

Case No. RF-448 (50676)

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ALEXANDRIA, VA 22313-1450

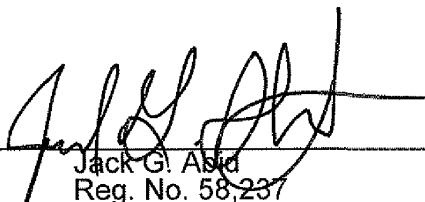
In re Application of: **CHAUNCEY, ET AL.**
Serial No.: **Not yet assigned**
Filed: **Herewith**
For: **WIRELESS COMMUNICATION SYSTEM
COMPENSATING FOR INTERFERENCE
AND RELATED METHODS**

Sir:

Transmitted herewith is an INFORMATION DISCLOSURE STATEMENT in the above-identified application.

1. ☒ This IDS is submitted under 37 C.F.R. § 1.97. No fee is required.
2. ☐ This IDS is submitted under 37 C.F.R. § 1.97(c). Enclosed is a check in the amount of \$ 180.00.
3. ☐ This IDS is submitted under 37 C.F.R. § 1.97(c) and (e). No fee is required.
4. ☐ This IDS is submitted under 37 C.F.R. § 1.97(d) and (e). Enclosed is a check in the amount of \$ 130.00 to cover the petition fee.
5. ☒ The Commissioner is hereby authorized to charge or credit any discrepancies in fee amounts to Deposit Account No. 01-0484.
6. ☒ Please associate this application with Customer No. 27975.

Date: June 4, 2008



Jack G. Abid
Reg. No. 58,237

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:)
CHAUNCEY, ET AL.)
)
Serial No. Not Yet Assigned)
)
Filing Date: Herewith)
)
For: WIRELESS COMMUNICATION SYSTEM)
COMPENSATING FOR INTERFERENCE)
AND RELATED METHODS)
)

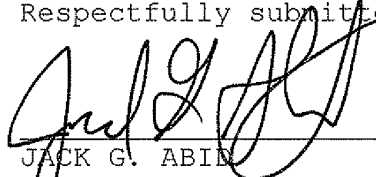
CITATION UNDER 37 CFR §1.97

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

Sir:

Attached is Form PTO-1449 listing several references for consideration in the examination of the above-identified application. In accordance with current USPTO procedures published 05 AUG 2003, in 1276 OG 55, copies of the U.S. patent documents cited in the form 1449A are not attached. The undersigned would be happy to provide copies of these references if requested. Copies of non-U.S. patent documents, if any, are attached. It is requested that these references be considered by the Examiner and officially made of record in accordance with the provisions of 37 CFR §1.97 and Section 609 of the MPEP.

Respectfully submitted,



JACK G. ABIN
Reg. No. 58,237
Allen, Dyer, Doppelt, Milbrath
& Gilchrist, P.A.
255 S. Orange Avenue, Suite 1401
Post Office Box 3791
Orlando, Florida 32802
407/841-2330
Attorney for Applicant

SUBSTITUTE FORM PTO-1449A LIST OF PATENTS AND APPLICANT'S INFORMATION DISCLOSURE STATEMENT			Atty Docket: Serial No.: Applicant: Filing Date: Group:		RF-448 (50676) Not Yet Assigned CHAUNCEY, ET AL Herewith		
U.S. PATENT DOCUMENTS							
Examiner Initials		Document Number	Date	Name	Class	Sub Class	Filing Date
	AA	6,115,409	9/5/00	UPADHYAY ET AL.	375	144	6/21/99
	AB	7,039,417	5/2/06	LYLE ET AL.	455	452.2	9/25/03
	AC	2004/0028003	2/12/04	DIENER ET AL.	370	319	4/22/03
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
FOREIGN PATENT DOCUMENTS							
		Document Number	Date	Country	Class	Sub Class	Translation
	AM						
	AN						
	AO						
	AP						
OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)							
	AQ	www.redlinecommunications.com , RedCONNEX AN-80i Advanced Broadband Wireless Infrastructure Solution.					
	AR						
	AS						
EXAMINER:				DATE CONSIDERED:			

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

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COMPLETE IF KNOWN

Application Number	Not yet assigned
Filing Date	Herewith
First Named Inventor	CHAUNCEY, ET AL.
Attorney Docket Number	RF-448 (50676)
Title (Required)	WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS

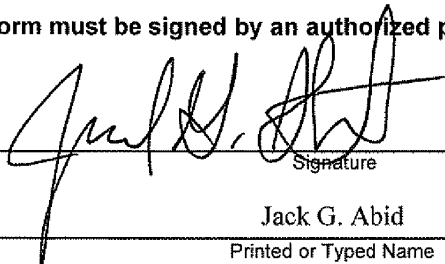
The undersigned hereby grants the USPTO authority to provide the European Patent Office (EPO), the Japan Patent Office (JPO), and any other intellectual property offices in which a foreign application claiming priority to the above-identified application is filed access to the above-identified patent application. See 37 CFR 1.14(c) and (h).

In accordance with 37 CFR 1.14(h)(3), access will be provided to a copy of the application-as-filed with respect to: 1) the above-identified application, 2) any foreign application to which the above-identified application claims priority under 35 USC 119(a)-(d) if a copy of the foreign application that satisfies the certified copy requirement of 37 CFR 1.55 has been filed in the above-identified US application, and 3) any U.S. application from which benefit is sought in the above-identified application.

This written authorization should be submitted prior to the filing of a subsequent foreign application, in which priority is claimed to the above-identified patent application, with any intellectual property office (e.g., the EPO or JPO).

No fee will be charged under 37 CFR 1.19(b)(1) for providing a participating intellectual property office with an electronic copy of the above-identified application.

This form must be signed by an authorized party in accordance with 37 CFR 1.14(c).



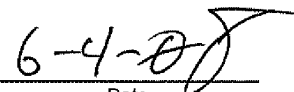
Signature

Jack G. Abid

Printed or Typed Name

Attorney

Title



Date

407-841-2330

Telephone Number

58,237

Registration Number, if applicable

This collection of information is required by 37 CFR 1.14(h). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process an application). Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450, DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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Electronic Patent Application Fee Transmittal				
Application Number:				
Filing Date:				
Title of Invention:		WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS		
First Named Inventor/Applicant Name:		David CHAUNCEY		
Filer:		Christopher F. Regan/Norma Pardo		
Attorney Docket Number:		RF-448 (50676)		
Filed as Large Entity				
Utility Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Utility application filing	1011	1	310	310
Utility Search Fee	1111	1	510	510
Utility Examination Fee	1311	1	210	210
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				1030

Electronic Acknowledgement Receipt

EFS ID:	3400825
Application Number:	12132757
International Application Number:	
Confirmation Number:	8369
Title of Invention:	WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS
First Named Inventor/Applicant Name:	David CHAUNCEY
Customer Number:	74701
Filer:	Christopher F. Regan/Norma Pardo
Filer Authorized By:	Christopher F. Regan
Attorney Docket Number:	RF-448 (50676)
Receipt Date:	04-JUN-2008
Filing Date:	
Time Stamp:	12:35:33
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$ 1030
RAM confirmation Number	6752
Deposit Account	080870
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
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1		50676_appln.pdf	2144035	yes	44
			36903939c345b0da494b1664b1474a11d53080cb		
	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Application Data Sheet		1	1	
	Specification		2	22	
	Claims		23	27	
	Abstract		28	28	
	Drawings-only black and white line drawings		29	34	
	Oath or Declaration filed		35	37	
	Information Disclosure Statement Letter		38	39	
	Information Disclosure Statement (IDS) Filed		40	40	
	NPL Documents		41	43	
	Authorization to access Appl. by Trilateral Office		44	44	
	Warnings:				
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	8421	no	2
			c6a6d6772c523e2071135be8449a1587e740b1ae		
Warnings:					
Information:					
Total Files Size (in bytes):			2152456		

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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

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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ALEXANDRIA, VA 22313-1450

Transmitted herewith for filing is the patent
application of:

Inventors: **David CHAUNCEY; Mitel KULINER; Elias THEODOROU**

For: **WIRELESS COMMUNICATION SYSTEM COMPENSATING
FOR INTERFERENCE AND RELATED METHODS**

Enclosed are:

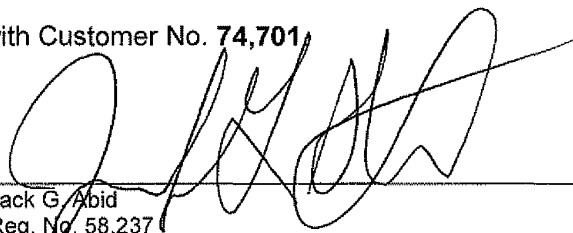
- ☒ Patent Application: 27 pages, 20 claims
- ☒ 6 sheets of drawings. The suggested drawing figure to be published is FIG. 1
- ☒ A declaration and power of attorney
- ☒ Citation Under 37 CFR 1.97 and PTO-1449A
- ☒ Authorization to Permit Access to Application by Participating Offices
- ☒ Assignee info:
 - Name: Harris Corporation
 - Address: 1025 West NASA Blvd.
Melbourne, Florida 32919
Corporation of the State of Delaware

The filing fee has been calculated as shown below:

	(Col. 1)		(Col. 2)		SMALL ENTITY		LARGE ENTITY	
FOR:	# FILED		# EXTRA		RATE	FEE	RATE	FEE
BASIC FEE						\$ 75		\$ 310
SEARCH FEE						\$ 255		\$ 510
EXAMINATION FEE						\$ 105		\$ 210
TOTAL CLAIMS	20	-20	0	X 25	\$		X 50	\$ 0
INDEP CLAIMS	3	- 3	0	X 105	\$		X 210	\$ 0
TOTAL PAGES		- 100	0	X 130*	\$		X 260*	\$
* for each additional 50 sheets that exceeds 100 sheets					TOTAL	\$	TOTAL	\$ 1,030

- ☒ The filing fee in the amount of \$1,030.00 is being charged to Harris Corporation Deposit Account No. **08-0870** on EFS-Web.
- ☒ The Commissioner is authorized to charge or credit any discrepancies in fee amounts to Deposit Account No. **08-0870**.
- ☒ PLEASE ADDRESS CORRESPONDENCE TO ATTORNEY OF RECORD:
CHRISTOPHER F. REGAN
- ☒ Please associate this application with Customer No. **74,701**

June 4, 2008
Date



Jack G. Abid
Reg. No. 58,237

Case No. RF-448 (50676)

COMMISSIONER FOR PATENTS
P.O. BOX 1450
ALEXANDRIA, VA 22313-1450

Transmitted herewith for filing is the patent
application of:

Inventors: **David CHAUNCEY; Mitel KULINER; Elias THEODOROU**

For: **WIRELESS COMMUNICATION SYSTEM COMPENSATING
FOR INTERFERENCE AND RELATED METHODS**

Enclosed are:

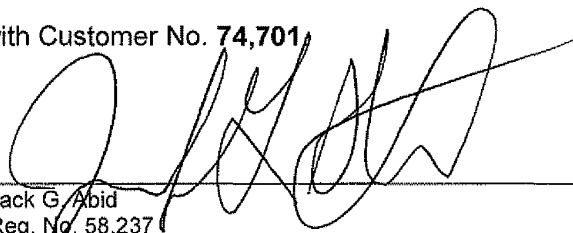
- ☒ Patent Application: 27 pages, 20 claims
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 - Name: Harris Corporation
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Melbourne, Florida 32919
Corporation of the State of Delaware

The filing fee has been calculated as shown below:

	(Col. 1)		(Col. 2)		SMALL ENTITY		LARGE ENTITY	
FOR:	# FILED		# EXTRA		RATE	FEE	RATE	FEE
BASIC FEE						\$ 75		\$ 310
SEARCH FEE						\$ 255		\$ 510
EXAMINATION FEE						\$ 105		\$ 210
TOTAL CLAIMS	20	-20	0	X 25	\$		X 50	\$ 0
INDEP CLAIMS	3	- 3	0	X 105	\$		X 210	\$ 0
TOTAL PAGES		- 100	0	X 130*	\$		X 260*	\$
* for each additional 50 sheets that exceeds 100 sheets					TOTAL	\$	TOTAL	\$ 1,030

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- ☒ PLEASE ADDRESS CORRESPONDENCE TO ATTORNEY OF RECORD:
CHRISTOPHER F. REGAN
- ☒ Please associate this application with Customer No. **74,701**

June 4, 2008
Date



Jack G. Abid
Reg. No. 58,237

**WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR
INTERFERENCE AND RELATED METHODS**

Field of the Invention

[0001] The present invention relates to the field of communications, and, more particularly, to interference compensation and related methods.

Background of the Invention

[0002] As wireless communications has become prevalent in society, it is not uncommon for two wireless communications devices to interfere with the operation of each other when operating within transmission range of each other. Indeed, this type of interference has become more frequent with increasing wireless connectivity permeating society, such as, cellular phones and mobile email devices. For example, when IEEE 802.11b (WiFi) wireless devices, for example, laptop computers, became readily available to the home consumer, "cordless" home telephones were capable of rendering the WiFi devices inoperable due to interference.

[0003] Interference is typically categorized into two types: narrowband interference and wideband interference. Narrowband interference includes forms of interference

that are concentrated around a relatively small frequency bandwidth. Several common approaches to compensating for narrowband interference may include, for example, forward error correction (FEC), baseband coding (FHSS/DSSS spread spectrum), diversity in frequency and/or time, and signal cancellation.

[0004] Differently, wideband interference includes forms of interference that are spread out across a relatively large frequency bandwidth. Several common approaches to compensating for wideband interference may include, for example, FEC, adaptive data rate (modulation and channel bandwidth), adaptive power control, diversity in frequency and/or time, and signal cancellation.

[0005] Another common type of interference is self interference. Common causes of self interference may include, for example, collocation or frequency reuse. In particular, collocation may be caused by two wireless communication systems being deployed too closely together while frequency reuse may be caused by two wireless communication systems using the same frequency band/channel. Several approaches to compensating for self interference, which are available during planning and development stages of wireless communication systems, include, for example, installation (isolation between antennas), frequency planning, antenna pattern manipulation, synchronization of transmitters, and filtering (duplexing).

[0006] Although interference is commonly generated inadvertently, another frequent source may be intentionally created by an unauthorized user, e.g. a jammer. Indeed, similar to the cordless home telephone, the unauthorized user may render a wireless communication

system inoperable or may reduce the effectiveness, for example, capacity, of the wireless communication system.

[0007] Regardless of the source, there is a desire to reduce the effect of interference in communications. For example, high spectral efficiency wireless communications devices, for example, an RF-7800W-OU440, as available from the Harris Corporation of Melbourne, FL, the assignee of the present application, use high signal-to-noise ratio transmissions and may be susceptible to interference.

[0008] An approach to interference in wireless communication systems may be interference compensation. For example, frequency diversity may be used to compensate for the interference by adjusting the operating frequency of the wireless communications device to a frequency free of the interference. Another approach to interference compensation is spatial diversity using a plurality of antennas. In this approach, the undesired interference is canceled out using the time shifted variants received at each antenna.

[0009] Another approach to interference compensation is disclosed in United States Patent No. 6,115,409 to Upadhyay et al. This system includes an array of antennas for spatial diversity. The system uses the spatial diversity to cancel out the interference. Moreover, the system uses spatial and temporal filters to cancel out wideband and narrowband interference in the antenna array.

[0010] Another approach to interference compensation is disclosed in United States Patent No. 7,039,417 to Lyle et al. The system of Lyle et al. cycles through available channels and evaluates the presence of

interference on each channel. The system may also determine the type of electronic device causing the interference, i.e. a cell phone or a microwave. The system assigns a quality-of-service parameter for the channel and moves on to the next channel. Using the table of service parameters for each available channel, the system may select a channel that is interference free or subject to low levels of interference. In other words, this system uses frequency diversity to compensate for interference.

Summary of the Invention

[0011] In view of the foregoing background, it is therefore an object of the present invention to provide effective interference compensation.

[0012] This and other objects, features, and advantages in accordance with the present invention are provided by a wireless communication system comprising first and second wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic. The first and second wireless communications devices may include respective first and second orthogonal frequency-division multiplexing (OFDM) wireless transceivers and respective first and second controllers coupled thereto. The first controller may be for detecting received interference, for determining a type of the received interference from among a plurality of interference types comprising wideband interference and narrowband interference, and for setting the at least one settable link characteristic to compensate for the received interference based upon the interference type.

Advantageously, the wireless communication system may provide efficient interference compensation based upon the interference type.

[0013] The plurality of interference types may further include self interference. Moreover, the first controller may detect the received interference based upon a comparison of a current received signal to at least one prior received signal. The first controller may also repeat the detecting, determining, and setting.

[0014] More particularly, the at least one settable link characteristic may comprise at least one receive processing characteristic. The at least one settable link characteristic may comprise at least one transmit processing characteristic. In some embodiments, the first controller may cooperate with the second controller to set the at least one transmit processing characteristic.

[0015] Further, the first controller may generate an interference map of the received interference onto OFDM cells. The first controller may set the at least one settable link characteristic based upon the interference map.

[0016] The first controller may determine the interference type based upon at least one of fade characteristics, noise characteristics, and path characteristics. For example, the at least one settable link characteristic may comprise at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering.

[0017] Another aspect is directed to a method for compensating interference in a wireless communication

system comprising first and second OFDM wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic. The method may comprise detecting received interference, determining a type of the interference from among a plurality of interference types comprising wideband interference and narrowband interference, and setting the at least one settable link characteristic to compensate for the interference based upon the interference type.

Brief Description of the Drawings

[0018] FIG. 1 is a schematic diagram of the wireless communication system according to the present invention.

[0019] FIG. 2 is a flowchart of a method for compensating interference in the wireless communication system of FIG. 1.

[0020] FIG. 3 is a block diagram for an embodiment of the detection of interference according to the present invention.

[0021] FIG. 4 is a block diagram for an embodiment of the generation of an interference map according to the present invention.

[0022] FIG. 5 is a block diagram for an embodiment of the narrowband adaptive filtering according to the present invention.

[0023] FIG. 6 is a more detailed schematic block diagram of the controller of FIG. 1.

Detailed Description of the Preferred Embodiments

[0024] The present invention will now be described more fully hereinafter with reference to the accompanying

drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. Like numbers refer to like elements throughout.

[0025] Referring initially to FIGS. 1-2, a wireless communication system **20** illustratively includes first **21** and second **25** wireless communications devices. Additionally, the wireless communication system **20** may include more than two wireless communications devices and/or a wireless base station. Alternatively, the wireless communication system **20** may include only one wireless communications device and a wireless base station. The first **21** and second **25** wireless communications devices illustratively communicate with one another via a wireless communications link having a plurality of settable link characteristics. For example, the settable link characteristics include at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering.

[0026] The first and second wireless communications devices **21**, **25** illustratively include first and second wireless transceivers **23**, **27**, respective first and second controllers **22**, **26** coupled to the wireless transceivers, and respective first and second antennas **24**, **30** coupled to the wireless transceivers. The first and second wireless transceivers **23**, **27** illustratively comprise

respective first and second orthogonal frequency-division multiplexing (OFDM) transceivers.

[0027] The method for compensating interference **28a-28c** in the wireless communication system **20** begins at Block **32**, the first wireless communications device **21** receives a transmission from the second wireless communications device **25** at Block **34**. Illustratively, the transmission from the first wireless communications device **21** to the second wireless communications device **25** is problem free (shown with solid line). Differently, the return transmission is subject to interference **28a-28c** from an unknown source (shown with dashed line). At decision Block **36**, the first controller **22** illustratively detects whether there is any received interference **28a-28c**. The first controller **22** may detect the received interference **28a-28c** based upon a comparison of a current received signal to at least one prior received signal.

[0028] More specifically, the first controller **22** may store data associated with past performance of the received signal and compare the current received signal with the stored data to determine whether there is any received interference **28a-28c**. If no interference **28a-28c** with the return transmission is detected, the first wireless communications device **21** makes no adjustments and returns to Block **34** to continue to receive the return transmission and transmit any remaining data.

[0029] Referring briefly and additionally to FIG. 3, a diagram **50** shows the first controller **22** detecting the interference **28a-28c** by at least performing interference parameter estimation. This includes monitoring **51** bit-error rate (BER), signal-to-noise and distortion ratio, and packet retransmission characteristics. These

parameters are monitored and compared with history **52** of received signals. The history is broken into short term (seconds) **53**, medium term (hours/days) **54**, and long term (weeks/months) **55** statistics. The comparison of link performance parameters with historical data allows the algorithm to advantageously determine the cause of the degradation in link performance, i.e. is it a short term fade or truly interference.

[0030] Referring again to FIGS. 1-2, if interference **28a-28c** is detected, the method moves to Block **40** where the first controller **22** determines a type of the interference from among a plurality of interference types comprising narrowband interference **28a**, wideband interference **28b**, and self interference **28c**. The first controller **22** determines the relative bandwidth of the interferer to the operating channel. More specifically, the first controller **22** determines the interference type based upon at least one of fade characteristics (flat or frequency selective), noise characteristics (wideband or narrowband), and path characteristics (line-of-sight or multipath).

[0031] For example, measurements made as part of the detection portion of the algorithm may be categorized into regions that map into modulation and FEC parameter selections. For interference-avoidance methods, bandwidth determination may often be adequate. In an interference-avoidance approach, the interference is detected then communications are conducted in regions or zones free from or with minimal interference.

[0032] Interference coexistence approaches subdivide in two categories: transmit parameters, such as, modulation type for FEC parameters; and reception

processing, such as, adaptive filtering, demodulation decision-region adjustment, or turbo-code transition-probability adjustment.

[0033] For interference coexistence methods, the detection schemes may be augmented to become estimation processes to allow for more effective optimization. More parameters may be measured; consequently, this may lead to other categorizations. Also, a monitoring process may be implemented with the algorithm method to adaptively adjust these regions based on effectiveness, based upon a closed-loop process to ensure convergence and stability. Advantageously, probability of success (or equivalently minimized BER) is increased.

[0034] Several techniques may be used to accomplish this. The first technique may include scanning a sample of the available channels. The receiver scans the designated operating channels and records the noise floor on each one. A map is created to determine the extent of the interfering source. In the event that the interference appears to be isolated to a small portion of the band, further scans using a smaller step size may be initiated to refine the breadth of the interfering source.

[0035] The second technique involves changing the operating channel bandwidth. This may apply to links that are using the 20 MHz or 40 MHz bandwidth setting. The categorization algorithm may monitor the noise floor on the channel at the wider and narrower bandwidths. If the bandwidth is reduced by one half but the noise floor remains constant, then the interferer is narrower than the channel bandwidth. If the noise floor is reduced by

one half, then the interferer is wider than the channel bandwidth.

[0036] The third technique uses signal processing centered on the Fourier transform associated with the OFDM. The bandwidth of the interferer can be determined through analysis of the spectral components, shown in a diagram **60** of FIG. 4. The method for spectral mapping beings by making assumptions about the coherence time of the channel **61**. The OFDM map is then subdivided **62** into groups. Subsequently, a selected group of subcarriers has their emission suspended **63**. The fast Fourier transform (FFT/IFFT) is then performed **64** to provide a subcarrier map **65**. The spectral power in use and idle ranges are calculated **66**. Lastly, subcarrier allocation/usage is transmitted **67** to all users.

[0037] Referring again to FIGS. 1-2, at Block **42**, the first controller **22** sets the settable link characteristics to compensate for the interference based upon the interference type. The settable link characteristics may comprise at least one receive processing characteristic and/or at least one transmit processing characteristic. The first controller **22** illustratively cooperates with the second controller **26** to set the at least one transmit processing characteristic. In some embodiments, the first controller **22** may independently set the transmit processing characteristic.

[0038] The first controller **22** may selectively set the settable link characteristics. In other words, the first controller **22** applies a "recipe" of interference compensation to communications, the recipe being based upon the type of interference detected and a pre-existing

priority based algorithm. The following lists give the priority of application for settable link characteristics for narrowband and wideband interferers.

Narrowband Compensation

1. Adaptive power control
2. Narrowband adaptive filtering
3. Adaptive waveform
4. Adaptive channel bandwidth
5. Diversity in Frequency - change operating frequency

Wideband Compensation:

1. Adaptive power control
2. Adaptive guard band - use Spectral Map, subcarrier allocation information to deactivate subcarrier
3. Narrowband adaptive filtering
4. Adaptive waveform
5. Adaptive channel bandwidth
6. Diversity in Frequency - change operating frequency
7. Diversity in Time
 - a. Change OFDM symbol time
 - b. Change OFDM symbol duration for cyclic extension

Flexibility to distribute the algorithms, providing enhanced monitoring and more direct compensation to the signal itself, may give better results.

[0039] Adaptive power control may permit the first and second wireless communications devices **21**, **25** to negotiate transmit power based upon transmission characteristics. By enabling the increase of transmit power to overcome interference sources, it is possible to burn through the interference and therefore increase the signal-to-noise/interference ratio. This method of

compensation may be simple and efficient, and should be used as a first line of defense, being noted as the first priority in both compensation method lists above. It is also applicable to narrow and wideband interference **28a-28b** sources but not for collocation issues.

[0040] Frequency diversity techniques compensate for the interference by changing the operating frequency. This includes techniques, such as, intelligent channel selection where a radio scans its available spectrum and moves to a clean frequency. This technique can be effective at maintaining the data throughput but can require frequency coordination between the first and second wireless communications devices **21, 25**.

[0041] Diversity in time can be an effective technique for packet based systems that are receiving interference from a pulsed source. By modifying the frame timing, it may be possible to align the pulsed interference to be out of sequence with the desired transmission between the first and second wireless communications devices **21, 25**. This may be effective in point-to-multipoint mode where a master can choose the point in time that it uses to transmit to any particular slave (avoiding local interference at the slave).

[0042] Adaptive waveform (modulation and FEC) may be adapted based on the amount and type of interference **28a-28c**. This includes changing the modulation type and/or the FEC rate to change the required signal-to-noise ratio of the system. The appropriate waveform for any specific type of interference **28a-28c** is dependent on the amount and type of interference that is present. It may be helpful to recognize the type of interference **28a-28c** when using an adaptive waveform technique. There can be

significant differences in system performance that result from matching the correct waveform with the interference **28a-28c**. For instance, the process gain that results from different error correction techniques is dependent on the cause of the errors (Reed-Solomon works better for burst errors and convolutional coding works better for random errors). Therefore, it may be helpful to tailor the adaptive waveform algorithm to the type of interference **28a-28c**.

[0043] In addition to changing the waveform (described above), the channel bandwidth can also be changed to compensate for interference **28a-28c**. If the interfering source is wideband, the interferer will appear to be more like Gaussian noise and narrowing the channel bandwidth will reduce the noise within the channel. This improves the overall signal-to-noise ratio by sacrificing channel throughput. However, the opposite may be true for narrowband interferers. If the bandwidth of the interferer is narrower than the channel bandwidth, narrowing the channel bandwidth will result in a higher level of interference **28a-28c** within the receiver. Therefore, it may be helpful that the interference **28a-28c** be characterized before an interference compensation technique is chosen.

[0044] Spatial diversity for signal cancellation or the use of multiple antennas (MIMO) may create an opportunity to use active cancellation to compensate for interference **28a-28c**. The theory behind MIMO is that the multiple antennas receive time shifted versions of a desired and undesired signal. Signal processing is then used to shift the desired signal into phase alignment and the undesired signal out of phase alignment (180 degrees

out of phase). This shift in the phase of the signal may result in an improvement in desired signal power and a significant reduction in undesired signal power, therefore improving the overall signal-to-interference ratio. The use of spatial diversity for signal cancellation may not affect the data throughput of the channel and this method should be considered to be one of the primary interference mitigation methods for both wideband **28b** and narrowband interference **28a**.

[0045] Null steering can also be used as an interference mitigation technique. This method uses the capability of detecting the direction of arrival for the received interference **28a-28c**. Once the azimuth is determined, a null in the antenna pattern can be steered in the direction of the interfering source. This method works for both wideband and narrowband interferers and adaptive and fixed antenna patterns. However, it does use either a mechanical or electronically steered antenna. Advantageously, significant reductions in interference power can be achieved using this method.

[0046] Referring again to FIGS. 1-2, at decision Block **44**, the first controller **22** may optionally repeat the detecting, determining, and setting by returning to Block **34**. In other words, the first controller **22** may apply its interference compensation algorithm iteratively. If the received signal does not return to a historical state indicative of interference free transmission, the method returns to Block **34** and the setting of settable link characteristics at Block **42** is adjusted appropriately, i.e. feedback analysis. If the received signal returns to normal historical performance, the method ends at Block **46**.

[0047] In the embodiments where the first and second wireless communications devices **21**, **25** include OFDM transceivers, the first controller **22** generates an interference map of the received interference **28a-28c** onto OFDM cells. Moreover, the first controller **22** sets the settable link characteristics based upon the interference map.

[0048] Referring to FIG. 5, a detailed and exemplary illustration of the algorithm for interference compensation is illustrated. Narrowband adaptive filtering (diagram **70**) includes dividing the dividing the interference into wideband (from other wideband OFDM spectrum users) **71** and narrowband **72**. The wideband interference is represented **73** as a plurality of stochastic narrowband interferers. A Kalman filter is then applied **74**. The subcarrier allocation/usage information is then used **75** in the decision making process.

[0049] Referring specifically to FIGS. 1 and 6, the first controller **22** illustratively includes an enhanced interference mitigation (EIM) module **101**, a media access control (MAC) module **102** coupled to the EIM module, and a physical layer (PHY) module **105** coupled to the EIM module and MAC module. The MAC module **102** includes a network flows block **103** and scheduling block **104** coupled to each other.

[0050] The EIM module **101** may execute the EIM algorithms and uses available detection data to build a map of the OFDM cells. This map is provided as input to the scheduling block **104** for informing what FEC and modulation can be used for each zone. As will be appreciated by those skilled in the art, the zone sizes

and shapes may be implementation-dependent. Zone types that could span the space from a fixed zone with single symbol duration across subcarriers to a more flexible zone assignment scheme where each symbol duration/subchannel could be assigned a maximum permissible FEC/modulation setting.

[0051] The EIM module **101** may request the scheduling block **104** to schedule zones free of transmissions to be used for measurements. The EIM module **101** can vary in sophistication from simply detecting interference levels and recommending frequency switches to highly complex Kalman or H-infinity tracking algorithms, for example.

[0052] The network flows block **103** is the source and sink for data referred to as "service flows" or that use the MAC module **102**. Quality-of-Service (QoS) and other factors may establish the priority of each flow. The network flows block **103** uses available information from the PHY module **105** based algorithms to determine a good performance metric for a given interference environment. This metric may comprise, for example, a priority-weighted aggregate flow rate through a node.

[0053] The scheduling block **104** uses the data from the EIM module **101** along with the network flows requested data rates and associated priorities to schedule data transmission and reception. The data is placed into zones using the EIM maps to optimize the aggregate priority-weighted flow rate. Further, special modes, such as, mesh and coordinating with other nodes in own network, can be performed here, requiring a level of distributed scheduling.

[0054] The PHY module **105** includes a detection block **106** for determining if interference **28a-28c** exists in the

received signal and measuring the amount of energy in a specified OFDM cell. The detection block **106** is for zones that have been designated to be free of transmission so that all the detected energy is from interfering sources. This type of block can also make use of cells that include pilot tones to make signal-to-interference measurements since the signal structure of the pilot is known. The detection block **106** processing can vary in complexity from simple power measurement to more complex signal-processing code -for the pilot carrier cells and for characterizing the signal for cases where knowledge of signal structure will help with more effective compensation.

[0055] The PHY module **105** illustratively includes a difference detection block **107** for performing signal-to-interference measurements. The difference detection block **107** includes stored algorithms that can use detected signal and FEC data to reconstruct the signal of interest and effectively subtract it from the raw signal to generate signal-to-interference estimates for any specified cell.

[0056] The PHY module **105** illustratively includes a FEC block **110** for performing the error correction encoding and decoding. Overall, the FEC block **110** contributes to EIM by including a large number of algorithms and settings to allow finer compensation granularity. The FEC block **110** interfaces with the difference detection block **107** by including a wider range of algorithms to increases the observability compared to the difference detection block described above. For example, if the algorithms determine exact errors bits

and soft error values or certainties, then that can be used to better characterize the interference **28a-28c**.

[0057] The PHY module **105** illustratively includes a symbol detection and mapping (SDM) block **113** that is similar to the FEC block **110** except modulations and detection algorithms are used in place of error-correcting code. The PHY module **105** also illustratively includes an OFDM block **114** for interfacing with the EIM module **101** by providing the number of frequency bandwidths, carrier spacing, and FFT sizes it supports.

[0058] The PHY module **105** illustratively includes an Rx filter block **116** for filtering the signal and compensating for the effects of the interference **28a-28c**. This block may be programmed for zone and anticipated reception. The PHY module **105** illustratively includes a Tx filter block **117** for filtering that compensates for the effects of the interference **28a-28c** by applying an inverse matched filter, for example. The Tx filter block **117** may be programmed for zone and anticipated reception.

[0059] The PHY module **105** illustratively includes a Zone Schedule Control (ZSC) block **112** for providing an increase in the ability to compensate based on increased flexibility that can be used to place service flow data in zones. The PHY module **105** illustratively includes an analog-to-digital converter **115** feeding into the Rx filter block **116**, and a digital-to-analog converter **118** receiving the output of the Tx filter block **117**.

[0060] This exemplary algorithm may be applied to narrowband and wideband interference **28a-28b**. The wireless communication system **20** may associate narrowband interference with the following characteristics: OFDM synchronization and frame detection are intermittent.

The subcarrier interference may be associated with a single subcarrier or with groups thereof. The known data symbols in the preamble and pilots are continuously correlated with stored/delayed versions of each other.

[0061] The wireless communication system **20** may then filter narrowband interference **28a** adaptively by at least combining subcarrier allocation/usage information with narrowband filtering carried out in existing FFT/IFFT processing. The interference **28a-28c** may be suppressed before the preamble is fed into the correlation module. When the frequency offset is less than 1% of subcarrier spacing, then it is accurate enough to maintain orthogonality of the OFDM signals.

[0062] Wideband interference **28b** may be detected when interference is caused by WiFi wireless devices or other wideband systems operating in the operating spectrum of the wireless communication system **20**. The side lobes of the sinc-shaped spectra on each subcarrier interfere with subcarriers in use by other systems. The subcarriers in use by the other systems may not be orthogonal with the wireless communication system **20**. Power control information may be used, for example, mean interference power difference being large (several percentage points) between subcarriers with and without interference **28a-28c**. An adaptive guard band may also be used by deactivating one or more subcarriers adjacent to the subcarriers experiencing the interference **28a-28c**. For longer OFDM duration, time domain windowing for OFDM symbols may be used -root raised cosine windows sharpen the spectral pulses on each subcarrier and lower the side lobes resulting in less interference power.

[0063] Many modifications and other embodiments of the invention will come to the mind of one skilled in the art having the benefit of the teachings presented in the foregoing descriptions and the associated drawings. Therefore, it is understood that the invention is not to be limited to the specific embodiments disclosed, and that modifications and embodiments are intended to be included within the scope of the appended claims.

THAT WHICH IS CLAIMED IS:

1. A wireless communication system comprising:

first and second wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic;

said first and second wireless communications devices comprising respective first and second orthogonal frequency-division multiplexing (OFDM) wireless transceivers and respective first and second controllers coupled thereto;

said first controller for
detecting received interference,
determining a type of the received
interference from among a plurality of interference
types comprising wideband interference and
narrowband interference, and

setting the at least one settable link
characteristic to compensate for the received
interference based upon the interference type.

2. The wireless communication system according to Claim 1 wherein the plurality of interference types further comprises self interference.

3. The wireless communication system according to Claim 1 wherein said first controller detects the received interference based upon a comparison of a current received signal to at least one prior received signal.

4. The wireless communication system according to Claim 1 wherein said first controller repeats the detecting, determining, and setting.

5. The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one receive processing characteristic.

6. The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and wherein said first controller cooperates with said second controller to set the at least one transmit processing characteristic.

7. The wireless communication system according to Claim 1 wherein said first controller generates an interference map of the received interference onto OFDM cells.

8. The wireless communication system according to Claim 7 wherein said first controller sets the at least one settable link characteristic based upon the interference map.

9. The wireless communication system according to Claim 1 wherein said first controller determines the interference type based upon at least one of fade characteristics, noise characteristics, and path characteristics.

10. The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering.

11. A wireless communications device communicating with an other wireless communications device via a wireless communications link having at least one settable link characteristic, the wireless communications device comprising:

an orthogonal frequency-division multiplexing (OFDM) wireless transceiver; and

a controller coupled to said wireless transceiver;

said controller for

detecting received interference,

determining a type of the received interference from among a plurality of interference types comprising wideband interference and narrowband interference, and

setting the at least one settable link characteristic to compensate for the received interference based upon the interference type.

12. The wireless communication system according to Claim 11 wherein the plurality of interference types further comprises self interference.

13. The wireless communications device according to Claim 11 wherein said controller detects the

received interference based upon a comparison of a current received signal to at least one prior received signal.

14. The wireless communications device according to Claim 11 wherein the at least one settable link characteristic comprises at least one receive processing characteristic.

15. The wireless communications device according to Claim 11 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and wherein said controller cooperates with the other wireless communications device to set the at least one transmit processing characteristic.

16. A method for compensating interference in a wireless communication system comprising first and second orthogonal frequency-division multiplexing (OFDM) wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic, the method comprising:

detecting received interference;

determining a type of the received interference from among a plurality of interference types comprising wideband interference and narrowband interference; and

setting the at least one settable link characteristic to compensate for the received interference based upon the interference type.

17. The method according to Claim 16 wherein the plurality of interference types further comprises self interference.

18. The method according to Claim 16 wherein the detecting comprises comparing a current received signal to at least one prior received signal.

19. The method according to Claim 16 further comprising repeating the detecting, determining, and setting.

20. The method according to Claim 16 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and further comprising cooperating between the first and second wireless communications devices to set the at least one transmit processing characteristic.

**WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR
INTERFERENCE AND RELATED METHODS**

Abstract of the Disclosure

A wireless communication system may include first and second wireless communications devices communicating with one another via a wireless communications link having a settable link characteristic. The first and second wireless communications devices may include respective first and second wireless transceivers and respective first and second controllers coupled thereto. The first controller may be for detecting received interference, for determining a type of the interference from among interference types comprising wideband interference and narrowband interference, and for setting the settable link characteristic to compensate for the interference based upon the interference type.

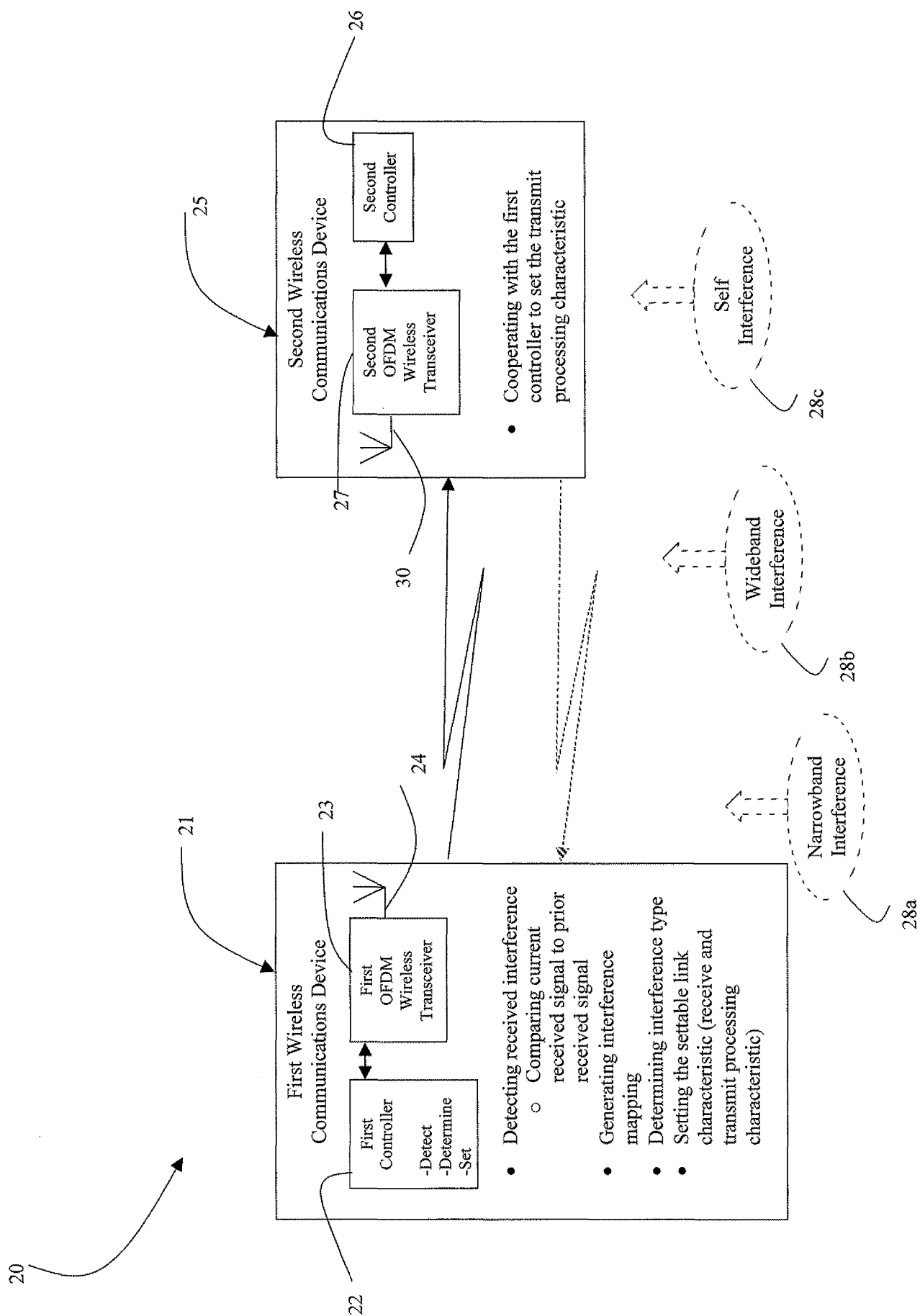


Figure 1

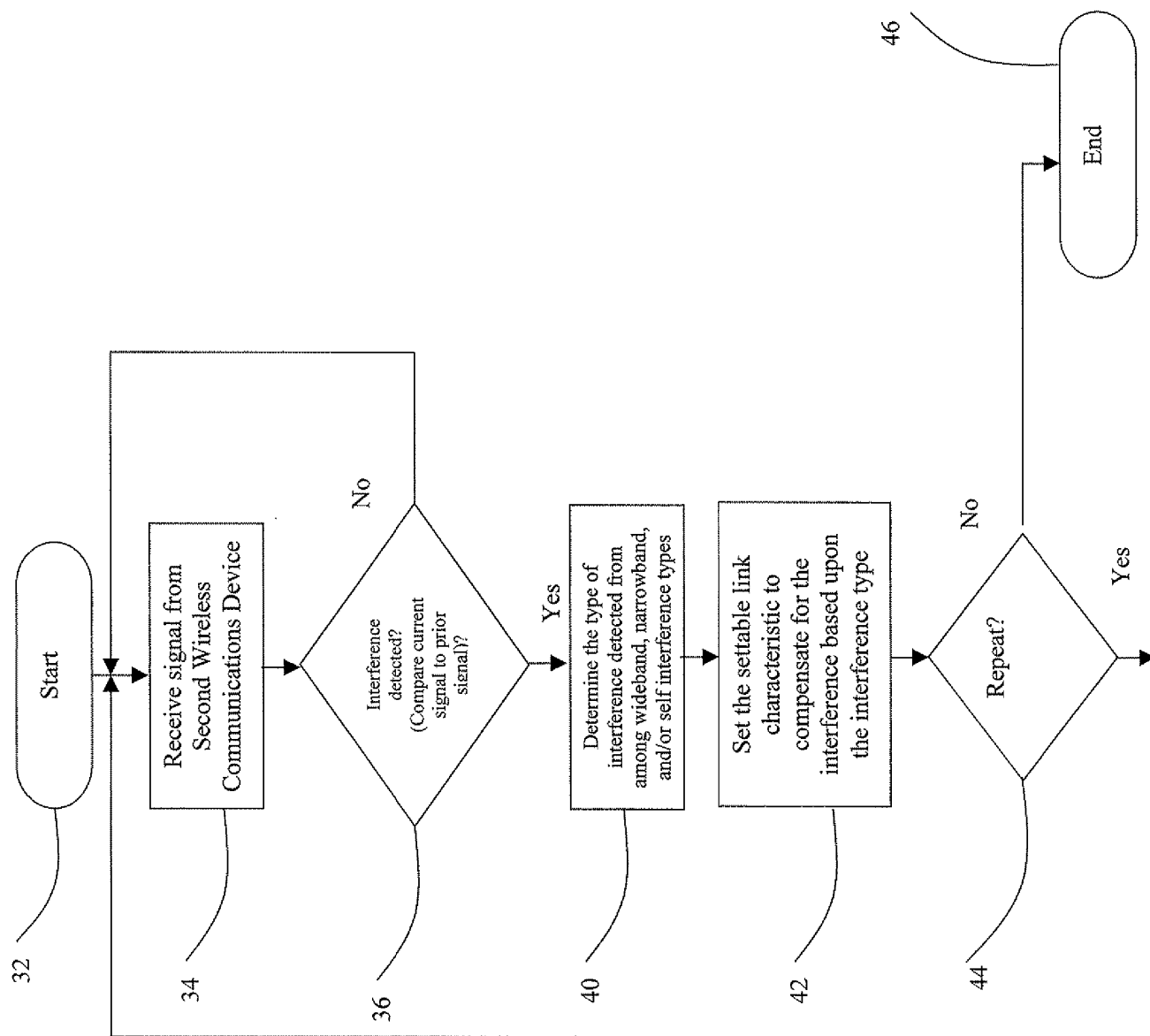


Figure 2

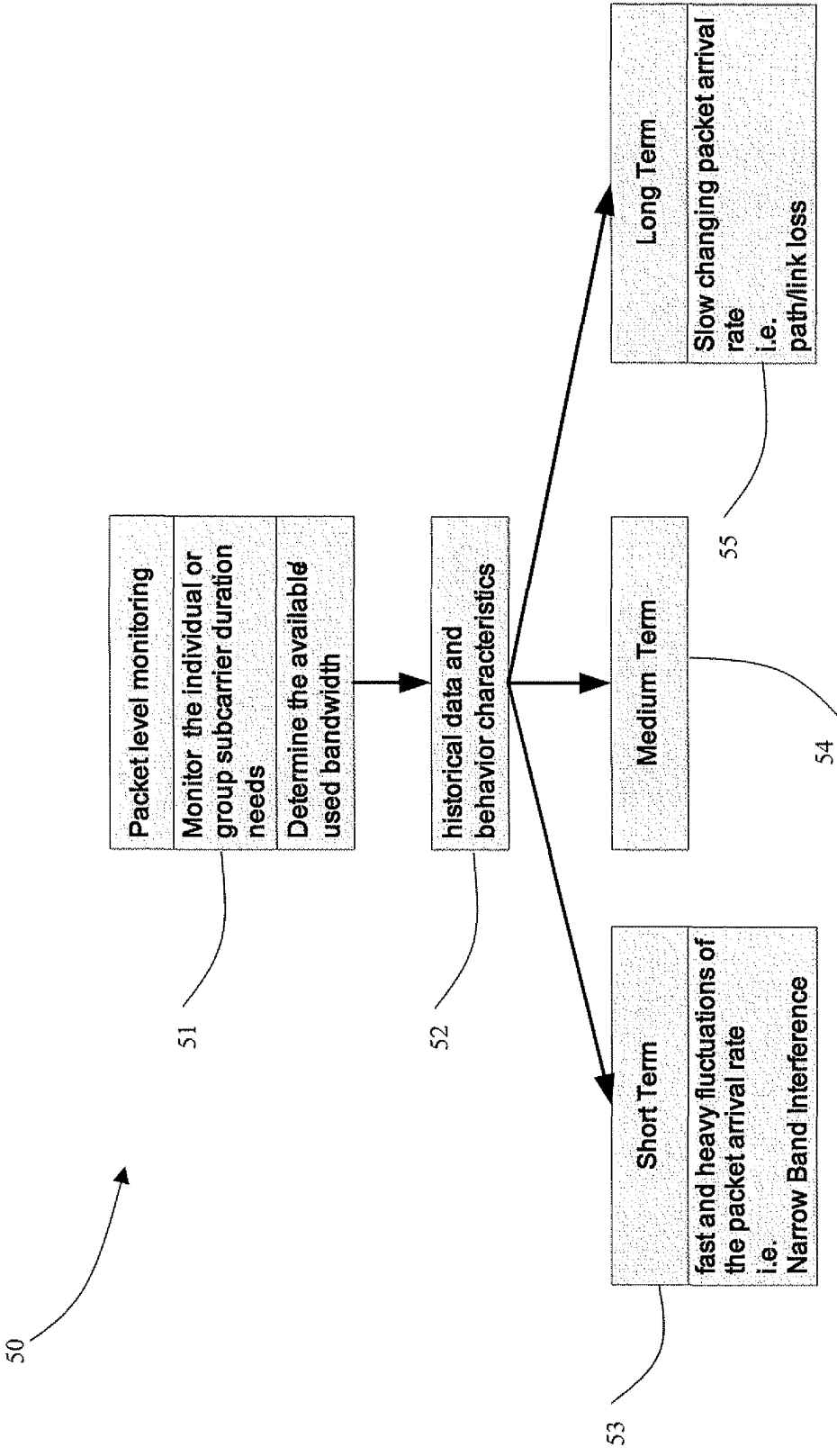


Figure 3

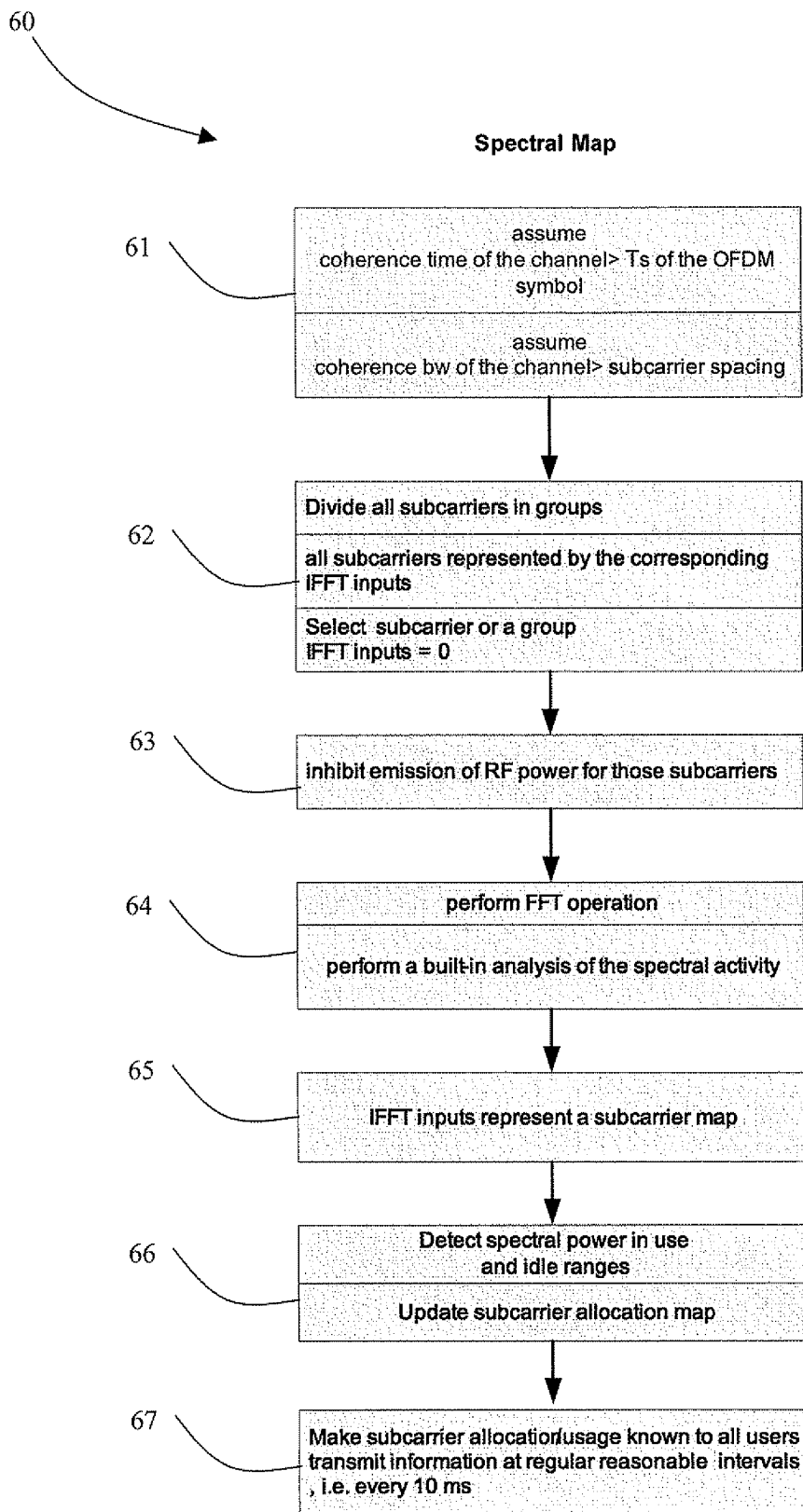


Figure 4

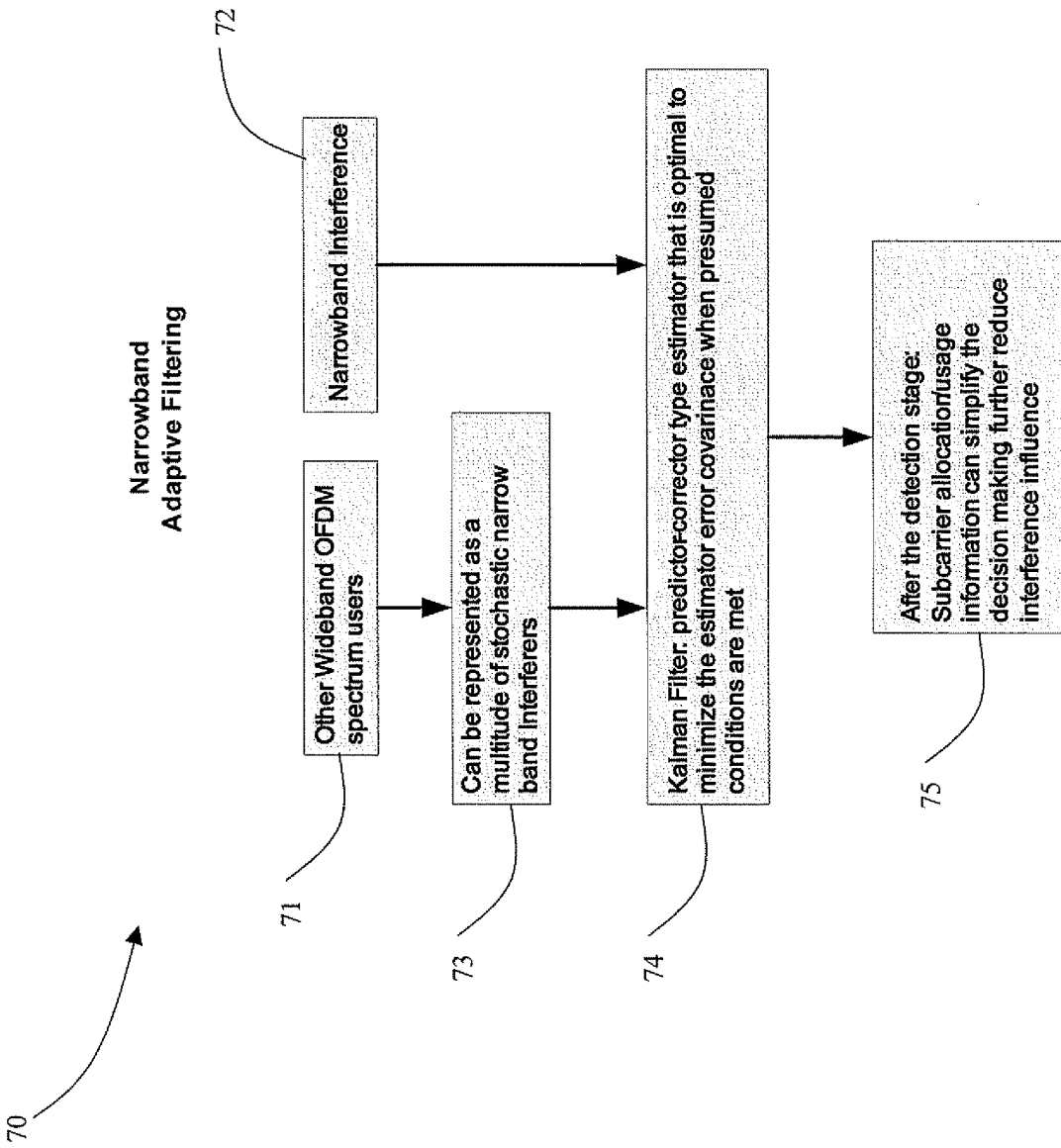


Figure 5

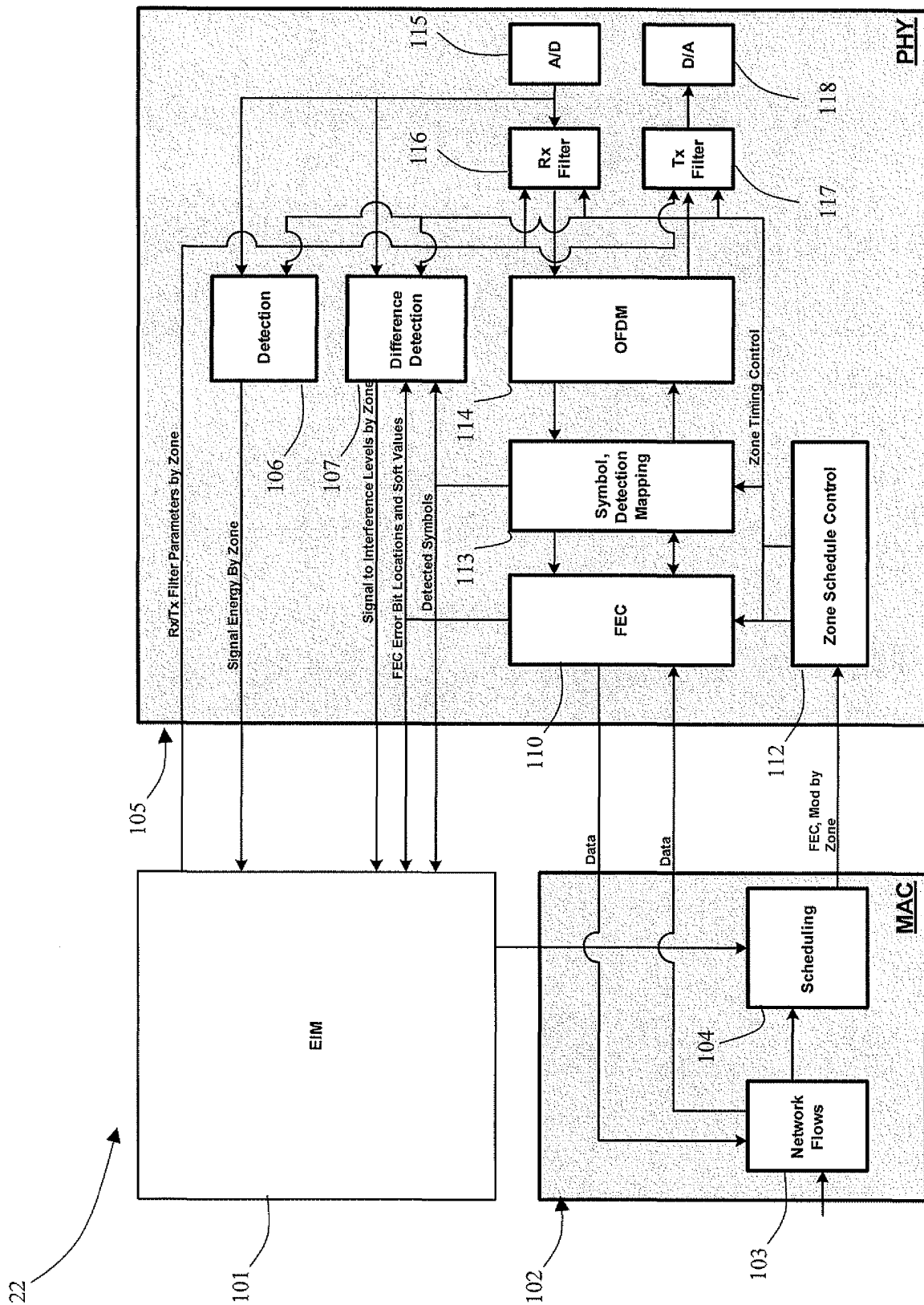


Figure 6

Prior Foreign Application(s) Priority Claimed

<u>(Number)</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	[]	[]
			Yes	No
<u>(Number)</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	[]	[]
			Yes	No
<u>(Number)</u>	<u>(Country)</u>	<u>(Day/Month/Year Filed)</u>	[]	[]
			Yes	No

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

<u>(Appln Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status)</u>
(patented, pending, aban.)		

<u>(Appln Serial No.)</u>	<u>(Filing Date)</u>	<u>(Status)</u>
(patented, pending, aban.)		

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

English Language Declaration

POWER OF ATTORNEY: As a named inventor, I hereby appoint the practitioners associated with Customer No.:

74701

to prosecute this application and transact all business in the Patent and Trademark Office connected therewith.

Direct Telephone Calls to:

Christopher F. Regan
(407) 841-2330

Full name of sole or first inventor: David CHAUNCEY

Inventor's

Signature:

David C. Chauncey

Date:

5/27/2008

Residence:

Fairport, New York

Citizenship:

Citizen of U.S.

Mailing Address:

33 Brimfield Circle

Fairport, New York, 14550

Full name of second inventor: Mitel KULINER

Residence:

Rochester, New York

Citizenship:

Citizen of U.S.

Mailing Address:

281 Hollywood Avenue

Rochester, NY 14618

Inventor's

Signature:

Mitel Kuliner

Date:

5/27/2008

Full name of third inventor: Elias THEODOROU

Residence:

Rochester, New York

Citizenship:

Citizen of U.S.

Mailing Address:

54 White Oak Bend

Rochester, New York, 14624

Elias Kuliner

-3-

6/2/08

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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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PATENT APPLICATION FEE DETERMINATION RECORD					Application or Docket Number		
Substitute for Form PTO-875					12/132,757		
APPLICATION AS FILED – PART I							
(Column 1)			(Column 2)		OR		
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	12047788	OTHER THAN SMALL ENTITY		
BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A		RATE (\$)	FEE (\$)	
SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A		N/A	310	
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A		N/A	210	
TOTAL CLAIMS (37 CFR 1.16(i))	20	0	X\$ 25		X\$50	0	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	3	0	X\$100		X\$210	0	
APPLICATION SIZE FEE (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	0	TOTAL	1030	
APPLICATION AS AMENDED – PART II							
(Column 1)		(Column 2)		(Column 3)		OR	
AMENDMENT A	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	Minus **	=	X =		X =	
	Independent (37 CFR 1.16(h))	Minus ***	=	X =		X =	
	Application Size Fee (37 CFR 1.16(s))			N/A		N/A	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))			TOTAL ADD'T FEE		TOTAL ADD'T FEE	
(Column 1)		(Column 2)		(Column 3)		OR	
AMENDMENT B	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	RATE (\$)	ADDITIONAL FEE (\$)
	Total (37 CFR 1.16(i))	Minus **	=	X =		X =	
	Independent (37 CFR 1.16(h))	Minus ***	=	X =		X =	
	Application Size Fee (37 CFR 1.16(s))			N/A		N/A	
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))			TOTAL ADD'T FEE		TOTAL ADD'T FEE	
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.							

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

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APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY. DOCKET NO	TOT CLAIMS	IND CLAIMS
12/132,757	06/04/2008	2618	1030	RF-448 (50676)	20	3

CONFIRMATION NO. 8369

74701

ALLEN, DYER, DOPPELT, MILBRATH & GILCHRIST
255 S ORANGE AVENUE
SUITE 1401
ORLANDO, FL 32801

FILING RECEIPT



OC000000030398788

Date Mailed: 06/13/2008

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

Applicant(s)

David CHAUNCEY, Fairport, NY;
Mitel Kuliner, Rochester, NY;
Elias Theodorou, Rochester, NY;

Assignment For Published Patent Application

Harris Corporation, Melbourne, FL

Power of Attorney: The patent practitioners associated with Customer Number 74701

Domestic Priority data as claimed by applicant

Foreign Applications

Permission to Access - A proper **Authorization to Permit Access to Application by Participating Offices** (PTO/SB/39 or its equivalent) has been received by the USPTO.

Projected Publication Date: To Be Determined - pending completion of Security Review

Non-Publication Request: No

Early Publication Request: No

Title

WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS

Preliminary Class

455

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.

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:)
CHAUNCEY, ET AL.)
)
Serial No. 12/132,757)
)
Filing Date: JUNE 4, 2008)
)
For: WIRELESS COMMUNICATION SYSTEM)
 COMPENSATING FOR INTERFERENCE)
 AND RELATED METHODS)

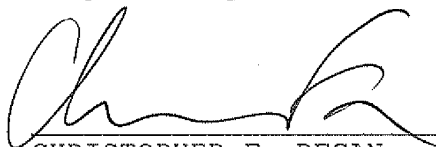
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Sir:

Enclosed are six (6) sheets of formal drawings to be
filed in the above-identified patent application.

Respectfully submitted,



CHRISTOPHER F. REGAN
Reg. No. 34,906
Allen, Dyer, Doppelt, Milbrath
& Gilchrist, P.A.
255 S. Orange Ave., Suite 1401
P. O. Box 3791
Orlando, Florida 32802
(407) 841-2330

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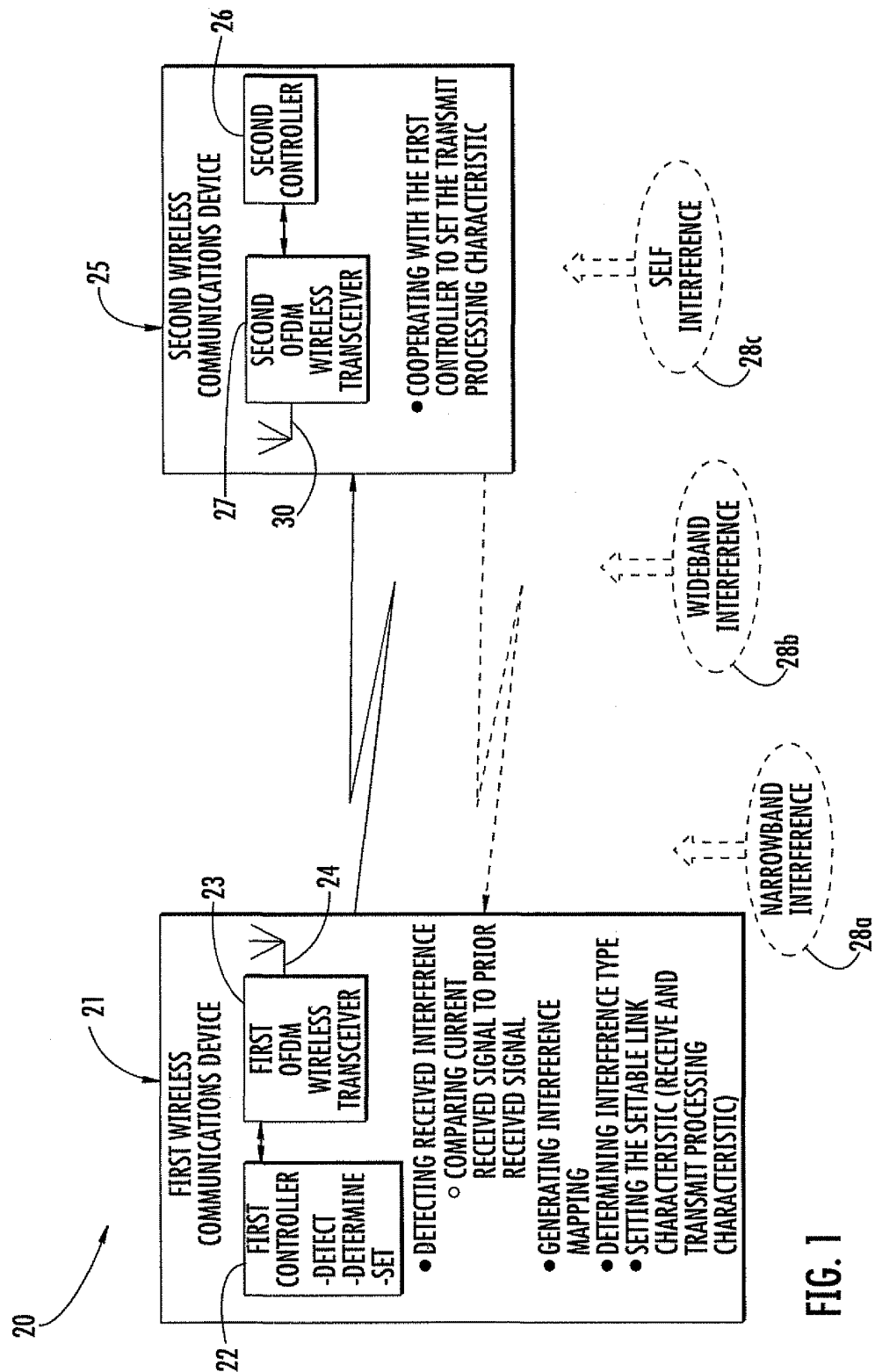
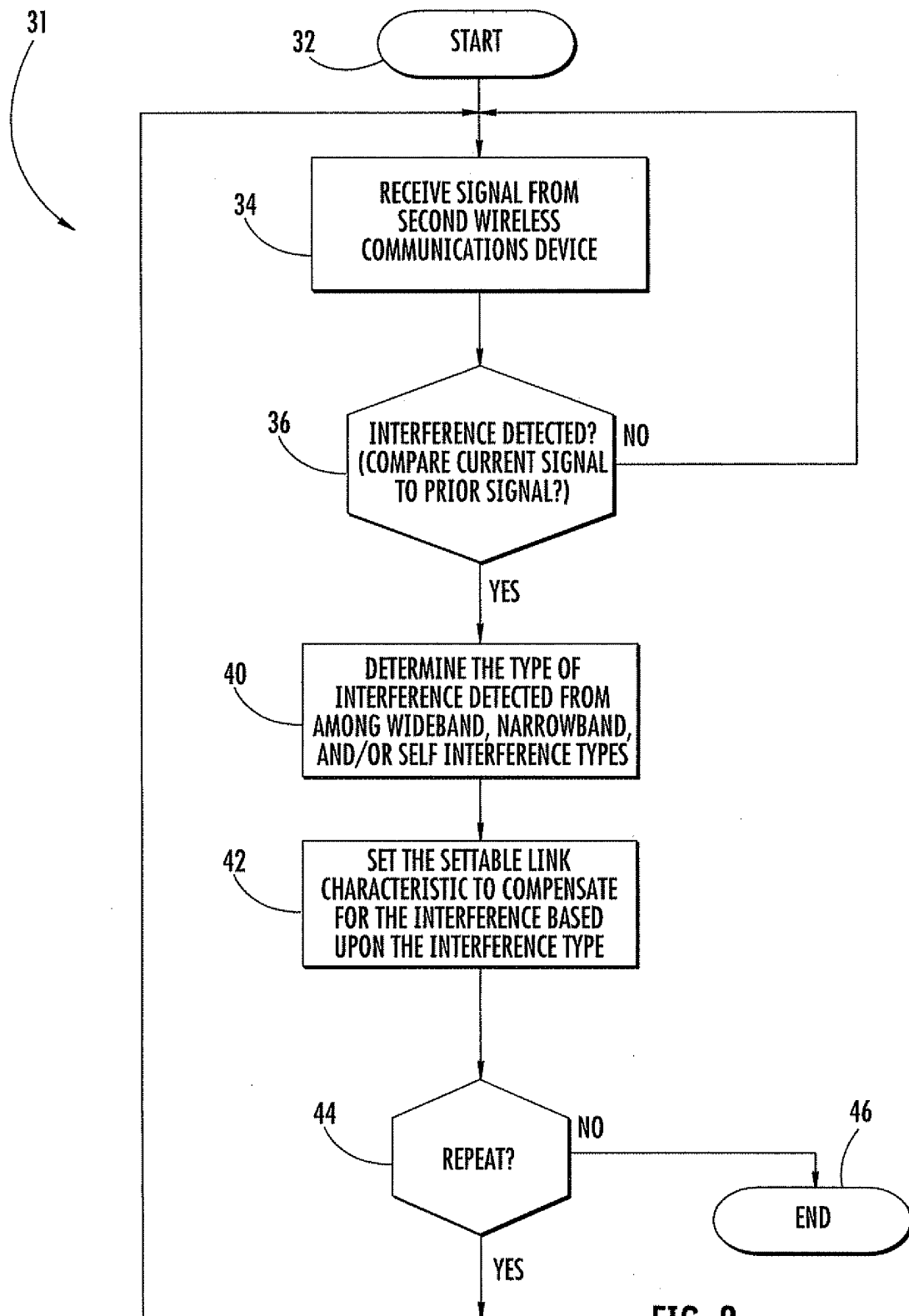


FIG. 1

2/6



3/6

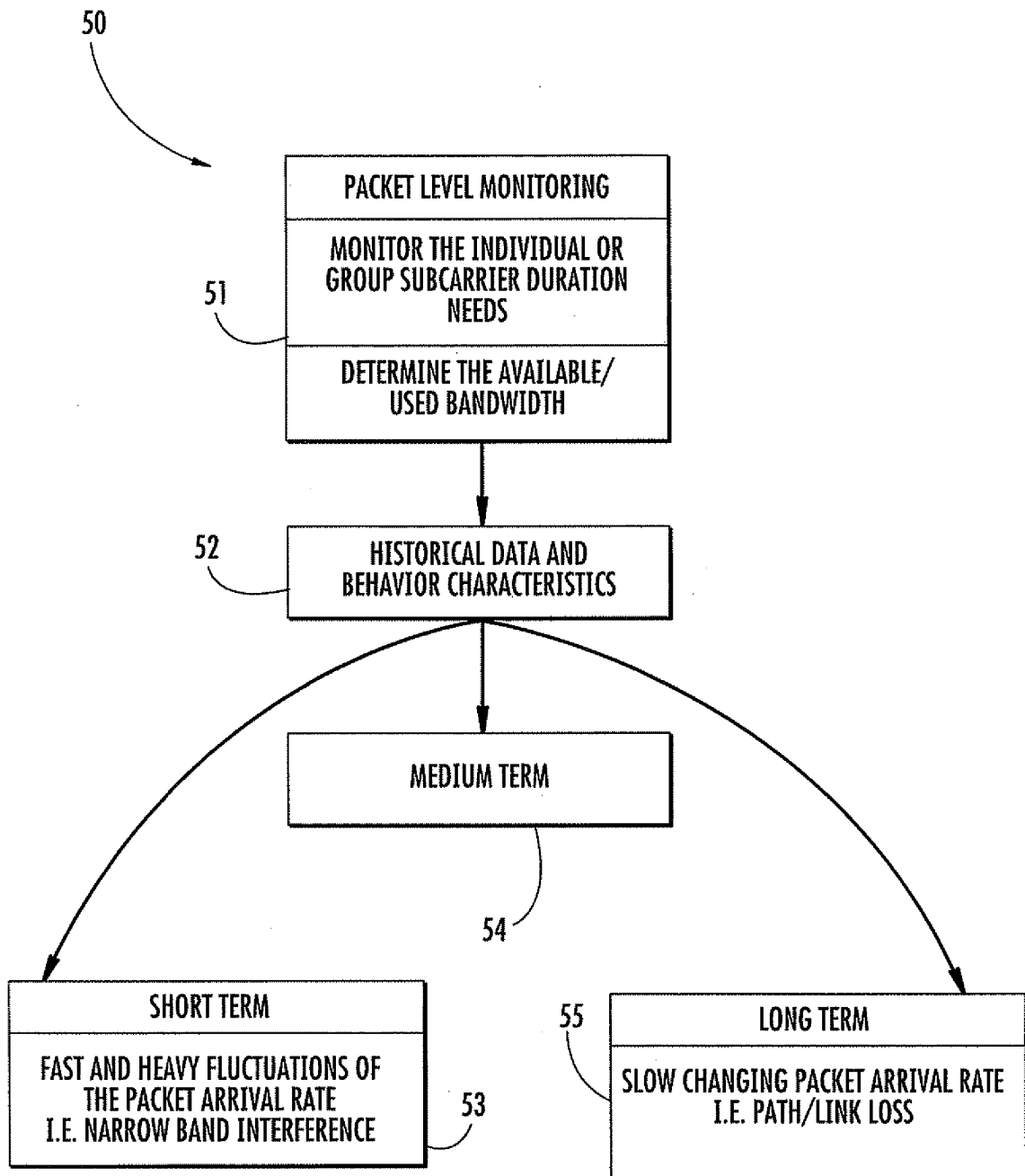


FIG. 3

4/6

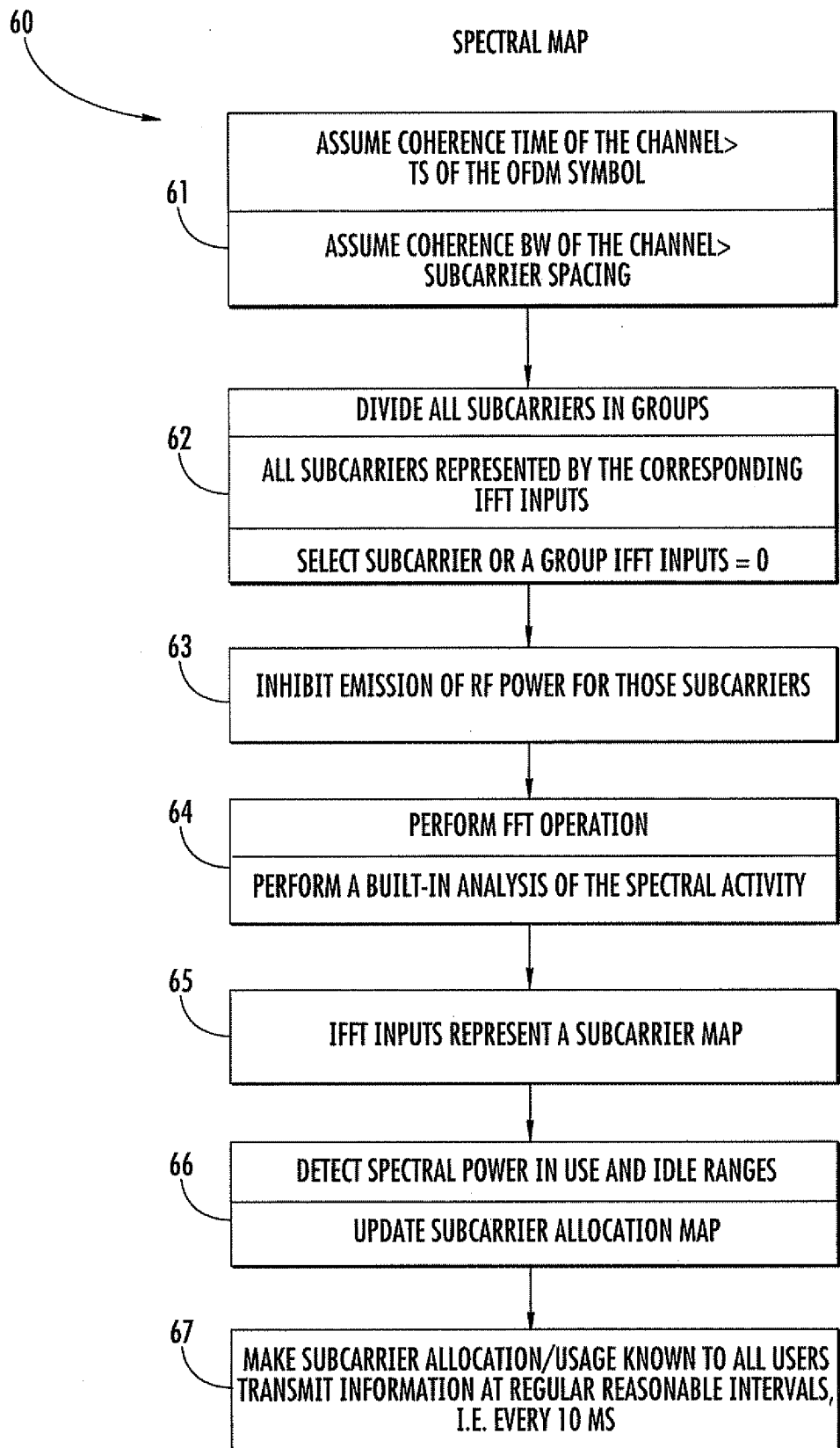


FIG. 4

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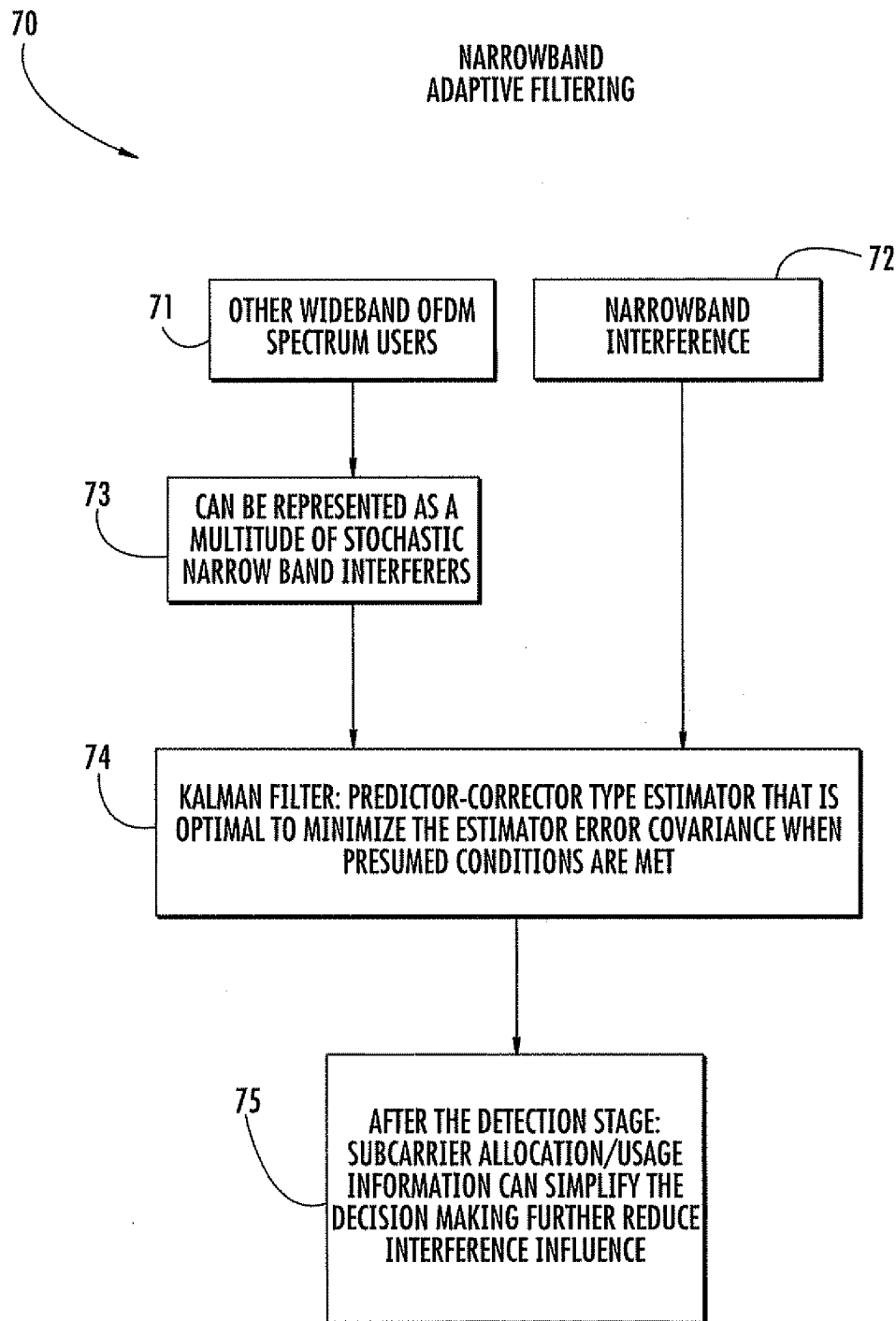


FIG. 5

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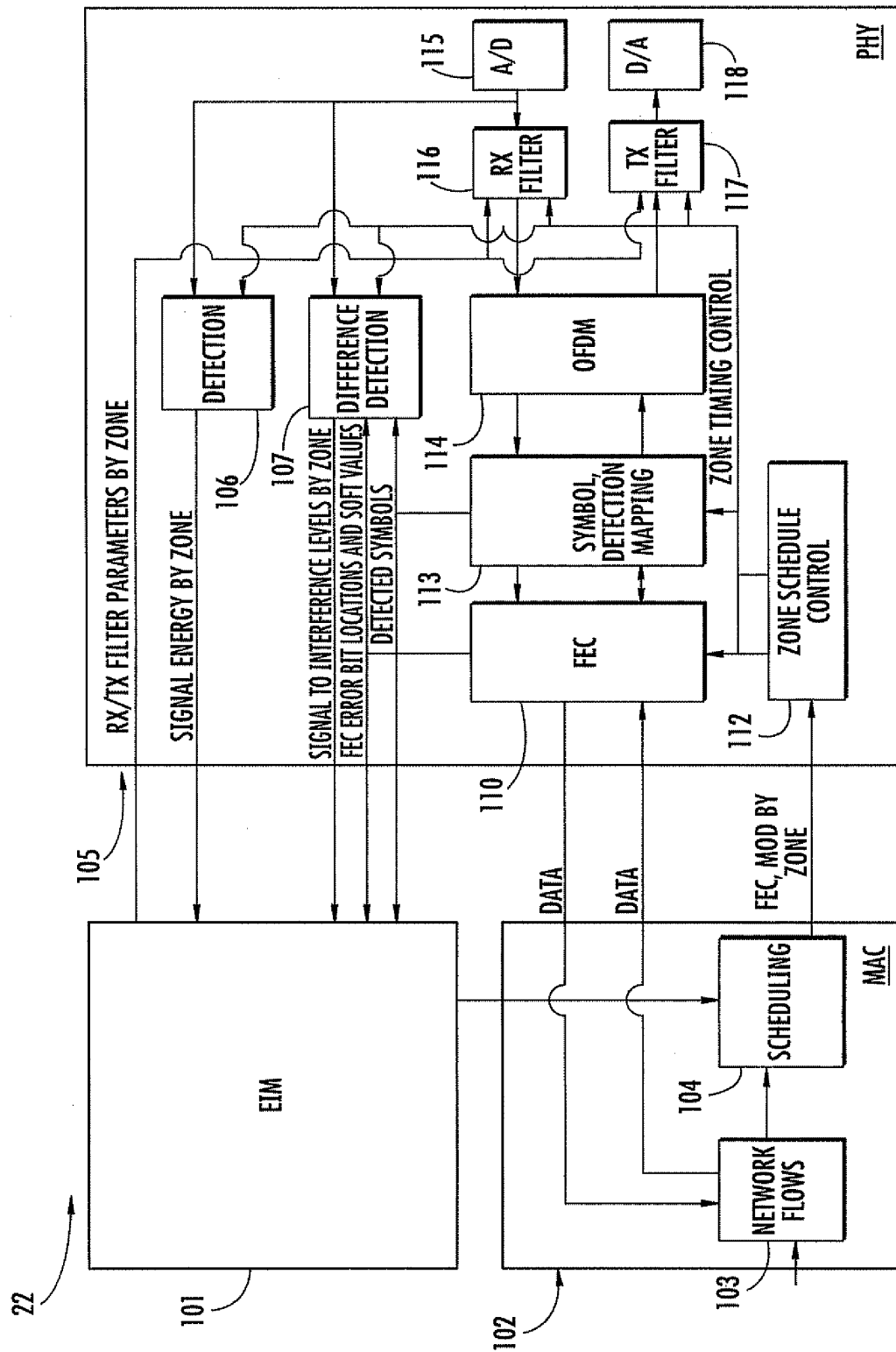


FIG. 6

Electronic Acknowledgement Receipt

EFS ID:	3625332
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12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)

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page 1 of 1

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(71) Applicant (for all designated States except US): **TELEFONAKTIEBOLAGET L.M. ERICSSON (PUBL) [SE/SE]; S-164 80 Stockholm (SE).**
(72) Inventor; and
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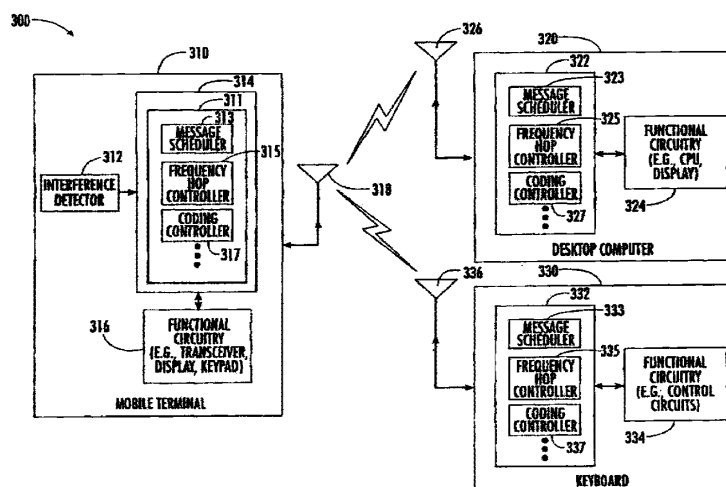
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(74) Agent: **MEEKS, Robert, M.; Myers Bigel Sibley Sajovec, P.A., P.O. Box 37428, Raleigh, NC 27627 (US).**

(54) Title: **APPARATUS AND METHODS FOR SELECTIVE INTERFERENCE MITIGATION**



(57) Abstract: Selective compensation for interference in a communications system, such as a piconet or scatternet using an Industrial-Scientific-Medical (ISM) frequency band, may be achieved, according to embodiments of the present invention, by adapting the interference mitigation scheme applied in a communications system based on comparison with known patterns associated with particular types of interference, such as interference generated by microwave ovens, medical equipment, industrial equipment and wireless communications devices. According to embodiments of the present invention, a communications system, such as wireless communications system, detects interference and changes from a first interference mitigation scheme to a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference, such as the half-cycle pulsed pattern typical of a microwave oven.

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APPARATUS AND METHODS FOR SELECTIVE INTERFERENCE MITIGATION

BACKGROUND OF THE INVENTION

The present invention relates to communications apparatus (systems) and methods, and more particularly, to interference mitigation apparatus and methods used in communications systems.

Wireless communications techniques are widely used to convey information in voice telephony, paging, data transfer and a host of other applications. One use of wireless communications techniques is in low-power, short-range communications, e.g., communications between devices located within a room, home, automobile passenger compartment, or other relatively small area. For example, communications protocols, such as the BluetoothTM set of protocols and the IEEE 802.11 protocols, have been developed that utilize a portion of the electromagnetic spectrum known as the Industrial-Scientific-Medical (ISM) band, a band of frequencies that are typically used by devices such as microwave ovens and other radio-frequency (RF) heating devices, ultrasonic humidifiers and jewelry cleaners, medical imaging devices such as magnetic resonance imaging (MRI) systems, and a variety of other industrial, scientific and medical equipment. As illustrated in FIG. 1, using such protocols and associated hardware and/or software, devices such as a mobile terminal (e.g., cellular telephone), desktop computer 20, laptop computer 30, printer 40, keyboard 50 and mouse 60 may be interconnected via radio links 5, forming one or more systems or networks, sometimes referred to as "piconets" or "scatternets," over which voice and other information may be exchanged.

A potential problem associated with communications in a system using an ISM band is that such a band is typically used in a loosely regulated fashion by both communications devices and non-communications devices. For example, in the United States, rules established by the Federal Communications Commission "regulate" the ISM band such that no particular user is granted possession of a particular frequency or set of frequencies, as it is envisioned that the ISM band will be used by devices with limited transmit power, making such allocation of the airwaves unnecessary and/or undesirable. Consequently, in a given environment, there is a likelihood that a communications system using the ISM band may encounter

interference from other devices using the ISM band, including communications devices, such as garage door opener transmitters or baby monitors, and non-communications devices, such as microwave ovens and industrial RF heating equipment.

5 Conventional communications systems that use the ISM band commonly implement some type of interference mitigation scheme to reduce the deleterious effects of interference. For example, the aforementioned BluetoothTM protocol set specifies use of a frequency-hopping scheme wherein a system of devices switches through a predetermined set of carrier frequencies at a predetermined rate to reduce
10 interference, and provides for further interference mitigation through optional use of forward error correction coding. Other techniques, such as retransmission techniques, may also be used to reduce negative effects of interference. However, such conventional interference mitigation techniques may be less effective than desired in the presence of strong in-band interference from devices designed to utilize the same
15 frequency band as the communications system. Accordingly, there is a need for improved methods and apparatus for interference mitigation.

SUMMARY OF THE INVENTION

The present invention may meet this and other needs by tailoring the selection
20 of interference mitigation schemes based on comparisons with predetermined interference patterns. According to embodiments of the present invention, selective compensation for interference in a communications system, such as a piconet or scatternet using an Industrial-Scientific-Medical (ISM) frequency band, may be achieved by adapting the interference mitigation scheme applied in the
25 communications system based on known patterns associated with particular types of interference, such as interference patterns typically exhibited by microwave ovens, industrial equipment and communications devices. According to embodiments of the present invention, a communications system, such as a wireless communications system, detects interference and changes from a first interference mitigation scheme
30 to a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with a predetermined pattern associated with a predetermined type of interference, such as the half-cycle pulsed pattern typical of a microwave oven.

According to other embodiments of the present invention, the communications system applies the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference. For example, the communications system may predict an interval of increased
5 interference based on the predetermined pattern, e.g., an interval in which a microwave oven pulse is predicted to be present. The communications system may choose to perform a variety of actions based on the prediction, including foregoing transmission of messages during the predicted interval, changing coding of messages transmitted during the predicted interval, foregoing transmission of messages to a
10 selected device of the communications system during the predicted interval and foregoing use of a selected frequency to communicate messages during the predicted interval.

According to other embodiments of the present invention, a communications system includes at least one communications device operative to communicate via a
15 communications medium. The communications system also includes an interference detector that detects interference in the communications medium. The communications system further includes an interference mitigation controller, operatively associated with the at least one communications device and responsive to the interference detector circuit, that causes the at least one communication device to
20 change from using a first interference mitigation scheme to using a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with a predetermined pattern associated with a predetermined type of interference. The at least one communications device may include a communications circuit, and at least one of the interference detector and the
25 interference mitigation controller may be operatively associated with the communications circuit. For example, the interference detector circuit may be responsive to the communications circuit to detect interference. According to other embodiments of the present invention, the at least one communications device includes a plurality of communications devices, the interference detector includes at
30 least one interference detector circuit positioned at at least one of the plurality of communications devices, and the interference mitigation controller includes at least one interference mitigation controller circuit positioned at at least one of the plurality of communications devices.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic diagram illustrating a system of wireless communications devices according to the prior art.

FIGs. 2-5 are schematic diagrams illustrating communications systems according to embodiments of the present invention.

FIG. 6 is a flowchart illustrating exemplary interference mitigation operations according to an embodiment of the present invention.

FIG. 7 is a schematic diagram illustrating interference mitigation control apparatus according to another embodiment of the present invention.

FIGs. 8-10 are state diagrams illustrating exemplary interference mitigation operations according to embodiments of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention now will be described more fully hereinafter with reference to the accompanying drawings, in which preferred embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art. In the drawings, like numbers refer to like elements.

Referring to FIG. 2, a communications system 200 according to embodiments of the present invention includes a plurality of communications devices 210, an interference mitigation controller 230 and an interference detector 220. The interference detector 220 is operative to detect interference in a communications medium 240 used by the communications devices 210. The interference mitigation controller 230 is responsive to the interference detector 220, and operatively associated with the plurality of communications devices 210 such that it causes the communication devices 210 to change from using a first interference mitigation scheme, e.g., a first combination of a frequency hopping sequence, error correction coding and message scheduling, to using a second interference mitigation scheme, e.g., a second combination of frequency hopping sequence, error correction coding and message scheduling, if interference detected by the interference detector 220 is sufficiently correlated with predetermined pattern associated with a predetermined type of interference. The predetermined pattern may take the form, for example, of a

pattern, e.g., a pattern generally associated with a known type of device, such as a microwave oven or RF heating device, programmed or otherwise stored in the interference mitigation controller 230,. The predetermined pattern may also be identified *in situ*, e.g., by processing interference data collected by the interference
5 detector 220 and identifying the pattern therefrom.

The present invention arises from the realization that certain types of interference, such as interference produced in a network using a frequency band that also is used by devices such as microwave ovens or garage door openers, often exhibits behavior that is predictable. For example, a typical microwave oven
10 produces microwave radiation every other half-cycle of the frequency of the AC power line that powers the oven. Similarly, a device such as garage door opener transmitter typically produces interference in bursts of predetermined duration. Other types of interference may also be identified *in situ* by processing interference data and identifying repetitive patterns therein. Accordingly, improved interference mitigation
15 measures may be adopted that utilize these types of *a priori* knowledge of interference.

It will be appreciated that although FIG. 2 illustrates application of the present invention to a wireless communications environment, the scope of the present invention is not so limited. It will be appreciated that the present invention is
20 applicable to a variety of types of communications, including, but not limited to radio, wireline and optical communications. Although FIG. 2 conceptually illustrates the interference detector 220 and the interference mitigation controller 230 as separate from the communications devices 210, it will also be readily appreciated that the present invention is not limited to such a configuration. It will be understood that,
25 generally, functions of the communications devices 210, the interference detector 220 and the interference mitigation controller 230 may be implemented in separate devices, distributed among several devices, or combined, all or in part, in a single device.

FIG. 3 illustrates a wireless communications system 300 according to
30 embodiments of the present invention, specifically, a wireless communications system in which interference detection and interference mitigation control functions are integrated into wireless communications devices, here a mobile terminal (e.g., cell phone) 310, a desktop computer 320, and a keyboard 330. As shown, the desktop computer 320 includes functional circuitry 324, such as a central processing unit

(CPU) and display control circuitry. Similarly, the keyboard includes functional circuitry 334, such as control circuits that monitor and control keyboard operations. The personal computer 320 and the keyboard 330 include respective communications circuits 322, 332 that provide radio communications (e.g., provide a radio link
5 between the desktop computer 320 and the keyboard 330) via respective antennas 326, 336. As shown, the communications circuits 322, 332 include interference mitigation related circuits such as message scheduler circuits 323, 333 that control timing of message transmission, frequency hop controller circuits 325, 335 that control carrier frequencies at which messages are transmitted and/or received, and
10 coding controller circuits 327, 337 that control error correction coding and decoding operations. It will be appreciated that the communications circuits 322, 332 may include other interference mitigation related circuits, as well as circuits involved in other aspects of providing a wireless communications interface.

The mobile terminal 310 includes functional circuitry 316, such as radio
15 transceiver circuitry, display control circuitry, and keypad interface circuitry. The mobile terminal 310 also includes a communications circuit 314 that implements a wireless communications interface (e.g., radio links to the desktop computer 320 and the keyboard 330) for the mobile terminal 310 via an antenna 318. The communications circuit 314 includes an interference mitigation controller circuit 311,
20 here shown as including a message scheduler circuit 313, a frequency hop controller circuit 315 and a coding controller circuit 317. The mobile terminal 310 further includes an interference detector circuit 312 that is operative to detect interference in a communications medium in which the communications circuits 314, 322, 332 communicate. The interference mitigation controller circuit 311 is responsive to the
25 interference detector circuit 312 to control the interference mitigation scheme, for example, the particular combination of message scheduling, frequency hopping, and error control coding, applied by the communications circuits 314, 322, 332.

It will be appreciated that the interference detector circuit 312 may operate and be implemented in a number of different ways. For example, as suggested by FIG. 3,
30 an interference detector circuit 312 may be implemented as a standalone circuit, positioned in a particular device, that detects interference in the communications medium used by the communications circuits 314, 322, 332 independently of these circuits. However, it will be appreciated that the functions of the interference detector circuit 312 may also be integrated with other functions of the communications circuits

314, 322, 332. For example, the interference detector circuit 312 may monitor radio communications of the communications circuit 314, and may use such measures as bit error rate estimates, numbers of unacknowledged messages, and the like generated by the communications circuit 314 to detect the presence of interference.

5 It will also be appreciated that the interference mitigation controller circuit 311 may also be implemented in a number of different ways. For example, functions of the interference mitigation controller circuit 311 may be localized within a particular device, e.g., within the communications circuit 314 of the mobile terminal 310, or may be distributed among multiple devices and/or circuits.

10 The interference mitigation controller circuit 311 may also operate in a number of different ways. For example, responsive to detection of interference by the interference detector 312, the interference mitigation controller circuit 311 may analyze the detected interference using analog or digital signal comparison techniques. The interference mitigation controller circuit 311 may compare the
15 detected interference, for example, to a "library" of known patterns that are preprogrammed into the interference mitigation controller circuit 311 and/or which are identified *in situ* by the interference mitigation controller circuit 311 responsive to interference detected by the interference detector circuit 312. If the comparison indicates sufficient correlation between the detected interference and a pattern
20 associated with a predetermined type of interference, e.g., a half-wave pulsed pattern characteristic of a typical microwave oven or a pattern identified *in situ* by processing interference detected by the interference detector circuit 312, the interference mitigation controller circuit 311 may selectively implement an interference scheme in accord with the predetermined pattern associated with the predetermined type of
25 interference. For example, the interference mitigation controller circuit 311 may cause the communications circuit 314 to transmit appropriate messages to communications circuits 322, 332 in the desktop computer 320 and the keyboard 330 to cause these devices to, for example, forego transmitting messages during intervals in which interference is predicted to be most intense, to avoid using a particular
30 frequency during such an interval, or to apply a more robust level of error correction coding during such an interval.

FIG. 4 illustrates a wireless communications system 400 according to other embodiments of the present invention, in which interference detection and mitigation control functions are distributed in a different manner than illustrated in FIG. 3. A

first communications device, here a mobile terminal 410, includes functional circuitry 416 such as transceiver, display and keypad circuits. The mobile terminal 410 also includes a communications circuit 414 that provides a wireless communications interface via an antenna 418. The communications circuit 414 includes an
5 interference mitigation controller circuit 411, here shown as including message scheduler circuit 413, a frequency hop controller circuit 415 and a coding controller 417 circuit, operatively associated with an interference detector circuit 412.

A second wireless communications device, here a desktop computer 420, includes functional circuitry 426, such as CPU and display circuits. The functional
10 circuitry 426 is operatively associated with a communications circuit 424 that provides a wireless communications interface via an antenna 428. The communications circuit 424 includes an interference mitigation controller circuit 421, here shown as including message scheduler circuit 423, a frequency hop controller circuit 425 and a coding controller circuit 427. The interference mitigation controller
15 circuit 421 is operatively associated with an interference detector circuit 422.

According to embodiments of the present invention, wireless communications devices, such as the mobile terminal 410 and the desktop computer 420 of FIG. 4, can implement selective interference mitigation in a number of different ways. For example, in devices conforming to a protocol such as Bluetooth™, each of the
20 communications circuits 414, 424 may operate as a master device or a slave device in a piconet or similar system. Accordingly, for example, upon detection of interference by one of the interference detector circuits 412, 422, the interference mitigation controller circuit 411, 421 of one of the communications circuits 414, 424 that is currently serving as "master" may determine if the detected interference is sufficiently
25 correlated with a pattern associated with a known type of interference. If so, the master interference mitigation controller circuit 411, 421 may instruct one or more of the message scheduler circuits 413, 423, frequency hop controller circuits 415, 425, and coding controller circuits 417, 427 to use a new interference mitigation scheme, for example, to implement a new combination of message scheduling, frequency
30 hopping and/or error correction coding. It will be appreciated that, in general, the communications system 400 may be viewed as providing individual interference detector and interference mitigation controller circuits in each device 410, 420 of the communications system 400, or as providing interference detector and/or interference mitigation controller circuits that are distributed across multiple devices.

FIG. 5 illustrates a communications system 500 according to other embodiments of the present invention that illustrates how such distributed interference detection and interference mitigation control may be implemented. A first wireless communications device, here a mobile terminal 510, includes functional circuitry (not shown for clarity of illustration), such as circuitry that controls and/or monitors display, keypad, and wireless telephony functions. The mobile terminal 510 includes a communications circuit 514 which provides a communications interface via an antenna 520. The communications circuit 514 includes a processor 518, e.g., a microprocessor, microcontroller, or other data processing circuit, that is operatively associated with a radio transceiver 519 and a memory 516. An interference detector 512 is implemented as software or firmware routine (e.g., a portion of a "software stack") stored in the memory 516 and executed by the processor 518 to control and/or monitor the radio transceiver 519. Similarly, an interference mitigation controller 511 is implemented as a set of software routines, e.g., message scheduling, frequency hop control, and coding control routines 513, 515, 517, stored in the memory 516 and executed by the processor 518. For example, the message scheduling, frequency hop control, and coding control routines 513, 515, 517 of the interference mitigation controller 511 may be operative to cause the processor 518 to compare interference detected by the interference detector 512 with a pattern associated with a known type of interference and, if the detected interference is sufficiently correlated with the pattern of the known type of interference, to cause the processor 518 and the transceiver 519 to change to use of a particular interference mitigation technique. This may include, for example, causing the processor 518 and the transceiver 519 to send appropriate messages to command other devices to use a particular interference mitigation scheme.

A second wireless communications device, here a laptop computer 530, includes functional circuitry (not shown for clarity of illustration), such as circuitry that controls and/or monitors display, keypad, and other functions. The laptop computer 530 includes a communications circuit 534 that provides a communications interface via an antenna 540. The communications circuit 534 includes a processor 538, e.g., a microprocessor, microcontroller, or other data processing circuit, that is operatively associated with a radio transceiver 539 and a memory 536. An interference detector 532 is implemented as software or firmware routine (e.g., a portion of a "software stack") stored in the memory 536 and executed by the

processor 538 to control and/or monitor the radio transceiver 539. Similarly, an interference mitigation controller 531 is implemented as a set of software routines, e.g., message scheduling, frequency hop control, and coding control routines 533, 535, 537 stored in the memory 536 and executed by the processor 538. For example, the message scheduling, frequency hop control, and coding control routines 533, 535, 537 of the interference mitigation controller 531 may be operative to cause the processor 538 to compare interference detected by the interference detector routine 532 with a pattern associated with a known type of interference and, if the detected interference is sufficiently correlated with pattern associated with the known type of interference, to cause the processor 538 and the transceiver 539 to change to use of a particular interference mitigation technique. This may include, for example, causing the processor 538 and the transceiver 539 to send appropriate messages to command other devices to use a particular interference mitigation scheme.

Interference detection and mitigation functions of the communications system 500 of FIG. 5 may be implemented in a number of different ways. For example, in a master/slave environment, one of the communications circuits 514, 534, acting as a master, may determine whether interference detected by one or more of the interference detector routines 512, 532 is correlated to a pattern of a predetermined type of interference, and may dictate the appropriate interference mitigation scheme to be applied in the communications system 500. It will be appreciated that, in general, the communications system 500 may be viewed as providing individual interference detector and interference mitigation controller circuits in each device 510, 530 of the communications system 500, or as providing interference detector and/or interference mitigation controller circuits that are distributed over multiple devices.

FIG. 6 illustrates exemplary operations 600 for providing selective interference mitigation control according to other embodiments of the present invention. A first interference mitigation scheme, for example, a first combination of message scheduling, frequency hopping, and error correction coding, is applied in a communications system such as the communications systems 400, 500 of FIGs. 4 and 5 (Block 610). Interference is detected (Block 620). If the interference is sufficiently correlated to a pattern associated with a known type of interference, such as the half-wave pulsed interference typically produced by a microwave oven, the communications system changes to using a second interference mitigation scheme, e.g., a second combination of message scheduling, frequency hopping and error

correction coding (Block 630). If not, the communications system continues to use the first interference mitigation scheme (Block 610)

It will be appreciated that the operations of FIG. 6 may be implemented in a number of different ways within the scope of the invention. For example, a change in
 5 message scheduling may include changing the routing of and/or foregoing transmission of messages during intervals in which interference is predicted to be of higher intensity. For example, a communication system may suspend transmission of messages between devices during an interval in which interference is predicted to be
 10 of increased intensity. In other embodiments, if a particular device in a communications system is near a source of interference, the communications system may avoid sending messages to that particular device during a predicted interval of increased interference. Similarly, a change in frequency hopping may include avoiding the use of a particular frequency during a predicted interval of increased interference. A change in coding may include changing to a more robust (e.g.,
 15 redundant) error correction coding during a predicted interval of increased interference.

FIG. 7 illustrates an interference mitigation controller circuit 720 according to embodiments of the present invention, in which detected interference is compared to a pattern associated with a known type of interference. The interference mitigation
 20 controller circuit 720 includes a pattern comparing circuit 724 that is responsive to an interference detector circuit 710. The pattern comparing circuit 724 compares interference detected by the interference detector circuit 710 with a predetermined pattern 726, and controls interference mitigation circuitry, such as message scheduler circuit 723, a frequency hop controller circuit 725 and a coding controller circuit 727,
 25 responsive to the comparison. It will be appreciated that interference detector circuit 710 and the interference mitigation controller circuit 720 may be implemented using a variety of hardware, software and combinations thereof. For example, the interference detector circuit 710 and the interference mitigation control circuit 720 may be implemented within a communications circuit, such as the communications
 30 circuits 414, 424, 514, 534 of FIGs. 4 and 5.

FIG. 8 is a state diagram 800 illustrating exemplary operations of a communications system according to embodiments of the present invention. In a first state 810, a first interference mitigation scheme is applied. Upon detection of interference, the communications system transitions to a second state 820, in which

the communications system determines the degree of correlation between the detected interference and a pattern associated with a predetermined type of interference. If the interference is insufficiently correlated with the pattern associated with the predetermined type of interference, the communications system transitions back to the first state 810. If the interference is sufficiently correlated, however, the communications system transitions to a third state 830, in which the communications system predicts an interval in which the interference is expected to occur. After this interval is predicted, the communications system transitions to a fourth state 840 in which the system applies the second interference mitigation scheme for the predicted interval.

Upon expiration of the predicted interval, the communications system transitions back to the first state 810, in which it returns to using the first interference mitigation scheme. In some cases, for example, in cases in which the predetermined type of interference occurs as a single event, the communications system may then wait until interference is again detected. In other cases, however, the predetermined type of interference may be periodic in nature, exhibiting intermittent intervals of increased intensity. In such cases, the prediction of an interval of interference occurring in the third state 830 may include prediction of a series of interference intervals, e.g., a series of periodically-occurring intervals. Accordingly, when a next predicted interference interval commences, the communications system may transition from the first state 810, in which the first interference mitigation scheme is applied, to the fourth state 840, in which the second interference mitigation scheme is applied. Upon the ending of this next predicted interference interval, the communications system returns to the first state 810 and again applies the first interference mitigation scheme.

FIG. 9 is a state diagram 900 illustrating exemplary operations of a communications system according to other embodiments of the present invention, in particular, exemplary operations for providing selective interference mitigation in a communications system subject to an interference source, such as a microwave oven, that exhibits a pattern of interference characterized by periodic intervals of increased intensity. In a first state 910, a first interference mitigation scheme is applied. Upon detection of interference, the communications system transitions to a second state 920, in which the communications system determines whether detected interference exhibits a pulsed pattern that correlates with a half-cycle pulsed pattern typical of a

microwave oven magnetron. If the interference does not, the communications system transitions back to the first state 910. If the interference does sufficiently match this pattern, however, the communications system transitions to a third state 930, in which the communications system predicts one or more intervals in which increased

5 interference is expect to occur. For example, in this state the communications system may further analyze the detected interference to determine whether it is correlated to a particular cooking mode, e.g., high-power, medium-power, or defrost, which has a particular duty cycle associated therewith. The communications system may then predict corresponding intervals of increased interference accordingly. After these

10 intervals are predicted, the communications system transitions to a fourth state 940 in which it commands devices of the communications system to implement a second interference mitigation scheme, such as by transmitting appropriate command messages that command devices in the system to use a particular frequency hopping sequence (e.g., to avoid particular frequencies) during a predicted interference

15 interval, to avoid sending messages during a predicted interference interval, and/or to employ a certain type of error correction coding during a predicted interference interval. The communications system then transitions to a fifth state 950, in which it applies the second interference mitigation scheme for the predicted interval.

Upon expiration of the predicted interval, the communications system

20 transitions back to the first state 910, in which it returns to using the first interference mitigation scheme. In cases in which a single interference interval is predicted, the communications system may then wait until interference is again detected. In cases in which multiple intervals are predicted, however, the communications system may transition from the first state 910 to the fifth state 950 upon commencement of a next

25 predicted interference interval. Upon the ending of this next predicted interference interval, the communications system returns to the first state 910 and again applies the first interference mitigation scheme.

FIG. 10 is a state diagram 1000 that illustrates exemplary operations according to yet other embodiments of the present invention, in particular, operations in which a

30 communication system applies a different selected interference mitigation scheme depending upon whether detected interference is of a predictable or unpredictable type. A device begins in a normal channel operating state 1010, i.e., a state in which the communications system applies a "baseline" interference mitigation scheme, which may be, for example, a scheme in which little or no interference mitigation is

applied. Upon detection of interference, the communications system moves to a second state 1020 in which it determines whether the detected interference is of predictable type or an unpredictable type. For example, the communications system may compare the detected interference to a pattern of a predictable type of interference to determine if the detected interference is sufficiently correlated to the pattern to conclude that the detected interference is of the predictable type.

If the interference is of an unpredictable type, the communications system moves to a third state 1030 in which it transmits messages to devices of the communications system to command use of an interference mitigation scheme appropriate for combating unpredictable interference. For example, the communications system may assume that the unpredictable type of interference is random in character and may, therefore, command use of an interference mitigation scheme suited to compensating for random interference. When the detected unpredictable-type interference is no longer present, the communications system may then revert to the normal channel operation state 1010, e.g., by transmitting appropriate messages to the devices of the system to command a return to using interference mitigation measures appropriate to normal channel operation.

If detected interference is of a predictable type, however, the communications system transitions from the second state 1020 to a fourth state 1040, in which the communications system predicts one or more intervals during which interference can be expected. The system then transitions to a fifth state 1050, in which it transmits messages to devices of the communications system to command use of an interference mitigation scheme appropriate to the predictable type of interference during a predicted interval. When a predicted interval ends, the communications system reverts to the normal channel operation state 1010, e.g., by transmitting appropriate messages to the devices of the system to command a return to using interference mitigation measures appropriate to normal channel operation. In the case where multiple interference intervals are predicted, the communications system may again transition to the fifth state 1050, applying the predictable-type interference mitigation scheme upon commencement of a new predicted interference interval.

In the drawings and specification, there have been disclosed typical preferred embodiments of the invention and, although specific terms are employed, they are used in a generic and descriptive sense only and not for purposes of limitation, the scope of the invention being set forth in the following claims.

CLAIMS

THAT WHICH IS CLAIMED IS:

1. A method of operating a communications system, the method comprising:
detecting interference; and
changing from a first interference mitigation scheme to a second interference
5 mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference.
2. The method according to Claim 1, wherein changing from a first interference mitigation scheme to a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference comprises applying the
5 second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference.
3. The method according to Claim 2, wherein applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises applying the second interference mitigation scheme according to a predetermined periodicity associated with the
5 predetermined type of interference.
4. The method according to Claim 2, wherein applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises:
predicting an interval of increased interference based on the predetermined
5 pattern; and
performing at least one of the following:
foregoing transmission of messages during the predicted interval;
changing coding of messages transmitted during the predicted
10 interval;
foregoing transmission of messages to a selected device of the communications system during the predicted interval; and

foregoing use of a selected frequency to communicate messages during the predicted interval.

5. The method according to Claim 2, wherein applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises:

5 predicting an interval of increased interference based on the predetermined pattern; and
foregoing transmission of messages during the predicted interval.

6. The method according to Claim 2, wherein applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises:

5 predicting an interval of increased interference based on the predetermined pattern; and
changing coding of messages transmitted during the predicted interval.

7. The method according to Claim 2, wherein applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises:

5 predicting an interval of increased interference based on the predetermined pattern; and
foregoing transmission of messages to a selected device of the communications system during the predicted interval.

8. The method according to Claim 2, wherein applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises:

5 predicting an interval of increased interference based on the predetermined pattern; and
foregoing use of a selected frequency to communicate messages during the predicted interval.

9. The method according to Claim 1, wherein changing from a first interference mitigation scheme to a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference comprises transmitting a
5 message from a first communications device to a second communications device to command use of the second interference mitigation scheme.

10. The method according to Claim 1, wherein changing from a first interference mitigation scheme to a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference comprises changing at
5 least one of frequency hopping applied in the communications system, a message coding applied in the communications system and a message transmission scheduling applied in the communications system.

11. The method according to Claim 1, wherein the predetermined type of interference comprises one of a type of interference generated by a microwave generator and a type of interference generated by a wireless communications device.

12. The method according to Claim 1, wherein the predetermined pattern comprises a half-cycle pulse pattern associated with a microwave oven that occurs at a power line frequency, and wherein changing from a first interference mitigation scheme to a second interference mitigation scheme if the detected interference
5 exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference comprises changing from the first interference mitigation scheme to the second interference mitigation scheme if the detected interference exhibits a pulse pattern that occurs at a frequency sufficiently correlated to the power line frequency.

13. A communications system, comprising:
at least one communications device operative to communicate via a communications medium;
an interference detector that detects interference in the communications
5 medium; and

- an interference mitigation controller, operatively associated with the at least one communications device and responsive to the interference detector circuit, that causes the at least one communication device to change from using a first interference mitigation scheme to using a second interference mitigation scheme if the detected
- 10 interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference.

14. The system according to Claim 13, wherein the interference mitigation controller causes the communications device to apply the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference.

15. The system according to Claim 14, wherein the interference mitigation controller causes the communications device to apply the second interference mitigation scheme according to a predetermined periodicity associated with the predetermined type of interference.

16. The system according to Claim 14, wherein the interference mitigation controller predicts an interval of interference based on the predetermined pattern.

17. The system according to Claim 16, wherein the interference controller causes the at least one communications device to forego transmission of messages during the predicted interval.

18. The system according to Claim 16, wherein the interference mitigation controller causes the at least one communications device to change coding applied to messages transmitted during the predicted interval.

19. The system according to Claim 16, wherein the interference mitigation controller causes the at least one communications device to forego communicating with a selected communications device during the predicted interval.

20. The system according to Claim 16, wherein the interference mitigation controller causes the at least one communications device to forego use of a selected frequency to communicate messages during the predicted interval.

21. The system according to Claim 13, wherein the interference mitigation controller causes a first communications device to transmit a message to a second communications device to command use of the second interference mitigation scheme.

22. The system according to Claim 13, wherein the interference mitigation controller causes a change in at least one of a frequency hopping applied by the at least one communications device, a message coding applied by the at least one communications device and a message transmission scheduling applied by the at least one communications device if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference.

23. The system according to Claim 13, wherein the predetermined type of interference comprises one of a type of interference generated by a microwave generator and a type of interference generated by a wireless communications device.

24. The system according to Claim 13, wherein the predetermined pattern comprises a half-cycle pulse pattern associated with a microwave oven that occurs at a power line frequency, and wherein the interference mitigation controller causes the at least one communications device to change from using the first interference mitigation scheme to using the second interference mitigation scheme if the detected interference exhibits a pulse pattern that occurs at a frequency sufficiently correlated to the power line frequency.

25. The system according to Claim 13, wherein the at least one communications device includes a communications circuit, and wherein at least one of the interference detector and the interference mitigation controller are operatively associated with the communications circuit.

26. The system according to Claim 25, wherein the interference detector circuit is responsive to the communications circuit to detect interference.

27. The system according to Claim 13:
wherein the at least one communications device comprises a plurality of communications devices;
wherein the interference detector comprises at least one interference detector circuit positioned at at least one of the plurality of communications devices; and
wherein the interference mitigation controller comprises at least one interference mitigation controller circuit positioned at at least one of the plurality of communications devices.

28. A communications system, comprising:
at least one communications device operative to communicate using first and second interference mitigation schemes;
means for detecting interference; and
means, responsive to the means for detecting interference, for causing the at least one communications device to change from using the first interference mitigation scheme to using the second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference.

29. The system according to Claim 28, wherein the means for causing the at least one communications device to change from using the first interference mitigation scheme to using the second interference mitigation scheme comprises means for applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference.

30. The system according to Claim 29, wherein the means for applying the second interference mitigation scheme according to the predetermined pattern associated with the predetermined type of interference comprises:

means for predicting an interval of increased interference based on the predetermined pattern; and

means for performing at least one of the following:

foregoing transmission of messages during the predicted interval;

changing coding of messages transmitted during the predicted interval;

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foregoing transmission of messages to a selected device of the communications system during the predicted interval; and

foregoing use of a selected frequency to communicate messages during the predicted interval.

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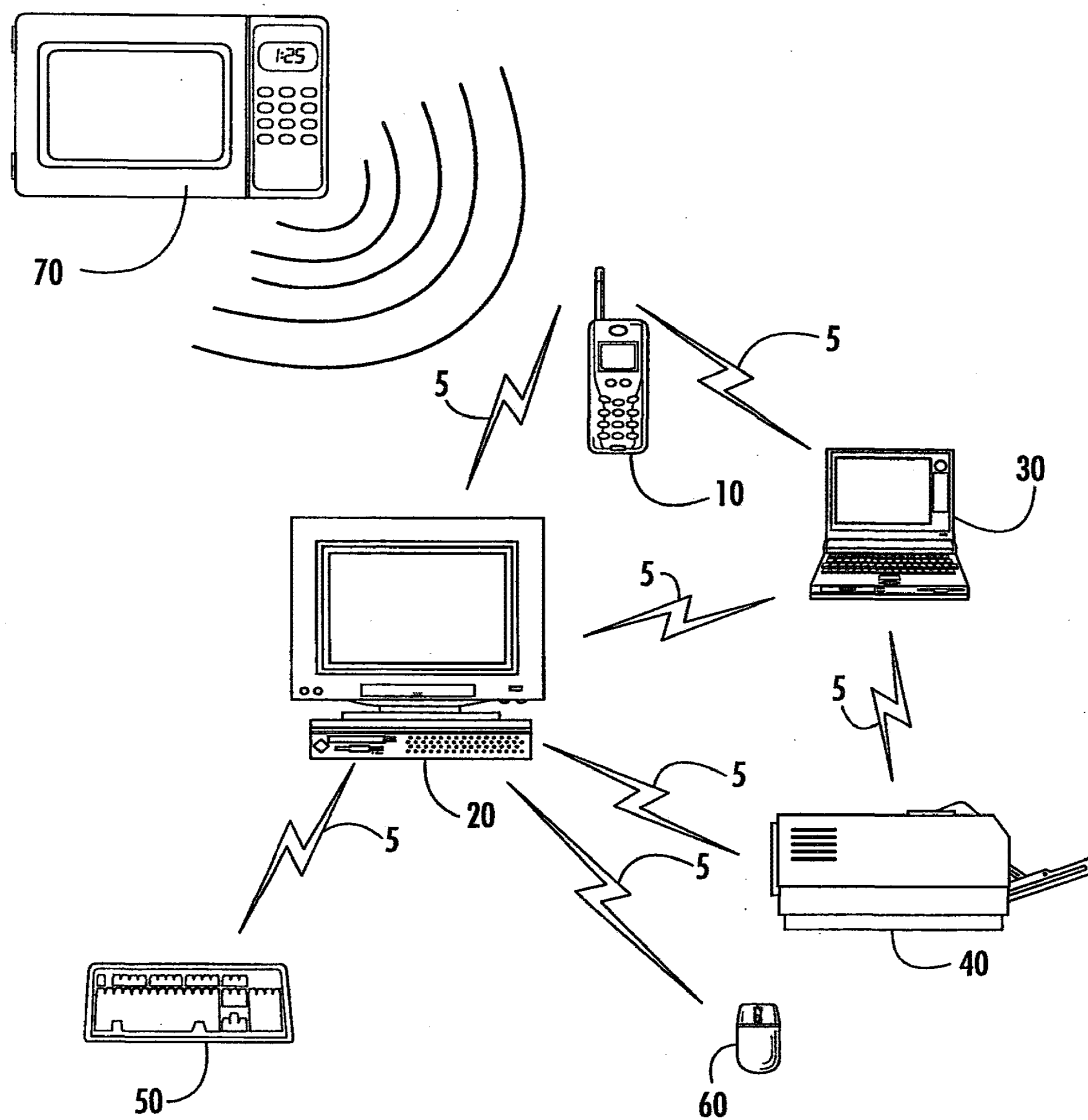
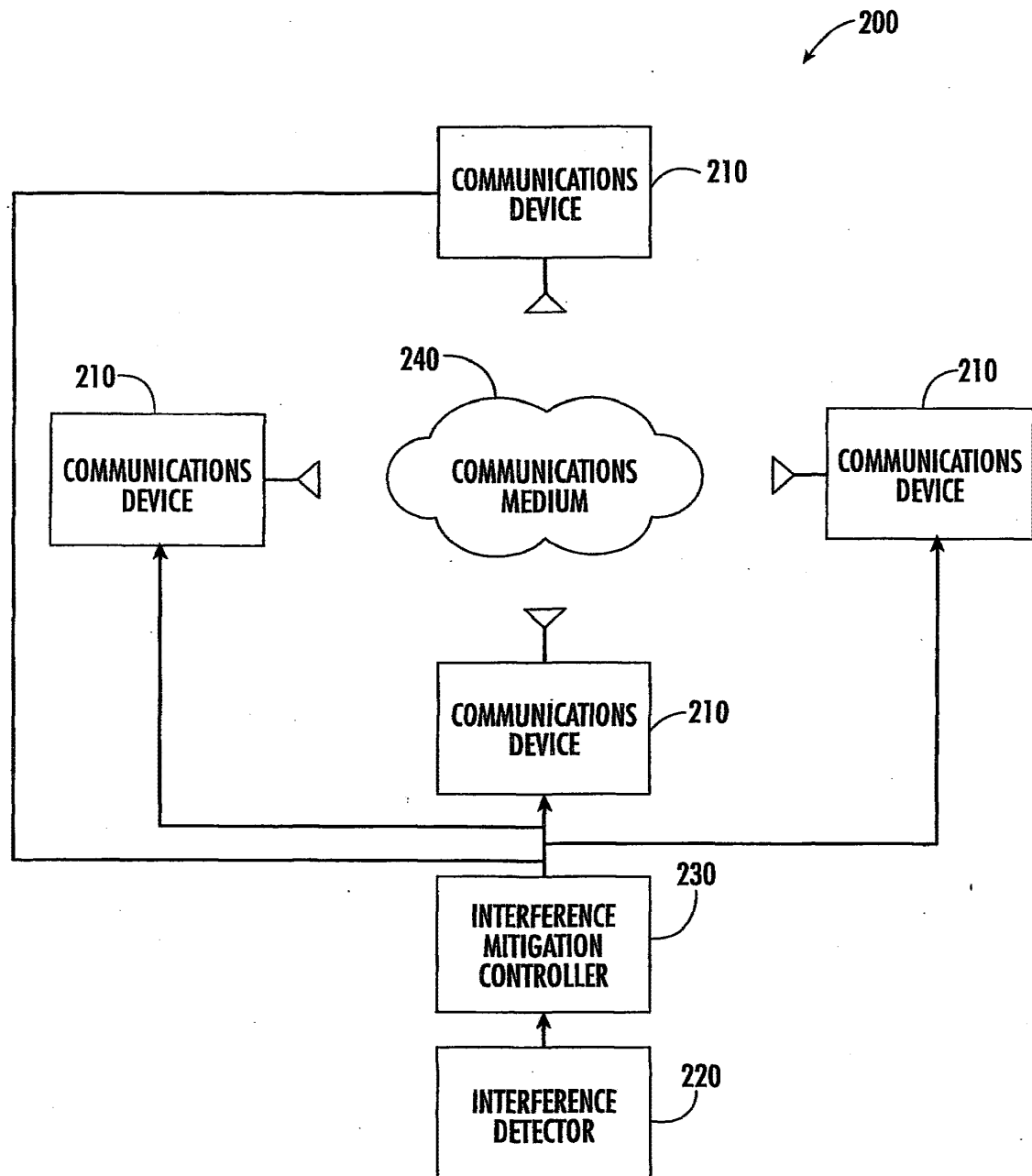


FIG. 1.
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**FIG. 2.**

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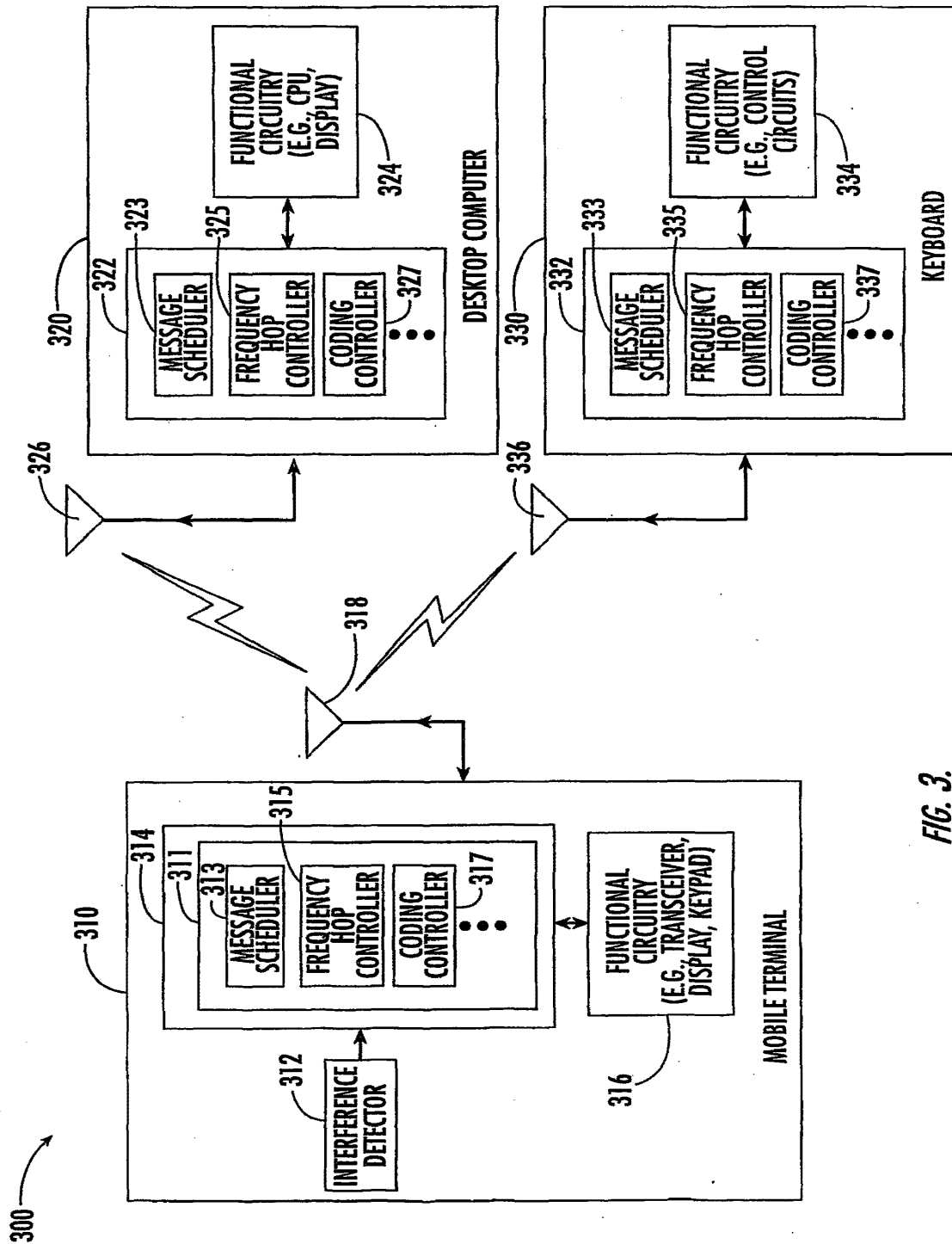


FIG. 3.

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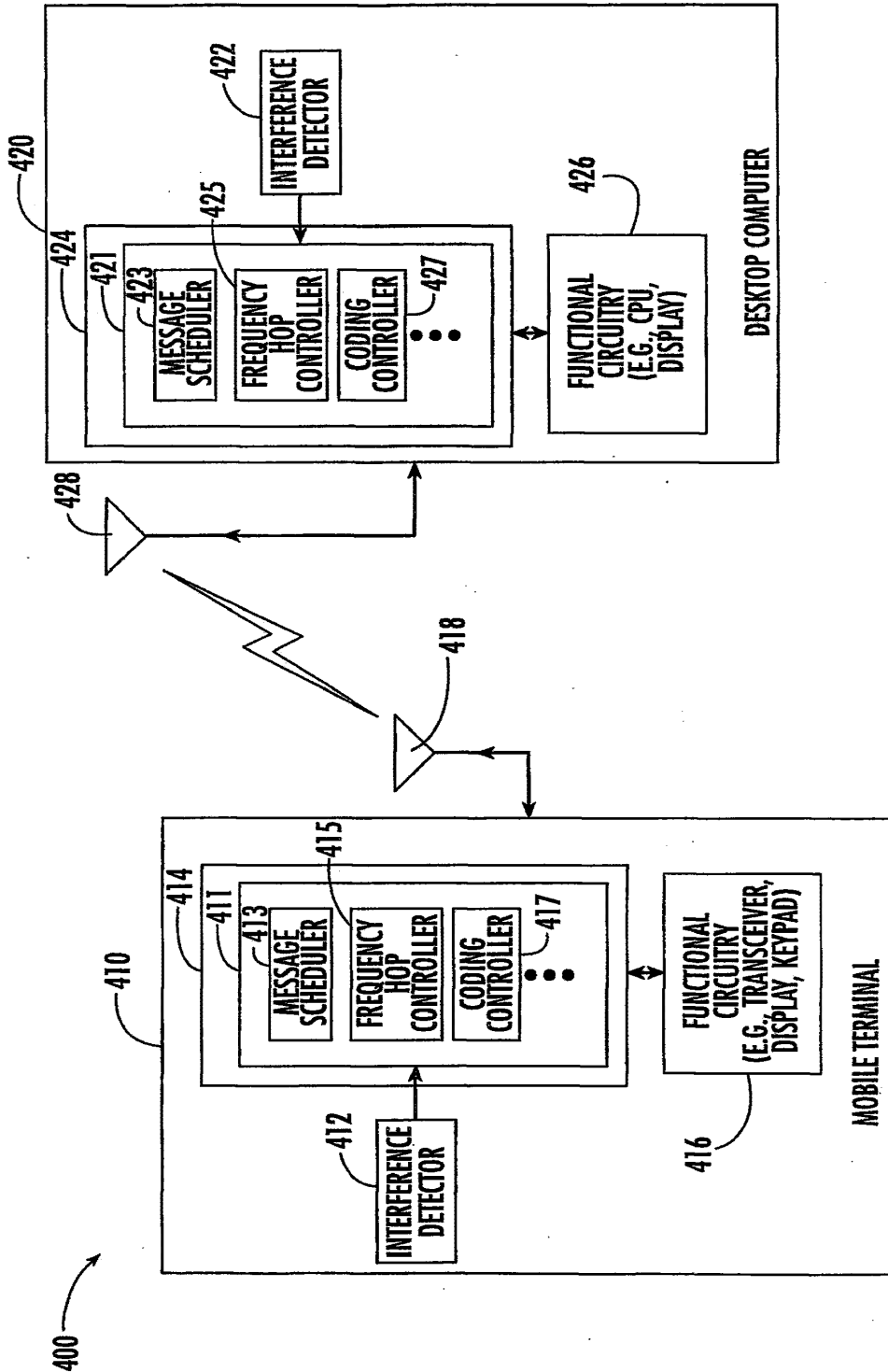


FIG. 4.

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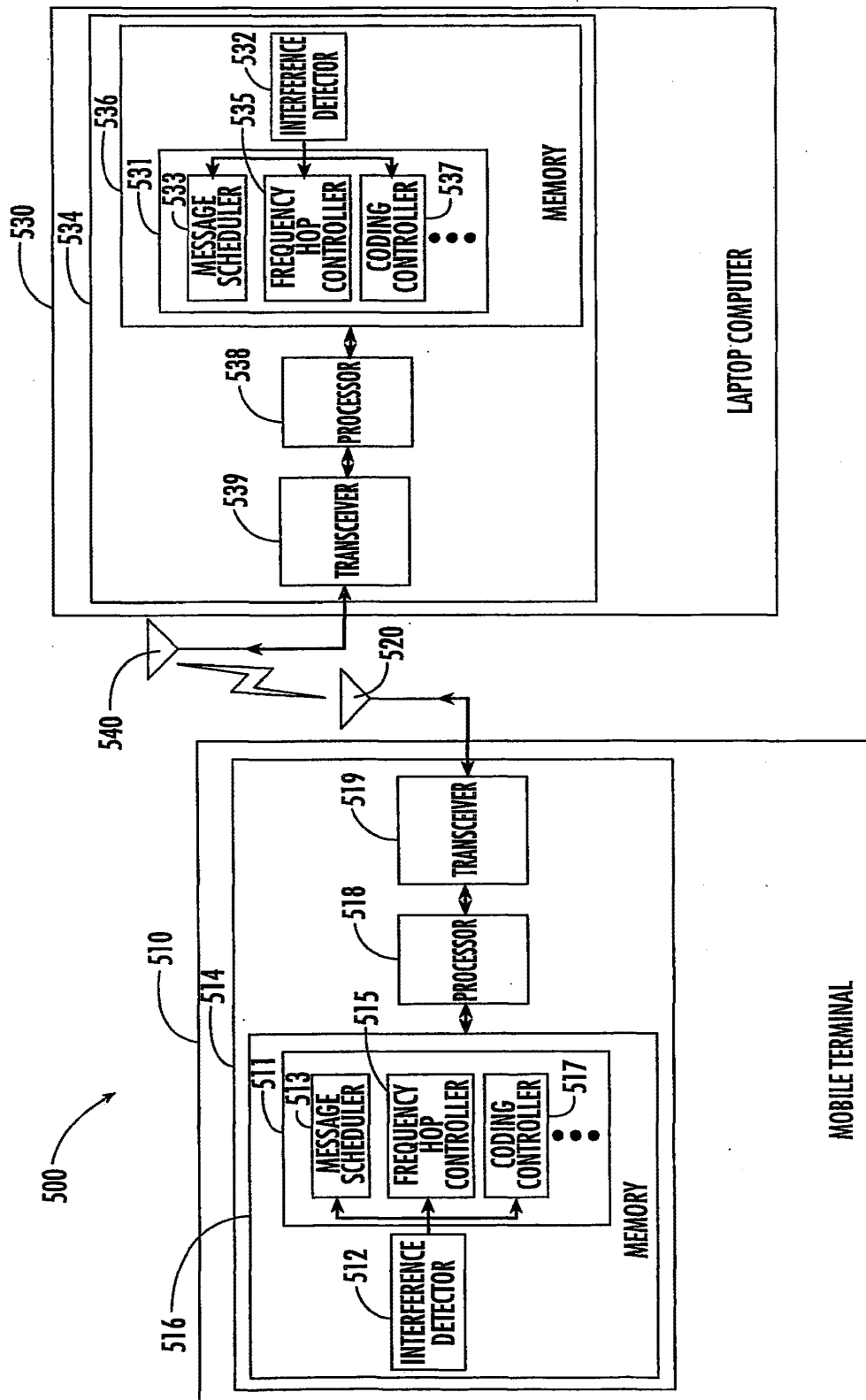
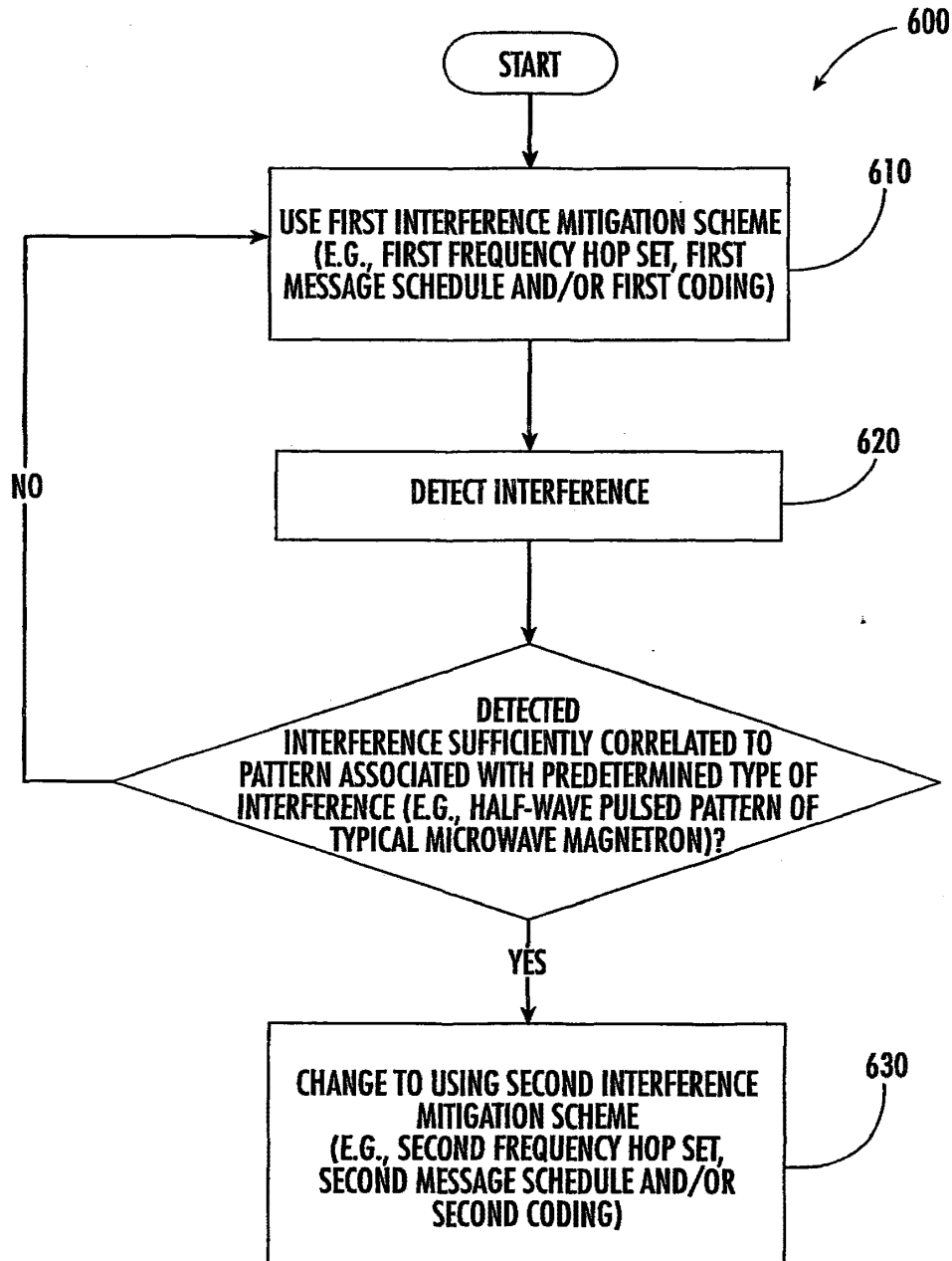
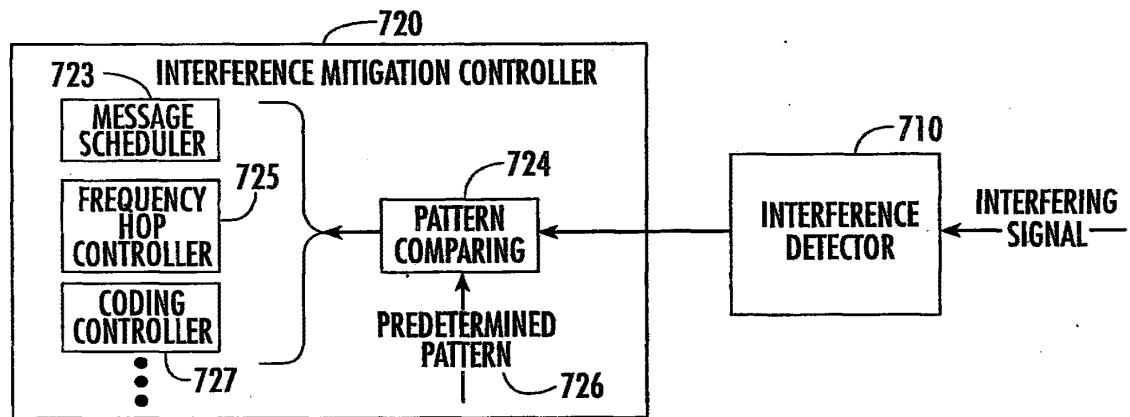


FIG. 5.

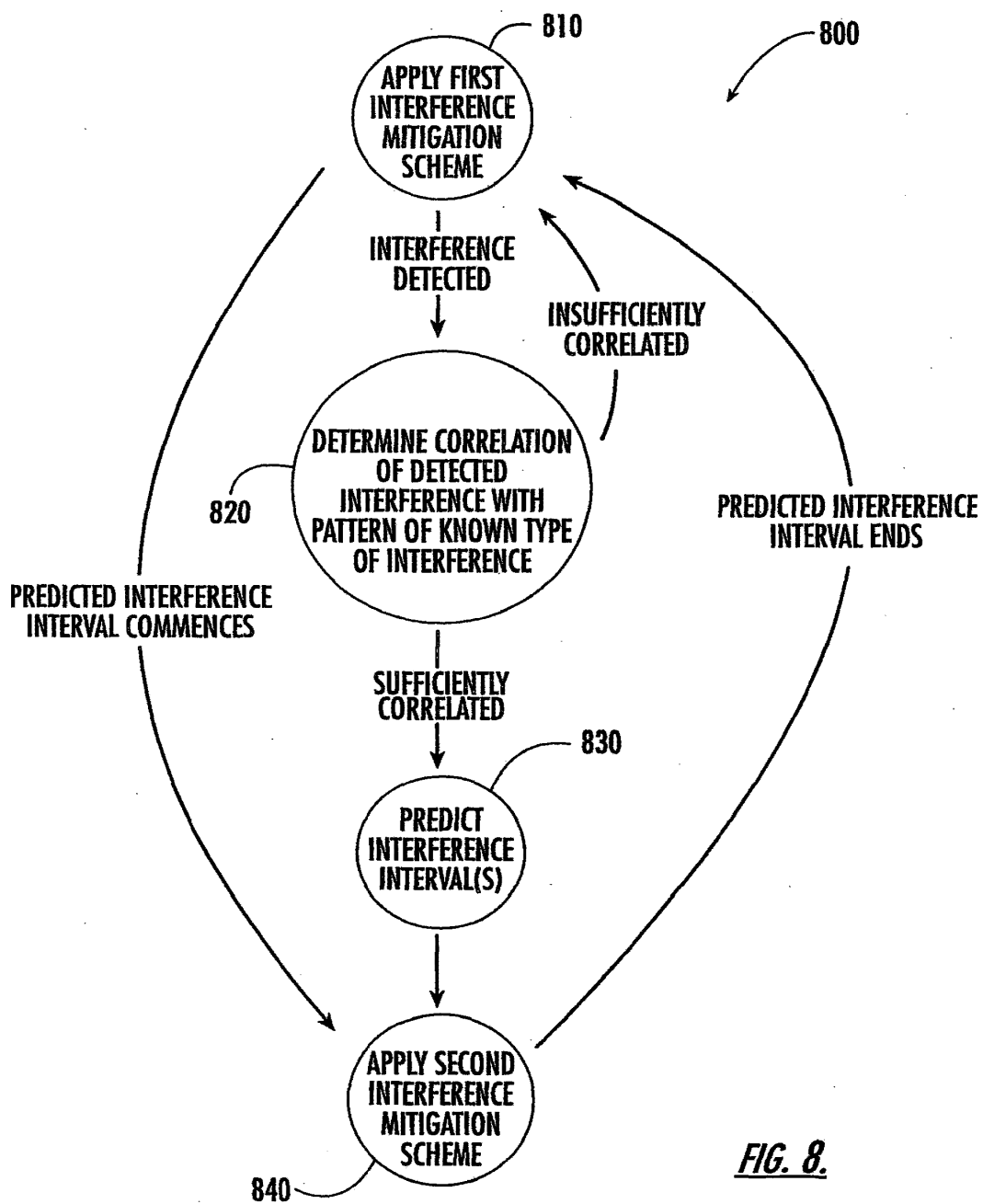
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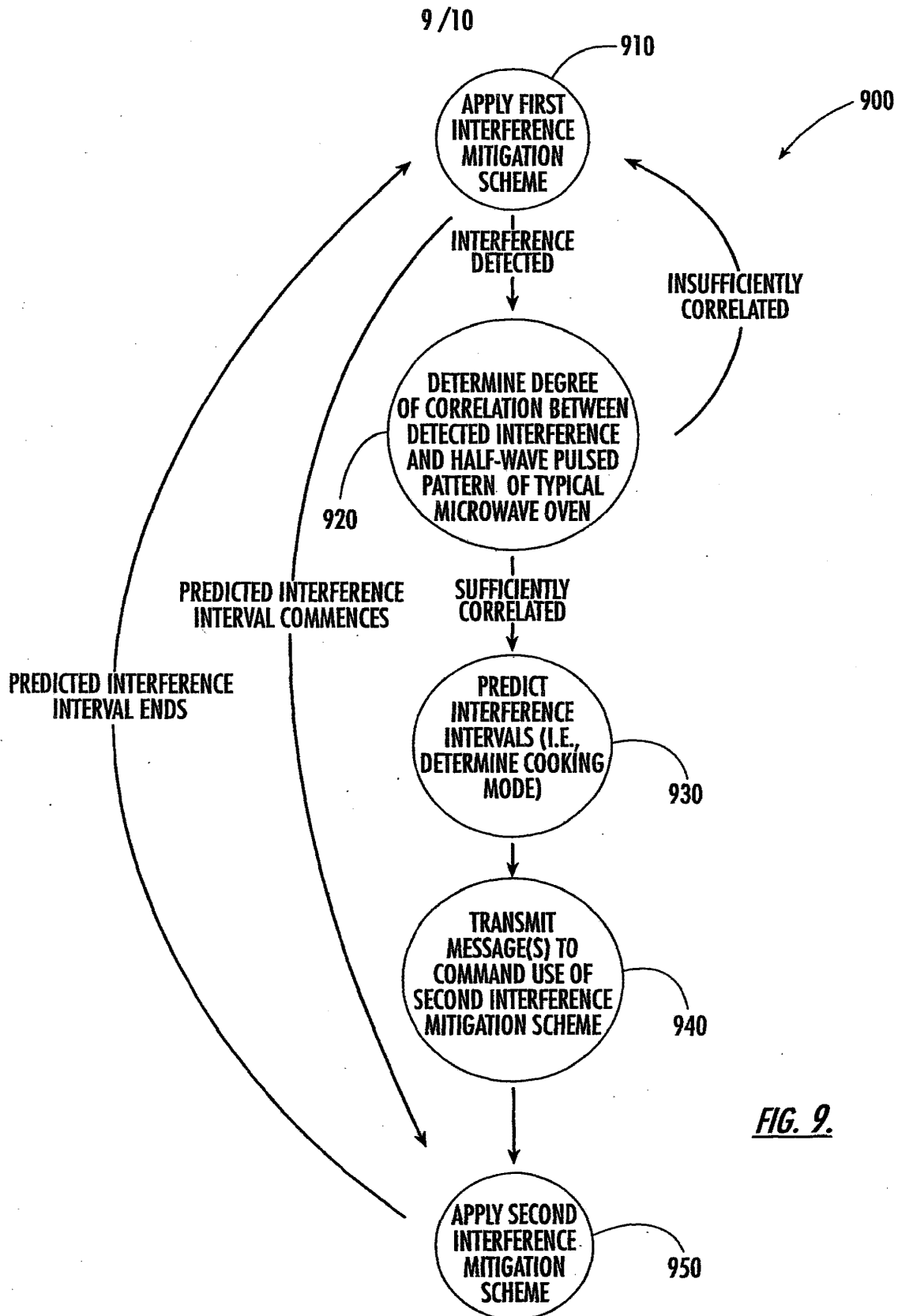
**FIG. 6.**

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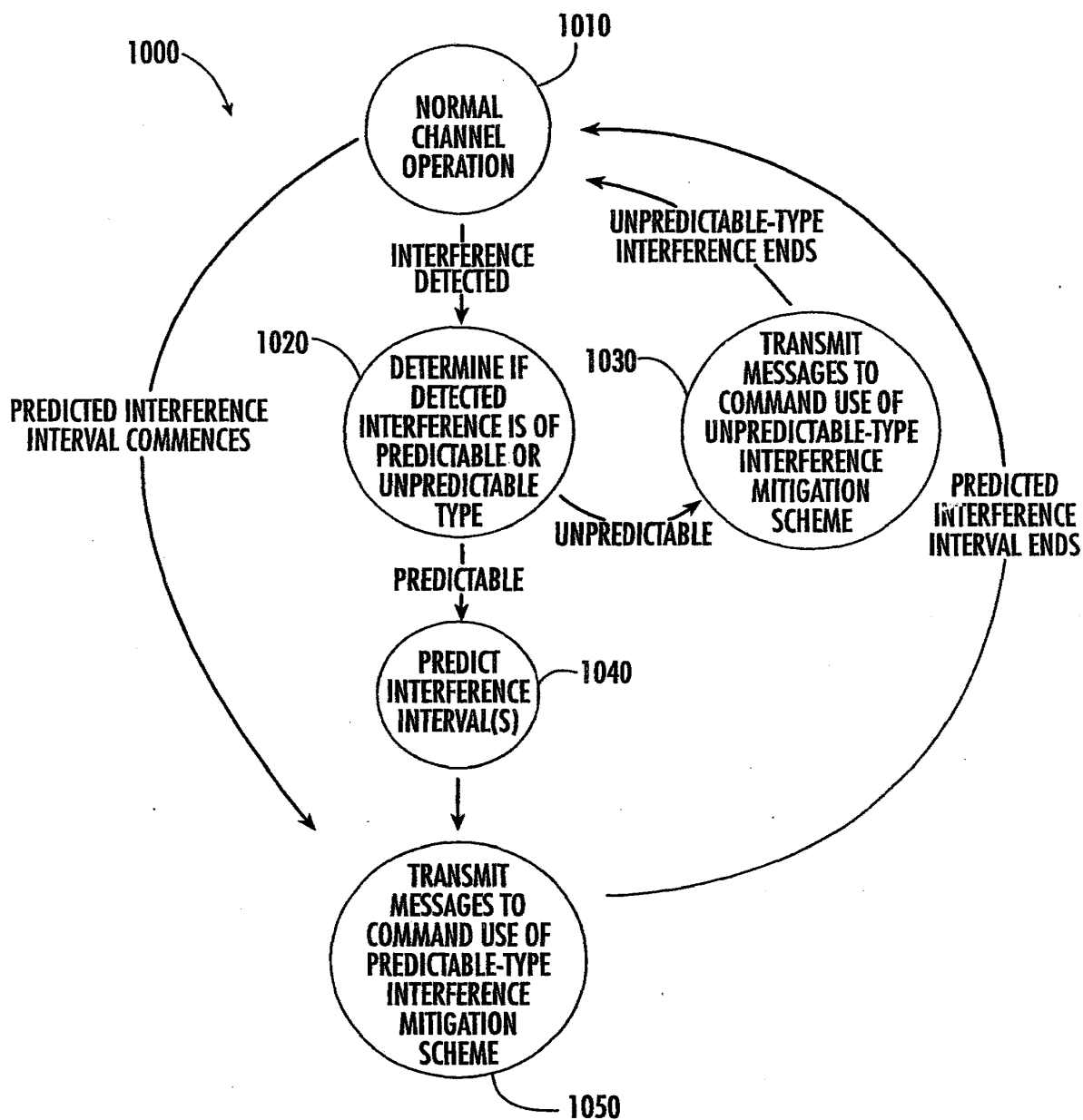
**FIG. 7.**

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**FIG. 8.**



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**FIG. 10.**

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(74) Agent: **MEEKS, Robert, M.**; Myers Bigel Sibley Sajovec, P.A., P.O. Box 37428, Raleigh, NC 27627 (US).

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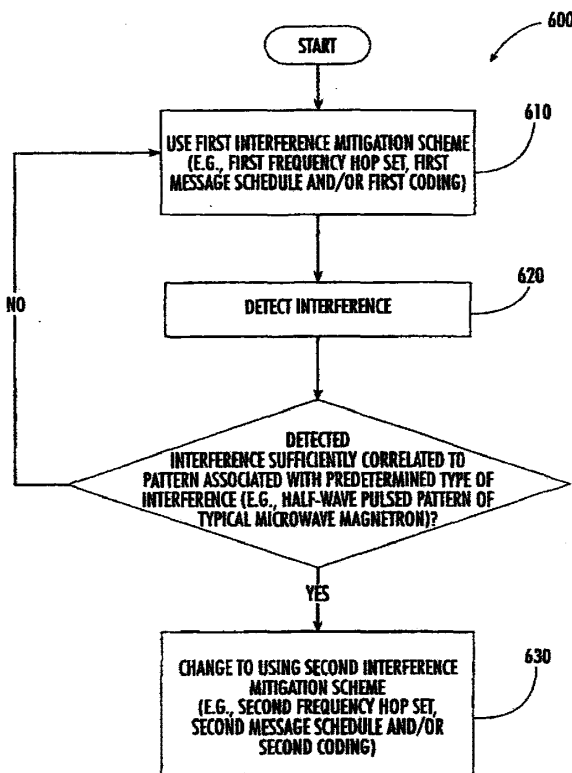
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(72) Inventor; and

(75) Inventor/Applicant (*for US only*): **BROWN, Thomas, A.**

[Continued on next page]

(54) Title: APPARATUS AND METHODS FOR SELECTIVE INTERFERENCE MITIGATION



(57) Abstract: Selective compensation for interference in a communications system, such as a piconet or scatternet using an Industrial-Scientific-Medical (ISM) frequency band, may be achieved, according to embodiments of the present invention, by adapting the interference mitigation scheme applied in a communications system based on comparison with known patterns associated with particular types of interference, such as interference generated by microwave ovens, medical equipment, industrial equipment and wireless communications devices. According to embodiments of the present invention, a communications system, such as wireless communications system, detects interference and changes from a first interference mitigation scheme to a second interference mitigation scheme if the detected interference exhibits a pattern sufficiently correlated with predetermined pattern associated with a predetermined type of interference, such as the half-cycle pulsed pattern typical of a microwave oven.

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Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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Y	page 6, line 36 - line 52; figures 2,3	14,28,29
	page 11, line 19 - line 42; claims 2,3,16;	3-12,
	figures 8,9	15-27,30
X	US 5 430 894 A (NOHARA AKIRA ET AL) 4 July 1995 (1995-07-04)	1,2,13,
	column 4, line 56 -column 6, line 64;	14,28,29
	figures 2-5	
X	EP 0 667 682 A (SHARP KK) 16 August 1995 (1995-08-16)	1,2,13,
	claims 1,2	14,28,29
	-/-	

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

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,
Fax: (+31-70) 340-3016

Authorized officer

Burghardt, G

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Y	EP 0 963 051 A (EASTMAN KODAK CO) 8 December 1999 (1999-12-08) column 2, line 7 - line 12 column 2, line 56 -column 4, line 31; figures 1,2	3-12, 15-27,30

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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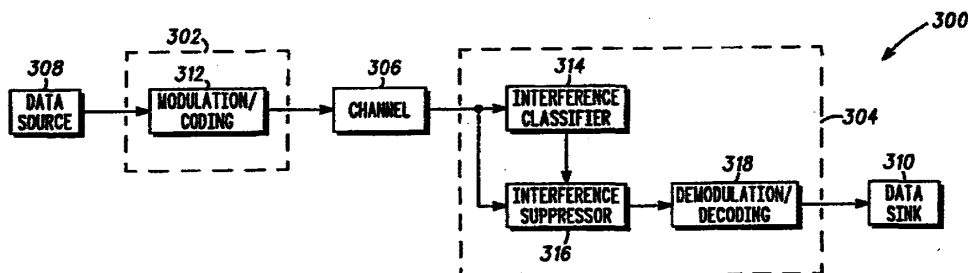
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(54) Title: METHOD AND APPARATUS FOR PERFORMING TARGETED INTERFERENCE SUPPRESSION

**(57) Abstract**

The invention relates to a communication system (300) having a receiver (304) that is capable of performing targeted interference suppression. An interference classifier (314) within the receiver (304) analyzes a signal received from a channel (306) and identifies and classifies interference components within the signal. An interference suppressor (316) then suppresses the interference components in the signal based on interference type. In one embodiment, the interference suppressor (316) includes a plurality of interference suppression modules that are each optimal for suppressing certain interference types. The interference suppressor (316) selects one of the interference suppression modules based on the type of interference present in the received signal. In another embodiment, a hybrid interference mitigation system (10) is provided by combining targeted interference suppression, frequency hopping adaptation, and processing gain adaptation.

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METHOD AND APPARATUS FOR PERFORMING TARGETED INTERFERENCE SUPPRESSION

Field of the Invention

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The invention relates in general to communications systems and, more particularly, to communications systems having interference suppression capabilities.

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Background of the Invention

Digital cellular communications systems, paging systems, land mobile radio, and mobile battlefield communication systems are called upon to operate effectively in increasingly adverse spectral environments. Obstacles to digital mobile communications include non-stationary co-site interference, ambient communication signals, and hostile jamming interference. Typical interference levels can be very high, especially in a tactical environment, and can often exceed the desired signal by 60 decibels or more. Such levels overwhelm the operational capabilities of current tactical and commercial radio systems. Furthermore, PCS, paging, and cellular communication networks that incorporate spread-spectrum technologies, such as CDMA, increasingly face capacity limitation caused in part by growing spectral clutter. The presence of ambient high power partialband and narrowband signals often precludes frequency reuse by spread-spectrum communication systems.

Therefore, there is a need for a method and apparatus for reducing the impact of undesirable spectral components in a communications system.

Brief Description of the Drawings

5 FIG. 1 is a high level block diagram illustrating a communication system in accordance with one embodiment of the present invention;

FIG. 2 is a block diagram illustrating a communication system in accordance with another aspect of the present invention;

10 FIG. 3 is a block diagram illustrating elements within the disturbance classification unit 74 of FIG. 2;

FIG. 4 is a joint time frequency (JTF) feature plane diagram illustrating inbound communication signal interferers versus time;

15 FIG. 5 is a cross section of a feature plane transformation diagram for a five FSK interference signal;

FIG. 6 is a flowchart illustrating a transformation masking method in accordance with one embodiment of the present invention;

20 FIGS 7-11 are graphs illustrating a method for performing preclassification filtering in accordance with one embodiment of the present invention;

FIGS. 12 and 13 are cross-sections of feature plane signal transformations illustrating the beneficial effects of using phase domain filtering;

25 FIG. 14 is a spectrum diagram illustrating a method for determining a baud rate for a binary phase shift keying (BPSK) signal in accordance with one embodiment of the present invention;

FIG. 15 illustrates a linear array of alternating Kronecker deltas that is used to determine a baud rate for an frequency shift

keying (FSK) signal in accordance with one embodiment of the present invention;

FIG. 16 is a spectrum diagram illustrating a method for determining a baud rate for an FSK signal in accordance with one
5 embodiment of the present invention;

FIG. 17 is a plot illustrating modal moment estimates for a data signal corrupted by a partial band noise jammer in accordance with one embodiment of the present invention;

FIG. 18 is a flowchart illustrating a process for deriving modal
10 moment estimates in accordance with one embodiment of the present invention;

FIG. 19 is a spectrum diagram illustrating a number of bands $W_s N$ for use in frequency hopping in accordance with one embodiment of the present invention;

15 FIG. 20 is a flowchart illustrating a method for performing frequency hop masking in accordance with one embodiment of the present invention;

FIG. 21 is a flowchart illustrating the operation of an inverse whitening function in accordance with one embodiment of the present
20 invention;

FIG. 22 is a spectrum diagram illustrating the spectrum of a spread spectrum data signal corrupted by a PSK partial band jammer
122;

FIG. 23 is a flowchart illustrating the operation of an adaptive
25 inverse weight interference suppression method in accordance with one embodiment of the present invention;

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FIG. 24 is a flowchart illustrating the operation of an adaptive excision interference suppression method in accordance with one embodiment of the present invention;

FIG. 25 is a flowchart illustrating a cascaded interference suppression procedure in accordance with one embodiment of the present invention; and

FIGS. 26-28 are spectrum diagrams illustrating a cascaded suppression procedure in accordance with one embodiment of the present invention.

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Detailed Description of the Drawings

The present invention relates to a communications system that is capable of reducing the impact of undesirable spectral components (e.g., noise, interference, and jamming) in a receive signal. The system includes an interference classifier for classifying each of the undesired spectral components (if any) by interference-type and an interference suppressor for suppressing the undesired interference components in the receive signal using one or more interference suppression methods that may be "targeted" to the specific type of interference. By targeting interference suppression by interference-type, a superior level of interference suppression performance is achieved as compared to prior art systems that use a common suppression method for all types of interference. In one embodiment of the invention, the interference classification and suppression functions are performed automatically.

The invention is capable of operating in real time on a short sample set, with power consumption that is within the capabilities of modern digital signal processors (DSP). In addition, the invention is capable of optimizing bit error rate (BER) performance given a variety of interferers without sacrifice of bandwidth or system capacity and, in some cases, can improve the bit error rate (BER) of a communications system by multiple orders of magnitude. The invention is of relatively low complexity and can be implemented using computationally efficient recognition/cancellation routines. In one embodiment, the invention is used to provide for frequency reuse in a situation where a spread spectrum communications system is overlaying one or more narrowband and/or partialband systems.

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As described in more detail below, the principles of the present invention can be, and preferably are, implemented in a spread spectrum communications system. A spread spectrum communications system is a system where the bandwidth of the transmitted radio frequency signal is wider than that required by the data rate and modulation type of the underlying information signal. That is, a second layer of modulation is used that "spreads" the spectrum of the modulated information signal to provide a number of important advantages. For example, spread spectrum systems are generally better at rejecting interference than are other types of communications systems. In addition, spread spectrum systems can support the use of code division multiple access (CDMA) techniques to provide a plurality of separate communication channels in a given bandwidth. Another advantage of spread spectrum techniques is that they are conducive to signal hiding in secure communications applications. Spread spectrum systems are also capable of high resolution ranging. Various methods, such as direct sequence spread spectrum (DSSS) and frequency hopping spread spectrum (FHSS), can be used to spread the bandwidth of the transmit signal.

FIG. 1 is a high level block diagram illustrating a system 300 in accordance with one embodiment of the present invention. As illustrated, the system 300 includes a transmitter 302 which communicates with a receiver 304 through a channel 306. The transmitter 302 receives data from a data source 308 and processes the data to create a transmit signal that is delivered to the channel 306. The receiver 304 receives a signal from the channel (which is a modified form of the transmit signal) and processes the signal to

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recover the original data. The recovered data is then delivered to the data sink 310.

The transmitter 302 includes, among other things, a modulation/coding unit 312 that applies modulation and/or coding to the data from the data source 308. For example, the modulation/coding unit 312 can apply source coding, channel coding, interleaving, and/or upconversion to the data signal. In a spread spectrum system, the modulation/coding unit can also apply signal spreading to the signal using methods that are well known in the art.

The receiver 304 includes an interference classifier 314, an interference suppressor 316, and a demodulation/ decoding unit 318. The receiver 304 receives the signal from the channel 306 in a signal receptor, such as an antenna. The interference classifier 314 analyzes the signal received from the channel 306 and identifies and classifies interference components within the signal. The interference components can be from any of a number of different sources, such as nearby communications systems and/or hostile entities attempting to jam transmissions from the transmitter 312. The interference classifier 314 outputs a signal indicative of the interference classification of each of the identified interference components. The interference suppressor 316 receives both the classification signal from the interference classifier 314 and the signal received from the channel 306. The interference suppressor 316 then selects one or more suppression methods that work best for the types of interference identified and uses the selected methods to suppress interference in the receive signal. After the interference components have been suppressed, the receive signal is transferred to the demodulation/decoding unit 318 to remove all modulation and/or

coding from the signal. The signal is then delivered to the data sink 310.

FIG. 2 is a more detailed block diagram illustrating a spread spectrum communications system 10 in accordance with one embodiment of the present invention. As illustrated, the system 10 includes an input device 12, a transmitter 14, a channel 16, a receiver 18, and an output device 20. The transmitter 14 receives an input signal from the input device 12 and processes the signal into a form for transmission into the channel 16. The channel 16 carries the signal from the transmitter 14 to the receiver 18. Receiver 18 processes the signal received from the channel to recover the original information that was generated by the input device 12. This recovered information is then transferred to the output device 20.

The input device 12 can include virtually any type of information source. That is, the input device 12 can provide, for example, audio information (such as speech), computer data, or video information. In the illustrated embodiment, input device 12 comprises a microphone for converting speech into an analog electrical signal indicative thereof.

The transmitter 14 includes: analog to digital (A/D) converter 22, encoder 24, multiplier 26, digitally controlled oscillator (DCO) 28, N level chip sequence generator 30, chip shaping filter 32, frequency hopping (FH) adaptation module 34, and processing gain adaptation module 36. A/D converter 22 is operative for digitizing the analog signal from the input device. That is, the A/D converter 22 samples the analog signal from the input device 12 and creates digital values (i.e., samples) that are each indicative of the magnitude of the analog signal at a particular instant in time (i.e., the sampling

time). It should be appreciated that an A/D converter 22 is only necessary if the input device 12 is providing analog input. The encoder 24 receives the digital signal from the A/D converter 22 and encodes it using any of a number of different digital encoding methods such as, for example, differential phase shift keying (DPSK), minimum shift keying (MSK), quaternary phase shift keying (QPSK), and quadrature amplitude modulation (QAM). Multiplier 26 receives the encoded data signal from encoder 24 and multiplies the signal with a radio frequency (RF) carrier signal and a pseudo noise (PN) sequence to create the transmit signal that is transmitted into the channel 16. It should be appreciated that multiple layers of multiplication may be performed in the multiplier 26 to achieve the transmit signal using the three inputs.

Multiplication by the RF carrier signal upconverts the encoded data signal to an RF frequency range centered about the carrier frequency. DCO 28 generates the RF carrier signal in response to a digital control signal from the frequency hopping (FH) adaptation module 34 (and/or from the processing gain adaptation module 36). The N level chip sequence generator 30 and chip shaping filter 32 generate the pseudo noise (PN) sequence that is used to spread the transmit signal in frequency in a process known as direct sequence spread spectrum (DSSS). The N level chip sequence generator 30 produces a multi-level PN sequence in a manner that is well known in the art. The chip shaping filter 32 filters the PN sequence in a manner that insures low probability of intercept/low probability of detection (LPI/LPD). After filtering, the PN sequence exhibits a more Gaussian time domain distribution which makes hostile detection and parameter extraction more difficult. Further, the chip shaping filter

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32 band limits the PN sequence to the channel, which reduces adjacent channel interference. Note that a preferred embodiment of the invention can include frequency hopping (FH) adaptation and processing gain (PG) adaptation in concert, exclusively, or no
5 adaptation. Without FH or PG adaptation, no feedback path is required.

The FH adaptation module 34 is operative for implementing adaptive frequency hopping spread spectrum techniques in the system
10. The FH adaptation module 34 delivers a digital signal to DCO 28 instructing it to change the center frequency of the carrier signal
10 based upon a frequency hopping sequence. By periodically changing center frequency, a number of advantages are obtained, such as increased resistance to jamming. In the preferred embodiment, the FH adaptation module 34 receives feedback from the receiver 18 which indicates, among other things, the type(s) and spectral
15 location(s) of interference that currently exists in the channel 16. The FH adaptation module 34 can determine from the feedback signals received from the interference suppression processor 42 that a particular frequency hopping band is occupied by interference that is difficult and/or impossible to overcome. The FH adaptation module
20 34 can then remove that frequency band from the frequency hopping sequence via frequency masking. When it is determined that the frequency band is no longer in an unsatisfactory condition, the FH adaptation module 34 can again enter the frequency band into the frequency hopping sequence. In the preferred embodiment, both the FH
25 adaptation module and the N level chip sequence generator 30 are synchronized by a sync signal 35 in a manner that is well known in the art.

The processing gain adaptation module 36 is operative for adaptively controlling the level of spreading that is imparted to the modulated carrier signal. In this regard, the processing gain adaptation module 36 delivers control signals to both the N level chip sequence generator 30 and the chip shaping filter 32 to set the level of spreading. Like the FH adaptation module 34, the processing gain adaptation module 36 receives feedback signals from the receiver 18 that are indicative of the type(s) and spectral location(s) of interference presently in the channel 16. The processing gain adaptation module 36 uses this information to determine an appropriate processing gain for the transmit signal in light of the identified interference. For example, if a narrow band interference signal is detected in the channel 16, the processing gain adaptation module 36 may decide to spread the modulated carrier an additional amount to further reduce the effect of the interfering signal. On the other hand, if little or no interference is detected in the channel 16, the processing gain adaptation module 36 may decide to reduce the level of processing gain (i.e., reduce spreading).

In a preferred embodiment of the present invention, the channel 16 is a wireless RF link. It should be appreciated, however, that the principles of the present invention can be implemented in communication systems having virtually any type of channel, including both wired and wireless channels. As illustrated in FIG. 2, the channel 16 includes an additive noise source 38 and a source of interference/jamming signals 40. Additive noise source 38 represents all sources of random noise in the channel 16. That is, additive noise source 38 includes, for example, sources of thermal noise, atmospheric noise, galactic noise, and others. Frequency

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selective fading or other types of fading can also occur in the channel

16. Interference source 40 represents the sources of all man-made interference in the channel 16. For example, interference source 40 can include partial band noise jammers, spread spectrum co-channel sources, wideband noise jammers, banded co-site signal sources, chirp jammers, multitone jammers, non-banded co-site signals, and others. Signals from both additive noise source 38 and interference source 40 combine with the transmit signal in the channel 16 to produce a modified signal. The modified signal is then received by the receiver 18.

The receiver 18 includes: interference suppression processor 42, co-processor module 44, jammer signal of interest (JSOI) memory 46, conjugate and complex multiply (CCM) unit 48, N level chip sequence generator 50, chip shaping filter 52, fast Fourier transform (FFT) unit 54, inverse FFT unit 56, detector 58, decoder 60, post processor 62, digital to analog converter (DAC) 64, and performance estimator 66. As will be described in more detail, the interference suppression processor 42 receives the modified signal from the channel 16 and suppresses the interference/jamming components therein using targeted interference suppression. Co-processor module 44 provides supplemental processing power (such as, e.g., to perform complex signal arithmetic) to the interference suppression processor 42 for increasing processing speed and thereby improving data throughput. JSOI memory 46 stores, among other things, a library of feature plane representations corresponding to different jamming and interference types that may be encountered in the channel 16. Interference suppression processor 42 uses the information stored in the JSOI memory 46 to identify and classify

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interference components in the receive signal. As will be described in more detail, the interference classifications are used by the interference suppression processor 42 to determine an appropriate form of interference suppression for the receive signal.

5 After the interference/jamming signals in the receive signal have been suppressed, the interference suppression processor 42 outputs the restored spread spectrum signal for despreading, demodulation, and decoding. Correlation of the output signal (i.e., to remove the pseudo noise modulation) is performed in the frequency
10 domain (although other embodiments can use time domain correlation). The N level chip sequence generator 50 and the chip shaping filter 52 are operative for creating the same PN sequence that was created in the transmitter 14 by N level chip sequence generator 30 and chip shaping filter 32. Operation of the N level chip
15 sequence generator 50 is synchronized using sync signal 100, which is a clock signal that is synchronized with the transmitter sync. signal, as will be familiar to those of skill in the art. The output of the chip shaping filter 52 is delivered to FFT unit 54 where it is converted to a frequency domain representation. Before conversion,
20 the FFT unit 54 applies weighting to the pseudo noise sequence to reduce FFT edge effects.

CCM 48 receives the frequency domain output signal from the interference suppression processor 42 and the frequency domain PN information from FFT unit 54. The CCM 48 determines the complex
25 conjugate of the data from the interference suppression processor 42 and then convolves this conjugate data with the frequency domain PN information. For reasons that are apparent to a person of ordinary skill in the art, a significant time uncertainty can exist between the

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PN sequence produced in the N level chip sequence generator 50 and chip shaping filter 52 and the PN sequence used to modulate the transmit signal in the transmitter 14. Use of frequency domain correlation in the receiver 18, rather than time domain correlation, provides significant computational savings when sample timing uncertainty is large. The convolved signal is delivered to inverse FFT 56 to be converted from a frequency domain representation to a time domain representation.

Detector 58 receives the time domain correlated data from the inverse FFT 56 and detects significant correlation energy to produce detected data. In the preferred embodiment of the invention, detector 58 uses ensemble integration to perform the detection function. That is, detector 58 combines the magnitude squared of the inverse FFT 56 output. At zero or negative signal to noise ratio (SNR) conditions, symbols must be combined in an ensemble fashion and compared to a noise based threshold. The threshold is computed and updated dynamically during non-transmission periods in order to maintain an apriori bit error rate (BER) relative to ambient noise. Further processing may also be performed to adjust threshold levels during minimal background interference conditions.

Following detection, the detected data is decoded and/or synthesized in decoder 60 to produce reconstructed data. Decoder 60 can perform adjustments to the multilevel code timing or phase in order to maximize the correlation peak of the signal. In this manner, the multi-symbol buffering nature of the detection process compliments blockwise, processor based frequency tuning offset correction methods, further improving correlation results. Decoder 60 produces in-phase and quadrature values from the detected data

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which are used to compute an instantaneous phase angle. The instantaneous phase angle is dealiased in the decoder 60 and decoding is performed via symbol based integration in order to produce the reconstructed data. The reconstructed data is then passed to the post processor 62 where operations such as adaptive post filtering enhancement or frequency de-emphasis may be performed, producing conditioned, reconstructed data. The conditioned reconstructed data is delivered to the DAC 64 where it is converted to an analog signal for output to output device 20.

10 Performance estimator 66 receives the reconstructed data from the decoder 60 and analyzes the data to calculate one or more performance metrics. These performance metrics are then transferred back to the interference suppression processor 42 for use in fine tuning the interference suppression function. In a preferred embodiment, signal to noise ratio (SNR), bit error rate (BER), and 15 spectral distortion (SD) are used as performance metrics, although other metrics may also be used.

As described above, the interference suppression processor 42 is used to determine the type of interference that is present in the receive signal and to perform interference suppression on the signal based on the types of interference identified. The interference suppression processor 42 delivers signals back to the FH adaptation module 34 and the processing gain adaptation module 36 in the transmitter that are indicative of interference type and spectral 20 location. Interference suppression processor 42 includes: frequency hopping tuner 68, FFT unit 70, signal memory 72, disturbance classification unit 74, jammer parameter extraction unit 76, and 25 targeted interference suppression unit 78. Frequency hopping tuner

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68 receives the receive signal and processes the signal based on the known frequency hopping sequence of the transmitter 14. Frequency hopping tuner 68 also receives sync signal 100 to aid in signal processing. Frequency hopping tuner 68 outputs a time domain data signal that includes both desired information from the transmitter 14 and noise/interference/jamming signals from the channel 16. In an alternate embodiment, frequency hopping is not performed in the transmit unit 14 or the receive unit 18 and the FH tuner 68 and the FH adaptation module 34 are not required.

The output signal from the frequency hopping tuner 68 is weighted (to minimize FFT edge effects) and processed in FFT unit 70 to convert it to a frequency domain representation. The frequency domain representation is then stored in the signal memory 72 for later use. Disturbance classification unit 74 receives both the frequency domain information from FFT unit 70 and the time domain information from the frequency hopping tuner 68 and uses the information to identify and classify the interference/jamming components in the input receive signal. Classification information from the disturbance classification unit 74 is then delivered to the jammer parameter extraction unit 76 which determines parameters describing the interference/jamming components based upon the classifications. That is, the parameter extraction method (i.e., the types of parameters that are extracted and the method of calculating them) that is used in the jammer parameter extraction unit 76 depends on the type of interference identified. By tailoring the parameter extraction method to the type of interference, the jammer parameter extraction unit 76 is able to determine signal

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characteristics that are specific to the interference (e.g., baud rate, bandwidth, deviation, etc.).

The targeted interference suppression unit 78 includes a library of software modules that are each capable of suppressing or removing undesired interference components from a subject signal. Each of the modules in the targeted interference suppression unit 78 works best with a particular type or class of interference/jamming. For example, one module may be best at suppressing spread spectrum co-channel signals while another is best at suppressing the effects of frequency selective fading. The targeted interference suppression unit 78 receives the classification output signal from the disturbance classification unit 74 and the parameter signals from the jammer parameter extraction unit 76 and uses this information to determine which module is best for suppressing the interference in the receive signal. If more than one type of interference is present in the receive signal, the targeted interference suppression unit 78 may choose more than one module to process the signal. After appropriate modules have been chosen by the targeted interference suppression unit 78, the unit 78 retrieves the frequency domain and/or time domain receive signal information from the signal memory 72 and processes it using the appropriate modules. After processing, targeted interference suppression unit 78 outputs a frequency domain spread spectrum signal having suppressed interference. This signal is processed in the remainder of the receiver unit 18, as described above, to produce a data signal which is delivered to output device 20.

As is apparent from the above description, the system 10 illustrated in FIG. 2 provides a hybrid system for interference mitigation. That is, three distinct mitigation subsystems (targeted

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interference suppression, FH adaptation and processing gain adaptation) are implemented to handle virtually any type of interference that can occur. The interference suppression processor 42 provides a receiver based pre-processor function for the removal of undesired jamming signals, effectively optimizing bit error rate performance without the sacrifice of bandwidth or system capacity. The interference suppression processor 42 targets narrow band and partial band jammers such as partial band noise jammers, spread spectrum co-channel signals, banded co-site and ambient signals, chirp jammers, multitone jammers, and non-banded co-site and ambient signals. The FH adaptation module 34 provides a supplementary means of interference mitigation via interference masking and/or randomization of signal errors. Processing gain adaptation module 36 provides additional anti-jam protection by means of chip rate adjustment. Chip rate adjustments are especially effective in the presence of wideband jammer or co-channel spread spectrum interference that cannot be canceled or suppressed via other methods. In applications where size, weight, power, and bandwidth limitations are important, such as handheld or manpack systems, the FH adaptation and processing gain adaptation components of the system 10 can be omitted. Such an omission removes the need for the FH adaptation module 34, the processing gain adaptation module 36, the feedback channel from the interference suppression processor 42, the frequency hopping tuner 68, and the digitally controlled oscillator 28 (which can be replaced by a single frequency oscillator).

The disturbance classification unit 74 processes the time and/or frequency domain receive signal data to produce a maximum

likelihood estimate of the disturbance class superset and/or subset classes. Class supersets can include narrow band, partial band and wideband classes. Class subsets, on the other hand, can include single tone, multi-tone, swept tone, banded communication signal, non-banded communication signal, partial band noise, or wideband noise. Interference may also be classified by modulation type, such as, for example, FSK, NRZ-ASK, and BPSK modulation. The disturbance classification unit 74 can utilize any of a number of techniques to recognize jammer and/or interference signals. For example, the disturbance classification unit 74 can employ tree based classification, multi-layer perceptron classification (MLP), or other methods of classification.

FIG. 3 is a block diagram illustrating the disturbance classification unit 74 in one embodiment of the present invention. As illustrated, the disturbance classification unit 74 includes a feature extraction unit 80 and a classifier 92. The feature extraction unit 80 receives time domain and/or frequency domain representations of the receive signal and processes this data to derive certain features and parameters that are unique to the interference/jamming components within the receive signal. These features and parameters are then delivered to the classifier 92 for use in classifying the interference and jamming components. In the illustrated embodiment, the feature extraction unit 80 includes: super class recognition unit 82, adaptive super class masking unit 84, subclass feature extraction unit 86, subclass interference suppression unit 88, and subclass parameter extraction unit 90. Superclass recognition unit 82 is operative for deriving parameters that are useful in classifying the interference/jamming components according to superclass. The

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superclass masking unit 84 is operative for signal separation, for example, to separate FSK, ASK and PSK signals. The subclass feature extraction unit 86 performs feature plane transformations on the receive signal to aid in the classification of interference/jamming components based on subclass. Subclass interference suppression unit 88 is operative for SNR improvement for the isolated signal. Subclass parameter extraction unit 90 determines subclass parameters from the input data based on the features identified by the subclass feature extraction unit 86.

10 The classifier 92 receives the features and parameters determined in the feature extraction unit 80 and uses them to classify the interference/jamming components in the receive signal. To expedite the classification process and facilitate real-time operation, a separate co-processor module 44 can be utilized by the classifier 92 and block 80. As part of the classification process, the classifier 92 compares features and parameters determined by the feature extraction unit 80 to those of known interference/jamming types that are stored in the JSOI memory 46. Use of a JSOI memory 46 allows new interference types to be added to the system in a quick and efficient manner in contrast to prior art methods that are fixed, "hard wired" implementations. In one embodiment of the invention, a content addressable memory (CAM) is utilized to both store the known interference types and to perform the required comparisons. As is well known in the art, a CAM is capable of comparing an input signal to the contents of a plurality of memory locations simultaneously. The CAM then outputs a signal indicating all memory locations that include the input signal. The classifier 92 outputs a signal that is indicative of the type of interference in the receive signal. Such

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classification can include, but is not limited to, the following banded and unbanded signals of interest:

Amplitude Modulation

5 PAM (Pulse Amplitude Modulation)
ASK (Amplitude Shift Keying)

Phase Modulation

10 M-ary PSK (Phase Shift Keying)
Offset M-ary PSK
PPM (Pulse Position Modulation)

Frequency Modulation

15 M-ary FSK (Frequency Shift Keying)
MSK (Minimum Shift Keying)
FDM/FM (Frequency Division Multiplexing/
Frequency Modulation) (non-banded)

Amplitude/Phase Modulation (AM/PM)

20 M-QAM (Quadrature Amplitude Modulation)

25 In one embodiment of the present invention, the superclass and subclass feature extraction and interference suppression functions are combined into a single unit and all recognition functions are performed by the disturbance classification unit 74.

In the preferred embodiment of the invention, the feature extraction unit 80 performs an efficient data analysis using circa 50 data transitions. For extremely low baud rates, feature extraction

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unit 80 also performs a feature accumulation function whereby features of contiguous signal sources are saved until sufficient data transitions have been accumulated for identification. In a preferred embodiment of the invention, a general-purpose set of classification parameters are computed by feature extraction unit 80.

Classification parameters are computed in the feature extraction unit 80 using at least one of a plurality of feature plane transformations. In one embodiment, the feature plane transformations are computed from a joint time-frequency (JTF) matrix H of order n,m where n represents a contiguous time index and m represents a contiguous spectral index.

FIG. 4 illustrates a JTF feature plane showing three discrete interference components versus time. The first component 102 corresponds to an FSK signal, the second component 103 corresponds to an non return to zero (NRZ)-ASK signal, and the third component 104 corresponds to a PSK signal. JTF matrix H quantifies the information in the JTF graph. The JTF matrix can be represented as follows:

$$H = \begin{bmatrix} h(0,0) & h(1,0) & h(2,0) & \dots & h(m-1,0) \\ h(0,1) & . & . & . & . \\ h(0,2) & . & . & . & . \\ . & . & . & . & . \\ h(0,n-1) & . & . & . & h(m-1,n-1) \end{bmatrix} \quad \text{Eq. 1}$$

The feature plane transformations are performed by using the JTF matrix H to compute a plurality of transformation matrices. The

23

following are some transformation matrices, TN, that may be used in this regard (although other similar transformations can also be used):

5

Transformation Matrix 1

$$T_1 = \begin{bmatrix} a(0,1) & a(0,2) & a(0,3) & a(0,m-1) \\ 0 & a(1,2) & a(1,3) & a(1,m-1) \\ 0 & 0 & a(2,3) & a(2,m-1) \\ \vdots & \vdots & \vdots & \vdots \\ 0 & \vdots & \vdots & a(m-2,m-1) \end{bmatrix} \quad \text{Eq. 2}$$

10 where

$$a(l,j) = \frac{\sum_{i=0}^{n-1} h(l, i) h(j, i) - \left(\sum_{i=0}^{n-1} h(l, i) \right) \left(\sum_{i=0}^{n-1} h(j, i) \right) / n}{\left[\left(\sum_{i=0}^{n-1} h(j, i)^2 - \left(\sum_{i=0}^{n-1} h(j, i) \right)^2 / n \right) \left(\sum_{i=0}^{n-1} h(l, i)^2 - \left(\sum_{i=0}^{n-1} h(l, i) \right)^2 / n \right) \right]^{1/2}}$$

15

$$\left[\left(\sum_{i=0}^{n-1} h(j, i)^2 - \left(\sum_{i=0}^{n-1} h(j, i) \right)^2 / n \right) \left(\sum_{i=0}^{n-1} h(l, i)^2 - \left(\sum_{i=0}^{n-1} h(l, i) \right)^2 / n \right) \right]^{1/2}$$

20

Eq. 3

25

24

Transformation Matrix 2

$$T_2 = \begin{bmatrix} b(0,1) & b(0,2) & b(0,3) & b(0,n-1) \\ 0 & b(1,2) & b(1,3) & b(1,n-1) \\ 0 & 0 & b(2,3) & b(2,n-1) \\ \vdots & \vdots & \vdots & \vdots \\ 0 & \vdots & \vdots & b(n-2,n-1) \end{bmatrix} \quad \text{Eq. 4}$$

5

10

where

$$b(l,j) = \frac{\left(\sum_{i=0}^{m-1} h(i,j) \right) / m - \left(\sum_{i=0}^{m-1} h(i,l) \right) \left(\sum_{i=0}^{m-1} h(i,j) \right)^2 / m}{\left[\left(\sum_{i=0}^{m-1} h(i,j) \right)^2 - \left(\sum_{i=0}^{m-1} h(i,l) \right)^2 / m \right]^{1/2}}$$

Eq. 5

Transformation Matrix 3

25

$$T_3 = [p_1, p_2, p_3, \dots, p_{m-1}], \text{ where } p_k = \max_i h(k,i)^2 \quad \text{Eq. 6}$$

25

Transformation Matrix 4

$$T4 = [\text{---}] \text{ where } \text{---} = \text{mean } h(k,i)^2 \text{ ---}$$

Eq. 7

5

Transformation Matrix 5

$$T5 = \begin{bmatrix} d(0,0) & d(1,0) & d(2,0) & \dots & d(m-1,0) \\ d(0,1) & . & . & . & . \\ d(0,2) & . & . & . & . \\ . & . & . & . & . \\ d(0,n-1) & . & . & . & d(m-1,n-1) \end{bmatrix} \quad \text{Eq. 8}$$

10

$$\begin{aligned} \text{where } d(l,J) &= +1, h(l,J)^2 > c \cdot P_{\max} \\ d(l,J) &= 0, \text{ otherwise} \end{aligned}$$

15

Transformation Matrix 6

$$T6 = [\text{---}] \text{ where } \text{---} = \text{mean } d(k,n) \text{ ---}$$

Eq. 9

20

Transformation Matrix 7

In addition to the transformation matrices set out above, computationally efficient signal mapping methods are used in accordance with the present invention to generate unique stationary patterns in order to supplement classification, while eliminating carrier frequency offset errors. Since the exact carrier frequency is undetermined before the mapping procedure, a balanced multiplication

25

26

is used in order to cancel the carrier components. Representing the input in-phase and quadrature signal samples as $x(i)$ and $y(i)$, and the transformation in-phase and quadrature samples as $px(i)$ and $py(i)$, the transformation is as follows:

5

$$px(j) = y(i + \text{---}\tau)(-x(i)) + x(i + \text{---}\tau)[x(i) + y(i)] \quad \text{Eq. 10}$$

$$py(j) = x(i + \text{---}\tau)[x(i) - y(i)] + y(i + \text{---}\tau)(x(i) + y(i)) \quad \text{Eq. 11}$$

where:

10

--- delay, in samples

$i = 1$ to N

$j = 1$ to $N - \text{---}$

15

For PSK signal formats, the desired delay τ is equal to the bit period. By up sampling to achieve a 10 to 1 oversampling, a close approximation to the desired delay can be obtained. Projection of the histogrammed polar space defined by the above transformation to a Cartesian space S gives the following transformation matrix which defines the unique signal signature, where L and Q are arbitrary integer constants corresponding to magnitude (L) and phase (Q) dimensions.

20

$$T7 = \begin{bmatrix} S(0,0) & S(1,0) & S(2,0) & \dots & S(Q-1,0) \\ S(0,1) & \cdot & \cdot & \cdot & \cdot \\ S(0,2) & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ S(0,L-1) & \cdot & \cdot & \cdot & S(Q-1,L-1) \end{bmatrix} \quad \text{Eq. 12}$$

25

27

T7 projections provide additional feature transformation data, as shown in Equations 13 and 14 below.

Transformation Matrix 8

5

T8 = [_____ where $\bar{S}_k$ = mean S(k,l) _____]
Eq. 13

Transformation Matrix 9

10

T9 = [_____ **where** $k = \text{mean } S(q,k)$ **_____q**
Eq. 14

15

For FSK signal formats, the desired delay τ is not necessarily equal to the bit period. The pattern is not stationary as in the PSK case where the pattern peaks remain relatively fixed in the phase coordinate dimension. The changing characteristic of the pattern structure for FSK formats can be used to distinguish signal formats that have phase slopes versus fixed phase states during the bit periods. This characteristic is made part of the signal descriptive vector and used to identify FSK formats. For pattern structures that change, phase derivative processing is used to derive a second signal pattern.

In order to obtain the optimum delay for a PSK signal, a baud rate estimate is employed. A delay of approximately one half bit, as estimated by the pre-filter process spectrum width determination, is

used. The actual baud rate is determined by performing a spectrum analysis of the transform output. From this baud rate, the proper one bit delay time can be determined. Methods for baud rate calculation are discussed below.

5 FIG. 5 illustrates a cross-section of a typical feature plane signal transformation for a five FSK interference signal, obtained using equations 10, 11, 12, and 13 above. It should be appreciated that the full feature plane transformation is a three dimensional representation and the two dimensional cross-section of FIG. 5 is
10 presented for ease of illustration. Feature plane transformations, such as the one in FIG. 5, de-emphasize the random components of the signal and emphasize the invariant features, supporting accurate classification of signal type by producing a unique signal signature. Note that the transformation includes five distinct frequency modes
15 that aid in identification of interference type. A plurality of feature plane transformations representing different interference types can be stored in the JSOI memory 46 for comparison with transformations derived from receive signals to classify interference components in the receive signals.

20 Since the signal processing required to perform the signal transformations includes non-linear processing, it is desirable to implement as much signal to noise ratio (SNR) improvement ahead of the signal processing as possible. In one embodiment of the invention, SNR improvement is performed before non-linear
25 processing in the H transform domain, as well as after non-linear processing in the TN transform domain. It is highly desirable that the SNR improvement not distort the signal features that produce the pattern for signal recognition. Furthermore, it is desirable to

separate co-existent signals in order to minimize feature aliasing. Two methods of SNR processing that can be employed are preclassification filtering and phase domain filtering. In the preferred embodiment of the present invention, both methods are
5 used.

FIG. 6 is a flowchart illustrating a superclass classification and masking method to perform preclassification filtering in accordance with one embodiment of the present invention. Prior to the operations performed by FIG. 6, it is assumed that the H matrix
10 and transformations T1 through T9 have been computed. Superclass classification begins with Select Min T1 260, which searches the array to produce the smallest correlation. Next, orthogonal 262 decision compares the value produced by Select Min T1 to an apriori negative constant to determine if a significant negative correlation
15 is present. If so, decision block 264 examines T5 for detection. If detection is positive nonzero, Mask SC0 266 then determines signal bandwidth from T1 indices n and m, which represent the signal extent for Super Class O. As a further step, class SC0 may be confirmed by comparing the peak power from columns n and m for consistency.
20 Finally, Mask SC0 266 filters the SC0 signal by zeroing the identified band, and stores the mask location to memory. Following consideration of all T1 (i.e., all SC0), the Superclass Classification continues with Select T6 SS 270, which examines the T6 transformation for near steady state (SS) values by comparison
25 against an apriori constant. For SS T6, the maximum signal energy is determined from Find Max T4, which coarsely locates the center frequency of the candidate signal, producing a peak index. Next, decision block 274 examines T5 for detection. If detection is

30

positive nonzero, Orthogonal Proximity 276 compares T1
 (corresponding to the index from Find Max T4 and proximity indices)
 against a second apriori negative constant to determine if significant
 negative correlation is present. If so, then Mask SC1 determines the
 5 bandwidth of the signal bounded by the contiguous detected SS values
 about the max T4 index, and filters the SC1 signal by zeroing the
 identified band, and stores the SC1 mask location to memory. If
 significant negative correlation is not present, then Mask SC2 280
 determines the bandwidth of the signal and filters the SC2 signal by
 10 zeroing the identified band, and stores the SC2 mask location to
 memory. Next, if all distinct steady state regions have been
 considered (i.e., all candidate signals within the analysis band), then
 all T6 SS 282 branches to End. In this discussion SC0 represents an
 FSK signal superclass, SC1 refers to banded signal superclasses (e.g.,
 15 PSK), and SC2 represents non-banded continuous wave (CW) signals.
 The masking and classification process of FIG. 6 serves as
 preliminary signal separation and recognition prior to sub-class
 parameter extraction and final classification.

After signal separation and superclass classification, the
 20 following sub-class parameters may be computed, although others
 may also be appropriate:

- | | | |
|------|--------------------------|----|
| 1 | Dynamic Range, | DR |
| 2 | Amplitude Modes, | AM |
| 25 3 | Amplitudes RMS, | AR |
| 4 | Discriminator Deviation, | DD |
| 5 | Phase Modes, | PM |
| 6 | Discriminator Mean, | DM |

		31	
7	Outlier to Mean Ratio,	OM	
8	Outlier to RMS Ratio,	OR	
9	Baud Rate,	BR	
10	Superclass,	SC	
5 11	Frequency Bandwidth,	BW	
12	Frequency Modes,	FM	
13	Frequency Center,	FC	

Transformations T7, T8, and T9 may be used to compute mode
 10 information by tabulation of peak information, for example, using
 derivatives of filtered transformations. Alternatively, the modes
 may be determined in a similar fashion using filtered histograms of
 dealiased phase information, magnitude information, or discriminator
 output. Discriminator output also provides signal bandwidths and
 15 center frequencies. The above-described features provide sufficient
 information for classification into multiple signal types including,
 but not limited to: CW, FSK, MPSK, QPSK, MASK, and FM Unbauded. It
 should be appreciated that preclassification filtering can be used to
 perform functions other than signal separation.

20 In one embodiment of the present invention, preclassification
 filtering is performed by isolating the narrow band interference
 signal of interest, estimating the bandwidth of the signal of interest,
 and prefiltering the signal of interest before classification functions
 are invoked. FIGS. 7-11 illustrate this method. First, as illustrated
 25 in FIG. 7, the signal of interest is converted into a frequency domain
 representation using a frequency transformation, such as a discrete
 Fourier transform (DFT) or a fast Fourier transform (FFT). The
 spectrum illustrated in FIG. 7 represents an MSK signal. The

frequency coefficients found using the frequency transformation are converted to power spectrum and smoothed by a moving average filter, or similar device, to achieve the smooth spectrum illustrated in FIG. 8. The smooth spectrum is histogrammed, as illustrated in FIG. 9, to determine the noise floor level of the interference signal of interest (i.e., the peak of the histogram). Using the peak spectrum location from the histogram as the location of the signal noise floor 96, the signal bandwidth at the noise power level is measured as illustrated in FIG. 10 producing bandwidth 98. This width is corrected to a null-to-null bandwidth by assuming the signal spectrum shape as $\sin(x)/x$ and utilizing the peak SNR reference to determine where on the $\sin(x)/x$ curve the width was measured. FIG. 11 illustrates the spectrum of the MSK signal after the prefiltering operation.

As described previously, phase domain filtering is another technique that can be used to improve SNR before nonlinear processing. Phase domain filtering involves filtering the de-aliased phase components of the signal of interest using a moving average filter although other filter embodiments can also be used. The moving average filter that is used should possess sufficient bandwidth to prevent distortion of the signals of interest. In one embodiment of the present invention, a three point moving average filter was found to possess sufficient bandwidth. The following equation describes one embodiment of a discrete time averaging filter that may be used to perform phase domain filtering:

$$y(n) = \frac{1}{(M+1)} \sum_{m=0}^M x(n-m)$$

The moving average filter is preferably applied repeatedly to the
5 signal of interest. Phase domain filtering has been found to be
effective on FSK, MSK, and PSK signals. Use with other types of
signals is also possible.

FIGS. 12 and 13 are cross-sections of feature plane signal
transformations illustrating the beneficial effects of using phase
10 domain filtering. FIG. 12 illustrates the T7 transform projection that
is obtained using a five tone FSK signal at 1 dB SNR (after spectral
excision interference suppression, as will be described shortly).
Such a transform should display five distinct feature peaks. As
illustrated in FIG. 12, these peaks are not present with enough signal
15 power to discern the presence of the five tone FSK signal. FIG. 13
illustrates the feature plane transform for the same signal after
phase domain filtering is applied. Note that the five distinct
frequency peaks are clearly visible. As can be appreciated, use of the
transformation illustrated in FIG. 13 significantly enhances the
20 likelihood of proper signal classification. The phase domain filtering
has effectively increased the SNR of the transform information by
approximately 6 to 7 dB. Classification and baud rate procedures can
then be used to process the improved transform. In order to overcome
the noise enhancement effects introduced by derivative computation,
25 phase domain filtering may be performed prior to application of the
discriminator.

As described previously, the baud rate of the interference signal of interest can be one of the extracted features that is delivered to the classifier 92 for use in classifying the signal of interest. In accordance with the present invention, methods are provided for determining the signal baud rate of the interfering signal of interest based on the modulation method of the signal of interest. That is, first it is necessary to determine the type of modulation being used (e.g., frequency modulation or phase modulation) and then a baud rate determination method is chosen based on modulation type.

5 If an interfering signal of interest is found to have phase modulation, baud rates are determined by analyzing the frequency content of the T7 feature space of the signal of interest represented by equations 10 and 11. That is, first a T7 feature space transformation is found for the signal of interest and then the feature transformation is

15 converted to a frequency domain representation using, for example, an FFT. The frequency domain representation is then analyzed to isolate a rate line corresponding to the baud rate. Even without prefiltering, a rate line can be detected at low SNRs (i.e., 0db and below) using this method. FIG. 14 is a graph illustrating the spectrum of the T7 feature

20 space of a BPSK signal at 0dB SNR. Note that the rate line 94, corresponding to 250 kHz, is clearly visible in FIG. 14 and may be readily extracted by a simple search algorithm.

For frequency modulation (FM) signals, a rate line may be established by observing the transitions in the T7 space. The transitions are used to generate a linear array of alternating Kronecker deltas as illustrated in FIG. 15 in connection with a five

25 tone FSK signal. A frequency transformation of the transition

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sequence produces a frequency spectrum (see FIG. 16) that clearly indicates the desired baud rate line 95.

As described previously, the targeted interference suppression unit 78 includes a plurality of interference suppression modules that can be used to suppress interference/jamming components within the receive signal. In accordance with the present invention, a plurality of interference suppression techniques are provided that can be implemented as modules within the targeted interference suppression unit 78. These techniques are (1) the inverse whitening function technique, (2) the adaptive inverse weight technique, and (3) the adaptive excision technique. In addition to these interference suppression techniques, as described previously, the system 10 also provides frequency hopping adaptation and processing gain adaptation functionality to help it adapt to hostile spectral environments. The above techniques will now be described.

In a preferred embodiment of the invention, first and second order statistics of the receive signal spectrum are derived prior to application of interference mitigation methods. That is, non-arithmetic modal moment estimates are used to describe different "modes" in the spectrum. Each mode corresponds to a single component in the receive signal including the fundamental communication signal and interference components. Modal moment estimates avoid jammer induced power bias that can arise when using arithmetic estimates. Modal moment estimates also allow multimode spectra to be accurately described and ultimately suppressed. Modal mode estimates are also tolerant of wide dynamic range fluctuations.

FIG. 17 is a plot illustrating typical modal moment estimates for a data signal corrupted by a partial band noise jammer. The x axis

of the plot represents the spectral magnitude of the receive signal. The y axis of the plot represents the frequency with which the receive signal achieved a particular magnitude. That is, the y axis is related to the number of samples in the input data that are within a particular magnitude range. As such, the plot represents a magnitude distribution for the frequency domain representation of the signal. As shown in FIG. 17, two modes are apparent from the plot. The first mode corresponds to the fundamental data signal (i.e., the desired information from the transmitter). The second mode corresponds to the partial band noise jammer. In accordance with one embodiment of the present invention, these two modes are described using modal estimates μ and σ , wherein μ is the mean magnitude and σ is the magnitude standard deviation of the mode. An adaptive limit α can also be determined from the plot to describe a limitation point for the first mode. In a preferred embodiment of the present invention, the adaptive limit α for the fundamental data signal is equal to $k\sigma + \mu$, where k is a constant.

FIG. 18 is a flowchart illustrating a process for deriving the modal moment estimates from the receive signal. A signal is first received from the channel (step 130). The receive signal is transformed to a frequency domain representation using a frequency transformation, such as an FFT (step 132). Magnitudes of the frequency transformed signal are then computed (step 134) and a modal envelope is developed (step 136). The modal envelope is then filtered (step 138) and a derivative is taken to aid in the detection of modes within the envelope (step 140). For example, the derivative will equal zero at the peaks of the modal envelope. Once the modes are identified, the mean magnitude μ of each mode is located (step

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142). A standard deviation σ is then measured for each mode (step 144). When modal moment estimates for each of the modes have been computed, an adaptive limit α is calculated (steps 146 and 148). The modal estimates are then stored for use in interference suppression (step 150).

As described above, in one embodiment of the present invention the adaptive limit α is calculated as the sum of (1) the mean magnitude of the fundamental data signal μ_1 , and (2) the product of a constant k and the magnitude standard deviation σ_1 of the fundamental data signal. In one embodiment of the invention, the constant k can be changed based on various factors, such as the type of interference that is present. For example, the constant k can be changed based on an estimate of relative jammer signal strength and bandwidth in order to obtain near optimum bit error rate performance.

Before discussing interference suppression methods, an expanded description of FH and processing gain adaptation will be made. FIG. 19 is a spectrum diagram illustrating a number of bands W_sN for use in frequency hopping. Although only four bands are shown, it should be appreciated that N can be virtually any number depending on the application. The bands W_sN all occur within a communication system bandwidth W_t . As illustrated, each band W_sN includes an interference signal. That is, band W_s1 includes a frequency selective fade 110, band W_s2 includes a partial band noise jammer 112, band W_s3 includes multiple tone jammers 114, and band W_s4 includes banded interference 116. As described above, the frequency hop adaptation module 34 will sequence through a predetermined hop sequence during normal operation, wherein the

frequency of operation of the system 10 will alternate among bands W_sN . In accordance with one aspect of the present invention, a particular band can be removed from the frequency hop rotation based on the interference content within the band. For example, the system 10 can determine that effective communications cannot be carried out in band W_s2 , due to the presence of the relatively powerful noise jammer 112, and W_s2 is removed from the frequency hopping sequence.

FIG. 20 is a flowchart illustrating one method for performing frequency hop masking. First, the transmitter 14 hops to the next frequency band in the hop sequence (step 152). The transmitter 14 then transmits a signal into the channel 16 within the new frequency band (step 154). For example, the transmitter 14 may transmit a spread spectrum signal within band W_s2 illustrated in FIG. 19. The signal is received from the channel 16 by the receiver 18 and is processed to determine interference classification (step 156). Modal estimates μ and σ are then determined for each of the modes identified (step 158). The modal estimates are then used to determine estimates for interference power and interference bandwidth for each of the identified modes (steps 160 and 162). Next, the signal is classified (step 163). An estimate of the bit error rate that will be achieved by demodulating and decoding the receive signal without interference suppression is calculated using the estimated power and bandwidth information and the classification information (step 164). The estimated bit error rate is then compared to a maximum tolerable bit error rate BER_{max} (step 166). If the BER does not exceed the maximum tolerable bit error rate, the system 10 hops to the next frequency band and the process is

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repeated. If the BER exceeds the maximum tolerable BER, the present hop band W_{sN} is masked from the hop sequence so that it is no longer used by the frequency hopping adaptation module 34 (until the interference condition changes) (step 170) and the system 10 then
5 hops to the next frequency band.

The procedure outlined in the flowchart of FIG. 20 can also be used for processing gain adaptation. That is, instead of changing the hop sequence in step 170, the processing gain parameters determined by the processing gain adaptation module 36 can be changed based on
10 the identified interference signals. In general, new processing gain parameters will be chosen to minimize the effect of the identified interference. The decision on whether to use frequency hopping adaptation or processing gain adaptation will depend on both the type or classification, spectral location, and level of the interference
15 identified by the disturbance classification unit 74 and the jammer parameter extraction unit 76 and the desired performance goals of the system 10. Circumstances may exist, for example, when both frequency hopping adaptation and the processing gain adaptation are performed.

20 In a preferred embodiment, the above-described FH/processing gain adaptation procedure is performed every time a receive signal is received from the channel 16. Alternatively, as will be described shortly, the procedure will only be performed if the selected interference suppression method does not achieve desirable results.
25 In such an embodiment, the interference modules will access an FH/processing gain adaptation module if a predetermined performance goal (such as a predetermined BER) is not achieved. A description of

40

the interference suppression methods of the present invention is now made.

5

INVERSE WHITENING FUNCTION

The inverse whitening function suppression method makes use of the fact that direct sequence spread spectrum data transmissions generally have a spectrum similar to that of band limited white noise.

10 Based on this fact, perturbations in the channel serve to color or distort the spectral characteristic of the channel from this white noise model. The inverse whitening function removes this distortion from the white noise model. FIG. 21 is a flowchart illustrating the operation of the inverse whitening function in one embodiment of the present invention. A signal is first received from the channel 16 (step 174). An estimate of the spectral envelope of all interfering signals within the receive signal is then obtained (step 176). In order to insure that the underlying phase information is undisturbed, an all-pole spectral envelope estimate is required. In one embodiment of the present invention, the following all-pole spectral model is implemented:

$$H(Z) = \frac{1}{1 + \sum_{k=1}^n a_k Z^{-k}}$$

Eq.15

25

41

Where a_k represents the prediction coefficients for an n th order model. The prediction coefficients may exemplify the periodic state estimate that is obtained by an adaptation processor using, for example, classic auto-correlation and durbin recursion.

- 5 After the spectral envelope is estimated, the receive signal is inverse filtered using the inverse of the spectral envelope to remove the interference components (step 178). In one embodiment of the invention, the inverse whitening filter is represented by the following equation:

10

$$y(n) = x(n) + \sum_{k=1}^N a(k)x(n-k) \quad \text{Eq.16}$$

- 15 After whitening, the whitened spectrum is delivered to the CCM 48 to initiate despreading and demodulation as described above (step 180). The inverse whitening procedure is then repeated for the next receive signal.

- 20 If the signal having the whitened spectrum still results in a relatively high BER, the system may want to perform FH or processing gain adaptation. In this regard, the following steps are also performed. Using the time domain residual signal and the receive signal, interference power estimates are calculated (step 184). The power estimates and interference classification are used to estimate
25 the BER that will be achieved (step 186). If the estimated BER exceeds a maximum BER, then frequency hop adaptation or processing gain adaptation can be performed as described above (step 188). BER estimates can also be computed using the modal approach of Fig. 20.

42

In an alternate embodiment, the inverse whitening approach is applied in the frequency domain. The interfering signal is located using modal estimates and subsequent noise floor characterization. The location of the interfering signal, the bandwidth of the signal, and the classification of the signal are used to apply an inverse filter envelope obtained from an a priori family of such envelopes. FIG. 22 is a spectrum diagram illustrating the spectrum of a spread spectrum data signal 120 corrupted by a PSK partial band jammer 122. In accordance with the invention, estimates are made of the spectral envelope of the PSK jammer 122 and an inverse matched filter estimate is derived (not shown). As illustrated in FIG. 22, the bandwidth (BW) and the center frequency (f_0) of the jammer 122 are estimated, and an inverse $\sin(x)/x$ matched filter response (not shown) is generated. The receive signal is applied to the inverse matched filter to obtain the whitened output spectrum with no reduction in system throughput. The inverse whitening function interference suppression method can be used to suppress a wide range of narrowband and partialband interference types, including tones, communication signals, and jammers. In addition, the inverse whitening function method is capable of improving bit error rate performance at high interference power level to signal power level ratios. The inverse whitening function method can also be used to remove the damaging effects of frequency selective fading from the received signal.

25

ADAPTIVE INVERSE WEIGHT

In the adaptive inverse weight interference suppression method, the modal moment estimates are used to selectively target all spectral outliers that exceed the adaptive modal limit α . As described earlier, the adaptive modal limit can be calculated as $\mu + k\sigma$.

- 5 Only those signals that exceed this limit are affected by the anti-jam suppression. For example, with reference to FIG. 17, only those points to the right of adaptive limit α on the graph are affected by the interference suppression method. An inverse weight ω is applied to each of these samples that, in one embodiment, is inversely
- 10 proportional to the observed deviation from α (i.e., inversely proportional to $\text{mag}(\text{sample}) - \alpha$). In one embodiment of the invention, the weights ω are determined by the following equation:

$$15 \quad \omega = \alpha / [\alpha + (\delta - \alpha)^m] \quad \text{Eq. 17}$$

where m is an integer.

- The adaptive inverse weight method can also be applied to proximity samples surrounding each spectral outlier sample, thereby
- 20 further improving performance by enhancing the attenuation of the interference envelope. That is, an inverse weighting can be applied to $\pm n$ samples on either side of each sample that exceeds the adaptive limit α . The adaptive inverse weight interference suppression method is effective for reducing the BER for signals containing a
- 25 myriad of different interference types, including intentional hostile jammers, and banded and non-banded interference. Also, the adaptive inverse weight method is effective at very high jammer power to signal power ratios.

44

FIG. 23 is a flowchart illustrating the operation of the adaptive inverse weight interference suppression method. First, a signal is received from the channel 16 in the receiver 18 (step 194). The signal is then frequency transformed to achieve a frequency domain representation and modal estimates μ, σ are computed for each of the identified modes (step 196). Next, an adaptive limit α is calculated using the modal estimates of the fundamental data signal (step 198). Each of the samples from the frequency domain information is then compared to the adaptive limit α (step 200). If the magnitude of a spectrum sample is greater than the adaptive limit, an inverse weight filter is applied to that sample (and optionally to proximity samples) as described above (steps 202 and 204). When all of the samples have been processed, the filtered signal is delivered to the CCM 48 to initiate despreading and demodulation (steps 206 and 208). Processing is then initiated for the next received signal.

To determine whether to perform FH or processing gain adaptation, interference power is estimated using the received signal and the adaptive limited data (step 212). The BER is estimated (step 214) and, if the BER is greater than a maximum value, frequency hopping or processing gain adaptation is performed (step 216).

Using the adaptive inverse weight interference suppression method, improved signal fidelity is obtained without sacrificing throughput. In general, the interference is suppressed without significant distortion of the underlying spread spectrum data.

ADAPTIVE EXCISION

45

In the adaptive excision method, the modal moment estimates are used to locate and characterize the interference signal components. An estimate of jammer signal bandwidth is then used to excise (i.e., remove) a portion of the signal spectrum from the receive
5 signal, including both interferer and signal. Unlike the adaptive inverse weight method, the adaptive excision method removes a portion of the spread spectrum signal spectrum from below the adaptive limit α . Consequently, the adaptive excision method does not achieve the bit error rate reductions that the adaptive inverse
10 weight method is capable of. However, the adaptive excision method is simpler to implement than the adaptive inverse weight method.

In one embodiment, a filter response modeling an ideal notch filter is used to remove the portion of the spectrum occupied by the interfering signal or signals. Other filter configurations, such as
15 sinusoidal rolloff functions, can alternatively be used to minimize adverse affects during reverse frequency transformation caused by sharp spectral edges. As with the other methods, the adaptive excision method improves signal fidelity without sacrificing bandwidth.

20 FIG. 24 is a flowchart illustrating one embodiment of the adaptive excision interference suppression method. A signal is first received from the channel 16 (step 220) and the signal is processed to compute the modal estimates μ , σ (step 222). The adaptive limit α is then calculated using the modal estimates for the fundamental
25 data signal (step 224). The frequency domain signal samples are then each compared to the adaptive limit α (step 225). If the magnitude of a sample is greater than α , a notch like filter response is applied to the sample (steps 226 and 228). Once all of the frequency domain

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samples have been processed, the frequency domain information is delivered to the CCM 48 to initiate despreading and demodulation of the data (step 230 and 232). As with the other methods, processing is also performed to determine whether frequency hop or processing gain adaptation is to be performed (steps 234-240).

As described previously, each of the above described interference suppression methods can be implemented in the targeted interference suppression unit 78. In addition, other interference suppression methods, such as prior art methods, can be implemented in the targeted interference suppression unit 78. The unit 78 will determine which method to use based upon the type or types of interference detected in the disturbance classification unit 74 and the jammer parameter extraction unit 76. It should be appreciated that it is also possible to cascade suppression methods in accordance with the present invention. That is, two or more suppression methods can be implemented in the targeted interference suppression unit 78 if it is determined that this is the best way to mitigate interference. FIG. 25 is a flowchart illustrating one such cascaded interference suppression procedure. The signal is received from the channel 16 in the receiver 18 (step 240). An adaptive inverse weight method is applied to the receive signal to remove one type of detected interference from the signal (step 242). An inverse whitening function is then applied to the receive signal to remove another type of interference from the signal (step 244). After the cascaded processing is complete, the restored signal is delivered to the CCM 48 to initiate despreading and demodulation (step 246). Processing of the next received signal is then initiated.

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FIGS 26-28 are spectrum diagrams illustrating a cascaded suppression procedure. FIG. 26 represents a received signal after being transformed to a frequency domain representation. As illustrated, the received signal includes both narrow band jammers 250 and frequency selective fading 252. Adaptive inverse weighting is first applied to remove the narrow band jammers 250 and the spectrum of FIG. 27 results. An inverse whitening function is then applied to the signal to remove the frequency selective fading 252 and the spectrum of FIG. 28 results. Virtually any combination of interference suppression methods can be implemented in the targeted interference suppression unit 78 in accordance with the present invention.

The principles of the present invention can be used in a wide range of applications, such as commercial paging, commercial cellular and PCS, spread spectrum wireless LAN, satellite uplink/crosslink/downlink, small unit operations, digital battlefield, code division multiple access (CDMA), and others. In one embodiment, the invention is implemented in full duplex, handheld communicators in a mobile communications system. In another embodiment, the invention is used in a spread spectrum PCS system which is overlaid on existing commercial/military narrowband systems to provide simultaneous frequency reuse. In a further embodiment, the invention is used in a spread spectrum digital paging system which is overlaid on existing commercial/military narrowband systems. Other applications are also possible.

It should be appreciated that the interference suppressor 316 of the present invention can be used without the interference classifier 314. That is, criteria other than precise interference type can be

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used to determine which of the interference suppression methods within the interference suppressor 316 should be used to perform suppression.

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CLAIMS

What is claimed is:

5 1. A receiver unit for use in a communications system that is operative in a predetermined frequency band, comprising:

 a signal receptor for receiving a signal from a communications channel;

 an interference classifier for classifying an interference
10 component within said signal, wherein said interference classifier classifies said interference component according to a plurality of interference types; and

 an interference suppressor for suppressing said interference component in said signal based on interference type.

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 2. A receiver unit, as claimed in claim 1, wherein said interference suppressor includes:

 a plurality of interference suppression modules for use in suppressing interference in said signal, wherein said plurality of
20 interference suppression modules are each optimized for use with predetermined interference types; and

 means for selecting at least one of said interference suppression modules based on interference type.

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 3. A receiver unit, as claimed in claim 1, wherein:
 said interference classifier includes means for determining at least one feature parameter transformation for said interference

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component, wherein said means for determining at least one feature parameter transformation includes means for receiving input in-phase signal samples $x(i)$ and quadrature signal samples $y(i)$ and for processing the samples according to the following transformation

5 equations:

$$\begin{aligned} px(j) &= y(i+___)x(i) + x(i+___)[x(i) + y(i)] \\ py(j) &= x(i+___)[x(i)-y(i)] + y(i+___)x(i) \end{aligned}$$

10 where $px(j)$ and $py(j)$ are the in-phase and quadrature transformations, respectively; $___$ = delay, in samples; $i = 1$ to N ; and $j = 1$ to $N - ___$

4. A receiver unit, as claimed in claim 1, further comprising:
 15 a performance estimator for determining at least one performance metric relating to the performance of said communications system and feedback means for delivering said at least one performance metric to said interference suppressor for use in fine tuning the interference suppressor.

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5. A method for reducing interference components in a received signal in a communications system, comprising the steps of:

receiving a signal from a channel;

classifying at least one interference component in said signal

5 according to interference type; and

performing interference suppression on said signal to reduce the level of said interference component within said signal, said performing step including selecting an interference suppression method from a plurality of interference suppression methods based on
10 interference type.

6. The method, as claimed in claim 5, wherein:

said plurality of interference suppression methods includes an adaptive excision method including the following steps:

15 obtaining a frequency domain representation of said signal;

determining a frequency location of said interference component with respect to said frequency domain representation; and

20 removing a portion of said frequency domain representation of said signal based on said frequency location of said interference component.

7. The method, as claimed in claim 5, wherein:

25 said plurality of interference suppression methods includes an inverse weight method including the following steps:

obtaining a frequency domain representation of said signal;

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determining portions of said frequency domain representation that exceed a limit value; and
reducing said portions in magnitude using an inverse weighting function.

5

8. The method, as claimed in claim 5, wherein:
said plurality of interference suppression methods includes an inverse whitening method including the following steps:

obtaining a frequency domain representation of said
10 signal;

determining a spectral envelope of said interference component using said frequency domain representation;

generating an inverse envelope function using said spectral envelope; and

15 applying said inverse envelope function to said frequency domain representation of said signal to reduce said interference component in said signal.

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9. A communications system having hybrid interference mitigation, said system comprising:

means for receiving a signal from a channel;

means for classifying at least one interference component

5 within said signal according to interference type;

means for suppressing said at least one interference component within said signal based on the interference type of said at least one component; and

adaptation means including at least one of the following:

10 means for performing frequency hopping adaptation by updating a frequency hopping sequence in response to said means for classifying; and

means for performing processing gain adaptation by updating the processing gain of a transmit signal in response to said means for classifying.

10. The communications system, as claimed in claim 9, wherein:

said adaptation means is enabled when an output signal of said means for suppressing fails to achieve a predetermined performance goal.

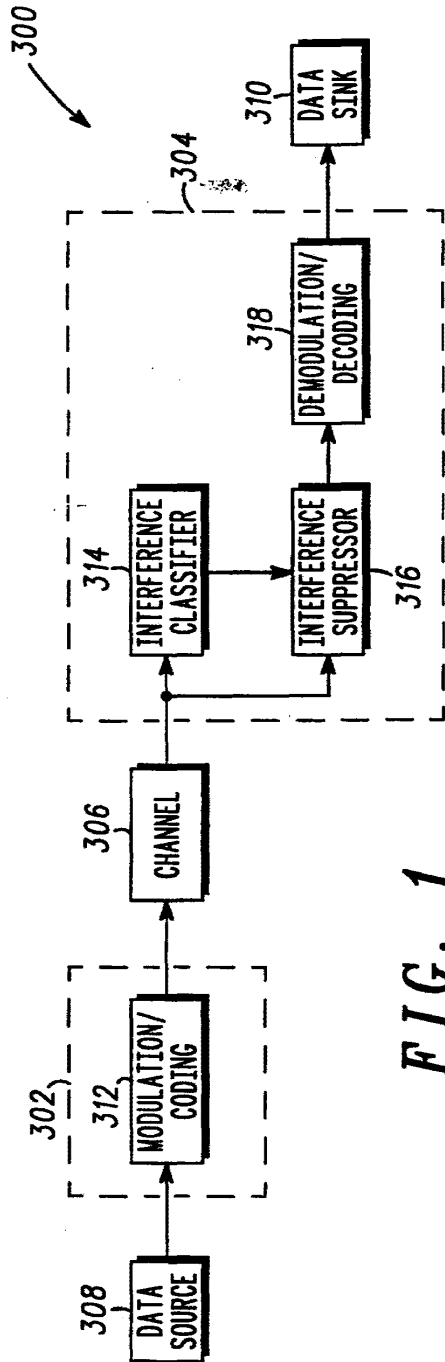


FIG. 1

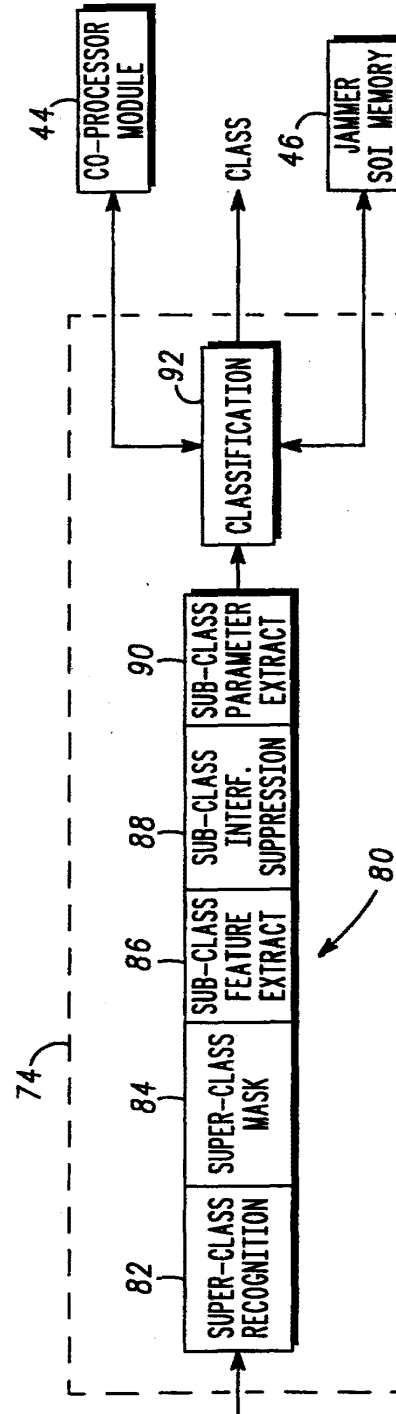


FIG. 3

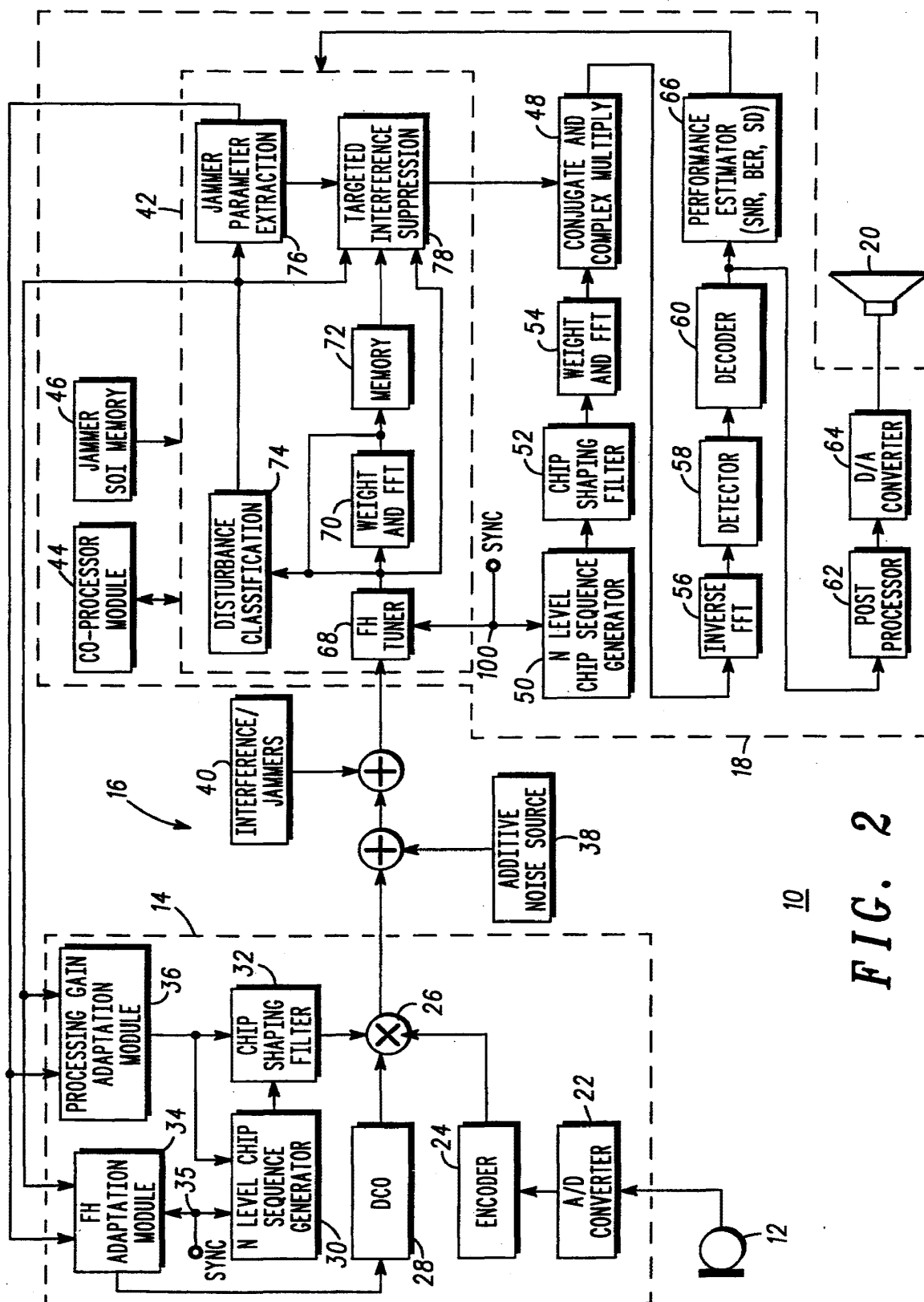


FIG. 2

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FIG. 4

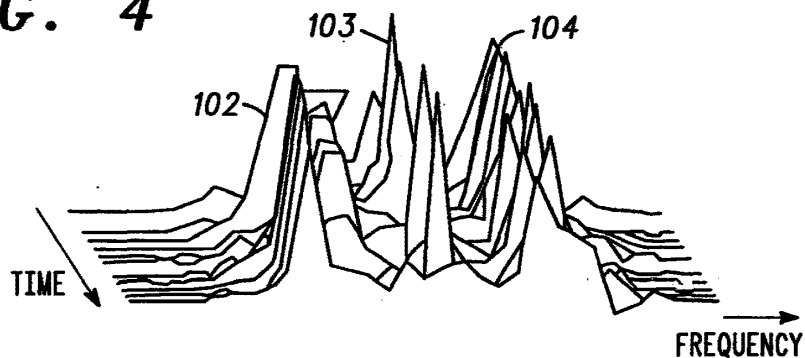


FIG. 5

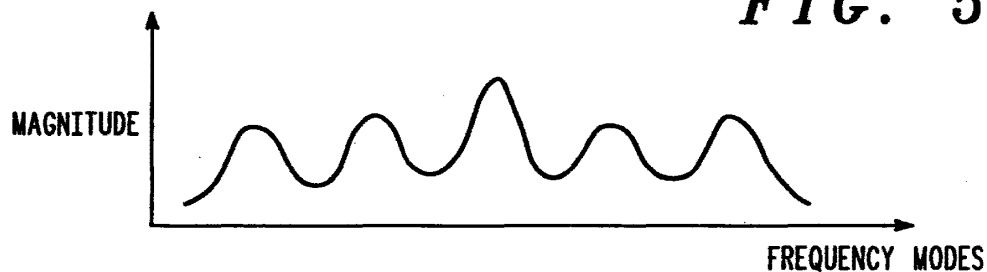


FIG. 7

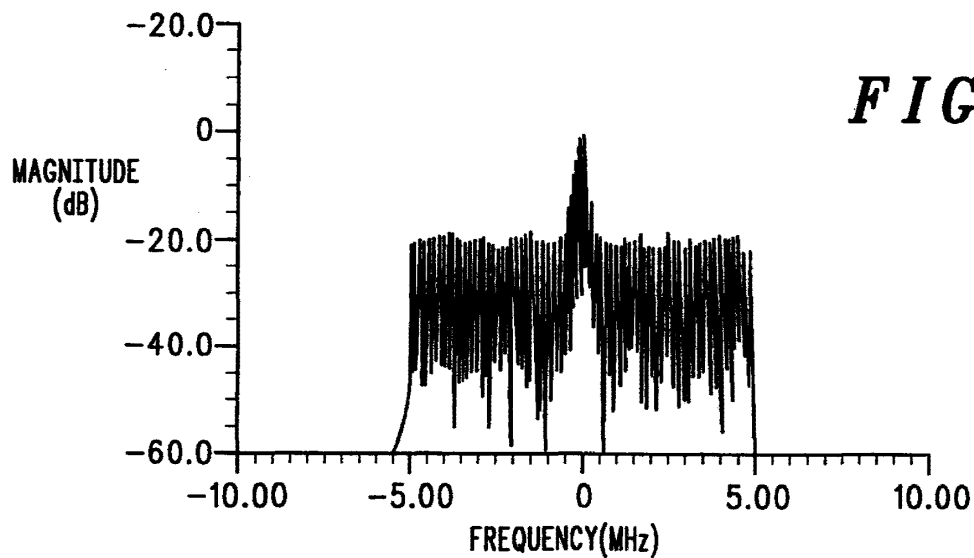
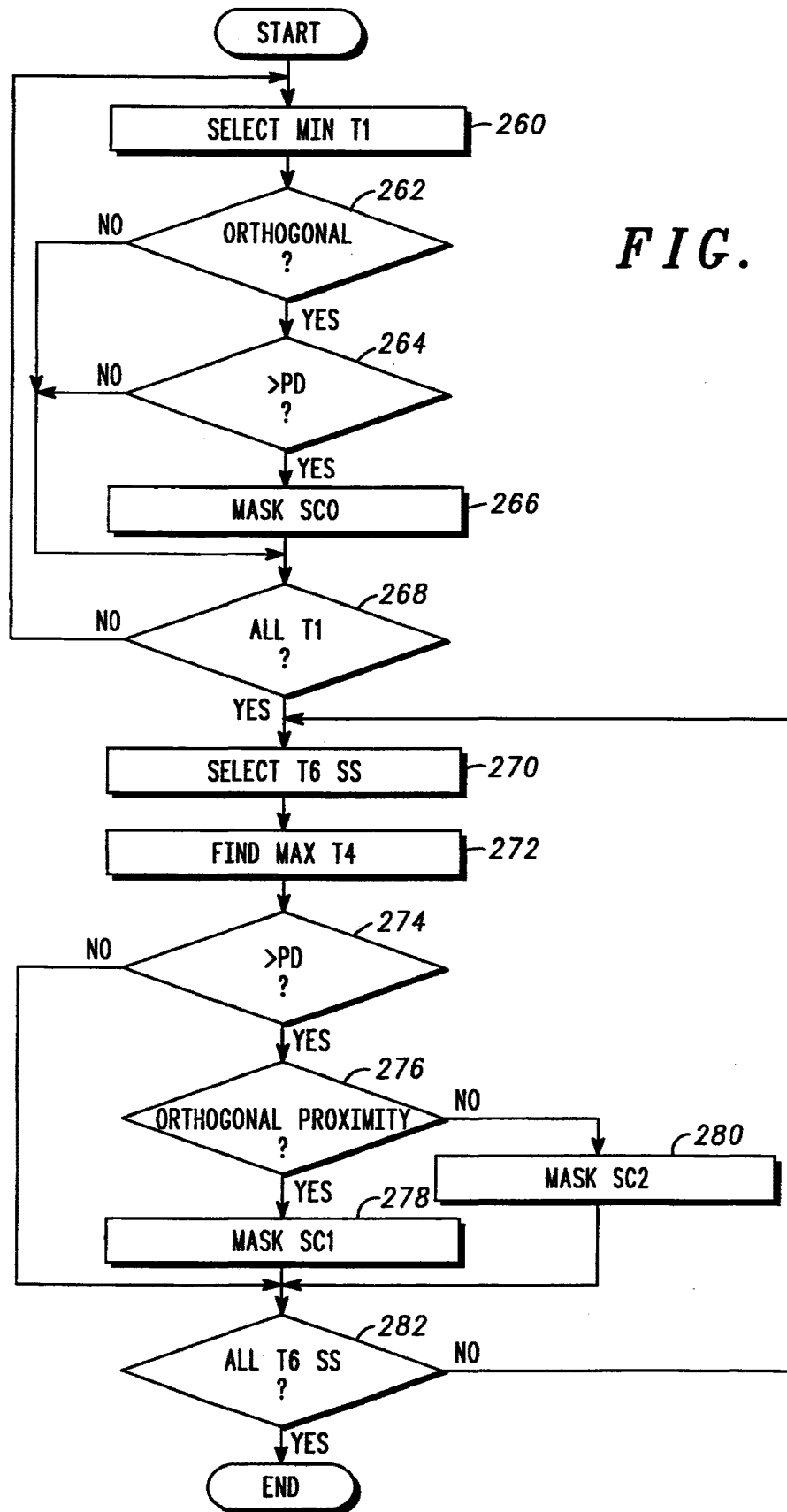
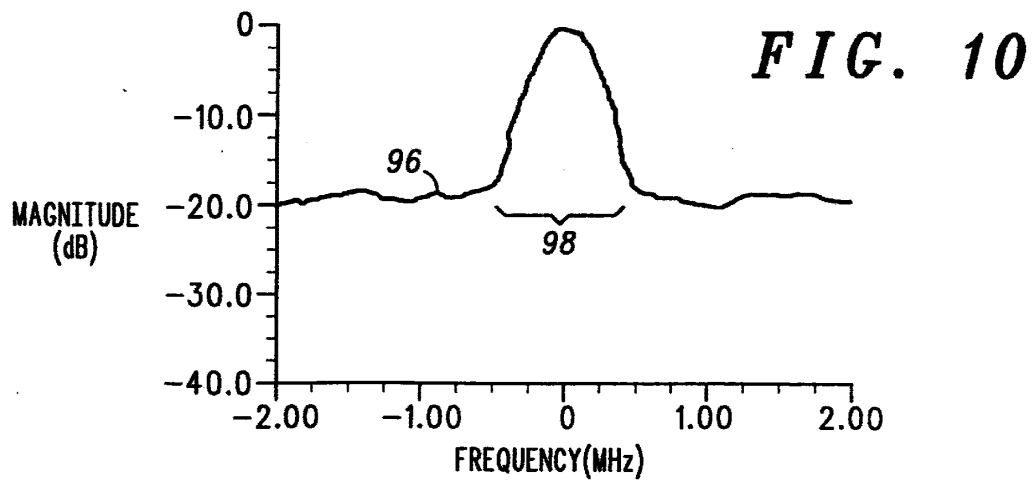
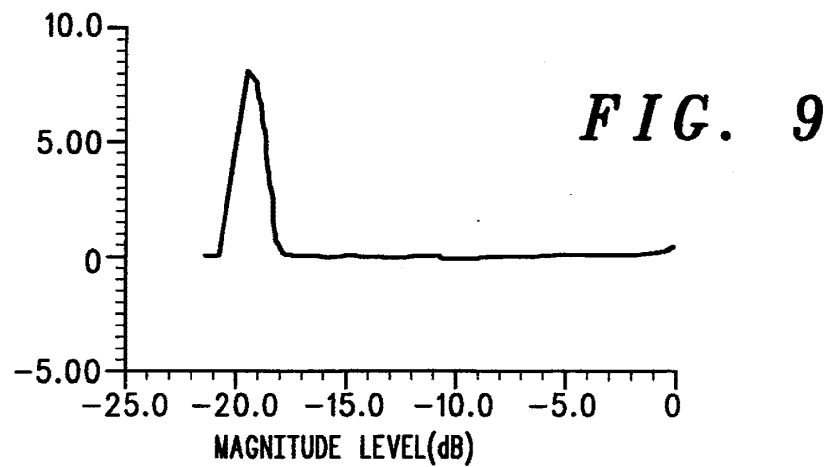
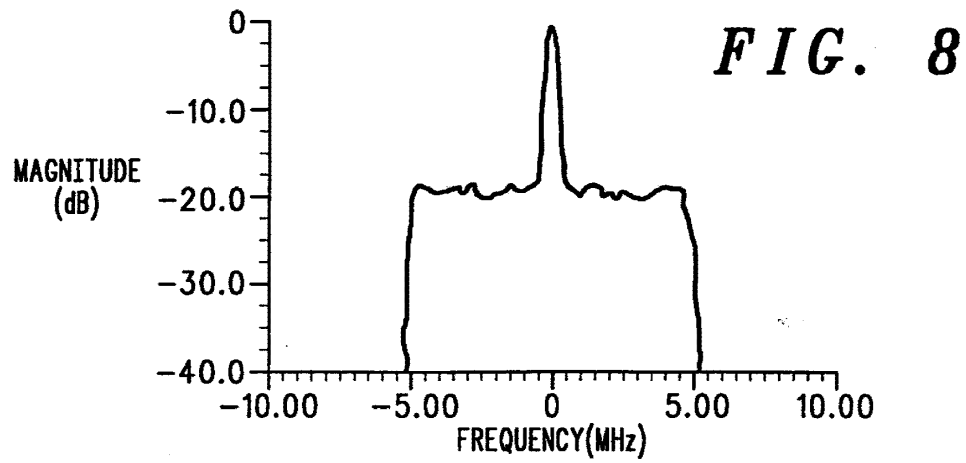


FIG. 6





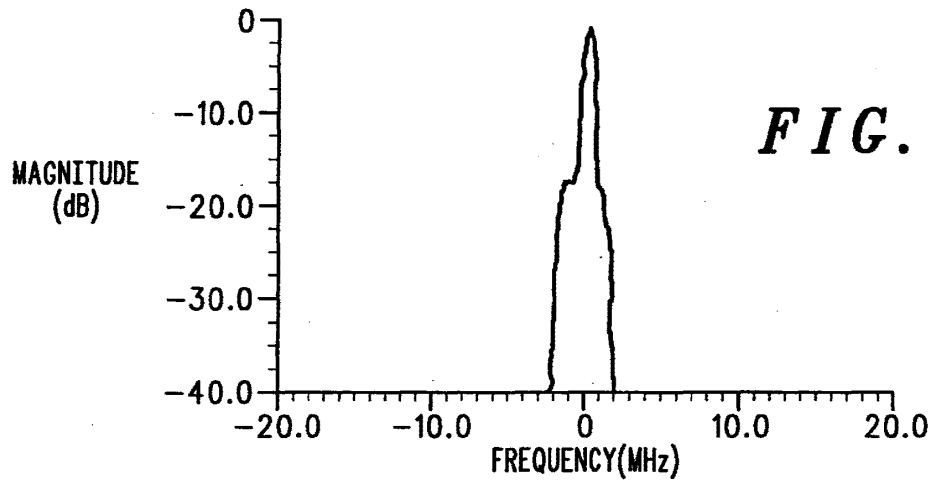
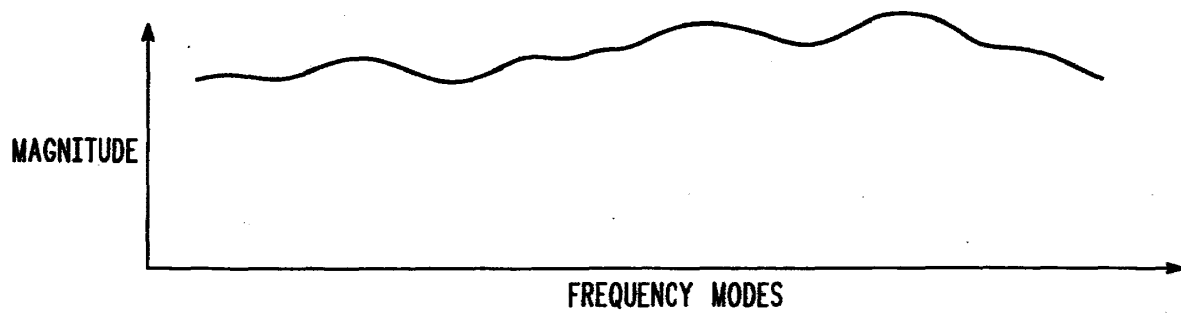
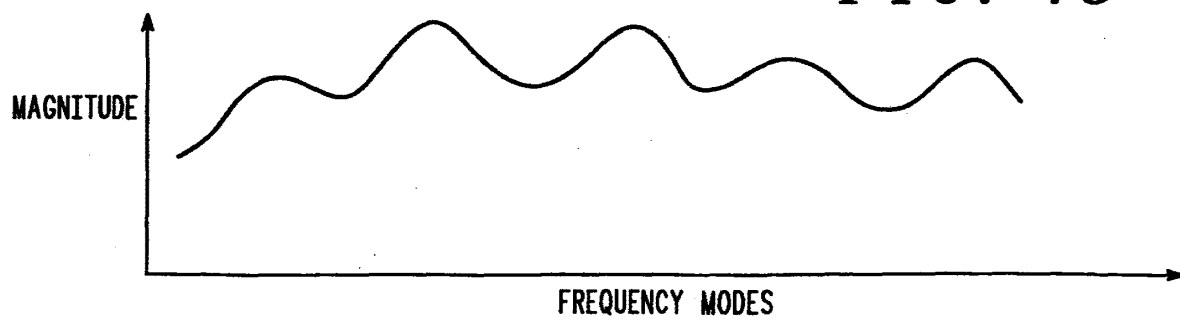
**FIG. 12****FIG. 13**

FIG. 14

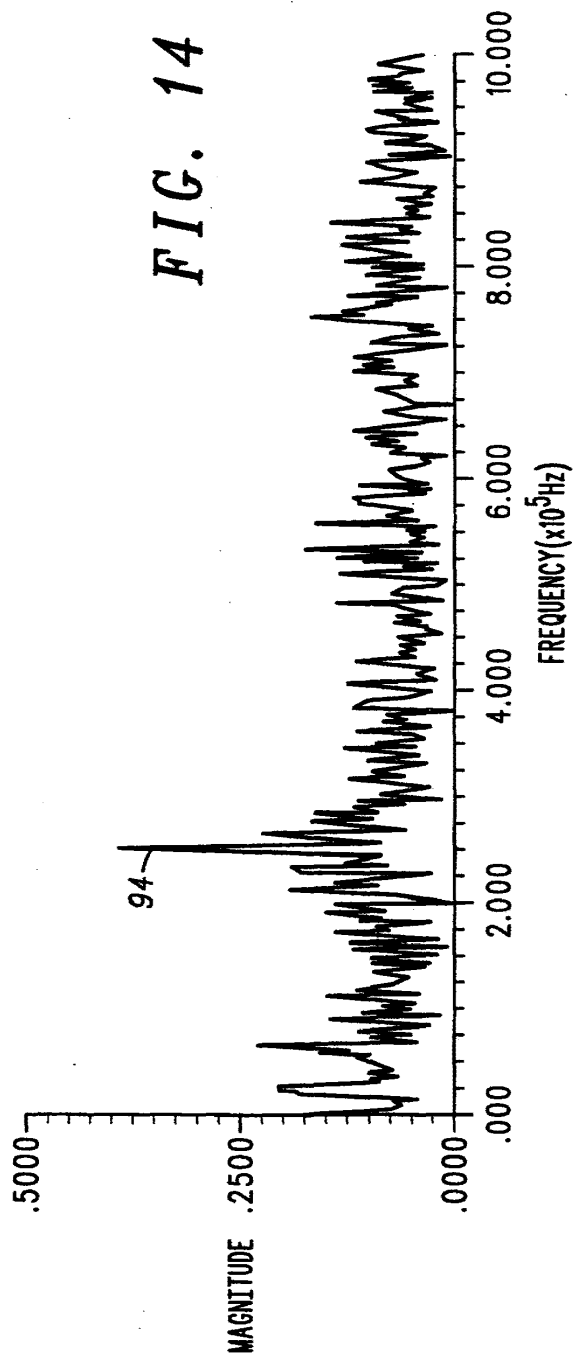
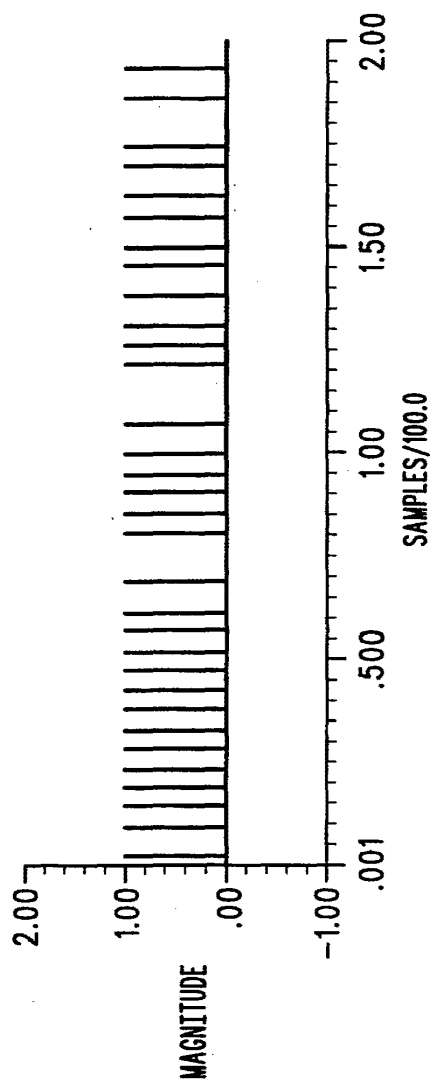
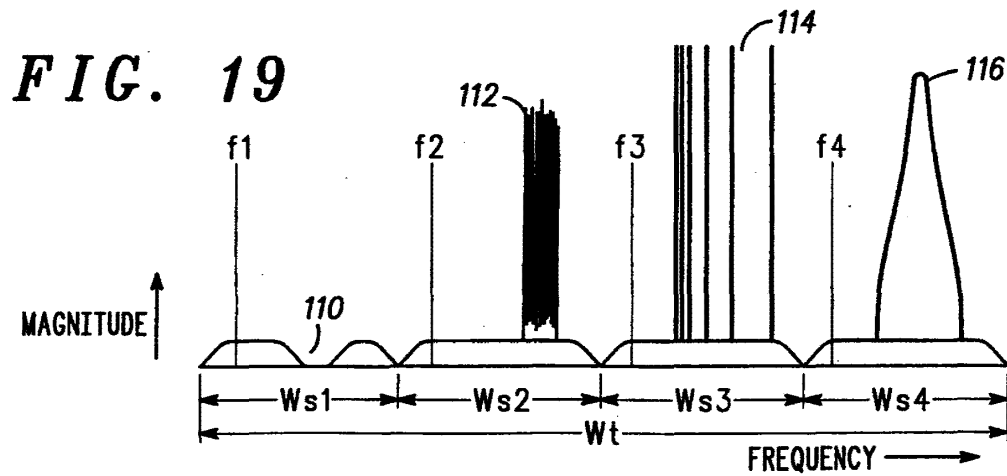
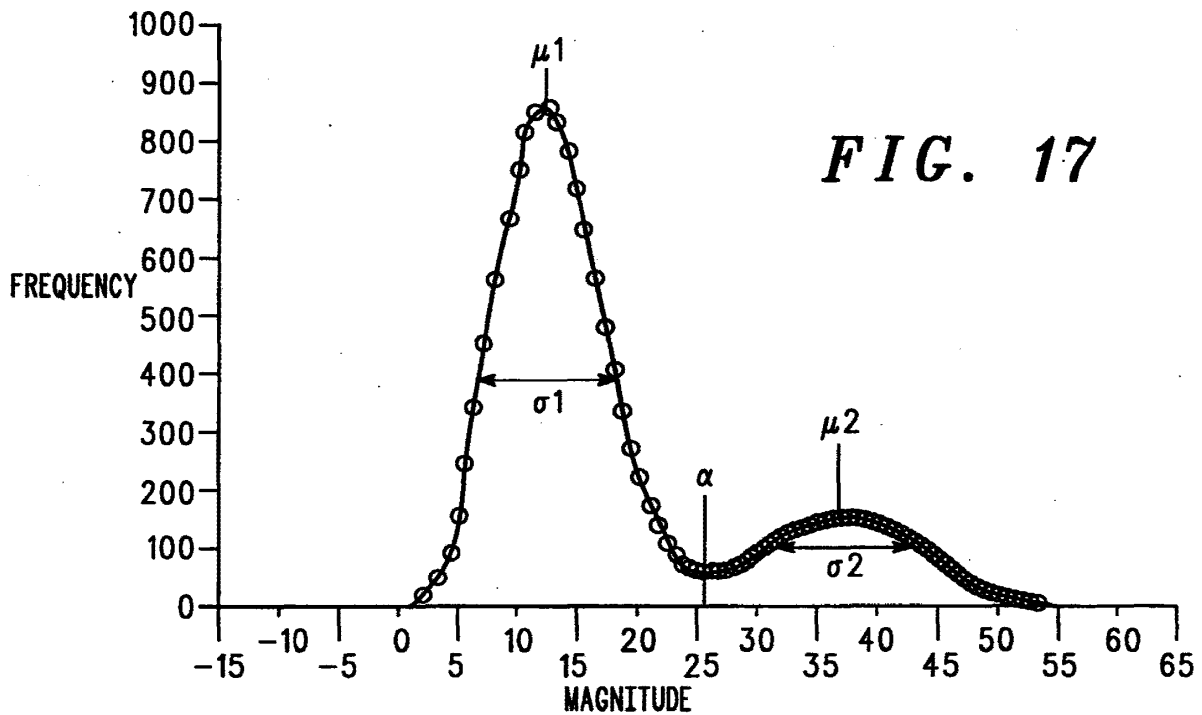
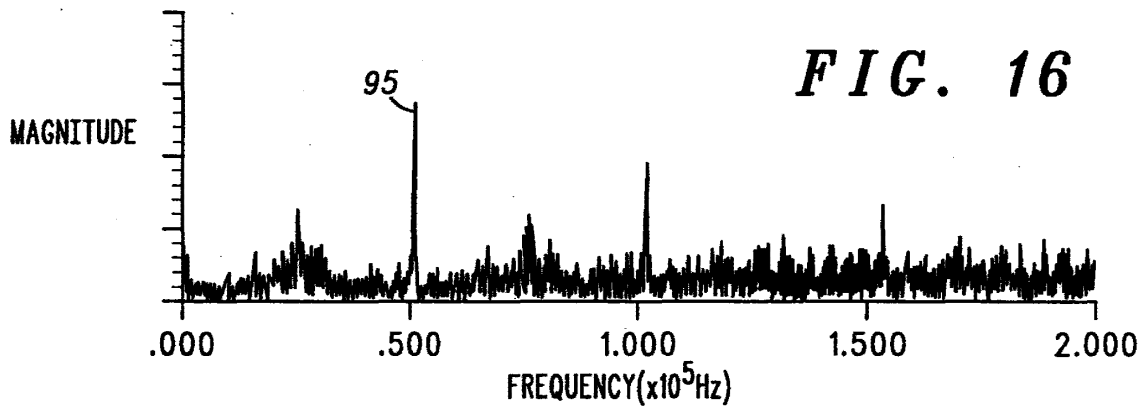
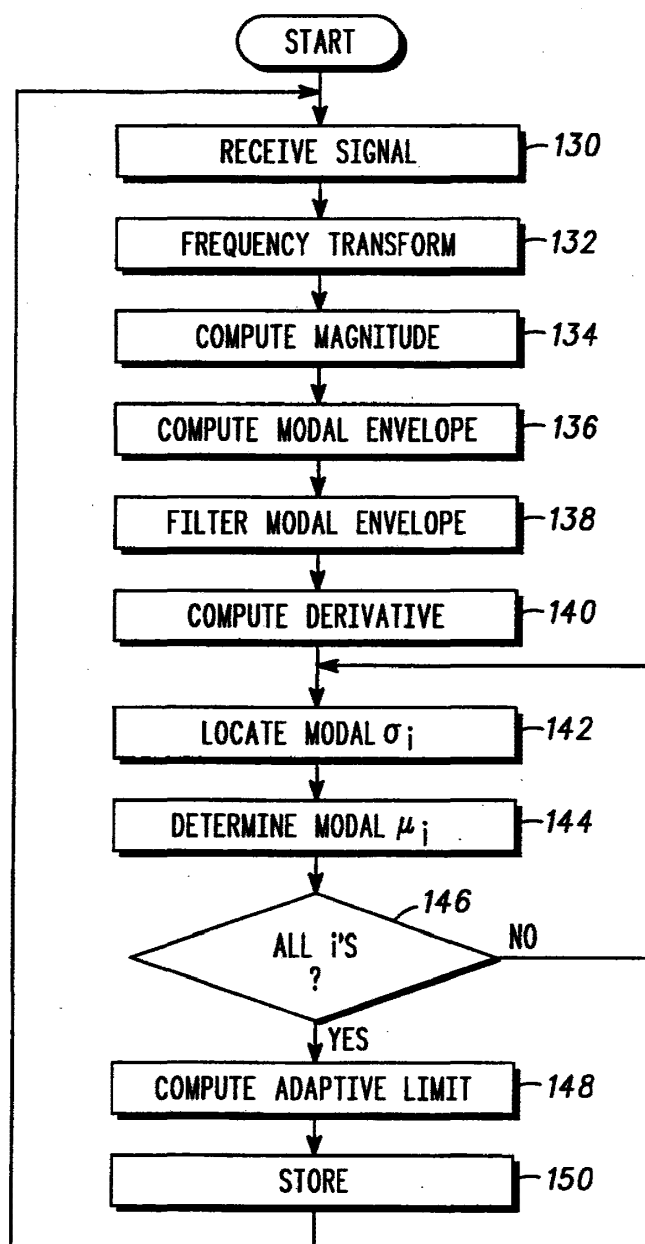


FIG. 15





*FIG. 18*

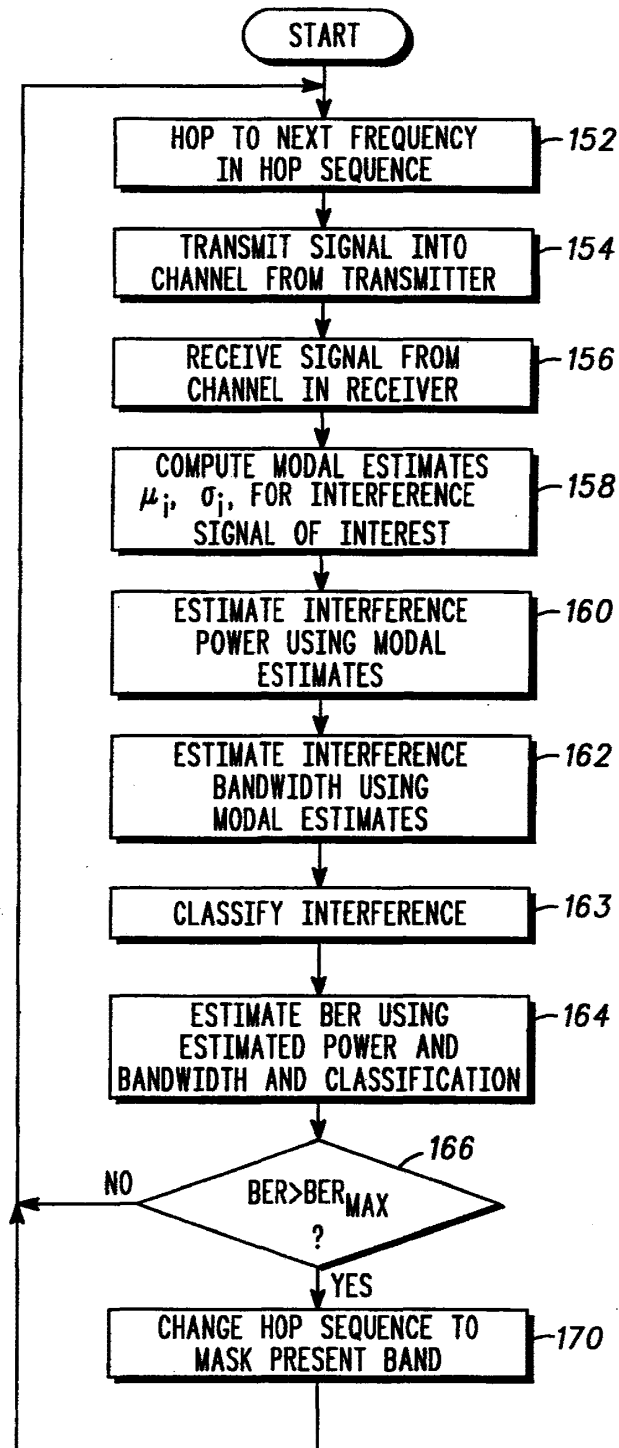
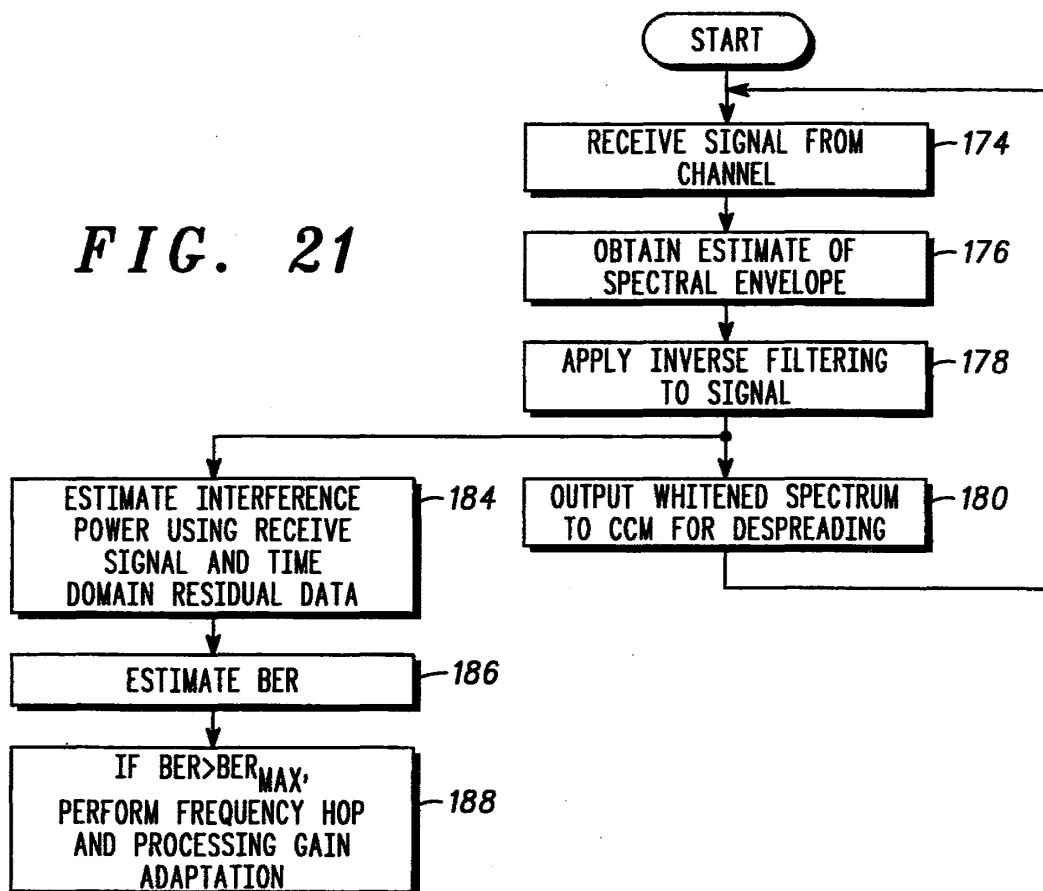
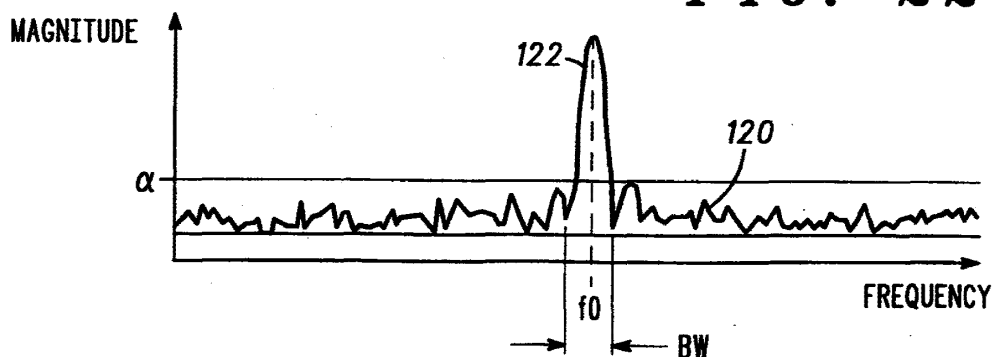
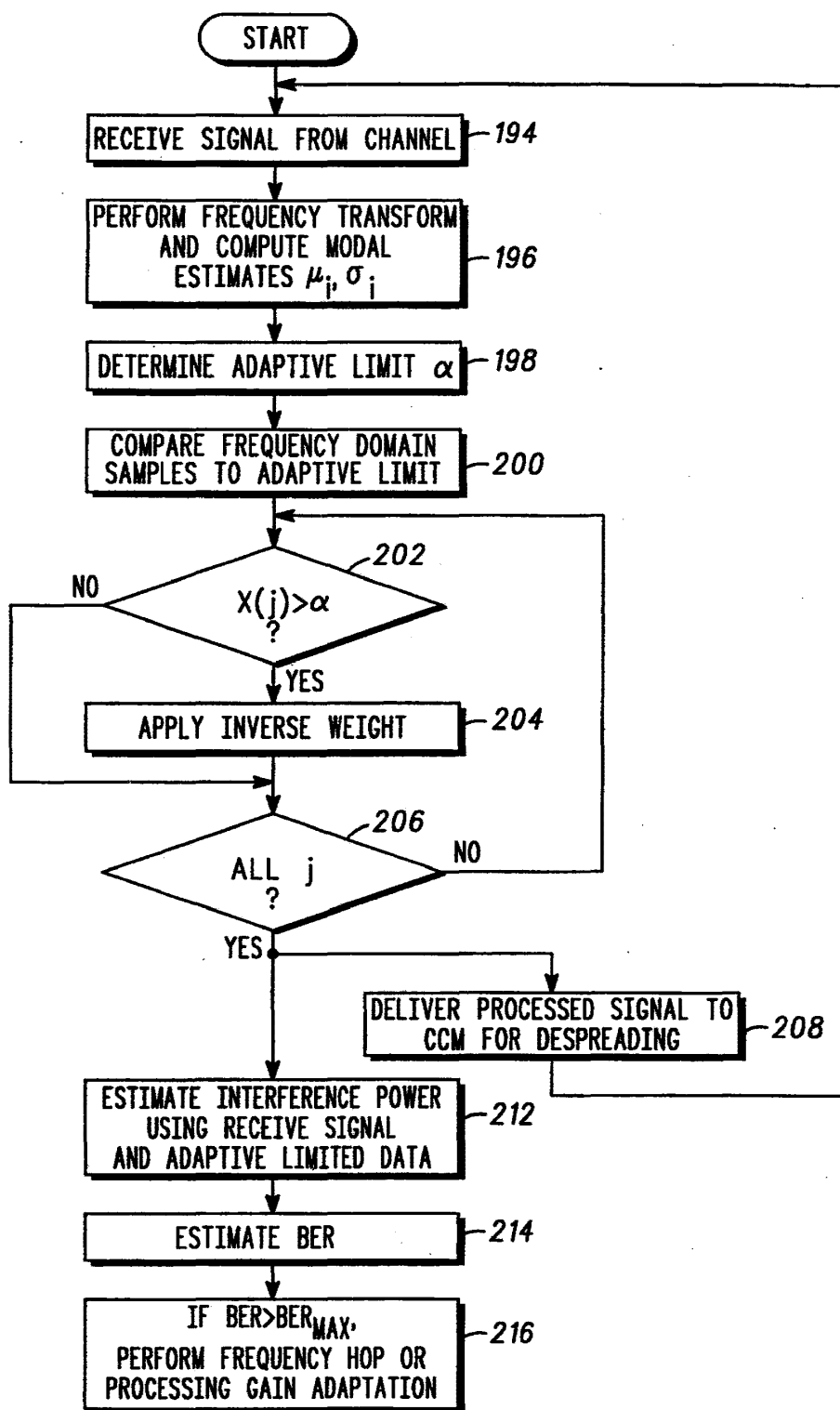
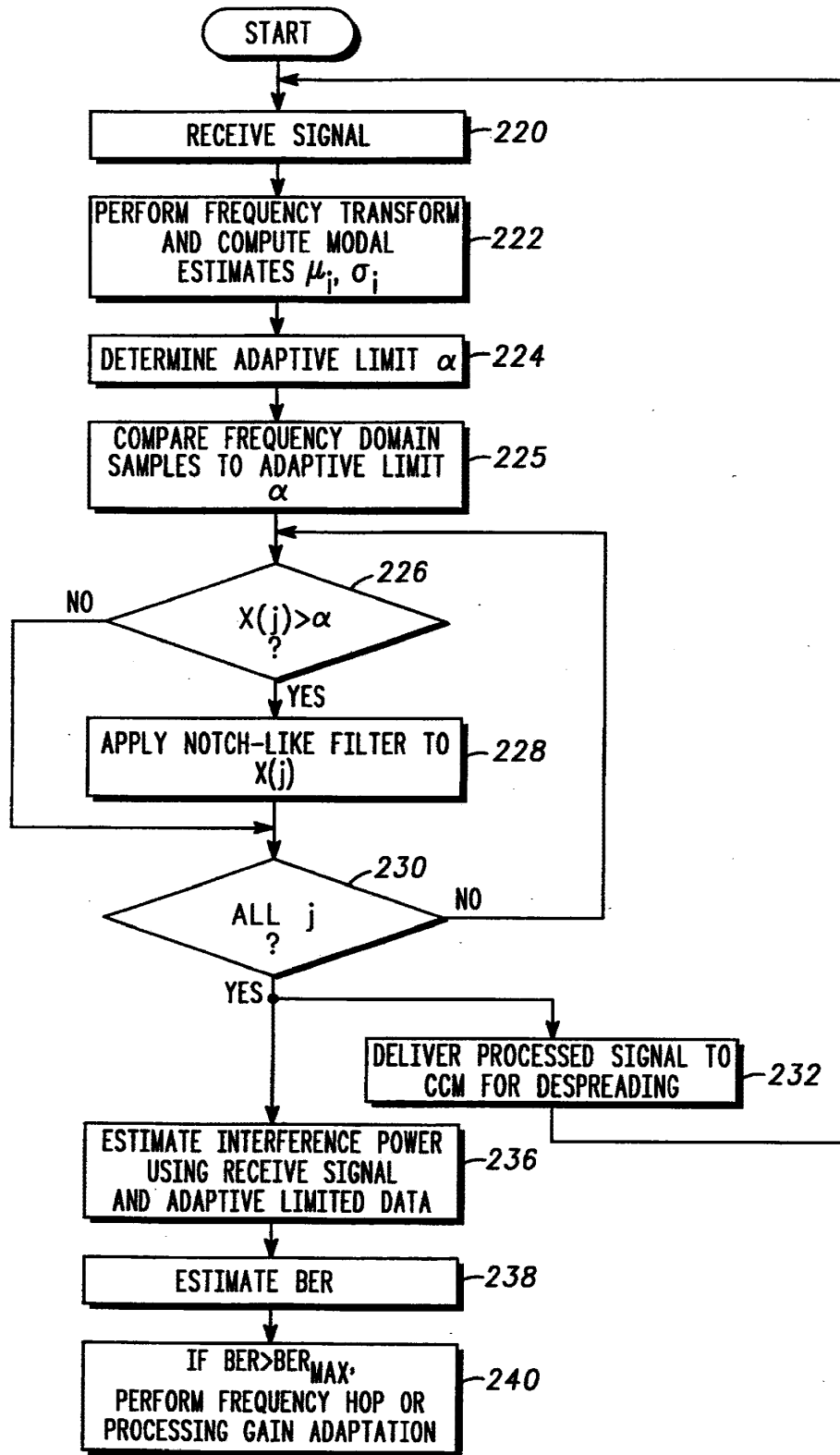
**FIG. 20**

FIG. 21*FIG. 22*

**FIG. 23**

**FIG. 24**

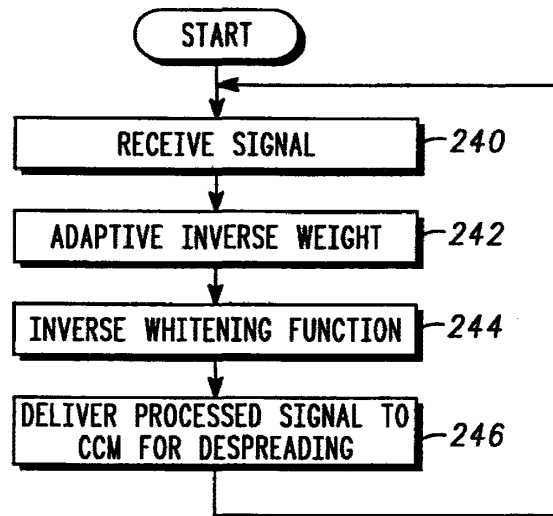


FIG. 25

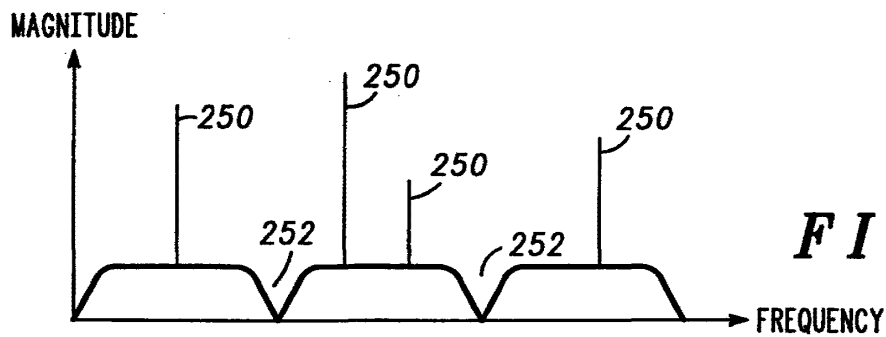


FIG. 26

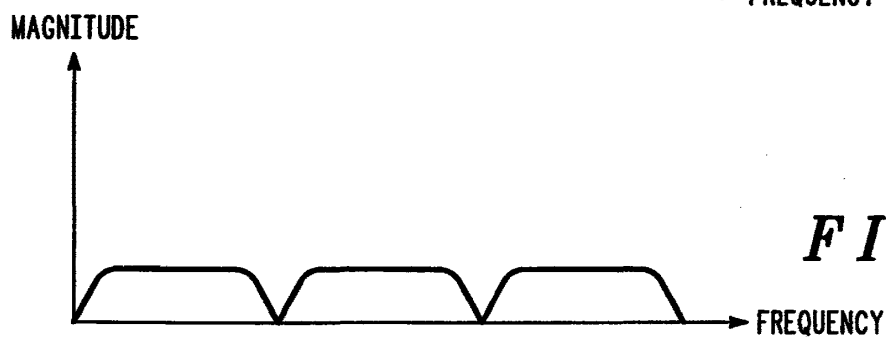


FIG. 27

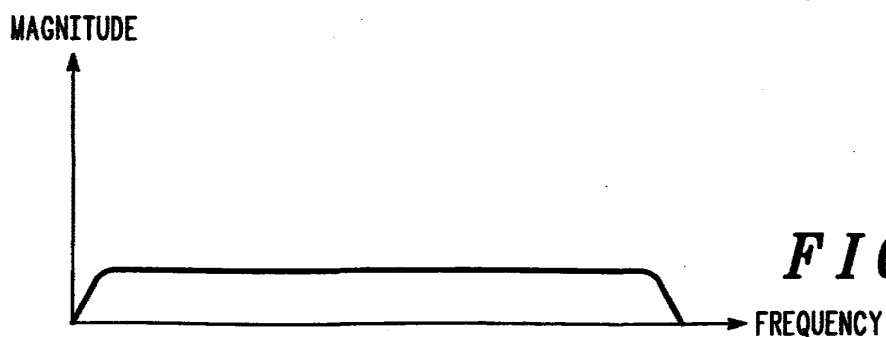


FIG. 28

INTERNATIONAL SEARCH REPORT

Inte. national Application No
PCT/US 99/00013

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04B1/12 H04L1/12

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 H04B

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

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 453 213 A (MARCONI GEC LTD) 23 October 1991	1
A	see the whole document ---	2-7
X	IEEE TRANSACTIONS ON SIGNAL PROCESSING, vol. 43, no. 11, 30 November 1995, pages 2776-2782, XP002101462	1
A	see page 2776, line 1 - page 2780, line 2 see figure 1 ---	2-6
A	WO 97 37457 A (ADICOM WIRELESS INC) 9 October 1997 see abstract see page 2, line 16 - page 3, line 27 -----	9,10

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

☒ Patent family members are listed in annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance
"E" earlier document but published on or after the international filing date
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"O" document referring to an oral disclosure, use, exhibition or other means
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"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

29 April 1999

Date of mailing of the international search report

27/05/1999

Name and mailing address of the ISA
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Lindhardt, U

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 99/00013

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
EP 0453213	A	23-10-1991	AU 643265 B	11-11-1993
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			EP 0888674 A	07-01-1999

Form PCT/ISA/210 (patent family annex) (July 1992)

BNSDOCID: <WO 9939444A1_L>

Electronic Acknowledgement Receipt

EFS ID:	6474240
Application Number:	12132757
International Application Number:	
Confirmation Number:	8369
Title of Invention:	WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS
First Named Inventor/Applicant Name:	David CHAUNCEY
Customer Number:	74701
Filer:	Christopher F. Regan/joellen murphy
Filer Authorized By:	Christopher F. Regan
Attorney Docket Number:	RF-448 (50676)
Receipt Date:	18-NOV-2009
Filing Date:	04-JUN-2008
Time Stamp:	08:50:11
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		50676idsisr.pdf	129581	yes	3
			035b2210aeaff14705d04c560e7e34f3aa711908		

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Transmittal Letter		1	2	
	Information Disclosure Statement (IDS) Filed (SB/08)		3	3	
Warnings:					
Information:					
2	Foreign Reference	wo0173956.pdf	1821612	no	37
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Case No. RF-448 (50676)

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In re Application of: **CHAUNCEY ET AL.**

Serial No.: **12/132,757**

Filed: **06/04/2008**

Confirmation No.: **8369**

For: **WIRELESS COMMUNICATION SYSTEM COMPENSATING
FOR INTERFERENCE AND RELATED METHODS**

Sir:

Transmitted herewith is an INFORMATION DISCLOSURE STATEMENT in the above-identified application.

1. ☒ This IDS is submitted under 37 C.F.R. § 1.97. No fee is required.
2. ☐ The requisite fee of \$180.00 is being paid by EFS web.
3. ☐ This IDS is submitted under 37 C.F.R. § 1.97 (c) and (e). No fee is required.
4. ☐ This IDS is submitted under 37 C.F.R. § 1.97 (d) and (e). Authorization is given to charge Deposit Account **08-0870** in the amount of \$180.00 to cover the processing fee.
5. ☒ The Commissioner is hereby authorized to charge or credit any discrepancies in fee amounts to Deposit Account No. **08-0870**.

Date: November 17, 2009

/CHRISTOPHER F. REGAN/
Christopher F. Regan
Reg. No. 34,906

Customer No.: 74701

Telephone: (407) 841-2330

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:	)	Atty. Docket No.:
CHAUNCEY ET AL.	)	RF-448 (50676)
	)	
Serial No. 12/132,757	)	
	)	Art Unit: 2611
Filing Date: 06/04/2008	)	
	)	
Confirmation No. 8369	)	Examiner:
	)	MOHAMMAD H. GHAYOUR
For: WIRELESS COMMUNICATION SYSTEM	)	
COMPENSATING FOR INTERFERENCE AND	)	
RELATED METHODS	)	
	)	

CITATION UNDER 37 CFR § 1.97

EFILED

Commissioner of Patents

Sir:

Attached is Form PTO-1449A listing references for consideration in the examination of the above-identified application. In accordance with current USPTO procedures published 05AUG2003, in 1276 OG 55, copies of the U.S. patent documents cited in the form PTO-1449A are not attached. The undersigned would be happy to provide copies of these references if requested. Copies of non-U.S. patent literature, if any, are attached. It is requested that this reference be considered by the Examiner and officially made of record in accordance with the provisions of 37 CFR § 1.97 and Section 609 of the MPEP.

Respectfully submitted,

/CHRISTOPHER F. REGAN/
Christopher F. Regan
Reg. No. 34,906

Telephone: (407) 841-2330

Customer No.: 74701



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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)

CONFIRMATION NO. 8369

74701

ALLEN, DYER, DOPPELT, MILBRATH & GILCHRIST
255 S ORANGE AVENUE
SUITE 1401
ORLANDO, FL 32801

PUBLICATION NOTICE



OC000000039174016

Title: WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS

Publication No. US-2009-0304095-A1

Publication Date: 12/10/2009

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.

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)	8369
74701	7590	10/17/2011		
ADDMG - Harris 255 S ORANGE AVENUE SUITE 1401 ORLANDO, FL 32801			EXAMINER KASSA, ZEWDU A	
			ART UNIT	PAPER NUMBER
			2611	
			NOTIFICATION DATE	DELIVERY MODE
			10/17/2011	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):

creganoa@addmg.com

DETAILED ACTION

Claim Rejections - 35 USC § 103

The following is a quotation of 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 of this title, 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 negated by the manner in which the invention was made.

- 1. Claims 1 and 4-11 are rejected under 35 U.S.C. 103(a) as being unpatentable over Aboba (US 2009/0124205) in view of Belogolovy (US 2008/0299932).**
2. As per claim 1, Aboba teaches a wireless communication system comprising: first and second wireless communications devices communicating with one another via a wireless communications link (Aboba, Fig. 1 item 12 14) having at least one settable link characteristic (Aboba, Fig. 4 item 401, Para [0034] "The communication device 12 ... includes ... Fig. 4", Para [0008] "... having an adaption selected based on the characterization of the interference signal"); said first controller for detecting received interference (Aboba, Fig. 4 item 401 450 "interference mitigation"), determining a type of the received interference from among a plurality of interference types comprising wideband interference and

narrowband interference (Aboba, Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ..."), and setting the at least one settable link characteristic to compensate for the received interference based upon the interference type (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal").

- While Aboba teaches said first and second wireless communications devices comprising respective first and second wireless transceivers and respective first and second controllers coupled thereto (Aboba, Fig. 1 item 12 14Fig. 4 item 401, Para [0034] "The communication device 12 ... includes ... Fig. 4", Aboba does not explicitly mention the transceivers are an orthogonal frequency-division multiplexing (OFDM) wireless transceivers. However, it is obvious and well known in the art the Aboba wireless transceivers adapts the IEEE 802.11 standard (Aboba, Para [0001]-[0002]) which implements an OFDM. Thus, it would have been obvious to one having ordinary skill in the art at the time of the invention Aboba teaches the instant limitation based on the known standard (see Belogolovy US 2008/0299932 Para [0052]).

3. As per claim 2, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein the plurality of interference types further comprises self interference (Aboba, Para [0005] "... collide on the same frequencies ...", Para [0006] "... interference from a transmission of nearby node (i.e. collision)").
4. As per claim 3, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein said first controller detects the received interference (Aboba, Fig. 4 item 401 450) based upon a comparison of a current received signal to at least one prior received signal (Aboba, Para [0043] "comparison" – wherein the current received signal compared to a previously received or stored signal).
5. As per claim 4, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein said first controller repeats the detecting, determining, and setting (Aboba, Fig. 2 item 102).
6. As per claim 5, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein the at least one settable link characteristic comprises at least one receive processing characteristic (Aboba, Fig. 1 item 12 14).

7. As per claim 6, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic (Aboba, Fig. 1 item 12 14); and wherein said first controller cooperates with said second controller to set the at least one transmit processing characteristic (Aboba, Para [0053]).

8. As per claim 7, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 (see claim 1). Aboba in view of Belogolovy does not explicitly teach wherein said first controller generates an interference map of the received interference onto OFDM cells. However, Aboba in view of Belogolovy teaches wherein said the first controller detects an interference, determines an interference type and compensate adaptively based on the interference type in an OFDM communication environment (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal", Para [0001]-[0002] "802.11"). Thus, it would have been obvious to one having ordinary skill in the art the adaptive system of Aboba in view of Belogolovy performs mapping of the interference adaptively and apply settable link based on the mapping in an OFDM communication environment or OFDM

cell (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal", Para [0001]-[0002] "802.11", Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ...").

9. As per claim 8, Aboba in view of Belogolovy teaches the wireless communication system according to claim 7 wherein said first controller sets the at least one settable link characteristic based upon the interference map (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal", Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ...").

10. As per claim 9, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein said first controller determines the interference type based upon at least one of fade characteristics, noise characteristics, and path characteristics (Aboba, Para [0039] "... signal to noise ratio (SNR) ...").

11. As per claim 10, Aboba in view of Belogolovy teaches the wireless communication system according to claim 1 wherein the at least one settable link characteristic comprises at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering (Aboba, Para [0030] "... FEC ...", Para [0031] "... transmit power ...").

12. As per claims 11-20 are similarly analyzed as claims 1-10.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ZEWDU KASSA whose telephone number is (571)270-5253. The examiner can normally be reached on Monday - Friday (7:30 - 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Payne can be reached on 571 272 3024. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

zk

/Zewdu Kassa/
Examiner, Art Unit 2611

Notice of References Cited	Application/Control No. 12/132,757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.	
	Examiner ZEWDU KASSA	Art Unit 2611	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2009/0124205	05-2009	Aboba et al.	455/63.1
*	B	US-2008/0299932	12-2008	Belogolovy et al.	455/296
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

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

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

<i>Index of Claims</i> 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

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

☐ Claims renumbered in the same order as presented by applicant			☐ CPA			☐ T.D.			☐ R.1.47		
CLAIM		DATE									
Final	Original	09/28/2011									
	1	✓									
	2	✓									
	3	✓									
	4	✓									
	5	✓									
	6	✓									
	7	✓									
	8	✓									
	9	✓									
	10	✓									
	11	✓									
	12	✓									
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	14	✓									
	15	✓									
	16	✓									
	17	✓									
	18	✓									
	19	✓									
	20	✓									

Search Notes 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

SEARCHED			
Class	Subclass	Date	Examiner
375	260,259,219,295,316,346,350	9/30/2011	zk
370	328,335,342,310	9/30/2011	zk

SEARCH NOTES		
Search Notes	Date	Examiner
East	9/30/2011	zk

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

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Receipt date: 11/18/2009

12132757 - GAU: 2611

SUBSTITUTE FORM PTO-1449A LIST OF PATENTS AND APPLICANT'S INFORMATION DISCLOSURE STATEMENT	
ATTORNEY DOCKET NO.: RF-448 (50676)	
SERIAL NO.: 12/132,757	FILING DATE: 06/04/2008
APPLICANT: CHAUNCEY ET AL.	GROUP: 2611

U.S. PATENT DOCUMENTS							
EX. INL		DOCUMENT NUMBER	DATE	NAME	CLASS	SUB CLASS	
		2002/0155811	10/2002	PRISMANTAS ET AL.	455	63	

FOREIGN PATENT DOCUMENTS							
EX. INL		DOCUMENT NUMBER	DATE	COUNTRY	CLASS	SUB-CLASS	TRANSLATION Yes -- No
		01/73956	10/2001	WO	H04B	1/00	
		99/39444	08/1999	WO	H04B	1/12	

OTHER ART							
EX. INL		(Including Author, Title, Date, Pertinent Pages, etc.)					
EXAMINER: /Zewdu Kassa/				DATE CONSIDERED: 09/30/2011			
EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609; * Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant.							

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /Z.K./



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CONFIRMATION NO. 8369

SERIAL NUMBER 12/132,757	FILING or 371(c) DATE 06/04/2008 RULE	CLASS 375	GROUP ART UNIT 2611	ATTORNEY DOCKET NO. RF-448 (50676)		
APPLICANTS David CHAUNCEY, Fairport, NY; Mitel Kuliner, Rochester, NY; Elias Theodorou, Rochester, NY; ** CONTINUING DATA ***** ** FOREIGN APPLICATIONS ***** ** IF REQUIRED, FOREIGN FILING LICENSE GRANTED **						
Foreign Priority claimed ☐ Yes ☒ No 35 USC 119(a-d) conditions met ☐ Yes ☒ No Verified and Acknowledged <u>/ZEWDU A KASSA/</u> Examiner's Signature		☐ Met after Allowance Initials	STATE OR COUNTRY NY	SHEETS DRAWINGS 6	TOTAL CLAIMS 20	INDEPENDENT CLAIMS 3
ADDRESS ADDMG - Harris 255 S ORANGE AVENUE SUITE 1401 ORLANDO, FL 32801 UNITED STATES						
TITLE WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS						
FILING FEE RECEIVED 1030	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:		☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit			

Receipt date: 06/04/2008

12132757 - GAU: 2611

Sheet 1 of 1

SUBSTITUTE FORM PTO-1449A LIST OF PATENTS AND APPLICANT'S INFORMATION DISCLOSURE STATEMENT			Atty Docket: Serial No.: Applicant: Filing Date: Group:		RF-448 (50676) Not Yet Assigned CHAUNCEY, ET AL Herewith		
U.S. PATENT DOCUMENTS							
Examiner Initials		Document Number	Date	Name	Class	Sub Class	Filing Date
	AA	6,115,409	9/5/00	UPADHYAY ET AL.	375	144	6/21/99
	AB	7,039,417	5/2/06	LYLE ET AL.	455	452.2	9/25/03
	AC	2004/0028003	2/12/04	DIENER ET AL.	370	319	4/22/03
	AD						
	AE						
	AF						
	AG						
	AH						
	AI						
	AJ						
	AK						
	AL						
FOREIGN PATENT DOCUMENTS							
		Document Number	Date	Country	Class	Sub Class	Translation
	AM						
	AN						
	AO						
	AP						
OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)							
	AQ	www.redlinecommunications.com , RedCONNEX AN-80i Advanced Broadband Wireless Infrastructure Solution.					
	AR						
	AS						
EXAMINER: /Zewdu Kassa/				DATE CONSIDERED: 09/30/2011			

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

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /Z.K./

EAST Search History

EAST Search History (Prior Art)

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	215	(375/260,259,219,295,316,346,350,370/328,335,342,310).ccls. and ((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (narrowband or (narrow adj band)) and (wideband)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 17:45
L2	22	((DAVID) near2 (CHAUNCEY)).INV.	US-PGPUB; USPAT	OR	OFF	2011/09/30 17:46
L3	13	((MITEL) near2 (KULINER)).INV.	US-PGPUB; USPAT	OR	OFF	2011/09/30 17:46
L4	1	((ELIAS) near2 (THEODOROU)).INV.	US-PGPUB; USPAT	OR	OFF	2011/09/30 17:47
L5	1	((DAVID) near2 (CHAUNCEY)).INV. and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT	OR	OFF	2011/09/30 17:47
L6	1	((MITEL) near2 (KULINER)).INV. and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT	OR	OFF	2011/09/30 17:48
S1	1	"12132757"	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 13:40
S3	64	((narrowband with interference) and (wideband with interference)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 14:50
S4	57	((narrowband with interference) and (wideband with interference)).clm. and (@ad<"20080604" or @prad<"20080604")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 14:51
S5	7	((narrowband with interference) and (wideband with interference)).clm. and (@ad<"20080604" or @prad<"20080604") and (self with interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 14:53
S6	41	((narrowband near4 interference) and (wideband near4 interference)).clm. and	US-PGPUB; USPAT;	OR	ON	2011/09/29 15:00

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S7	37	((narrowband with interference) and (wideband with interference)).clm. and (@ad<"20080604" or @prad<"20080604") and (inter\$7 near2 interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:22
S8	25695	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:24
S9	667	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (narrowband or (narrow adj band)) and (wideband	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:26
S10	271	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) same (wideband) same interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:27
S11	122	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) same (wideband) same interference) and (narrowband or (narrow adj band)).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:28
S12	82	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) same (wideband) same interference) and (narrowband or (narrow adj band)).clm. and (wideband).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:28
S13	130	(((narrowband or (narrow adj band)) adj2 interference)) and ((wideband adj2 interference)) and (@ad<"20080604" or @prad<"20080604"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:41
S14	188	(((narrowband or (narrow adj band)) adj2 interference)) and ((wideband or broadband) adj2 interference) and (@ad<"20080604" or @prad<"20080604"))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:51

S15	52	((narrowband near4 interference) and ((wideband or broadband) near4 interference)).clm. and (@ad<"20080604" or @prad<"20080604")	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/29 15:52
S16	271	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) same (wideband) same interference) and (narrowband or (narrow adj band)) and (wideband) and (interference compar\$5 (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 13:59
S17	256	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) same (wideband) same interference) and (narrowband or (narrow adj band)) and (wideband) and (current with (previous or prior) with compar\$5 (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:02
S18	11173	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:49
S19	102	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 (receiv\$4 near3 signal)) and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:51
S20	0	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 with (receiv\$4 near3 signal)) and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:52
S21	6	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 with (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:52
S22	0	(narrowband with interference) and (wideband with interference) and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 with (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:53
S23	1661	((interference)).clm. and ((interference)).ab. and (@ad<"20080604"	US-PGPUB; USPAT;	OR	ON	2011/09/30 14:53

		or @prad<"20080604") and (compar\$5 with (receiv\$4 near3 signal))	USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB			
S24	1039	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (compar\$5 near4 (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:53
S25	13	((interference)).clm. and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 with (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:54
S26	117	((interference))and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 with (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:55
S27	104	((interference)).clm. and (@ad<"20080604" or @prad<"20080604") and ((previous or prior) with compar\$5 with (receiv\$4 near3 signal))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:56
S28	0	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (current with (previous or prior) with compar\$5 same (receiv\$4 near3 signal)) and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:58
S29	19	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (compar\$5 near5 (receiv\$4 near3 signal)) and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 14:58
S30	102	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference).clm.	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 15:16
S31	2	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference).clm. and ("802.11" with (ofdm or (orthogonal adj frequency adj division)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 15:17

S32	4	((interference)).clm. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference).clm. and ("802.11" with (ofdm or (orthogonal adj frequency adj division)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 15:18
S33	19	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference) and ("802.11" with (ofdm or (orthogonal adj frequency adj division)))	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 15:19
S34	122	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference) and ((ofdm or (orthogonal adj frequency adj division))) and map\$4	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 16:24
S35	2	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference) and ((ofdm or (orthogonal adj frequency adj division))) and (map\$4 same ofdm same cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 16:25
S36	4	((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference) and ((ofdm or (orthogonal adj frequency adj division))) and (map\$4 with interference with cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 16:26
S37	1	PCT/EP07/51302	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 16:27
S38	4	((interference)).clm. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference) and ((ofdm or (orthogonal adj frequency adj division))) and (map\$4 with interference with cell)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 16:28
S39	47	((interference)).clm. and (@ad<"20080604" or @prad<"20080604") and ((narrowband or (narrow adj band)) and (wideband) and interference) and ((ofdm or (orthogonal adj frequency adj division))) and (map\$4 with interference)	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 16:28
S40	24	((interference)).clm. and (@ad<"20080604" or @prad<"20080604") and ((narrowband	US-PGPUB; USPAT; USOCR;	OR	ON	2011/09/30 16:28

EAST Search History

		or (narrow adj band)) and (wideband and interference) and (ofdm or (orthogonal adj frequency adj division))) and (map\$4 near7 interference)	FPRS; EPO; JPO; DERWENT; IBM_TDB			
S42	215	(375/260,259,219,295,316,346,350, ,370/328,335,342,310).ccls. and ((interference)).clm. and ((interference)).ab. and (@ad<"20080604" or @prad<"20080604") and (narrowband or (narrow adj band)) and (wideband	US-PGPUB; USPAT; USOCR; FPRS; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2011/09/30 17:45

9/ 30/ 2011 5:48:51 PM**C:\ Users\ zkassa\ Documents\ EAST\ Workspaces\ 12132757.wsp**

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:	)	
CHAUNCEY ET AL.	)	
	)	
Serial No. 12/132,757	)	
	)	Attorney Docket No.:
	)	RF-448 (50676)
Confirmation No. 8369	)	
	)	Examiner: Z. KASSA
Filing Date: JUNE 4, 2008	)	
	)	Art Unit: 2611
	)	
For: WIRELESS COMMUNICATION SYSTEM	)	
COMPENSATING FOR INTERFERENCE	)	
AND RELATED METHODS	)	
	)	

AMENDMENT

EFILE

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

Sir:

Responsive to the Official Action of October 17, 2011,
please enter and consider the remarks and amendments set out
below.

In the Claims:

This listing of claims replaces all prior versions and listings of claims in the application.

1. (Currently amended) A wireless communication system comprising:

first and second wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic;

said first and second wireless communications devices comprising respective first and second orthogonal frequency-division multiplexing (OFDM) wireless transceivers and respective first and second controllers coupled thereto;

said first controller for

detecting received interference,

determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference, and

setting the at least one settable link characteristic to compensate for the received interference based upon the interference type.

2. (Canceled).

3. (Original) The wireless communication system according to Claim 1 wherein said first controller detects the received interference based upon a comparison of a current received signal to at least one prior received signal.

4. (Original) The wireless communication system according to Claim 1 wherein said first controller repeats the detecting, determining, and setting.

5. (Original) The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one receive processing characteristic.

6. (Original) The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and wherein said first controller cooperates with said second controller to set the at least one transmit processing characteristic.

7. (Original) The wireless communication system according to Claim 1 wherein said first controller generates an interference map of the received interference onto OFDM cells.

8. (Original) The wireless communication system according to Claim 7 wherein said first controller sets the at least one settable link characteristic based upon the interference map.

9. (Original) The wireless communication system according to Claim 1 wherein said first controller determines the interference type based upon at least one of fade

In re Patent Application of
CHAUNCEY ET AL.
Serial No. 12/132,757
Filed: JUNE 4, 2008

characteristics, noise characteristics, and path characteristics.

10. (Original) The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering.

11. (Currently amended) A wireless communications device communicating with an other wireless communications device via a wireless communications link having at least one settable link characteristic, the wireless communications device comprising:

an orthogonal frequency-division multiplexing (OFDM) wireless transceiver; and

a controller coupled to said wireless transceiver;
said controller for

detecting received interference,

determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference, and

setting the at least one settable link characteristic to compensate for the received interference based upon the interference type.

12. (Canceled).

13. (Original) The wireless communications device according to Claim 11 wherein said controller detects the received interference based upon a comparison of a current received signal to at least one prior received signal.

14. (Original) The wireless communications device according to Claim 11 wherein the at least one settable link characteristic comprises at least one receive processing characteristic.

15. (Original) The wireless communications device according to Claim 11 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and wherein said controller cooperates with the other wireless communications device to set the at least one transmit processing characteristic.

16. (Currently amended) A method for compensating interference in a wireless communication system comprising first and second orthogonal frequency-division multiplexing (OFDM) wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic, the method comprising:

detecting received interference;

determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference;
and

setting the at least one settable link characteristic

In re Patent Application of
CHAUNCEY ET AL.
Serial No. 12/132,757
Filed: JUNE 4, 2008

to compensate for the received interference based upon the interference type.

17. (Canceled).

18. (Original) The method according to Claim 16 wherein the detecting comprises comparing a current received signal to at least one prior received signal.

19. (Original) The method according to Claim 16 further comprising repeating the detecting, determining, and setting.

20. (Original) The method according to Claim 16 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and further comprising cooperating between the first and second wireless communications devices to set the at least one transmit processing characteristic.

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CHAUNCEY ET AL.
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Filed: JUNE 4, 2008

REMARKS

Applicants thank the Examiner for the careful and thorough examination of the present application. Applicants have amended independent Claims 1, 11, and 16 to incorporate the subject matter of former, now canceled, dependent Claims 2, 12, and 17, respectively.

Applicants submit that all claims are patentable, present arguments and amendments herein supporting such patentability, and respectfully request that the Examiner withdraw all pending rejections and allow all claims.

I. The Amended Claims

The present invention, as recited in amended independent Claim 1, for example, is directed to a wireless communication system. The wireless communication system comprises first and second wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic. The first and second wireless communications devices comprise respective first and second orthogonal frequency-division multiplexing (OFDM) wireless transceivers and respective first and second controllers coupled thereto. The first controller is for detecting received interference, determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference, and setting the at least one settable link characteristic to compensate for the received interference based upon the interference type. Amended independent Claims 11 and 16 are directed to sub-combination and method counterparts,

respectively, of the system of Claim 1 and have been amended similarly.

II. The Amended Claims Are Patentable

The Examiner rejected independent Claims 1, 11, and 16 and former dependent Claims 2, 12, and 17 over Aboba et al. in view of Belogolovy et al. Aboba et al. discloses a cognitive radio system comprising a wireless communications device, and a base station in communication therewith. The system also includes an interference source, depicted in Figure 1, reproduced below, as a microwave oven. The wireless communications device includes an interference mitigation module that detects characteristics of the interfering signal from the

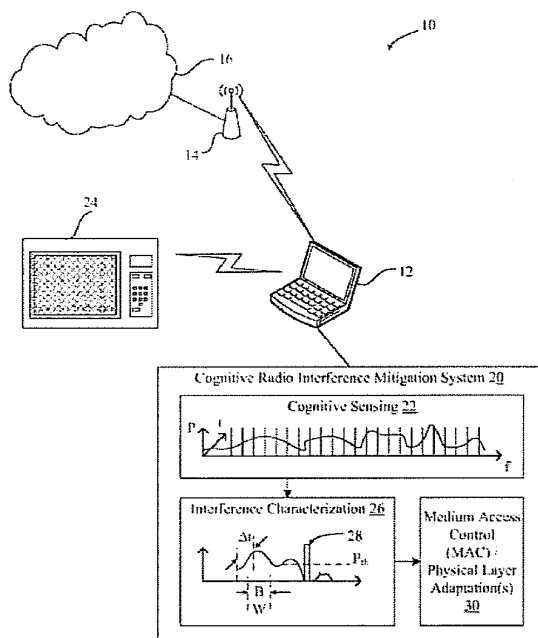


Figure 1 of Aboba et al.

interference source, such as whether the interfering signal is wideband or narrowband. Based upon the detected characteristics, the interference mitigation module adapts the transmission characteristics to compensate for the interfering signal.¹

The Examiner correctly notes that system disclosed in Aboba et al. fails to disclose the first and second wireless communications devices comprising respective

¹ Paragraph 27

first and second OFDM wireless transceivers, as recited by independent Claim 1, for example. Nevertheless, the Examiner notes that Aboba et al. discloses generally OFDM in the background section thereof. The Examiner contended that the skilled person would consider it obvious to modify the system of Aboba et al. to use OFDM since it is well known in the art. The Examiner cited Belogolovy et al. as an example of the well known nature of OFDM.

Belogolovy et al. discloses a wireless communication system for mitigating narrowband interference. In particular, the system divides the wideband spectrum being operated upon into a plurality of sub-bands, and detects the energy level in each sub-band. If the energy difference between adjacent sub-bands is greater than a threshold, the system assumes there is narrowband interference affecting the sub-band and applies a control signal to mitigate the interference. The wireless communication system of Belogolovy et al. may use 802.11a technology, which includes OFDM.

Applicants have amended each of the independent claims to recite the determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference. Applicants submit that none of the applied prior art references discloses or fairly suggests this claim feature. Differently, Aboba et al. discloses in the background discussion communication collision from televisions, microwaves, sulfur lamps, etc. Indeed, the interference mitigation technique disclosed by Aboba et al. may differentiate between narrowband and wideband interference, but it does not determine whether

In re Patent Application of
CHAUNCEY ET AL.
Serial No. 12/132,757
Filed: JUNE 4, 2008

such interference is self-inflicted, i.e. self-interference, as in the claimed invention.

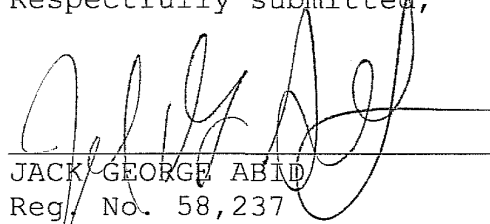
Accordingly, because of the above noted deficiency, it is submitted that amended independent Claims 1, 11, and 16 are patentable over the prior art. Their respective dependent claims, which recite yet further distinguishing features, are also patentable over the prior art and require no further discussion herein.

In re Patent Application of
CHAUNCEY ET AL.
Serial No. 12/132,757
Filed: JUNE 4, 2008

CONCLUSIONS

In view of the amendments to the claims and the arguments presented above, it is submitted that all of the claims are patentable. Accordingly, a Notice of Allowance is respectfully requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned at the telephone number listed below.

Respectfully submitted,



JACK GEORGE ABID
Reg. No. 58,237
Allen, Dyer, Doppelt, Milbrath
& Gilchrist, P.A.
255 S. Orange Avenue, Suite 1401
Post Office Box 3791
Orlando, Florida 32802
407-841-2330
407-841-2343 fax
Attorney for Applicants

Electronic Acknowledgement Receipt

EFS ID:	11806739
Application Number:	12132757
International Application Number:	
Confirmation Number:	8369
Title of Invention:	WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS
First Named Inventor/Applicant Name:	David CHAUNCEY
Customer Number:	74701
Filer:	Christopher F. Regan/Sherry Leonard
Filer Authorized By:	Christopher F. Regan
Attorney Docket Number:	RF-448 (50676)
Receipt Date:	11-JAN-2012
Filing Date:	04-JUN-2008
Time Stamp:	09:48:19
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		50676_Amendment.pdf	356722	yes	12
			ef2bbcf66662ebe09f491f0b750e1441397a96ef		

	Multipart Description/PDF files in .zip description		
	Document Description	Start	End
	Miscellaneous Incoming Letter	1	1
	Amendment/Req. Reconsideration-After Non-Final Reject	2	2
	Claims	3	7
	Applicant Arguments/Remarks Made in an Amendment	8	12
Warnings:			
Information:			
Total Files Size (in bytes):		356722	
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.			

Case No. RF-448 (50676)

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

In re Application of: **CHAUNCEY ET AL.**

Serial No.: **12/132,757**

Confirmation No.: **8369**

Filed: **JUNE 4, 2008**

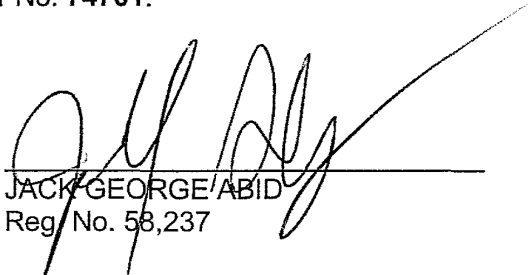
For: **WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR
INTERFERENCE AND RELATED METHODS**

Sir:

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

- ☐ Applicant qualifies as a small entity under 37 CFR § 1.27.
- ☒ No additional fee is required.
- ☒ The Commissioner is hereby authorized to charge or credit any discrepancies in fee amounts to Deposit Account No. 08-0870.
- ☒ **PLEASE ADDRESS ALL CORRESPONDENCE TO ATTORNEY OF RECORD:
CHRISTOPHER F. REGAN**
- ☒ This application is associated with Customer No. **74701**.

January 11, 2012
DATE



JACK GEORGE ABID
Reg. No. 58,237

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

PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875					Application or Docket Number 12/132,757		Filing Date 06/04/2008		☐ To be Mailed	
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APPLICATION AS FILED – PART I						OTHER THAN SMALL ENTITY			
(Column 1)		(Column 2)		SMALL ENTITY ☐ OR		OTHER THAN SMALL ENTITY			
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR	RATE (\$)	FEE (\$)		
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A			
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A			N/A			
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A			
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X \$ =		OR	X \$ =			
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =			X \$ =			
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))			If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))									
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL			

APPLICATION AS AMENDED – PART II						OTHER THAN SMALL ENTITY					
(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		OTHER THAN SMALL ENTITY	
AMENDMENT	01/11/2012	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	RATE (\$)	ADDITIONAL FEE (\$)		
	Total (37 CFR 1.16(i))	* 17	Minus ** 20	= 0	X \$ =		OR	X \$60=	0		
	Independent (37 CFR 1.16(h))	* 3	Minus *** 3	= 0	X \$ =		OR	X \$250=	0		
☐ Application Size Fee (37 CFR 1.16(s))											
☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))											
					TOTAL ADD'L FEE			TOTAL ADD'L FEE		0	

(Column 1)		(Column 2)		(Column 3)		SMALL ENTITY		OR		OTHER THAN SMALL ENTITY	
AMENDMENT	CLAIMS REMAINING AFTER AMENDMENT	HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)	OR	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))											
					TOTAL ADD'L FEE			TOTAL ADD'L FEE			

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

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.



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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)	8369
74701	7590	04/25/2012	EXAMINER	
ADDMG - Harris			KASSA, ZEWDU A	
255 S ORANGE AVENUE			ART UNIT	
SUITE 1401			PAPER NUMBER	
ORLANDO, FL 32801			2611	
			NOTIFICATION DATE	DELIVERY MODE
			04/25/2012	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):

creganoa@addmg.com

Office Action Summary	Application No. 12/132,757		Applicant(s) CHAUNCEY ET AL.	
	Examiner ZEWDU KASSA		Art Unit 2611	

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

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

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

Status

1) ☒ Responsive to communication(s) filed on 11 January 2012.
 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) 1,3-11,13-16 and 18-20 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) 1, 3-11, 13-16 and 18-20 is/are rejected.
 8) ☐ Claim(s) ____ is/are objected to.
 9) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

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

Priority under 35 U.S.C. § 119

13) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 a) ☐ All b) ☐ Some * c) ☐ None of:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
 * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

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

DETAILED ACTION

1. This office action is in response to communication filled on 01/11/2012. Claims 1, 3-11, 13-16 and 18-20 are pending on this application.
2. Applicant's arguments with respect to claims 1, 3-11, 13-16 and 18-20 have been fully considered but are not persuasive/moot in view of the new ground(s) of rejection.

Response to Remarks

3. Regarding independent claims applicants asserts that "The Examiner correctly notes that system disclosed in Aboba et al. fails to disclose the first and second wireless communications devices comprising first and second OFDM wireless transceiver" (Remarks, section II second paragraph).

Examiner respectfully disagrees.

While Aboba teaches said first and second wireless communications devices comprising respective first and second wireless

transceivers and respective first and second controllers coupled thereto (Aboba, Fig. 1 item 12 14 Fig. 4 item 401, Para [0034] "The communication device 12 ... includes ... Fig. 4", Aboba does not explicitly mention the transceivers are an orthogonal frequency-division multiplexing (OFDM) wireless transceivers. However, it is obvious and well known in the art the Aboba wireless transceivers adapts the IEEE 802.11 standard (Aboba, Para [0001]-[0002]) which implements an OFDM. Thus, it would have been obvious to one having ordinary skill in the art at the time of the invention Aboba teaches the instant limitation based on the known standard (see Belogolovy US 2008/0299932 Para [0052]). Applicant argument is not persuasive.

Claim Rejections - 35 USC § 103

The following is a quotation of 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 of this title, 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 negated by the manner in which the invention was made.

4. Claims 1, 3-11, 13-16 and 18-20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Aboba (US 2009/0124205) in view of Belogolovy (US 2008/0299932) and Scharf (US 20060153283).

5. As per claim 1, Aboba teaches a wireless communication system comprising: first and second wireless communications devices communicating with one another via a wireless communications link (Aboba, Fig. 1 item 12 14) having at least one settable link characteristic (Aboba, Fig. 4 item 401, Para [0034] "The communication device 12 ... includes ... Fig. 4", Para [0008] "... having an adaption selected based on the characterization of the interference signal"); said first controller for detecting received interference (Aboba, Fig. 4 item 401 450 "interference mitigation"), determining a type of the received interference from among a plurality of interference types comprising wideband interference and narrowband interference (Aboba, Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ..."), and setting the at least one settable link characteristic to compensate for the received interference based upon the interference type (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal").

- While Aboba teaches said first and second wireless communications devices comprising respective first and second wireless transceivers and respective first and second controllers coupled thereto (Aboba, Fig. 1 item 12 14 Fig. 4 item 401, Para [0034] "The communication device 12 ... includes ... Fig. 4", Aboba does not explicitly mention the transceivers are an orthogonal frequency-division multiplexing (OFDM) wireless transceivers. However, it is obvious and well known in the art the Aboba wireless transceivers adapts the IEEE 802.11 standard (Aboba, Para [0001]-[0002]) which implements an OFDM. Thus, it would have been obvious to one having ordinary skill in the art at the time of the invention Aboba teaches the instant limitation based on the known standard (see Belogolov US 2008/0299932 Para [0052]).

While Aboba teaches determining a type of the received interference from among a plurality of interference types comprising wideband interference and narrowband interference (Aboba, Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ...") and discussing an interference that exist on the same frequency in general (Aboba, Para [0005] "... collide

on the same frequencies ...", Para [0006] "... interference from a transmission of nearby node (i.e. collision)"), Aboba does not explicitly mention a self-interference being compensated. Scharf teaches the need to compensate self-interference in an OFDM communication system (Scharf, Para [0080] "self-interference", Fig. 1F item 125 115). Therefore, taking the combined teaching of Aboba and Scharf as a whole, it would have been obvious to one having ordinary skill in the art at the time of the invention, to incorporate this feature in to the system of Aboba, in the manner as claimed and as taught by Scharf, for the benefit of improving the performance of the communication system by compensating for self-interference.

6. As per claim 3, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 wherein said first controller detects the received interference (Aboba, Fig. 4 item 401 450) based upon a comparison of a current received signal to at least one prior received signal (Aboba, Para [0043] "comparison" – wherein the current received signal compared to a previously received or stored signal).

7. As per claim 4, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 wherein said first

controller repeats the detecting, determining, and setting (Aboba, Fig. 2 item 102).

8. As per claim 5, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 wherein the at least one settable link characteristic comprises at least one receive processing characteristic (Aboba, Fig. 1 item 12 14).

9. As per claim 6, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic (Aboba, Fig. 1 item 12 14); and wherein said first controller cooperates with said second controller to set the at least one transmit processing characteristic (Aboba, Para [0053]).

10. As per claim 7, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 (see claim 1). Aboba in view of Belogolovy does not explicitly teach wherein said first controller generates an interference map of the received interference onto OFDM cells. However, Aboba in view of Belogolovy teaches wherein said the first controller detects an interference, determines an interference type and

compensate adaptively based on the interference type in an OFDM communication environment (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal", Para [0001]-[0002] "802.11"). Thus, it would have been obvious to one having ordinary skill in the art the adaptive system of Aboba in view of Belogolovy performs mapping of the interference adaptively and apply settable link based on the mapping in an OFDM communication environment or OFDM cell (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal", Para [0001]-[0002] "802.11", Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ...").

11. As per claim 8, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 7 wherein said first controller sets the at least one settable link characteristic based upon the interference map (Aboba, Para [0008] "... having an adaption selected based on the characterization of the interference signal", Para [0030] "... determination is made as to whether the interference signal is categorized as narrowband ... Para [0031] ... If not narrowband ... then a wideband interference signal is further categorized ...").

12. As per claim 9, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 wherein said first controller determines the interference type based upon at least one of fade characteristics, noise characteristics, and path characteristics (Aboba, Para [0039] "... signal to noise ratio (SNR) ...").

13. As per claim 10, Aboba in view of Belogolovy and Scharf teaches the wireless communication system according to claim 1 wherein the at least one settable link characteristic comprises at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering (Aboba, Para [0030] "... FEC ...", Para [0031] "... transmit power ...").

14. As per claims 11-20 are similarly analyzed as claims 1-10.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to ZEWDU KASSA whose telephone number is (571)270-5253. The examiner can normally be reached on Monday - Friday (7:30 - 5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, David Payne can be reached on 571 272 3024. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

zk

/Zewdu Kassa/
Examiner, Art Unit 2611

Notice of References Cited	Application/Control No. 12/132,757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.	
	Examiner ZEWDU KASSA	Art Unit 2611	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2009/0124205	05-2009	Aboba et al.	455/63.1
*	B	US-2008/0299932	12-2008	Belogolovy et al.	455/296
*	C	US-2006/0153283	07-2006	Scharf et al.	375/148
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

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

NON-PATENT DOCUMENTS

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

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

Search Notes 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

SEARCHED			
Class	Subclass	Date	Examiner
375	260,259,219,295,316,346,350	9/30/2011	zk
370	328,335,342,310	9/30/2011	zk

SEARCH NOTES		
Search Notes	Date	Examiner
East	9/30/2011	zk
East	4/18/2012	zk

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

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<i>Index of Claims</i> 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

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

☐ Claims renumbered in the same order as presented by applicant				☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		DATE							
Final	Original	09/28/2011	04/18/2012						
	1	✓	✓						
	2	✓	-						
	3	✓	✓						
	4	✓	✓						
	5	✓	✓						
	6	✓	✓						
	7	✓	✓						
	8	✓	✓						
	9	✓	✓						
	10	✓	✓						
	11	✓	✓						
	12	✓	-						
	13	✓	✓						
	14	✓	✓						
	15	✓	✓						
	16	✓	✓						
	17	✓	-						
	18	✓	✓						
	19	✓	✓						
	20	✓	✓						

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of:	)	
CHAUNCEY ET AL.	)	
	)	
Serial No. 12/132,757	)	
	)	Attorney Docket No.:
	)	RF-448 (50676)
Confirmation No. 8369	)	
	)	Examiner: Z. KASSA
Filing Date: JUNE 4, 2008	)	
	)	Art Unit: 2611
	)	
For: WIRELESS COMMUNICATION SYSTEM	)	
COMPENSATING FOR INTERFERENCE	)	
AND RELATED METHODS	)	
	)	

AMENDMENT

EFILE

Commissioner for Patents

Commissioner:

Responsive to the Official Action of April 25, 2012,
please enter and consider the amendments and remarks set out
below.

In re Patent Application of
CHAUNCEY ET AL.
Serial No. 12/132,757
Filed: JUNE 4, 2008

In the Claims:

This listing of claims replaces all prior versions and listings of claims in the application.

1. (Currently amended) A wireless communication system comprising:

first and second wireless communications devices configured to communicate ~~communicating~~ with one another via a wireless communications link having at least one settable link characteristic;

said first and second wireless communications devices comprising respective first and second orthogonal frequency-division multiplexing (OFDM) wireless transceivers and respective first and second controllers coupled thereto and configured to store short term and long term historical characteristics of interference;

said first controller configured to ~~for~~
detecting detect received interference,
determining determine a type of the
received interference from among a plurality of
interference types comprising wideband interference,
self interference, and narrowband interference based
upon comparing at least one characteristic of a
current received signal with the short term and long
term historical characteristics of interference, and
~~setting~~ set the at least one settable link
characteristic to compensate for the received
interference based upon the interference type.

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2. (Canceled).

3. (Canceled)

4. (Currently amended) The wireless communication system according to Claim 1 wherein said first controller is configured to repeat ~~repeats~~ the detecting, determining, and setting.

5. (Original) The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one receive processing characteristic.

6. (Currently amended) The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and wherein said first controller is configured to cooperate ~~cooperates~~ with said second controller to set the at least one transmit processing characteristic.

7. (Currently amended) The wireless communication system according to Claim 1 wherein said first controller is configured to generate ~~generates~~ an interference map of the received interference onto OFDM cells.

8. (Currently amended) The wireless communication system according to Claim 7 wherein said first controller is

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configured to set ~~sets~~ the at least one settable link
characteristic based upon the interference map.

9. (Currently amended) The wireless communication system according to Claim 1 wherein said first controller is configured to determine ~~determines~~ the interference type based upon at least one of fade characteristics, noise characteristics, and path characteristics.

10. (Original) The wireless communication system according to Claim 1 wherein the at least one settable link characteristic comprises at least one of transmission power, frequency diversity, time diversity, modulation, forward error correction (FEC), channel bandwidth, and adaptive filtering.

11. (Currently amended) A wireless communications device operable to communicate ~~communicating~~ with an other wireless communications device via a wireless communications link having at least one settable link characteristic, the wireless communications device comprising:

an orthogonal frequency-division multiplexing (OFDM) wireless transceiver; and

a controller coupled to said wireless transceiver and configured to store short term and long term historical characteristics of interference;

said controller configured to for

~~detecting~~ detect received interference,

~~determining~~ determine a type of the

received interference from among a plurality of

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interference types comprising wideband interference, self interference, and narrowband interference based upon comparing at least one characteristic of a current received signal with the short term and long term historical characteristics of interference, and setting set the at least one settable link characteristic to compensate for the received interference based upon the interference type.

12. (Canceled).

13. (Canceled).

14. (Original) The wireless communications device according to Claim 11 wherein the at least one settable link characteristic comprises at least one receive processing characteristic.

15. (Currently amended) The wireless communications device according to Claim 11 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and wherein said controller is configured to cooperate ~~cooperates~~ with the other wireless communications device to set the at least one transmit processing characteristic.

16. (Currently amended) A method for compensating interference in a wireless communication system comprising first and second orthogonal frequency-division multiplexing

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(OFDM) wireless communications devices communicating with one another via a wireless communications link having at least one settable link characteristic, the method comprising:

detecting received interference;

storing short term and long term historical characteristics of interference;

determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference based upon comparing at least one characteristic of a current received signal with the short term and long term historical characteristics of interference; and

setting the at least one settable link characteristic to compensate for the received interference based upon the interference type.

17. (Canceled).

18. (Canceled).

19. (Original) The method according to Claim 16 further comprising repeating the detecting, determining, and setting.

20. (Original) The method according to Claim 16 wherein the at least one settable link characteristic comprises at least one transmit processing characteristic; and further comprising cooperating between the first and second

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wireless communications devices to set the at least one
transmit processing characteristic.

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CHAUNCEY ET AL.
Serial No. **12/132,757**
Filed: **JUNE 4, 2008**

REMARKS

Applicants thank the Examiner for the careful and thorough examination of the present application, for correctly withdrawing the prior rejections of the claims, and for extending all courtesies to Applicants' Attorney during the telephonic interview of June 26, 2012.

During the telephonic interview, Applicants proposed amending the independent claims and have proceeded as such herein. In particular, Applicants have amended independent Claims 1, 11, and 16 to more clearly define the claimed invention over the prior art. Applicants have also canceled dependent Claims 3, 13, and 18 for consistency and amended dependent Claims 4, 6-9, and 15 to correct minor informalities.

Applicants submit that all claims are patentable, present arguments and amendments herein supporting such patentability, and respectfully request that the Examiner withdraw all pending rejections and allow all claims.

I. The Amended Claims

The present invention, as recited in amended independent Claim 1, for example, is directed to a wireless communication system. The wireless communication system comprises first and second wireless communications devices configured to communicate with one another via a wireless communications link having at least one settable link characteristic. The first and second wireless communications devices comprise respective first and second orthogonal frequency-division multiplexing (OFDM) wireless transceivers

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and respective first and second controllers coupled thereto and configured to store short term and long term historical characteristics of interference. Claim 1 has been amended to recite the first controller is configured to detect received interference, determine a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference based upon comparing at least one characteristic of a current received signal with the short term and long term historical characteristics of interference. Support for this claim amendment is found in paragraphs 28-29 of the present application. The first controller is also configured to set the at least one settable link characteristic to compensate for the received interference based upon the interference type.

Amended independent Claims 11 and 16 are directed to sub-combination and method counterparts, respectively, of the system of Claim 1 and have been amended similarly.

II. The Amended Claims Are Patentable

The Examiner rejected independent Claims 1, 11, and 16 over Aboba et al. in view of Belogolovy et al. and Scharf et al. Aboba et al. discloses a cognitive radio system comprising a wireless communications device, and a base station in communication therewith. The system also includes an interference source, depicted in Figure 1, reproduced below, as a microwave oven. The wireless communications device includes an interference mitigation module that detects characteristics of the interfering signal from the

interference source, such as whether the interfering signal is wideband or narrowband. Based upon the detected characteristics, the interference mitigation module adapts the transmission characteristics to compensate for the interfering signal.¹

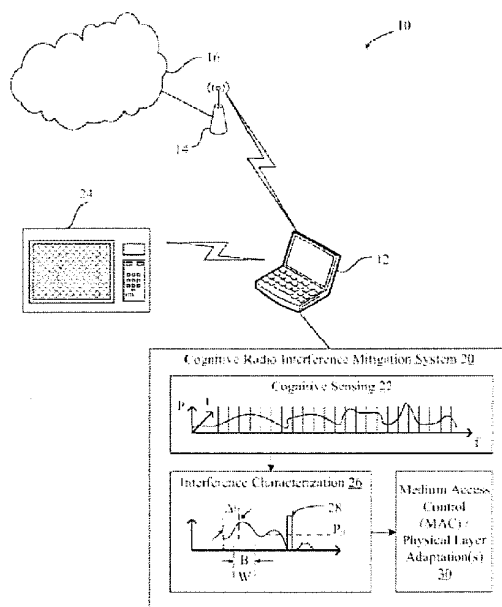


Figure 1 of Aboba et al.

The Examiner correctly notes that the system disclosed in Aboba et al. fails to disclose the first and second wireless communications devices comprising respective first and second OFDM wireless transceivers, as recited by independent Claim 1, for example. Nevertheless, the Examiner notes that Aboba et al. discloses generally OFDM in the background section thereof. The Examiner contended that the

¹ Paragraph 27.

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skilled person would consider it obvious to modify the system of Aboba et al. to use OFDM since it is well known in the art. The Examiner cited Belogolovy et al. as an example of the well known nature of OFDM.

Belogolovy et al. discloses a wireless communication system for mitigating narrowband interference. In particular, the system divides the wideband spectrum being operated upon into a plurality of sub-bands, and detects the energy level in each sub-band. If the energy difference between adjacent sub-bands is greater than a threshold, the system assumes there is narrowband interference affecting the sub-band and applies a control signal to mitigate the interference. The wireless communication system of Belogolovy et al. may use 802.11a technology, which includes OFDM.

The Examiner correctly notes that Aboba et al. and Belogolovy et al. each fails to disclose determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and narrowband interference, as recited by independent Claim 1, for example. The Examiner looks to Scharf et al. for this deficiency. Scharf et al. discloses an OFDM receiver that performs a forward transform on the received signal to provide a baseband signal for processing. The transform includes a variable for mitigating self-interference.

Applicants have amended each of the independent claims to recite determining a type of the received interference from among a plurality of interference types comprising wideband interference, self interference, and

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CHAUNCEY ET AL.

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_____/

narrowband interference based upon comparing at least one
characteristic of a current received signal with the short
term and long term historical characteristics of interference.

Applicants submit that none of the applied prior art references discloses or fairly suggests this claim feature. Differently, Aboba et al. discloses storing "interference patterns" so as to recognize a current interfering source.² As discussed in the present application, this above underlined claim feature permits advantageous determination of the cause of the degradation in link performance, i.e. permitting the first controller to determine, for example, whether the degradation is the result of short term fade or true interference, and also determining the type of the received interference from among a plurality of interference types, as recited in amended independent Claim 1.

Accordingly, because of the above noted deficiency, it is submitted that amended independent Claims 1, 11, and 16 are patentable over the prior art. Their respective dependent claims, which recite yet further distinguishing features, are also patentable over the prior art and require no further discussion herein.

² Paragraph 43.

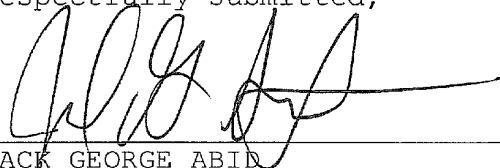
In re Patent Application of
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CONCLUSIONS

In view of the amendments to the claims and the arguments presented above, it is submitted that all of the claims are patentable. Accordingly, a Notice of Allowance is respectfully requested in due course. Should any minor informalities need to be addressed, the Examiner is encouraged to contact the undersigned at the telephone number listed below.

The Commissioner is hereby authorized to charge or credit any discrepancies in fee amounts to Deposit Account No. 08-0870.

Respectfully submitted,



JACK GEORGE ABID
Reg. No. 58,237
Allen, Dyer, Doppelt, Milbrath
& Gilchrist, P.A.
255 S. Orange Avenue, Suite 1401
Post Office Box 3791
Orlando, Florida 32802
407-841-2330
407-841-2343 fax
Attorney for Applicants

Electronic Acknowledgement Receipt

EFS ID:	13336831
Application Number:	12132757
International Application Number:	
Confirmation Number:	8369
Title of Invention:	WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS
First Named Inventor/Applicant Name:	David CHAUNCEY
Customer Number:	74701
Filer:	Christopher F. Regan/Sherry Leonard
Filer Authorized By:	Christopher F. Regan
Attorney Docket Number:	RF-448 (50676)
Receipt Date:	25-JUL-2012
Filing Date:	04-JUN-2008
Time Stamp:	14:50:10
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	no
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File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		50676_Amendment_7_25_12.pdf	619409 db8b746868843ds52aa72de551a2fc25b40f02d2	yes	14

Multipart Description/PDF files in .zip description			
Document Description		Start	End
Transmittal Letter		1	1
Amendment/Req. Reconsideration-After Non-Final Reject		2	2
Claims		3	8
Amendment/Req. Reconsideration-After Non-Final Reject		9	14

Warnings:

Information:

Total Files Size (in bytes):	619409
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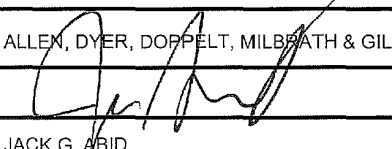
This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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.

TRANSMITTAL FORM (to be used for all correspondence after initial filing)	Application Number	12/132,757
	Filing Date	JUNE 4, 2008
	First Named Inventor	CHAUNCEY ET AL.
	Art Unit	2611
	Examiner Name	Z. KASSA
Total Number of Pages in This Submission	Attorney Docket Number	RF-448 (50676)

ENCLOSURES (Check all that apply)		
☐ Fee Transmittal Form ☐ Fee Attached ☒ Amendment/Reply ☐ After Final ☐ Affidavits/declaration(s) ☐ Extension of Time Request ☐ Express Abandonment Request ☐ Information Disclosure Statement ☐ Certified Copy of Priority Document(s) ☐ Reply to Missing Parts/ Incomplete Application ☐ Reply to Missing Parts under 37 CFR 1.52 or 1.53	☐ Drawing(s) ☐ Licensing-related Papers ☐ Petition ☐ Petition to Convert to a Provisional Application ☐ Power of Attorney, Revocation Change of Correspondence Address ☐ Terminal Disclaimer ☐ Request for Refund ☐ CD, Number of CD(s) _____ ☐ Landscape Table on CD	☐ After Allowance Communication to TC ☐ Appeal Communication to Board of Appeals and Interferences ☐ Appeal Communication to TC (Appeal Notice, Brief, Reply Brief) ☐ Proprietary Information ☐ Status Letter ☐ Other Enclosure(s) (please identify below):
Remarks		
SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT		
Firm Name	ALLEN, DYER, DORPELT, MILBRATH & GILCHRIST, P.A.	
Signature		
Printed name	JACK G. ABID	
Date	JULY 25, 2012	Reg. No. 58,237

CERTIFICATE OF TRANSMISSION/MAILING			
I hereby certify that this correspondence is being facsimile transmitted to the USPTO or deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date shown below:			
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Typed or printed name		Date	

This collection of information is required by 37 CFR 1.5. 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 2 hours 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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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875				Application or Docket Number 12/132,757		Filing Date 06/04/2008		☐ To be Mailed			
APPLICATION AS FILED – PART I											
(Column 1)			(Column 2)			SMALL ENTITY ☐ OR		OTHER THAN SMALL ENTITY			
FOR	NUMBER FILED	NUMBER EXTRA	RATE (\$)	FEE (\$)	OR		RATE (\$)	FEE (\$)			
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A				N/A				
☐ SEARCH FEE (37 CFR 1.16(k), (l), or (m))	N/A	N/A	N/A				N/A				
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A				N/A				
TOTAL CLAIMS (37 CFR 1.16(j))	minus 20 =	*	X \$ =				X \$ =				
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X \$ =				X \$ =				
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))			If the specification and drawings exceed 100 sheets of paper, the application size fee due is \$250 (\$125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).								
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))											
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL				TOTAL				
APPLICATION AS AMENDED – PART II											
(Column 1)			(Column 2)			(Column 3)		SMALL ENTITY OR		OTHER THAN SMALL ENTITY	
AMENDMENT	07/25/2012	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE (\$)	ADDITIONAL FEE (\$)		RATE (\$)	ADDITIONAL FEE (\$)	
	Total (37 CFR 1.16(i))	* 14	Minus	** 20	= 0	X \$ =		OR	X \$60=	0	
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X \$ =		OR	X \$250=	0	
	☐ Application Size Fee (37 CFR 1.16(s))							OR			
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR			
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE		
								TOTAL ADD'L FEE		0	
AMENDMENT		CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	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))							OR			
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR			
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE		
					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE			
* If the entry in column 1 is less than the entry in column 2, write "0" in column 3. ** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20". *** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3". The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.											

 Legal Instrument Examiner:
 /DEBORAH POLLARD/

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

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



UNITED STATES PATENT AND TRADEMARK OFFICE

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

NOTICE OF ALLOWANCE AND FEE(S) DUE

74701 7590 08/13/2012
ADDMG - Harris
255 S ORANGE AVENUE
SUITE 1401
ORLANDO, FL 32801

EXAMINER

KASSA, ZEWDU A

ART UNIT PAPER NUMBER

2611

DATE MAILED: 08/13/2012

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)	8369

TITLE OF INVENTION: WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	\$1740	\$300	\$0	\$2040	11/13/2012

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

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

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

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

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

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

If the SMALL ENTITY is shown as NO:

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

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

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

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

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

PART B - FEE(S) TRANSMITTAL

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

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

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

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.

74701 7590 08/13/2012
ADDMG - Harris
255 S ORANGE AVENUE
SUITE 1401
ORLANDO, FL 32801

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)	8369

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nonprovisional	NO	\$1740	\$300	\$0	\$2040	11/13/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
KASSA, ZEWDU A	2611	375-260000

1. Change of correspondence address or indication of "Fee Address" (37 CFR 1.363).
☐ Change of correspondence address (or Change of Correspondence Address form PTO/SB/122) attached.
☐ "Fee Address" indication (or "Fee Address" Indication form PTO/SB/47; Rev 03-02 or more recent) attached. **Use of a Customer Number is required.**

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

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

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

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

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

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

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

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

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

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

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

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

Authorized Signature _____ Date _____
 Typed or printed name _____ Registration No. _____

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

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



UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)	8369
74701	7590	08/13/2012	EXAMINER	
ADDMG - Harris			KASSA, ZEWDU A	
255 S ORANGE AVENUE			ART UNIT	
SUITE 1401			PAPER NUMBER	
ORLANDO, FL 32801			2611	

DATE MAILED: 08/13/2012

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

The Patent Term Adjustment to date is 804 day(s). If the issue fee is paid on the date that is three months after the mailing date of this notice and the patent issues on the Tuesday before the date that is 28 weeks (six and a half months) after the mailing date of this notice, the Patent Term Adjustment will be 804 day(s).

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

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

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

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.

Notice of Allowability	Application No.	Applicant(s)	
	12/132,757	CHAUNCEY ET AL.	
	Examiner	Art Unit	
	ZEWDU KASSA	2611	

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

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

1. ☒ This communication is responsive to 07/25/2012.
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 1,4-11,14-16,19-20.
4. ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
 - a) ☐ All b) ☐ Some* c) ☐ None of the:
 1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. ____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

* Certified copies not received: ____.

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

5. ☐ A SUBSTITUTE OATH OR DECLARATION must be submitted. Note the attached EXAMINER'S AMENDMENT or NOTICE OF INFORMAL PATENT APPLICATION (PTO-152) which gives reason(s) why the oath or declaration is deficient.
6. ☐ CORRECTED DRAWINGS (as "replacement sheets") must be submitted.
 - (a) ☐ including changes required by the Notice of Draftsperson's Patent Drawing Review (PTO-948) attached
 - 1) ☐ hereto or 2) ☐ to Paper No./Mail Date ____.
 - (b) ☐ including changes required by the attached Examiner's Amendment / Comment or in the Office action of Paper No./Mail Date ____.

Identifying indicia such as the application number (see 37 CFR 1.84(c)) should be written on the drawings in the front (not the back) of each sheet. Replacement sheet(s) should be labeled as such in the header according to 37 CFR 1.121(d).
7. ☐ DEPOSIT OF and/or INFORMATION about the deposit of BIOLOGICAL MATERIAL must be submitted. Note the attached Examiner's comment regarding REQUIREMENT FOR THE DEPOSIT OF BIOLOGICAL MATERIAL.

Attachment(s)

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

/Zewdu Kassa/ Examiner, Art Unit 2611	
--	--

Issue Classification 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

ORIGINAL						INTERNATIONAL CLASSIFICATION												
CLASS		SUBCLASS				CLAIMED					NON-CLAIMED							
375		260				H	0	4	K	1 / 10 (2006.01.01)								
CROSS REFERENCE(S)																		
CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)																	
375	260	259	219	295	316													
375	346	350																
370	328	335	342	310														

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

NONE (Assistant Examiner) _____ (Date) _____		Total Claims Allowed: 14	
/ZEWDU KASSA/ Examiner.Art Unit 2611 (Primary Examiner) _____ (Date) _____		08/07/2012 O.G. Print Claim(s) 1	O.G. Print Figure 2

Search Notes 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

SEARCHED			
Class	Subclass	Date	Examiner
375	260,259,219,295,316,346,350	9/30/2011	zk
370	328,335,342,310	9/30/2011	zk

SEARCH NOTES		
Search Notes	Date	Examiner
East	9/30/2011	zk
East	4/18/2012	zk
East	8/7/2012	zk

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
375	260,259,219,295,316,346,350	8/7/2012	zk

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<i>Index of Claims</i> 	Application/Control No. 12132757	Applicant(s)/Patent Under Reexamination CHAUNCEY ET AL.
	Examiner ZEWDU KASSA	Art Unit 2611

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

☒ Claims renumbered in the same order as presented by applicant					☐ CPA		☐ T.D.		☐ R.1.47	
CLAIM		DATE								
Final	Original	09/28/2011	04/18/2012	08/07/2012						
	1	✓	✓	=						
	2	✓	-	-						
	3	✓	✓	-						
	4	✓	✓	=						
	5	✓	✓	=						
	6	✓	✓	=						
	7	✓	✓	=						
	8	✓	✓	=						
	9	✓	✓	=						
	10	✓	✓	=						
	11	✓	✓	=						
	12	✓	-	-						
	13	✓	✓	-						
	14	✓	✓	=						
	15	✓	✓	=						
	16	✓	✓	=						
	17	✓	-	-						
	18	✓	✓	-						
	19	✓	✓	=						
	20	✓	✓	=						

PART B - FEE(S) TRANSMITTAL

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

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

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

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74701 7590 08/13/2012
ADDMG - Harris
255 S ORANGE AVENUE
SUITE 1401
ORLANDO, FL 32801

Certificate of Mailing or Transmission

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	06/04/2008	David CHAUNCEY	RF-448 (50676)	8369

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nonprovisional	NO	\$1740	\$300	\$0	\$2040	11/13/2012

EXAMINER	ART UNIT	CLASS-SUBCLASS
KASSA, ZEWDU A	2611	375-260000

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

ALLEN, DYER, DOPPELT,
 MILBRATH & GILCHRIST, P.A.
 Attorneys at Law
 255 S. Orange Ave., Ste. 1401
 PO Box 3791
 Orlando, FL 32802-3791

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

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

(A) NAME OF ASSIGNEE

(B) RESIDENCE: (CITY and STATE OR COUNTRY)

HARRIS CORPORATION

MELBOURNE, FL

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

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

- ☒ Issue Fee
☒ Publication Fee (No small entity discount permitted)
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- ☐ A check is enclosed.
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☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 08-0870 (enclose an extra copy of this form).

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

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

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

Authorized Signature /CHRISTOPHER F. REGAN/

Date AUGUST 15, 2012

Typed or printed name CHRISTOPHER F. REGAN

Registration No. 34906

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Electronic Patent Application Fee Transmittal				
Application Number:		12132757		
Filing Date:		04-Jun-2008		
Title of Invention:		WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS		
First Named Inventor/Applicant Name:		David CHAUNCEY		
Filer:		Christopher F. Regan/LOIS LOVE		
Attorney Docket Number:		RF-448 (50676)		
Filed as Large Entity				
Utility under 35 USC 111(a) Filing Fees				
Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1740	1740
Publ. Fee- early, voluntary, or normal	1504	1	300	300

Description	Fee Code	Quantity	Amount	Sub-Total in USD(\$)
Extension-of-Time:				
Miscellaneous:				
Total in USD (\$)				2040

Electronic Acknowledgement Receipt	
EFS ID:	13505885
Application Number:	12132757
International Application Number:	
Confirmation Number:	8369
Title of Invention:	WIRELESS COMMUNICATION SYSTEM COMPENSATING FOR INTERFERENCE AND RELATED METHODS
First Named Inventor/Applicant Name:	David CHAUNCEY
Customer Number:	74701
Filer:	Christopher F. Regan/LOIS LOVE
Filer Authorized By:	Christopher F. Regan
Attorney Docket Number:	RF-448 (50676)
Receipt Date:	15-AUG-2012
Filing Date:	04-JUN-2008
Time Stamp:	16:43:54
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	\$ 2040
RAM confirmation Number	3521
Deposit Account	080870
Authorized User	
The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows: Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees) Charge any Additional Fees required under 37 C.F.R. Section 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)	RF-448_ISSUE-FEE.pdf	114446	no	1
			33c675f326b7fa97d61f54823072d182c03e8bfe		
Warnings:					
Information:					
2	Fee Worksheet (SB06)	fee-info.pdf	32129	no	2
			a7ca3f1e88cc52fe1c2f0866560fe1a7f35445cd		
Warnings:					
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Total Files Size (in bytes):			146575		
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.					



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APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/132,757	01/01/2013	8345780	RF-448 (50676)	8369
74701	7590	12/12/2012		
ADDMG - Harris 255 S ORANGE AVENUE SUITE 1401 ORLANDO, FL 32801				

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 1246 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

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

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

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

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

David CHAUNCEY, Fairport, NY;
Mitel Kuliner, Rochester, NY;
Elias Theodorou, Rochester, NY;

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AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Western District of Texas on the following

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

DOCKET NO.	DATE FILED 1/20/2022	U.S. DISTRICT COURT Western District of Texas
PLAINTIFF SPEIR TECHNOLOGIES LTD.		DEFENDANT APPLE INC.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 8,345,780	1/1/2013	SPEIR TECHNOLOGIES LTD.
2 7,321,777	1/22/2008	SPEIR TECHNOLOGIES LTD.
3		
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1		
2		
3		
4		
5		

In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE
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AO 120 (Rev. 08/10)

TO: Mail Stop 8 Director of the U.S. Patent and Trademark Office P.O. Box 1450 Alexandria, VA 22313-1450	REPORT ON THE FILING OR DETERMINATION OF AN ACTION REGARDING A PATENT OR TRADEMARK
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In Compliance with 35 U.S.C. § 290 and/or 15 U.S.C. § 1116 you are hereby advised that a court action has been filed in the U.S. District Court Eastern District of Texas on the following

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

DOCKET NO.	DATE FILED 12/30/2021	U.S. DISTRICT COURT Eastern District of Texas
PLAINTIFF SPEIR TECHNOLOGIES LTD.		DEFENDANT SAMSUNG ELECTRONICS CO., LTD. and SAMSUNG ELECTRONICS AMERICA, INC.
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 8,345,780	1/1/2013	SPEIR TECHNOLOGIES LTD.
2 7,110,779	9/16/2006	SPEIR TECHNOLOGIES LTD.
3 7,321,777	1/22/2008	SPEIR TECHNOLOGIES LTD.
4		
5		

In the above—entitled case, the following patent(s)/ trademark(s) have been included:

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

DECISION/JUDGEMENT

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

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