals to said input/output devices and for coupling said subscriber signals to said upconverter; and

d. a plurality of said subscriber transceivers adapted to receive signals which are cross polarized with respect to radiofrequency signals which a plurality of other of said subscriber transceivers are adapted to receive.

17. A network according to claim 16 wherein at least one subscriber station within a cell is adapted to transmit radiofrequency signals which are cross polarized with respect to radiofrequency signals which other subscriber stations within said cell are adapted to transmit.

18. A network according to claim 16 wherein all subscriber stations within at least one cell are adapted to transmit radiofrequency signals which are not cross polarized with respect to one another, but which are cross polarized with respect to radiofrequency signals transmitted by subscriber stations in other cells.

19. A network according to claim 16 in which the remote node transceivers and said subscriber stations contain power backup circuitry for assuring reliability of the network to transmit and receive said telephony signals.

20. A network according to claim 16 comprising modulation circuitry adapted for modulating said telephony signals in a manner that ensures reliable telephonic communications.

21. A network according to claim 16 in which the subscriber station further comprises interface circuitry coupled to said second diplexer via coaxial cable, and is adapted to separate and route to appropriate input/output devices said video, digital and telephony signals.

22. A network according to claim 16 in which said video signals are coupled to an input/output device comprising analog video circuitry and a remote control for generating subscriber data signals.

23. A network according to claim 16 in which said video signals are coupled to an input/output device comprising a keyboard for generating subscriber data signals.

24. A network according to claim 16 in which said digital signals are coupled to an input/output device comprising analog video circuitry.

25. A network according to claim 16 in which said digital signals are coupled to an input/output device comprising analog video circuitry, digital video circuitry, and a keyboard for generating subscriber data signals.

26. A network according to claim 16 in which said digital signals are coupled to an input/output device comprising a computer.

27. A network according to claim 16 in which said digital signals are coupled to an input/output device adapted to input and output internet-compatible signals.

28. A network according to claim 16 in which said digital signals are coupled to an input/output device adapted to input and output data signals in a session on a network.

Figure 1

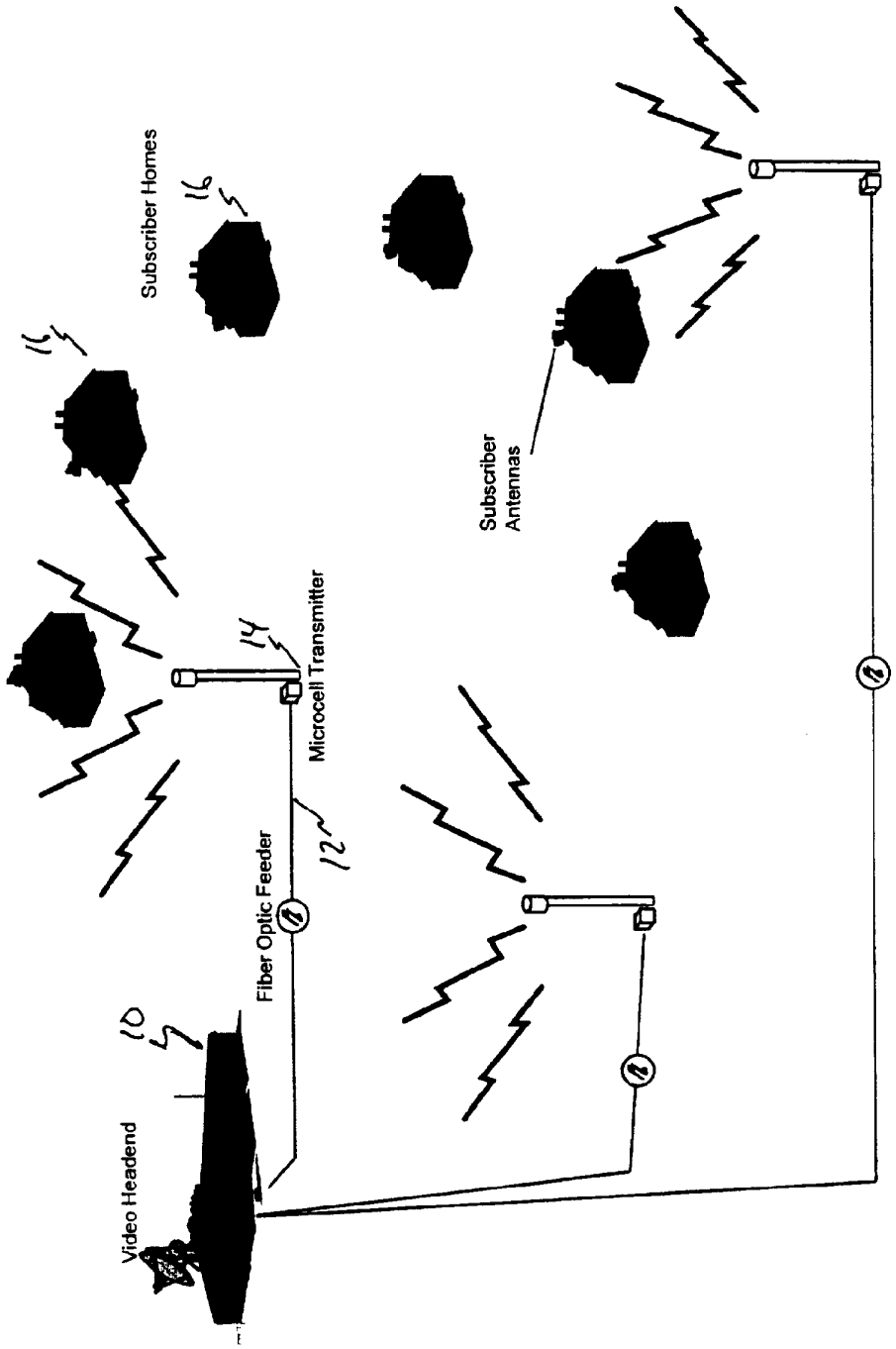

Subscriber Homes
16
15
Subscriber Antennas
14
Microcell Transmitter
12
Fiber Optic Feeder
10
Video Headend

Figure 2

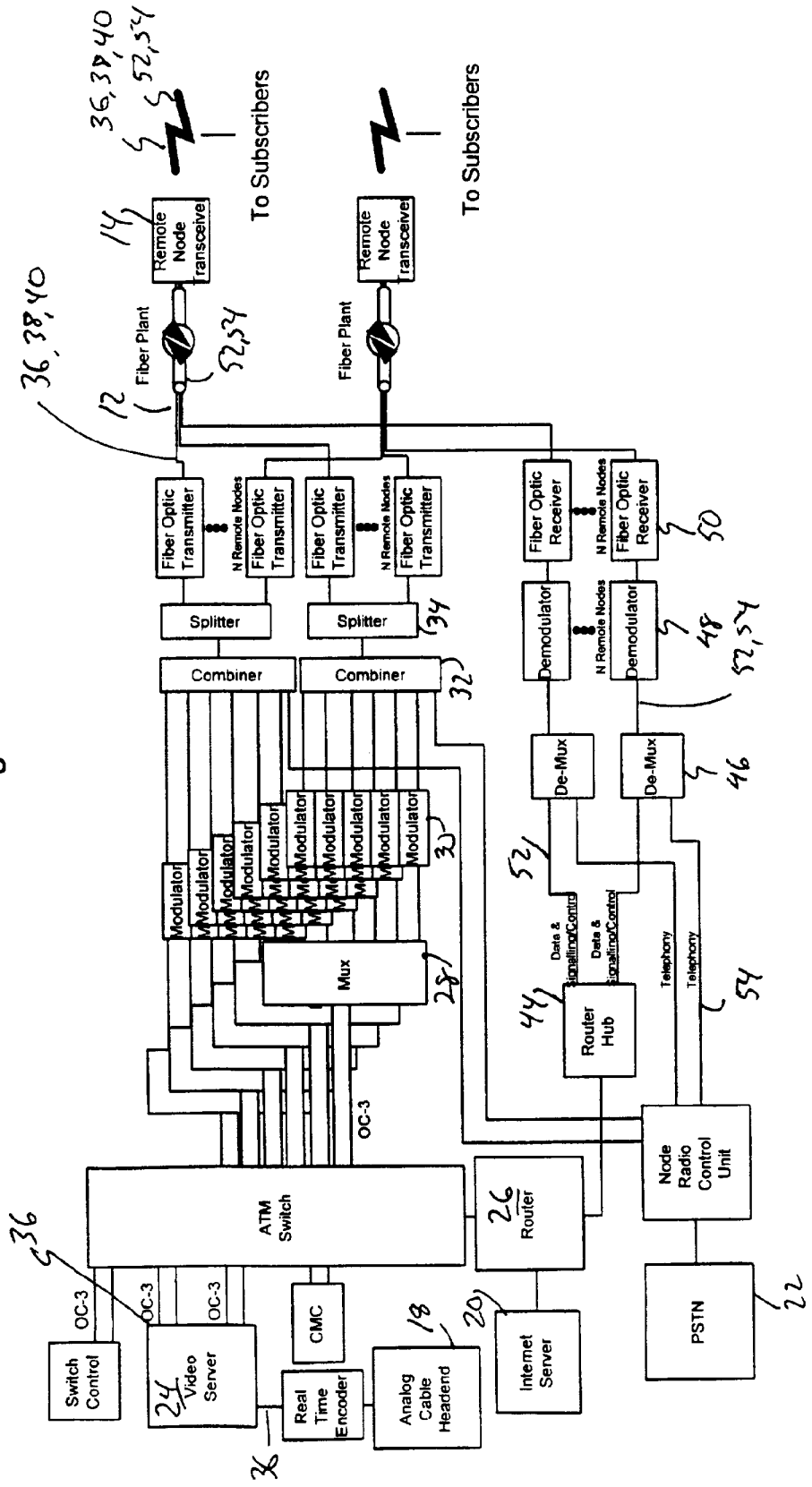

36, 38, 40
52, 54
To Subscribers
14
Remote Node Transceiver
12
Fiber Plant
Fiber Optic Transmitter
N Remote Nodes
Splitter
34
Combiner
32
Modulator
30
Mux
28
OC-3
ATM Switch
26
Router
Node Radio Control Unit
PSTN
22
Fiber Optic Receiver
50
Demodulator
48
De-Mux
46
Data & Signaling/Control
Router Hub
44
Telephony
54
52
36
Switch Control
Video Server
24
CMC
Real Time Encoder
38
Analog Cable Headend
18
Internet Server
20

Figure 3

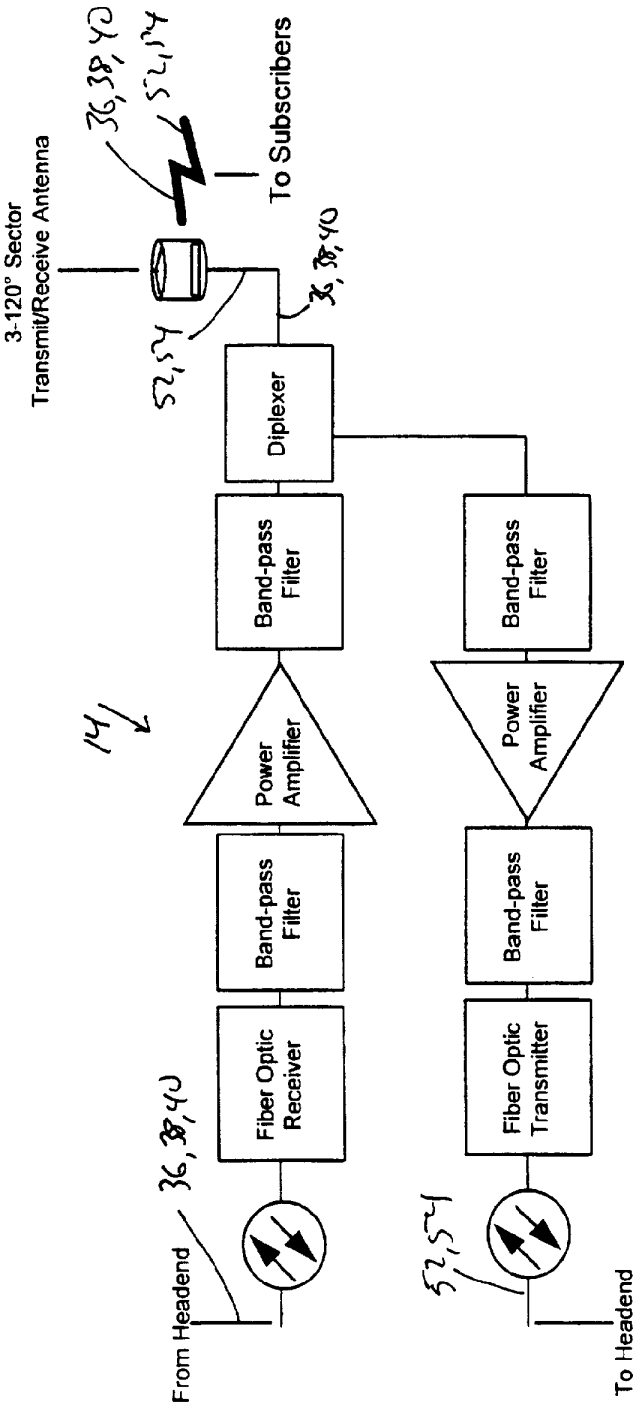

3-120° Sector
Transmit/Receive Antenna
To Subscribers
Diplexer
Band-pass Filter
Power Amplifier
Band-pass Filter
Fiber Optic Receiver
From Headend
Band-pass Filter
Power Amplifier
Band-pass Filter
Fiber Optic Transmitter
To Headend

Figure 4

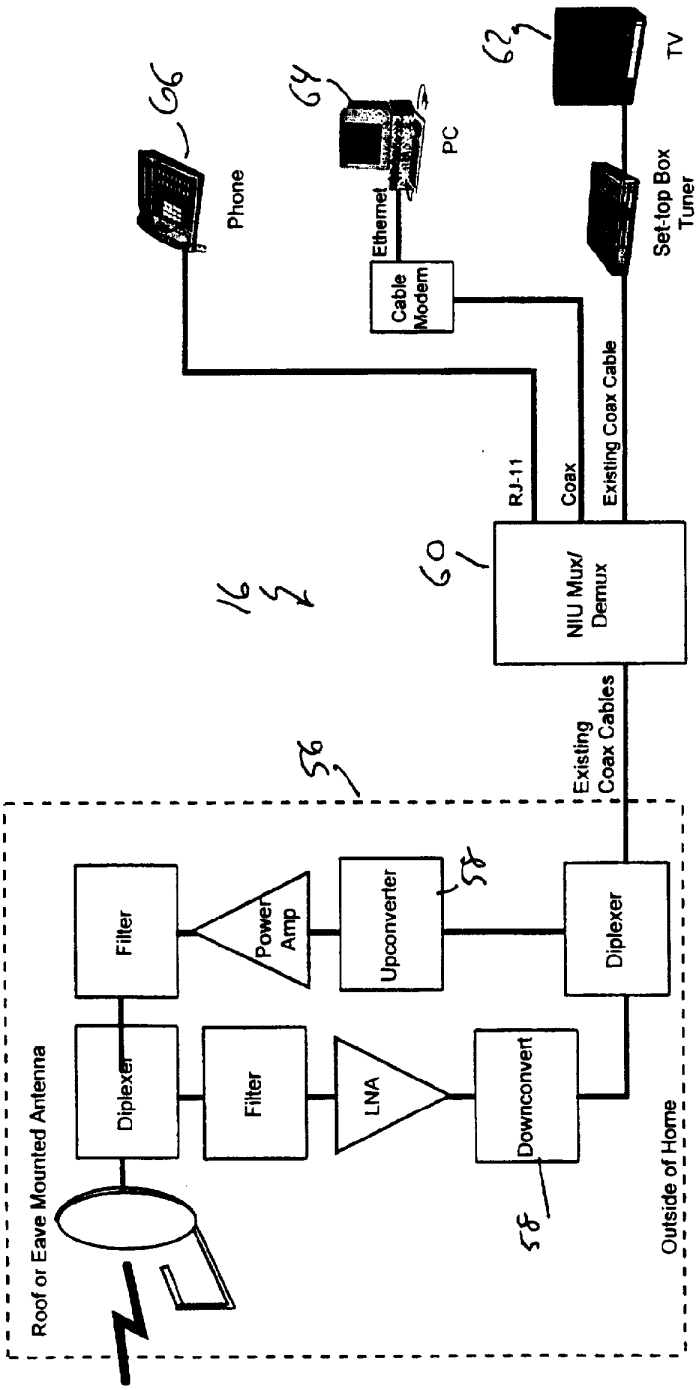
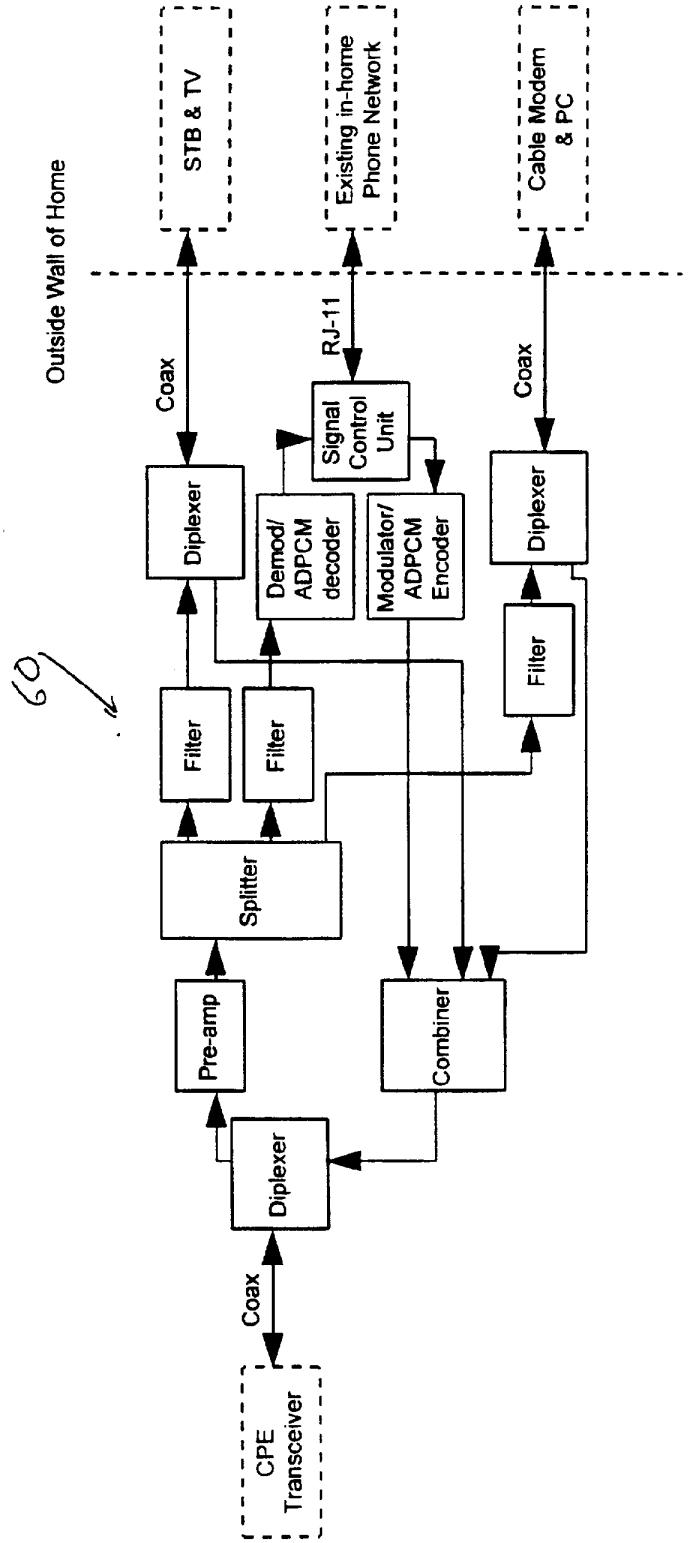

Roof or Eave Mounted Antenna
Diplexer
Filter
LNA
Downconvert
Filter
Power Amp
Upconverter
Diplexer
Outside of Home
Existing Coax Cables
NIU Mux/ Demux
RJ-11
Coax
Existing Coax Cable
Cable Modem
Ethernet
PC
Phone
Set-top Box Tuner
TV
56
58
60
62
64
66
16

Figure 5


60
Outside Wall of Home
STB & TV
Existing in-home Phone Network
Cable Modem & PC
Coax
RJ-11
Coax
Signal Control Unit
Diplexer
Demod/ ADPCM decoder
Modulator/ ADPCM Encoder
Diplexer
Filter
Filter
Filter
Splitter
Pre-amp
Combiner
Diplexer
Coax
CPE Transceiver

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 97/10087

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04H1/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04H H04B H04Q

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 95 25409 A (ENDLINK INC.) 21 September 1995	1-3, 5-11, 13-18, 20-26,28
A	see page 4, line 2-18 see page 6, line 29 - page 8, line 21 see page 9, line 31 - page 12, line 35 see page 15, line 2 - page 20, line 13 see page 23, line 2 - page 24, line 27 see page 27, line 28 - page 29, line 7 see page 32, line 20-22 --- -/--	19,27

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of the international search	Date of mailing of the international search report
7 November 1997	18. 11. 97

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Zanti, P

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

INTERNATIONAL SEARCH REPORT

Interna al Application No
PCT/US 97/10087

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	J.C.FAN,C.L.LU,R.F.KALMAN,L.G.KAZOVSKY: "DESIGN AND ANALYSIS OF A NOVEL FIBER-BASED PCS OPTICAL NETWORK." IEEE, - 18 June 1995 pages 601-605, XP000533047 ABSTRACT,I-INTRODUCTION,III-COMPARISON OF OPTICAL FIBER-BASED PCS SYSTEMS,IV-NUMERICAL RESULTS AND DISCUSSION. ---	1-3, 5-11, 13-18, 20-26,28
Y	HIROYO OGAWA,KOHIJ HORIKAWA,YOSHINORI NAKASUKA: "CASCADED EXTERNAL OPTICAL MODULATION LINK FOR RADIO DISTRIBUTION." IEEE, - 23 May 1994 pages 487-490, XP000527321 INTRODUCTION,LINK CONFIGURATION. ---	1-3, 5-11, 13-18, 20-26,28
A	WO 94 24783 A (CONIFER CORPORATION) 27 October 1994 see page 1, line 4-13 see page 6, line 2-32 see page 8, line 3 - page 17, line 38 -----	1,2,4, 6-8,12, 14-16, 21,24

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

INTERNATIONAL SEARCH REPORT

Information on patent family members

Interna al Application No
PCT/US 97/10087

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9525409 A	21-09-95	AU 2117595 A	03-10-95
		CA 2185711 A	21-09-95
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Form PCT/ISA/210 (patent family annex) (July 1992)

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Application No: 17/587,462

Foreign Priority claimed: ○ Yes ◉ No

35 USC 119 (a-d) conditions met: ☐ Yes ☑ No ☐ Met After Allowance

Verified and Acknowledged: /BLANE J JACKSON/ Examiner's Signature | Initials

Title: METHOD FOR RECEIVING A TELEVISION SIGNAL

FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
01/28/2022	348	2644	28427US13
RULE			

APPLICANTS

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Curtis Ling, Carlsbad, CA, UNITED STATES

Tim Gallagher, Carlsbad, CA, UNITED STATES

CONTINUING DATA

This application is a CON of 17217244 03/30/2021ABN

17217244 is a CON of 16430506 06/04/2019 PAT 10972781

16430506 is a CON of 15792318 10/24/2017 PAT 10313733

15792318 is a CON of 14948881 11/23/2015 PAT 9819992

14948881 is a CON of 14617973 02/10/2015 PAT 9210363

14617973 is a CON of 13962871 08/08/2013 PAT 9100622

13962871 is a CON of 12762900 04/19/2010 PAT 8526898

12762900 has PRO of 61170526 04/17/2009

FOREIGN APPLICATIONS

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17587462	CTNF	04/13/2022	28427US13
	892	04/13/2022	28427US13
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Electronic Petition Request	**TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT**
Application Number	17587462
Filing Date	28-Jan-2022
First Named Inventor	Madhukar Reddy
Attorney Docket Number	28427US13
Title of Invention	METHOD FOR RECEIVING A TELEVISION SIGNAL

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Owner	Percent Interest
Entropic Communications, LLC	100%

The owner(s) with percent interest listed above in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term of prior patent number(s)

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Signature	/Wayne H. Bradley/
Name	Wayne H. Bradley

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner).
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Electronic Patent Application Fee Transmittal

Application Number:	17587462
Filing Date:	28-Jan-2022
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Filer:	Wayne Bradley/Laura Foley
Attorney Docket Number:	28427US13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
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STATUTORY OR TERMINAL DISCLAIMER	1814	1	170	170
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Document Description: Electronic Terminal Disclaimer – Approved

Application No.: 17587462

Filing Date: 28-Jan-2022

Applicant/Patent under Reexamination: Reddy

Electronic Terminal Disclaimer filed on April 14, 2022

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Electronic Acknowledgement Receipt	
EFS ID:	45471357
Application Number:	17587462
International Application Number:	
Confirmation Number:	9515
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Customer Number:	23446
Filer:	Wayne Bradley/Laura Foley
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Attorney Docket Number:	28427US13
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Filing Date:	28-JAN-2022
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1	Terminal Disclaimer-Filed (Electronic)	eTerminal-Disclaimer.pdf	41292 73e1ce90e2877efdcb7d6c964f4c8dd75d87c9ee	no	2
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	37824 cf0181d9b62590ae1a09e67bdf5aad4cad4dd5c6	no	2
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National Stage of an International Application under 35 U.S.C. 371

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New International Application Filed with the USPTO as a Receiving Office

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Attorney Docket No. 28427US13

Patent Application of: Madhukar Reddy Application No. 17/587,462 Filed: January 28, 2022 Title: METHOD FOR RECEIVING A TELEVISION SIGNAL Examiner: JACKSON, BLANE J. Group Art Unit: 2644 Confirmation No.: 9515	**EFS ELECTRONIC FILING** **April 14, 2022**

Amendment

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

Dear Sir:

This paper responds to the Office Action of April 13, 2022 ("OA"). This response is timely filed. The Applicant respectfully requests reconsideration in view of the following remarks.

Amendments to the Claims begin on page 2.

Remarks begin on page 13.

LISTING OF CLAIMS

1-18 (Cancelled)

19. (Currently Amended) A method for receiving a television (TV) signal comprising:
digitizing a contiguous band of frequencies in an input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises a plurality of desired channels and a plurality of undesired channels;
concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels; and
providing the plurality of desired channels via a serial interface.

20. (Previously Presented) The method of claim 19, wherein the method comprises:
communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

21. (Previously Presented) The method of claim 19, wherein the method comprises:
generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

22. (Previously Presented) The method of claim 21, wherein:
the I and Q components of each corresponding complex signal are at baseband.

23. (Previously Presented) The method of claim 21, wherein the method comprises:
filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

24. (Previously Presented) The method of claim 21, wherein the method comprises:
demodulating, via each demodulator of a plurality of demodulators, the corresponding complex signal to generate a demodulated signal as a desired channel output.

25. (Previously Presented) The method of claim 19, wherein the method comprises:
demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

26. (Previously Presented) The method of claim 25, wherein the method comprises:
providing a plurality of demodulated desired channels via a parallel interface.

27. (Cancelled)

28. (Cancelled)

29. (Previously Presented) The method of claim 19, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

30. (Previously Presented) The method of claim 19, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

31. (Previously Presented) The method of claim 19, wherein:
the method is performed by a device comprising a digital video recorder (DVR).

32. (Previously Presented) The method of claim 19, wherein the method comprises:
configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

33. (Previously Presented) The method of claim 19, wherein:
the contiguous band of frequencies comprises a portion of a frequency spectrum of the input signal.

34. (Currently Amended) A method comprising:
digitizing an input signal via a wideband analog-to-digital converter (ADC), wherein the input signal comprises a plurality of desired channels and a plurality of undesired channels; ~~and~~

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs; and

providing the plurality of digital channel outputs via a serial interface.

35. (Previously Presented) The method of claim 34, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

36. (Previously Presented) The method of claim 34, wherein:

digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

37. (Previously Presented) The method of claim 36, wherein:

the I and Q components of each corresponding complex signal are at baseband.

38. (Previously Presented) The method of claim 36, wherein the method comprises:

a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

39. (Previously Presented) The method of claim 36, wherein the method comprises:

demodulating the corresponding complex signal to provide a demodulated channel as a digital channel output.

40. (Previously Presented) The method of claim 34, wherein the method comprises:

demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

41. (Previously Presented) The method of claim 40, wherein the method comprises:

providing the plurality of demodulated channels via a parallel interface.

42. (Cancelled)

43. (Cancelled)

44. (Previously Presented) The method of claim 34, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

45. (Previously Presented) The method of claim 34, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

46. (Previously Presented) The method of claim 34, wherein:
the method is performed by a device comprising a digital video recorder (DVR).

47. (Previously Presented) The method of claim 34, wherein the method comprises:
providing a picture-in-picture display signal according to the plurality of digital channel outputs.

48. (Previously Presented) The method of claim 34, wherein:
the plurality of desired channels and the plurality of undesired channels comprise a portion of a frequency spectrum of the input signal.

49. (New) A method for receiving a television (TV) signal comprising:
digitizing a contiguous band of frequencies in an input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises a plurality of desired channels and a plurality of undesired channels;
concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels; and
providing the plurality of desired channels,
wherein the method is performed by a device comprising a digital video recorder (DVR).

50. (New) The method of claim 49, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

51. (New) The method of claim 49, wherein the method comprises:

generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

52. (New) The method of claim 51, wherein:

the I and Q components of each corresponding complex signal are at baseband.

53. (New) The method of claim 51, wherein the method comprises:

filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

54. (New) The method of claim 51, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, the corresponding complex signal to generate a demodulated signal as a desired channel output.

55. (New) The method of claim 49, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

56. (New) The method of claim 55, wherein the method comprises:

providing a plurality of demodulated desired channels via a parallel interface.

57. (New) The method of claim 49, wherein the method comprises:

providing the plurality of desired channels via a parallel interface.

58. (New) The method of claim 49, wherein the method comprises:

providing the plurality of desired channels via a serial interface.

59. (New) The method of claim 49, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

60. (New) The method of claim 49, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

61. (New) The method of claim 49, wherein the method comprises:
configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

62. (New) The method of claim 49, wherein:
the contiguous band of frequencies comprises a portion of a frequency spectrum of the input signal.

63. (New) A method comprising:
digitizing an input signal via a wideband analog-to-digital converter (ADC), wherein the input signal comprises a plurality of desired channels and a plurality of undesired channels; and
digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs,
wherein the method is performed by a device comprising a digital video recorder (DVR).

64. (New) The method of claim 63, wherein the method comprises:
communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

65. (New) The method of claim 63, wherein:
digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

66. (New) The method of claim 65, wherein:
the I and Q components of each corresponding complex signal are at baseband.

67. (New) The method of claim 65, wherein the method comprises:
a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

68. (New) The method of claim 65, wherein the method comprises:
demodulating the corresponding complex signal to provide a demodulated channel as a digital channel output.

69. (New) The method of claim 63, wherein the method comprises:
demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

70. (New) The method of claim 69, wherein the method comprises:
providing the plurality of demodulated channels via a parallel interface.

71. (New) The method of claim 63, wherein the method comprises:
providing the plurality of digital channel outputs via a parallel interface.

72. (New) The method of claim 63, wherein the method comprises:
providing the plurality of digital channel outputs via a serial interface.

73. (New) The method of claim 63, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

74. (New) The method of claim 63, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

75. (New) The method of claim 63, wherein the method comprises:

providing a picture-in-picture display signal according to the plurality of digital channel outputs.

76. (New) The method of claim 63, wherein:

the plurality of desired channels and the plurality of undesired channels comprise a portion of a frequency spectrum of the input signal.

77. (New) A method for receiving a television (TV) signal comprising:

digitizing a contiguous band of frequencies in an input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises a plurality of desired channels and a plurality of undesired channels;

concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels;

providing the plurality of desired channels; and

configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

78. (New) The method of claim 77, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

79. (New) The method of claim 77, wherein the method comprises:

generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

80. (New) The method of claim 79, wherein:

the I and Q components of each corresponding complex signal are at baseband.

81. (New) The method of claim 79, wherein the method comprises:

filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

82. (New) The method of claim 79, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, the corresponding complex signal to generate a demodulated signal as a desired channel output.

83. (New) The method of claim 77, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

84. (New) The method of claim 83, wherein the method comprises:

providing a plurality of demodulated desired channels via a parallel interface.

85. (New) The method of claim 77, wherein the method comprises:

providing the plurality of desired channels via a parallel interface.

86. (New) The method of claim 77, wherein the method comprises:

providing the plurality of desired channels via a serial interface.

87. (New) The method of claim 77, wherein:

the plurality of desired channels comprises at least one cable broadcast channel.

88. (New) The method of claim 77, wherein:

the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

89. (New) The method of claim 77, wherein:

the method is performed by a device comprising a digital video recorder (DVR).

90. (New) The method of claim 77, wherein:

the contiguous band of frequencies comprises a portion of a frequency spectrum of the input signal.

91. (New) A method comprising:

digitizing an input signal via a wideband analog-to-digital converter (ADC), wherein the input signal comprises a plurality of desired channels and a plurality of undesired channels;

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs; and

configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

92. (New) The method of claim 91, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

93. (New) The method of claim 91, wherein:

digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

94. (New) The method of claim 93, wherein:

the I and Q components of each corresponding complex signal are at baseband.

95. (New) The method of claim 93, wherein the method comprises:

a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

96. (New) The method of claim 93, wherein the method comprises:

demodulating the corresponding complex signal to provide a demodulated channel as a digital channel output.

97. (New) The method of claim 91, wherein the method comprises:

demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

98. (New) The method of claim 97, wherein the method comprises:
providing the plurality of demodulated channels via a parallel interface.

99. (New) The method of claim 91, wherein the method comprises:
providing the plurality of digital channel outputs via a parallel interface.

100. (New) The method of claim 91, wherein the method comprises:
providing the plurality of digital channel outputs via a serial interface.

101. (New) The method of claim 91, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

102. (New) The method of claim 91, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

103. (New) The method of claim 91, wherein:
the method is performed by a device comprising a digital video recorder (DVR).

104. (New) The method of claim 91, wherein:
the plurality of desired channels and the plurality of undesired channels comprise a portion of a frequency spectrum of the input signal.

REMARKS

The present application includes pending claims 19-48. Claims 19-27, 29-30, 33-42, 44-45 and 48 have been rejected. Claims 28, 31, 32, 43, 46 and 47 as examined 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. The Office Action of April 13, 2022 ("OA") has been carefully considered.

Reconsideration in view of the following remarks is respectfully requested. Though the Applicant generally disagrees with such rejections, to expedite allowance of various pending claims, claims 19 and 34 have been amended, claims 27, 28, 42 and 43 have been cancelled, and claims 49-104 have been added as new.

Note that such amendments are in no way to be construed as the Applicant agreeing with any rejections not specifically discussed below. The Applicant respectfully traverses the above rejections at least for the reasons previously set forth during prosecution and at least based on the following remarks. Examination and reconsideration of the claims in view of the following remarks are respectfully requested.

Allowable Subject Matter

Claims 28, 31, 32, 43, 46 and 47 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. Accordingly, the follow amendment are submitted:

- All of the limitations of allowable claim 28 are added to base claim 19 and there are no intervening claims. Therefore, claim 19 as amended is allowable.
- Claims 20-26 and 29-33 are allowable at least according to their dependencies.
- Claims 27 and 28 as previously presented are cancelled.
- All of the limitations of allowable claim 43 are added to base claim 34 and there are no intervening claims. Therefore, claim 34 as amended is allowable.
- Claims 35-41 and 44-48 are allowable at least according to their dependencies.
- Claims 42 and 43 as previously presented are cancelled.

- New claim 49 includes all of the limitations of allowable claim 31 as examined and base claim 19 as examined and there are no intervening claims. Therefore, new claim 49 is allowable.
- New claims 50-62 include all of the limitations of claims 20-30, 32 and 33 as examined, respectively. New claims 50-62 are allowable at least according to their dependencies.
- New claim 63 includes all of the limitations of allowable claim 46 as examined and base claim 34 as examined and there are no intervening claims. Therefore, new claim 63 is allowable.
- New claims 64-76 include all of the limitations of claims 35-45, 47 and 48 as examined, respectively. New claims 64-76 are allowable at least according to their dependencies.
- New claim 77 includes all of the limitations of allowable claim 32 as examined and base claim 19 as examined and there are no intervening claims. Therefore, new claim 77 is allowable.
- New claims 78-90 include all of the limitations of claims 20-31 and 33 as examined, respectively. New claims 78-90 are allowable at least according to their dependencies.
- New claim 91 includes all of the limitations of allowable claim 47 as examined and base claim 34 as examined and there are no intervening claims. Therefore, new claim 91 is allowable.
- New claims 92-104 include all of the limitations of claims 35-46 and 48 as examined, respectively. New claims 92-104 are allowable at least according to their dependencies.

For the aforementioned reasons, claims 19-26, 29-41, 44-48 as amended are allowable and new claims 49-104 are allowable.

Double Patenting

The claims as examined are rejected on the ground of nonstatutory obviousness-type double patenting as being allegedly unpatentable over claims of U.S. Patent No. 9,100,622.

The Applicant respectfully traverses the above rejection, but in order to advance prosecution a terminal disclaimer is filed herewith. The terminal disclaimer obviates and therefore overcomes the nonstatutory obviousness-type double patenting rejection.

Rejections under 35 U.S.C.§103

Claims 19-27, 29, 30, 33-42, 44, 45 and 48 are rejected under 35 U.S.C. 103 as being allegedly unpatentable over Skones (U.S. Patent No. 6,760,342) in view of Uskali (WO 02/087230).

The Applicant traverses these rejections, but in order to advance prosecution has amended the claims as described above. Claims 19 and 34 as amended render moot and therefore overcome the rejection under 35 U.S.C. 103.

For at least the aforementioned reasons, claims 19-26, 29-41 and 44-48 as amended are allowable.

Final Matters

The Office Action makes various statements, including without limitation statements regarding the claims, 35 U.S.C. §103, the cited references, one of ordinary skill in the art, etc., that are now moot in view of the previously presented amendments and/or arguments. Thus, the Applicant will not address all of such statements at the present time. However, the Applicant expressly reserves the right to challenge such statements in the future should the need arise (*e.g.*, if such statements should become relevant by reappearing in a rejection of any current or future claim or be relied upon in any proceeding involving this application or a corresponding patent). The Applicant also respectfully reserves the right to argue additional reasons that support the allowability of all claims, whether or not argued in this Response or previous responses, should that need arise in the future.

Conclusion

The Applicant submits that the pending claims are in condition for allowance and courteously solicits an expeditious Notice of Allowability with respect to all pending claims. If the Examiner has any questions or the Applicant can be of any assistance, the Examiner is invited to contact the undersigned attorney.

The Commissioner is authorized to charge any necessary fees, or credit any overpayment to the Deposit Account of McAndrews, Held & Malloy, Account No. 13-0017.

Respectfully submitted,

Dated: April 14, 2022

/Wayne H. Bradley/
Wayne H. Bradley
Reg. No. 39,916

McAndrews, Held & Malloy, Ltd.
500 W. Madison Street
34th Floor
Chicago, Il 60661
Phone (312) 775-8000
Fax (312) 775-8100

Electronic Patent Application Fee Transmittal

Application Number:	17587462
Filing Date:	28-Jan-2022
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Filer:	Wayne Bradley/Laura Foley
Attorney Docket Number:	28427US13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
CLAIMS IN EXCESS OF 20	1202	52	100	5200
INDEPENDENT CLAIMS IN EXCESS OF 3	1201	3	480	1440
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**6640**

Electronic Acknowledgement Receipt	
EFS ID:	45471336
Application Number:	17587462
International Application Number:	
Confirmation Number:	9515
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Customer Number:	23446
Filer:	Wayne Bradley/Laura Foley
Filer Authorized By:	Wayne Bradley
Attorney Docket Number:	28427US13
Receipt Date:	14-APR-2022
Filing Date:	28-JAN-2022
Time Stamp:	10:21:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$6640
RAM confirmation Number	E20224DA22161983
Deposit Account	130017
Authorized User	Laura Foley
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		28427US13_FINAL_response.pdf	68396 627120e4eaba38f49023ccb0f7faf677d79451e2	yes	16

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Request for Reconsideration-After Non-Final Rejection	1	1
	Claims	2	12
	Applicant Arguments/Remarks Made in an Amendment	13	16

Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	40205 2b9f82d9232b80eddf2347d3e081c39743bb2faa	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	108601		

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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

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PTO/SB/06 (09-11)
Approved for use through 1/31/2014. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 17/587,462	Filing Date 01/28/2022	☐ To be Mailed

ENTITY: ☑ LARGE ☐ SMALL ☐ MICRO

APPLICATION AS FILED - PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA		RATE ($)	FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A		N/A	
☐ SEARCH FEE (37 CFR 1.16(k), (i), or (m))	N/A	N/A		N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A		N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*		x $100 =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*		x $480 =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $310 ($155 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).				
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))					
* If the difference in column 1 is less than zero, enter "0" in column 2.				TOTAL	

APPLICATION AS AMENDED - PART II

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT	04/14/2022	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 82	Minus	** 30	= 52		x $100 =	5200
	Independent (37 CFR 1.16(h))	* 6	Minus	*** 3	= 3		x $480 =	1440
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	6640

		(Column 1)		(Column 2)	(Column 3)			
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	*	Minus	**	=		x $0 =	
	Independent (37 CFR 1.16(h))	*	Minus	***	=		x $0 =	
	☐ Application Size Fee (37 CFR 1.16(s))							
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							
							TOTAL ADD'L FEE	

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

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

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

PTO/SB/08a (01-22)
Approved for use through 05/31/2024. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	17587462
Filing Date	2022-01-28
First Named Inventor	Madhukar Reddy
Art Unit	2644
Examiner Name	JACKSON, BLANE J.
Attorney Docket Number	28427US13

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7130576		2006-10-31	Gurantz et al	
	2	7477871		2009-01-13	Gurantz et al	
	3	7542715		2009-06-02	Gurantz et al	
	4	7783958		2010-08-24	Eidson et al	
	5	7941091		2011-05-10	Doherty et al	
	6	8023912		2011-09-20	Petrovic et al	
	7	8086170		2011-12-27	Petrovic et al	
	8	8238813		2012-08-07	Popoli	

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17587462
	Filing Date	2022-01-28
	First Named Inventor	Madhukar Reddy
	Art Unit	2644
	Examiner Name	JACKSON, BLANE J.
	Attorney Docket Number	28427US13

	9	8566678		2013-10-22	Eidson et al	
	10	8611809		2013-12-17	Popoli	
	11	8892026		2014-11-18	Petrovic et al	
	12	9219557		2015-12-22	Bargroff et al	
	13	9413476		2016-08-09	Petrovic et al	
	14	9853757		2017-12-26	Petrovic et al	
	15	10439746		2019-10-08	Petrovic et al	
	16	11139902		2021-10-05	Petrovic et al	

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17587462
	Filing Date	2022-01-28
	First Named Inventor	Madhukar Reddy
	Art Unit	2644
	Examiner Name	JACKSON, BLANE J.
	Attorney Docket Number	28427US13

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

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NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		

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EXAMINER SIGNATURE

Examiner Signature		Date Considered	

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

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17587462
	Filing Date	2022-01-28
	First Named Inventor	Madhukar Reddy
	Art Unit	2644
	Examiner Name	JACKSON, BLANE J.
	Attorney Docket Number	28427US13

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Wayne H. Bradley/	Date (YYYY-MM-DD)	2022-04-20
Name/Print	Wayne H. Bradley	Registration Number	39916

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

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

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

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

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

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

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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

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

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Acknowledgement Receipt

EFS ID:	45520737
Application Number:	17587462
International Application Number:	
Confirmation Number:	9515
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Customer Number:	23446
Filer:	Wayne Bradley/Laura Foley
Filer Authorized By:	Wayne Bradley
Attorney Docket Number:	28427US13
Receipt Date:	20-APR-2022
Filing Date:	28-JAN-2022
Time Stamp:	16:33:03
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	Information Disclosure Statement (IDS) Form (SB08)	28427US13_IDS_sb08a_EFS-WEB.pdf	1236269 b06da8008b1302cec8c8e476456e7c4c0d7dbb85	no	5

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Total Files Size (in bytes):	1236269

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New International Application Filed with the USPTO as a Receiving Office

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Document Code:WFEE

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Sale Item Reference Number	Effective Date
17587462	04/20/2022

Document Number	Fee Code	Fee Code Description	Amount Paid	Payment Method
I20224SE57221493	1806	SUBMISSION- INFORMATION DISCLOSURE STMT	$260.00	Deposit Account

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
17/587,462	01/28/2022	Madhukar Reddy	28427US13

CONFIRMATION NO. 9515

PUBLICATION NOTICE

23446
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

OC000000133959590

Title:METHOD FOR RECEIVING A TELEVISION SIGNAL

Publication No.US-2022-0159332-A1
Publication Date:05/19/2022

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Public Records Division. The Public Records Division can be reached by telephone at (571) 272-3150 or (800) 972-6382, by facsimile at (571) 273-3250, by mail addressed to the United States Patent and Trademark Office, Public Records Division, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently https://portal.uspto.gov/pair/PublicPair. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

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May 20, 2022 05:53:40 AM

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Application	Document	Mailroom Date	Attorney Docket No.
17587462	NTC.PUB	05/19/2022	28427US13

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UNITED STATES PATENT AND TRADEMARK OFFICE

PATENT APPLICATION INFORMATION RETRIEVAL SYSTEM

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
Attorney Docket No. 28427US13

Patent Application of: Madhukar Reddy Application No. 17/587,462 Filed: January 28, 2022 Title: METHOD FOR RECEIVING A TELEVISION SIGNAL Examiner: JACKSON, BLANE J. Group Art Unit: 2644 Confirmation No.: 9515	**EFS ELECTRONIC FILING** **June 2, 2022**

Supplemental Amendment

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

Dear Sir:

The Office Action of April 13, 2022 ("OA") was responded to on April 14, 2022 ("Response"). Claims 19-26, 29-41, 44-104 as presented in the Response are believed to be allowable. The Applicant respectfully requests the entry of this Supplemental Amendment prior to a notice of allowance.

Amendments to the Claims begin on page 2.

Remarks begin on page 13.

LISTING OF CLAIMS

1-18. (Cancelled)

19. (Currently Amended) A method for receiving a television (TV) signal comprising:

receiving an input signal from a cable network;

digitizing a contiguous band of frequencies in ~~an~~ the input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises all received channels that exist in the input signal and the received channels comprise[[s]] a plurality of desired channels and a plurality of undesired channels;

concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels; and

providing the plurality of desired channels via a serial interface.

20. (Previously Presented) The method of claim 19, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

21. (Previously Presented) The method of claim 19, wherein the method comprises: generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

22. (Previously Presented) The method of claim 21, wherein:

the I and Q components of each corresponding complex signal are at baseband.

23. (Previously Presented) The method of claim 21, wherein the method comprises: filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

24. (Previously Presented) The method of claim 21, wherein the method comprises: demodulating, via each demodulator of a plurality of demodulators, the corresponding complex signal to generate a demodulated signal as a desired channel output.

25. (Previously Presented) The method of claim 19, wherein the method comprises: demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

26. (Previously Presented) The method of claim 25, wherein the method comprises: providing a plurality of demodulated desired channels via a parallel interface.

27. (Cancelled)

28. (Cancelled)

29. (Previously Presented) The method of claim 19, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

30. (Previously Presented) The method of claim 19, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

31. (Previously Presented) The method of claim 19, wherein:
the method is performed by a device comprising a digital video recorder (DVR).

32. (Previously Presented) The method of claim 19, wherein the method comprises:
configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

33. (Cancelled)

34. (Currently Amended) A method comprising:

receiving an input signal from a cable network;

digitizing ~~an~~ all received channels in the input signal via a wideband analog-to-digital converter (ADC), wherein the ~~input signal comprises~~ received channels comprise a plurality of desired channels and a plurality of undesired channels; ~~and~~

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs; and

providing the plurality of digital channel outputs via a serial interface.

35. (Previously Presented) The method of claim 34, wherein the method comprises: communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

36. (Previously Presented) The method of claim 34, wherein:

digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

37. (Previously Presented) The method of claim 36, wherein:

the I and Q components of each corresponding complex signal are at baseband.

38. (Previously Presented) The method of claim 36, wherein the method comprises:

a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

39. (Previously Presented) The method of claim 36, wherein the method comprises: demodulating the corresponding complex signal to provide a demodulated channel as a

digital channel output.

40. (Previously Presented) The method of claim 34, wherein the method comprises: demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

41. (Previously Presented) The method of claim 40, wherein the method comprises: providing the plurality of demodulated channels via a parallel interface.

42. (Cancelled)

43. (Cancelled)

44. (Previously Presented) The method of claim 34, wherein:
the plurality of desired channels comprises at least one cable broadcast channel.

45. (Previously Presented) The method of claim 34, wherein:
the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

46. (Previously Presented) The method of claim 34, wherein:
the method is performed by a device comprising a digital video recorder (DVR).

47. (Previously Presented) The method of claim 34, wherein the method comprises: providing a picture-in-picture display signal according to the plurality of digital channel outputs.

48. (Cancelled)

49. (Currently Amended) A method for receiving a television (TV) signal comprising:

receiving an input signal from a cable network;

digitizing a contiguous band of frequencies in ~~an~~ the input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises all received channels that exist in the input signal and the received channels comprise[[s]] a plurality of desired channels and a plurality of undesired channels;

concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels; and

providing the plurality of desired channels,

wherein the method is performed by a device comprising a digital video recorder (DVR).

50. (Previously Presented) The method of claim 49, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

51. (Previously Presented) The method of claim 49, wherein the method comprises:

generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

52. (Previously Presented) The method of claim 51, wherein:

the I and Q components of each corresponding complex signal are at baseband.

53. (Previously Presented) The method of claim 51, wherein the method comprises:

filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

54. (Previously Presented) The method of claim 51, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, the corresponding complex signal to generate a demodulated signal as a desired channel output.

55. (Previously Presented) The method of claim 49, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

56. (Previously Presented) The method of claim 55, wherein the method comprises: providing a plurality of demodulated desired channels via a parallel interface.

57. (Previously Presented) The method of claim 49, wherein the method comprises: providing the plurality of desired channels via a parallel interface.

58. (Previously Presented) The method of claim 49, wherein the method comprises: providing the plurality of desired channels via a serial interface.

59. (Previously Presented) The method of claim 49, wherein:

the plurality of desired channels comprises at least one cable broadcast channel.

60. (Previously Presented) The method of claim 49, wherein:

the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

61. (Previously Presented) The method of claim 49, wherein the method comprises:

configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

62. (Cancelled)

63. (Currently Amended) A method comprising:

receiving an input signal from a cable network;

digitizing ~~an~~ all received channels in the input signal via a wideband analog-to-digital converter (ADC), wherein the ~~input signal~~ received channels comprise[[s]] a plurality of desired channels and a plurality of undesired channels; and

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs,

wherein the method is performed by a device comprising a digital video recorder (DVR).

64. (Previously Presented) The method of claim 63, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

65. (Previously Presented) The method of claim 63, wherein:

digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

66. (Previously Presented) The method of claim 65, wherein:

the I and Q components of each corresponding complex signal are at baseband.

67. (Previously Presented) The method of claim 65, wherein the method comprises:

a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

68. (Previously Presented) The method of claim 65, wherein the method comprises:

demodulating the corresponding complex signal to provide a demodulated channel

as a digital channel output.

69. (Previously Presented) The method of claim 63, wherein the method comprises:

demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

70. (Previously Presented) The method of claim 69, wherein the method comprises: providing the plurality of demodulated channels via a parallel interface.

71. (Previously Presented) The method of claim 63, wherein the method comprises: providing the plurality of digital channel outputs via a parallel interface.

72. (Previously Presented) The method of claim 63, wherein the method comprises: providing the plurality of digital channel outputs via a serial interface.

73. (Previously Presented) The method of claim 63, wherein:

the plurality of desired channels comprises at least one cable broadcast channel.

74. (Previously Presented) The method of claim 63, wherein:

the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

75. (Previously Presented) The method of claim 63, wherein the method comprises:

providing a picture-in-picture display signal according to the plurality of digital channel outputs.

76. (Cancelled)

77. (Currently Amended) A method for receiving a television (TV) signal comprising:

receiving an input signal from a cable network;

digitizing a contiguous band of frequencies in ~~an~~ the input signal via a wideband analog-to-digital converter (ADC), wherein the contiguous band of frequencies comprises all received channels that exist in the input signal and the received channels comprise a plurality of desired channels and a plurality of undesired channels;

concurrently selecting each of the plurality of desired channels from the input signal without selecting any of the plurality of undesired channels;

providing the plurality of desired channels; and

configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

78. (Previously Presented) The method of claim 77, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

79. (Previously Presented) The method of claim 77, wherein the method comprises:

generating, via each mixer of a plurality of mixers, a complex signal corresponding to each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

80. (Previously Presented) The method of claim 79, wherein:

the I and Q components of each corresponding complex signal are at baseband.

81. (Previously Presented) The method of claim 79, wherein the method comprises:

filtering, via each filter of a plurality of filters, the corresponding complex signal, and wherein each corresponding complex signal comprises a 6 MHz channel.

82. (Previously Presented) The method of claim 79, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, the

corresponding complex signal to generate a demodulated signal as a desired channel output.

83. (Previously Presented) The method of claim 77, wherein the method comprises:

demodulating, via each demodulator of a plurality of demodulators, a desired channel, of the plurality of desired channels.

84. (Previously Presented) The method of claim 83, wherein the method comprises: providing a plurality of demodulated desired channels via a parallel interface.

85. (Previously Presented) The method of claim 77, wherein the method comprises: providing the plurality of desired channels via a parallel interface.

86. (Previously Presented) The method of claim 77, wherein the method comprises: providing the plurality of desired channels via a serial interface.

87. (Previously Presented) The method of claim 77, wherein:

the plurality of desired channels comprises at least one cable broadcast channel.

88. (Previously Presented) The method of claim 77, wherein:

the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

89. (Previously Presented) The method of claim 77, wherein:

the method is performed by a device comprising a digital video recorder (DVR).

90. (Cancelled)

91. (Currently Amended) A method comprising:

receiving an input signal from a cable network;

digitizing ~~an~~ all received channels in the input signal via a wideband analog-to-digital converter (ADC), wherein the ~~input signal comprises~~ received channels comprise a plurality of desired channels and a plurality of undesired channels;

digitally down converting each desired channel, of the plurality of desired channels, to generate a plurality of digital channel outputs; and

configuring at least some of the plurality of desired channels as an output for a picture-in-picture display.

92. (Previously Presented) The method of claim 91, wherein the method comprises:

communicating the input signal from a cable network connector to the wideband ADC via at least one of an analog amplifier and an analog filter.

93. (Previously Presented) The method of claim 91, wherein:

digitally down converting comprises generating a corresponding complex signal for each of the plurality of desired channels, and wherein each corresponding complex signal comprises an in-phase (I) component and a quadrature (Q) component.

94. (Previously Presented) The method of claim 93, wherein:

the I and Q components of each corresponding complex signal are at baseband.

95. (Previously Presented) The method of claim 93, wherein the method comprises:

a filtering the corresponding complex signal, wherein a bandwidth of the complex signal is 6 MHz.

96. (Previously Presented) The method of claim 93, wherein the method comprises:

demodulating the corresponding complex signal to provide a demodulated channel as a digital channel output.

97. (Previously Presented) The method of claim 91, wherein the method comprises:

demodulating each digitally down converted, desired channel to generate a plurality of demodulated channels.

98. (Previously Presented) The method of claim 97, wherein the method comprises: providing the plurality of demodulated channels via a parallel interface.

99. (Previously Presented) The method of claim 91, wherein the method comprises: providing the plurality of digital channel outputs via a parallel interface.

100. (Previously Presented) The method of claim 91, wherein the method comprises: providing the plurality of digital channel outputs via a serial interface.

101. (Previously Presented) The method of claim 91, wherein:

the plurality of desired channels comprises at least one cable broadcast channel.

102. (Previously Presented) The method of claim 91, wherein:

the plurality of desired channels comprises at least one channel delivered via a Data Over Cable Service Interface Specification (DOCSIS) protocol.

103. (Previously Presented) The method of claim 91, wherein:

the method is performed by a device comprising a digital video recorder (DVR).

104. (Cancelled)

REMARKS

The Office Action of April 13, 2022 ("OA") was responded to on April 14, 2022 ("Response"). Claims 19-26, 29-41, 44-104 as presented in the Response are believed to be allowable.

This Supplemental Amendment amends claims 19, 34, 49, 63 77, and 91 and cancels claims 33, 48, 62, 76, 90, and 104. Accordingly 19-26, 29-32, 34-41, 44- 47, 49-61, 63-75, 77-89, and 91-103 as amended are believed to be allowable. The Applicant respectfully requests the entry of this Supplemental Amendment prior to a notice of allowance.

Conclusion

The Applicant submits that the pending claims are in condition for allowance and courteously solicits an expeditious Notice of Allowability with respect to all pending claims. If the Examiner has any questions or the Applicant can be of any assistance, the Examiner is invited to contact the undersigned attorney.

The Commissioner is authorized to charge any necessary fees, or credit any overpayment to the Deposit Account of McAndrews, Held & Malloy, Account No. 13-0017.

Respectfully submitted,

Dated: June 2, 2022

/Wayne H. Bradley/
Wayne H. Bradley
Reg. No. 39,916

McAndrews, Held & Malloy, Ltd.
500 W. Madison Street
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Chicago, Il 60661
Phone (312) 775-8000
Fax (312) 775-8100

Electronic Acknowledgement Receipt

EFS ID:	45864607
Application Number:	17587462
International Application Number:	
Confirmation Number:	9515
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Customer Number:	23446
Filer:	Wayne Bradley/Laura Foley
Filer Authorized By:	Wayne Bradley
Attorney Docket Number:	28427US13
Receipt Date:	02-JUN-2022
Filing Date:	28-JAN-2022
Time Stamp:	18:39:40
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		28427US13_FINAL_response.pdf	56614 b87057535eccb5dffb89c9c4752eb2f65588bb28	yes	14

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Supplemental Response or Supplemental Amendment	1	1
	Claims	2	13
	Applicant Arguments/Remarks Made in an Amendment	14	14
Warnings:			
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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.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

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NOTICE OF ALLOWANCE AND FEE(S) DUE

23446 7590 06/15/2022

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

EXAMINER
JACKSON, BLANE J

ART UNIT	PAPER NUMBER
2644	

DATE MAILED: 06/15/2022

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/587,462	01/28/2022	Madhukar Reddy	28427US13	9515

TITLE OF INVENTION: METHOD FOR RECEIVING A TELEVISION SIGNAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	09/15/2022

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 ENTITY STATUS shown above. If the ENTITY STATUS is shown as SMALL or MICRO, verify whether entitlement to that entity status still applies.

If the ENTITY STATUS is the same as shown above, pay the TOTAL FEE(S) DUE shown above.

If the ENTITY STATUS is changed from that shown above, on PART B - FEE(S) TRANSMITTAL, complete section number 5 titled "Change in Entity Status (from status indicated above)".

For purposes of this notice, small entity fees are 1/2 the amount of undiscounted fees, and micro entity fees are 1/2 the amount of small entity fees.

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. 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.

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P.O. Box 1450
Alexandria, Virginia 22313-1450

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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)

23446 7590 06/15/2022
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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.

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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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

(Typed or printed name)
(Signature)
(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/587,462	01/28/2022	Madhukar Reddy	28427US13	9515

TITLE OF INVENTION: METHOD FOR RECEIVING A TELEVISION SIGNAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	09/15/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
JACKSON, BLANE J	2644	348-731000

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/AIA/122 or PTO/SB/122) attached.

❑ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). 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. Fees submitted: ❑ Issue Fee ❑ Publication Fee (if required) ❑ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

❑ Electronic Payment via EFS-Web ❑ Enclosed check ❑ Non-electronic payment by credit card (Attach form PTO-2038)

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. _____

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

❑ Applicant certifying micro entity status. See 37 CFR 1.29

❑ Applicant asserting small entity status. See 37 CFR 1.27

❑ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/587,462	01/28/2022	Madhukar Reddy	28427US13	9515

23446 7590 06/15/2022

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CHICAGO, IL 60661

EXAMINER	
JACKSON, BLANE J	

ART UNIT	PAPER NUMBER
2644	

DATE MAILED: 06/15/2022

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

The Office has discontinued providing a Patent Term Adjustment (PTA) calculation with the Notice of Allowance.

Section 1(h)(2) of the AIA Technical Corrections Act amended 35 U.S.C. 154(b)(3)(B)(i) to eliminate the requirement that the Office provide a patent term adjustment determination with the notice of allowance. See Revisions to Patent Term Adjustment, 78 Fed. Reg. 19416, 19417 (Apr. 1, 2013). Therefore, the Office is no longer providing an initial patent term adjustment determination with the notice of allowance. The Office will continue to provide a patent term adjustment determination with the Issue Notification Letter that is mailed to applicant approximately three weeks prior to the issue date of the patent, and will include the patent term adjustment on the patent. Any request for reconsideration of the patent term adjustment determination (or reinstatement of patent term adjustment) should follow the process outlined in 37 CFR 1.705.

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.

OMB Clearance and PRA Burden Statement for PTOL-85 Part B

The Paperwork Reduction Act (PRA) of 1995 requires Federal agencies to obtain Office of Management and Budget approval before requesting most types of information from the public. When OMB approves an agency request to collect information from the public, OMB (i) provides a valid OMB Control Number and expiration date for the agency to display on the instrument that will be used to collect the information and (ii) requires the agency to inform the public about the OMB Control Number's legal significance in accordance with 5 CFR 1320.5(b).

The information collected by PTOL-85 Part B 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 30 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.

Privacy Act Statement

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

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

1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether disclosure of these records is required by the Freedom of Information Act.
2. A record from this system of records may be disclosed, as a routine use, in the course of presenting evidence to a court, magistrate, or administrative tribunal, including disclosures to opposing counsel in the course of settlement negotiations.
3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.
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7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.
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9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Notice of Allowability	Application No. 17/587,462	Applicant(s) Reddy et al.	
	Examiner BLANE J JACKSON	Art Unit 2644	AIA (FITF) Status No

-- 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 the supplemental amendment filed 02 June 2022.
   ☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on _____.

2. ☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on _____; the restriction requirement and election have been incorporated into this action.

3. ☑ The allowed claim(s) is/are See Continuation Sheet . As a result of the allowed claim(s), you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see **http://www.uspto.gov/patents/init_events/pph/index.jsp** or send an inquiry to **PPHfeedback@uspto.gov.**

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

   Certified copies:

   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.

5. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
   ☐ 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. ☑ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date _____.
3. ☐ Examiner's Comment Regarding Requirement for Deposit of Biological Material _____.
4. ☐ Interview Summary (PTO-413), Paper No./Mail Date. _____.
5. ☐ Examiner's Amendment/Comment
6. ☑ Examiner's Statement of Reasons for Allowance
7. ☐ Other _____.

/BLANE J JACKSON/
Primary Examiner, Art Unit 2644

Continuation of 3. The allowed claim(s) is/are: 19-26,29-32,34-41,44-47,49-61,63-75,77-89 and 91-103

DETAILED ACTION

Notice of Pre-AIA or AIA Status

The present application is being examined under the pre-AIA first to invent provisions.

Terminal Disclaimer

The terminal disclaimer filed on 14 April 2022 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of US 9,100,622 has been reviewed and is accepted. The terminal disclaimer has been recorded.

Information Disclosure Statement

The Information Disclosure Statement filed 20 April 2022 is made of record.

Allowable Subject Matter

Claims 19-26, 29-32, 34-41, 44-47, 49-61, 63-75, 77-89 and 91-103 are allowed. Reference the applicant's Remarks filed 14 April 2022 and 02 June 2022 for reasons for allowance.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to BLANE J JACKSON whose telephone number is (571)272-7890. The examiner can normally be reached 7:30-4:30 M-TH; 8-2 FRI.

Examiner interviews are available via telephone, in-person, and video conferencing using a USPTO supplied web-based collaboration tool. To schedule an interview, applicant is encouraged to use the USPTO Automated Interview Request (AIR) at http://www.uspto.gov/interviewpractice.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Kathy Wang-Hurst can be reached on 571 270 5371. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of published or unpublished applications may be obtained from Patent Center. Unpublished application information in Patent Center is available to registered users. To file and manage patent submissions in Patent Center, visit: https://patentcenter.uspto.gov. Visit https://www.uspto.gov/patents/apply/patent-center for more information about Patent Center and https://www.uspto.gov/patents/docx for information about filing in DOCX format. For additional questions, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/BLANE J JACKSON/
Primary Examiner, Art Unit 2644

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/587,462	Reddy et al.
	Examiner	**Art Unit**
	BLANE J JACKSON	2644

CPC						
Symbol					**Type**	**Version**
H04N	/	21	/	4263	F	2013-01-01
H04B	/	1	/	0014	I	2013-01-01
H04N	/	5	/	50	I	2013-01-01
H04N	/	21	/	4383	I	2013-01-01
H04N	/	21	/	454	I	2013-01-01
H04N	/	21	/	6193	I	2013-01-01
H04N	/	21	/	6143	I	2013-01-01
H04N	/	5	/	455	I	2013-01-01
H04N	/	21	/	4382	I	2013-01-01

CPC Combination Sets							
Symbol					**Type**	**Set**	**Ranking**	**Version**
	/		/					

NONE		Total Claims Allowed:	
(Assistant Examiner)	(Date)	76	
/Blane J Jackson/	03 June 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	19	2

U.S. Patent and Trademark Office — Part of Paper No.: 20220525

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/587,462	Reddy et al.
	Examiner	**Art Unit**
	BLANE J JACKSON	2644

INTERNATIONAL CLASSIFICATION				
CLAIMED				
H04B	/	1	/	00
H04N	/	21	/	41
H04B	/	1	/	16

NON-CLAIMED				
	/		/	

US ORIGINAL CLASSIFICATION	
CLASS	**SUBCLASS**

CROSS REFERENCES(S)						
CLASS	**SUBCLASS (ONE SUBCLASS PER BLOCK)**					

NONE		**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	76	
/Blane J Jackson/	03 June 2022	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	19	2

U.S. Patent and Trademark Office — Part of Paper No.: 20220525

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/587,462	Reddy et al.
	Examiner	**Art Unit**
	BLANE J JACKSON	2644

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

CLAIMS

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	19	10	30	20	41	28	52	38	63	49	74	59	85	69	96
2	20	11	31		42	29	53	39	64	50	75	60	86	70	97
3	21	12	32		43	30	54	40	65		76	61	87	71	98
4	22		33	21	44	31	55	41	66	51	77	62	88	72	99
5	23	13	34	22	45	32	56	42	67	52	78	63	89	73	100
6	24	14	35	23	46	33	57	43	68	53	79		90	74	101
7	25	15	36	24	47	34	58	44	69	54	80	64	91	75	102
8	26	16	37		48	35	59	45	70	55	81	65	92	76	103
	27	17	38	25	49	36	60	46	71	56	82	66	93		104
	28	18	39	26	50	37	61	47	72	57	83	67	94		
9	29	19	40	27	51		62	48	73	58	84	68	95		

NONE (Assistant Examiner)	(Date)	**Total Claims Allowed:** 76	
/Blane J Jackson/ (Primary Examiner)	03 June 2022 (Date)	O.G. Print Claim(s) 19	O.G. Print Figure 2

U.S. Patent and Trademark Office Part of Paper No.: 20220525

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	17/587,462	Reddy et al.
	Examiner	Art Unit
	BLANE J JACKSON	2644

CPC - Searched*		
Symbol	Date	Examiner
H04N 5/455, 5/50, 21/4382, 21/4383, 21/454, 21/6143, 21/6193	04/07/2022	BJJ
H04B 1/16, 1/0014	04/07/2022	BJJ

CPC Combination Sets - Searched*		
Symbol	Date	Examiner

US Classification - Searched*			
Class	Subclass	Date	Examiner

* See search history printout included with this form or the SEARCH NOTES box below to determine the scope of the search.

Search Notes		
Search Notes	Date	Examiner
Review of parent patents & IDS, PE@E Search with DP to FAOM	04/07/2022	BJJ
Review of amendments & prior art; update SEARCH to issue	05/20/2022	BJJ

Interference Search			
US Class/CPC Symbol	US Subclass/CPC Group	Date	Examiner
	no interference listed symbol / group	05/20/2022	BJJ

Doc code: IDS
Doc description: Information Disclosure Statement (IDS) Filed

PTO/SB/08a (01-22)
Approved for use through 05/31/2024. 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 contains a valid OMB control number.

INFORMATION DISCLOSURE STATEMENT BY APPLICANT
(Not for submission under 37 CFR 1.99)

Application Number	17587462
Filing Date	2022-01-28
First Named Inventor	Madhukar Reddy
Art Unit	2644
Examiner Name	JACKSON, BLANE J.
Attorney Docket Number	28427US13

U.S.PATENTS Remove

Examiner Initial*	Cite No	Patent Number	Kind Code[1]	Issue Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1	7130576		2006-10-31	Gurantz et al	
	2	7477871		2009-01-13	Gurantz et al	
	3	7542715		2009-06-02	Gurantz et al	
	4	7783958		2010-08-24	Eidson et al	
	5	7941091		2011-05-10	Doherty et al	
	6	8023912		2011-09-20	Petrovic et al	
	7	8086170		2011-12-27	Petrovic et al	
	8	8238813		2012-08-07	Popoli	

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.J.J/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
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	Examiner Name	JACKSON, BLANE J.
	Attorney Docket Number	28427US13

	9	8566678		2013-10-22	Eidson et al	
	10	8611809		2013-12-17	Popoli	
	11	8892026		2014-11-18	Petrovic et al	
	12	9219557		2015-12-22	Bargroff et al	
	13	9413476		2016-08-09	Petrovic et al	
	14	9853757		2017-12-26	Petrovic et al	
	15	10439746		2019-10-08	Petrovic et al	
	16	11139902		2021-10-05	Petrovic et al	

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U.S.PATENT APPLICATION PUBLICATIONS Remove

Examiner Initial*	Cite No	Publication Number	Kind Code[1]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear
	1					

If you wish to add additional U.S. Published Application citation information please click the Add button. Add

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	Art Unit	2644
	Examiner Name	JACKSON, BLANE J.
	Attorney Docket Number	28427US13

FOREIGN PATENT DOCUMENTS Remove

Examiner Initial*	Cite No	Foreign Document Number[3]	Country Code[2] i	Kind Code[4]	Publication Date	Name of Patentee or Applicant of cited Document	Pages,Columns,Lines where Relevant Passages or Relevant Figures Appear	T[5]
	1							

If you wish to add additional Foreign Patent Document citation information please click the Add button Add

NON-PATENT LITERATURE DOCUMENTS Remove

Examiner Initials*	Cite No	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, pages(s), volume-issue number(s), publisher, city and/or country where published.	T[5]
	1		

If you wish to add additional non-patent literature document citation information please click the Add button Add

EXAMINER SIGNATURE

Examiner Signature	/BLANE J JACKSON/	Date Considered	05/20/2022

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

[1] See Kind Codes of USPTO Patent Documents at www.USPTO.GOV or MPEP 901.04. [2] Enter office that issued the document, by the two-letter code (WIPO Standard ST.3). [3] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [4] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [5] Applicant is to place a check mark here if English language translation is attached.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.J.J/

INFORMATION DISCLOSURE STATEMENT BY APPLICANT (Not for submission under 37 CFR 1.99)		
	Application Number	17587462
	Filing Date	2022-01-28
	First Named Inventor	Madhukar Reddy
	Art Unit	2644
	Examiner Name	JACKSON, BLANE J.
	Attorney Docket Number	28427US13

CERTIFICATION STATEMENT

Please see 37 CFR 1.97 and 1.98 to make the appropriate selection(s):

That each item of information contained in the information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(1).

OR

☐ That no item of information contained in the information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the person signing the certification after making reasonable inquiry, no item of information contained in the information disclosure statement was known to any individual designated in 37 CFR 1.56(c) more than three months prior to the filing of the information disclosure statement. See 37 CFR 1.97(e)(2).

See attached certification statement.

The fee set forth in 37 CFR 1.17 (p) has been submitted herewith.

☒ A certification statement is not submitted herewith.

SIGNATURE

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

Signature	/Wayne H. Bradley/	Date (YYYY-MM-DD)	2022-04-20
Name/Print	Wayne H. Bradley	Registration Number	39916

This collection of information is required by 37 CFR 1.97 and 1.98. 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 1 hour 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.**

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ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /B.J.J/

PE2E SEARCH - Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	British Equivalents	Time Stamp
L1	16	("10439746" OR "11139902" OR "7130576" OR "7477871" OR "7542715" OR "7783958" OR "7941091" OR "8023912" OR "8086170" OR "8238813" OR "8566678" OR "8611809" OR "8892026" OR "9219557" OR "9413476" OR "9853757").pn.	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 09:32 AM
L2	73	Reddy-Madhukar.in.	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 11:12 AM
L3	610	(H04N OR H04B) AND cable adj6 TV SAME set adj5 top AND band adj5 frequenc$4 SAME (band OR channel adj6 stack$4)	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 12:37 PM
L4	9831956	(H04N OR H04B) AND cable adj6 TV SAME set adj5 top AND band adj5 frequenc$4 SAME (band OR channel adj6 stack$4) some (mixer OR down adj4 conversion) SAME ((desire OR undesired) adj5 channel)	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 12:39 PM
L5	0	(H04N OR H04B) AND cable adj6 TV SAME set adj5 top AND band adj5 frequenc$4 SAME (band OR channel adj6 stack$4) SAME (mixer OR down adj4 conversion) SAME ((desire OR undesired) adj5 channel)	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 12:39 PM
L6	31	(H04N OR H04B) AND cable adj6 TV SAME set adj5 top AND band adj5 frequenc$4 SAME (band OR channel adj6 stack$4) SAME ((desired OR undesired)	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 12:40 PM

		adj5 channel)					
L7	210	(H04N OR H04B) AND (television OR TV) SAME set adj5 top AND band adj5 frequenc$4 SAME (band OR channel adj6 (stack$4 OR contiguous$4)) SAME (desired OR undesired) adj5 channel	(US-PGPUB; USPAT)	OR	ON	ON	2022/05/20 12:45 PM

PE2E SEARCH - Search History (Interference)

There are no Interference searches to show.

PART B - FEE(S) TRANSMITTAL

Complete and send this form, together with applicable fee(s), by mail or fax, or via EFS-Web.

By mail, send to: Mail Stop ISSUE FEE
Commissioner for Patents
P.O. Box 1450
Alexandria, Virginia 22313-1450

By fax, send to: (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)

23446 7590 06/15/2022
MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

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 transmitted to the USPTO via EFS-Web or by facsimile to (571) 273-2885, on the date below.

Wayne H. Bradley	(Typed or printed name)
/Wayne H. Bradley/	(Signature)
June 15, 2022	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/587,462	01/28/2022	Madhukar Reddy	28427US13	9515

TITLE OF INVENTION: METHOD FOR RECEIVING A TELEVISION SIGNAL

APPLN. TYPE	ENTITY STATUS	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	UNDISCOUNTED	$1200	$0.00	$0.00	$1200	09/15/2022

EXAMINER	ART UNIT	CLASS-SUBCLASS
JACKSON, BLANE J	2644	348-731000

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/AIA/122 or PTO/SB/122) attached.

☐ "Fee Address" indication (or "Fee Address" Indication form PTO/AIA/47 or 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 McAndrews, Held & Malloy, Ltd.
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 must have been previously recorded, or filed for recordation, as set forth in 37 CFR 3.11 and 37 CFR 3.81(a). Completion of this form is NOT a substitute for filing an assignment.

(A) NAME OF ASSIGNEE	(B) RESIDENCE: (CITY and STATE OR COUNTRY)
ENTROPIC COMMUNICATIONS, LLC	NEW YORK, NY

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

4a. Fees submitted: ☒ Issue Fee ☒ Publication Fee (if required) ☐ Advance Order - # of Copies _____

4b. Method of Payment: *(Please first reapply any previously paid fee shown above)*

☒ Electronic Payment via EFS-Web ☐ Enclosed check ☐ Non-electronic payment by credit card (Attach form PTO-2038)

☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment to Deposit Account No. 130017

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

☐ Applicant certifying micro entity status. See 37 CFR 1.29

☐ Applicant asserting small entity status. See 37 CFR 1.27

☐ Applicant changing to regular undiscounted fee status.

NOTE: Absent a valid certification of Micro Entity Status (see forms PTO/SB/15A and 15B), issue fee payment in the micro entity amount will not be accepted at the risk of application abandonment.
NOTE: If the application was previously under micro entity status, checking this box will be taken to be a notification of loss of entitlement to micro entity status.
NOTE: Checking this box will be taken to be a notification of loss of entitlement to small or micro entity status, as applicable.

NOTE: This form must be signed in accordance with 37 CFR 1.31 and 1.33. See 37 CFR 1.4 for signature requirements and certifications.

Authorized Signature /Wayne H. Bradley/ Date June 15, 2022

Typed or printed name Wayne H. Bradley Registration No. 39916

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Attorney Docket No.: 28427US13

Patent Application of:

Madhukar Reddy

Application No. 17/587,462

Filed: January 28, 2022

Title: METHOD FOR RECEIVING A TELEVISION SIGNAL

Examiner: JACKSON, BLANE J.

Group Art Unit: 2644

Confirmation No.: 79515

Filed electronically on June 15, 2022

COMMENTS ON STATEMENT OF REASONS FOR ALLOWANCE

Mail Stop: Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This paper responds to the Notice of Allowance mailed June 15, 2022 in the above-identified application (the "Application"). Applicants respectfully request entry of the following remarks in the record.

REMARKS

Claims 19-26, 29-32, 34-41, 44-47, 49-61, 63-75, 77-89 and 91-103 are allowed in the Notice of Allowance mailed on June 15, 2022. The Applicant thanks the Examiner for positive consideration of the claim.

Respectfully submitted,

Dated: June 15, 2022

/Wayne H. Bradley/
Wayne H. Bradley
Reg. No. 39,916

McAndrews, Held & Malloy, Ltd.
500 W. Madison Street
34th Floor
Chicago, Il 60661
Phone (312) 775-8000
Fax (312) 775-8100

Electronic Patent Application Fee Transmittal

Application Number:	17587462
Filing Date:	28-Jan-2022
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Filer:	Wayne Bradley/Deborah Wilson
Attorney Docket Number:	28427US13

Filed as Large Entity

Filing Fees for Utility under 35 USC 111(a)

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
UTILITY APPL ISSUE FEE	1501	1	1200	1200

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension-of-Time:				
Miscellaneous:				
			Total in USD ($)	**1200**

Electronic Acknowledgement Receipt	
EFS ID:	45963124
Application Number:	17587462
International Application Number:	
Confirmation Number:	9515
Title of Invention:	METHOD FOR RECEIVING A TELEVISION SIGNAL
First Named Inventor/Applicant Name:	Madhukar Reddy
Customer Number:	23446
Filer:	Wayne Bradley/Deborah Wilson
Filer Authorized By:	Wayne Bradley
Attorney Docket Number:	28427US13
Receipt Date:	15-JUN-2022
Filing Date:	28-JAN-2022
Time Stamp:	14:07:36
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	CARD
Payment was successfully received in RAM	$1200
RAM confirmation Number	E20226EE08023710
Deposit Account	130017
Authorized User	Deborah Wilson
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: 37 CFR 1.16 (National application filing, search, and examination fees) 37 CFR 1.17 (Patent application and reexamination processing fees)	

37 CFR 1.19 (Document supply fees)

37 CFR 1.20 (Post Issuance fees)

37 CFR 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1	Issue Fee Payment (PTO-85B)	28427US13_Issue-fee-transmittal_220615.pdf	1487310 09d58317a30a95795d1f2d43b83ae8125e854cca	no	1
Warnings:					
Information:					
2	Post Allowance Communication - Incoming	28427US13_Comments_on_Reasons_for_Allowance.pdf	21052 9c50a1e81ea4f036f154a783a87fb281fcdad6dd	no	2
Warnings:					
Information:					
3	Fee Worksheet (SB06)	fee-info.pdf	38028 fad6bbfcd6957f49be9aa67340d8b85628bfaa64	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	1546390		

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.

<u>New Applications Under 35 U.S.C. 111</u>
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.
<u>National Stage of an International Application under 35 U.S.C. 371</u>
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.
<u>New International Application Filed with the USPTO as a Receiving Office</u>
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.

To: mhmpto@mcandrews-ip.com,,
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Jun 15, 2022 08:56:59 AM

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SUITE 3400
CHICAGO, IL 60661
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The following USPTO patent application(s) associated with your Customer Number, 23446 , have new outgoing correspondence. This correspondence is now available for viewing in Private PAIR.

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Application	Document	Mailroom Date	Attorney Docket No.
17587462	NOA	06/15/2022	28427US13
	1449	06/15/2022	28427US13

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If you have any questions, please email the Electronic Business Center (EBC) at EBC@uspto.gov with 'e-Office Action' on the subject line or call 1-866-217-9197 during the following hours:

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CHICAGO, IL 60661

Courtesy Reminder for
Application Serial No: 17/587,462

Attorney Docket No: 28427US13
Customer Number: 23446
Date of Electronic Notification: 06/15/2022

This is a courtesy reminder that new correspondence is available for this application. If you have not done so already, please review the correspondence. The official date of notification of the outgoing correspondence will be indicated on the form PTOL-90 accompanying the correspondence.

An email notification regarding the correspondence was sent to the following email address(es) associated with your customer number:
mhmpto@mcandrews-ip.com

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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
17/587,462	07/26/2022	11399206	28427US13	9515

23446 7590 07/02/2022

MCANDREWS HELD & MALLOY, LTD
500 WEST MADISON STREET
SUITE 3400
CHICAGO, IL 60661

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 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

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

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

Any questions regarding the Patent Term Extension or Adjustment determination should be directed to the Office of Patent Legal Administration at (571)-272-7702. Questions relating to issue and publication fee payments should be directed to the Application Assistance Unit (AAU) of the Office of Patents Stakeholder Experience (OPSE), Stakeholder Support Division (SSD) at (571)-272-4200.

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

Madhukar Reddy, Carlsbad, CA;
Curtis Ling, Carlsbad, CA;
Tim Gallagher, Carlsbad, CA;

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

Entropic Communications, LLC, Carlsbad, CA;

The United States represents the largest, most dynamic marketplace in the world and is an unparalleled location for business investment, innovation, and commercialization of new technologies. The USA offers tremendous resources and advantages for those who invest and manufacture goods here. Through SelectUSA, our nation works to encourage and facilitate business investment. To learn more about why the USA is the best country in the world to develop technology, manufacture products, and grow your business, visit SelectUSA.gov.

IR103 (Rev. 10/09)

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Application	Document	Mailroom Date	Attorney Docket No.
17587462	ISSUE.NTF	07/02/2022	28427US13

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