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571-272-7822

Paper 18
Entered: May 29, 2015

UNITED STATES PATENT AND TRADEMARK OFFICE

BEFORE THE PATENT TRIAL AND APPEAL BOARD

2WIRE, INC.,
Petitioner,

v.

TQ DELTA LLC,
Patent Owner.

Case IPR2015-00239
Patent 7,471,721 B2

Before KALYAN K. DESHPANDE, JUSTIN T. ARBES, and TREVOR M. JEFFERSON, *Administrative Patent Judges.*

ARBES, *Administrative Patent Judge.*

DECISION
Denying Institution of *Inter Partes* Review
37 C.F.R. § 42.108

Petitioner 2Wire, Inc. filed a Petition (Paper 2, "Pet.") to institute an *inter partes* review of claim 1 of U.S. Patent No. 7,471,721 B2 (Ex. 1001, "the '721 patent") pursuant to 35 U.S.C. §§ 311–19. Patent Owner TQ Delta LLC filed a Preliminary Response (Paper 11, "Prelim. Resp."). We have jurisdiction under 35 U.S.C. § 314. Pursuant to 35 U.S.C. § 314(a), the Director may not authorize an *inter partes* review unless the information in the petition and preliminary response "shows that there is a reasonable likelihood that the petitioner would prevail with respect to at least 1 of the claims challenged in the petition." For the reasons that follow, we have decided not to institute an *inter partes* review.

I. BACKGROUND

A. The '721 Patent

The '721 patent pertains to multicarrier communications systems, such as digital subscriber line (DSL) systems using discrete multitone modulation (DMT), where a transmitter communicates over a communication channel by modulating "[c]arrier signals (carriers) or sub-channels spaced within a usable frequency band of the communication channel." Ex. 1001, col. 1, ll. 25–31. In such a system, the phase and amplitude of the modulated carrier signals typically "can be considered random" because they "result from the modulation of an arbitrary sequence of input data bits comprising the transmitted information." *Id.* at col. 1, ll. 40–44. In some situations, however, the phases of the modulated carriers may combine to produce a spike in the transmitted signal, which increases the peak-to-average power ratio (PAR) of the signal, i.e., the "ratio of the instantaneous peak value (i.e., maximum magnitude) of a signal parameter

(e.g., voltage, current, phase, frequency, power) to the time-averaged value of the signal parameter." *Id.* at col. 1, l. 52–col. 2, l. 17. According to the '721 patent, PAR is an important consideration in designing a DMT communication system because an increased PAR can result in high power consumption or clipping of the transmission signal. *Id.* at col. 1, l. 67–col. 2, l. 19. Therefore, there was a need in the art for a system that can "effectively scramble the phase of the modulated carrier signals in order to provide a low PAR for the transmission signal." *Id.* at col. 2, ll. 20–22.

Figure 1 of the '721 patent is reproduced below.

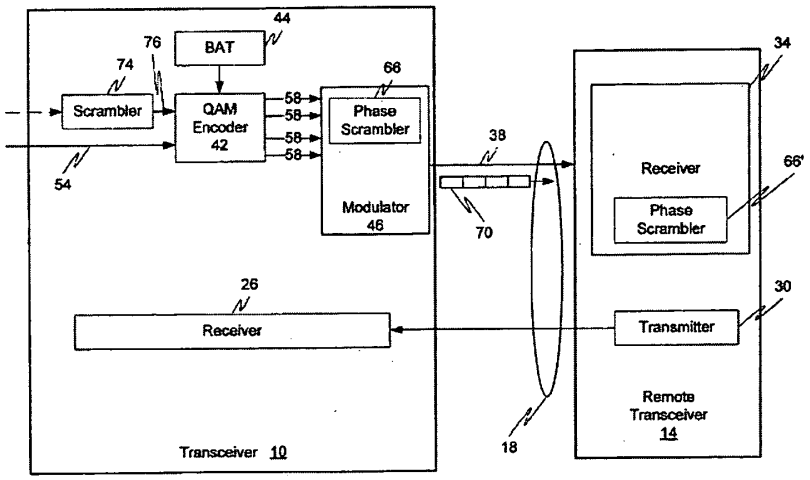

Fig. 1

Figure 1 above depicts transceiver 10 communicating transmission signal 38 over communication channel 18 (e.g., a pair of twisted wires of a telephone line) to remote transceiver 14. *Id.* at col. 3, ll. 18–43. Quadrature amplitude modulation (QAM) encoder 42 maps input serial data bit stream 54 in the time domain into parallel QAM symbols 58 in the frequency domain. *Id.* at col. 3, ll. 56–61. Modulator 46 modulates each carrier signal with a different

QAM symbol 58 so that the signals have the phase and amplitude associated with the respective QAM symbol 58 (and input serial bit stream 54). *Id.* at col. 4, ll. 3–15. Phase scrambler 66 in modulator 46 calculates a phase shift for each carrier signal and combines the calculated phase shift with the phase characteristic of the respective carrier signal. *Id.* at col. 4, ll. 41–64, col. 6, ll. 35–49. Phase scrambler 66 calculates the phase shift for a carrier signal by (1) determining one or more values "independently of the QAM symbols 58, and, therefore, independently of the bit value(s) modulated onto the carrier signal," and (2) solving a "predetermined equation" using the value associated with the carrier signal. *Id.* at col. 4, ll. 41–46, 57–60. For example, the value for a carrier signal may be "derived from one or more predefined parameters, such as a pseudo-random number generator." *Id.* at col. 4, ll. 46–51. According to the '721 patent, the use of a value determined independently of the input bit values results in a lower PAR for the transmission signal. *Id.* at col. 2, ll. 26–62. Transceiver 10 combines all of the carrier signals to form the transmission signal that is sent to remote transceiver 14. *Id.* at col. 8, ll. 18–23.

B. Challenged Claim

Claim 1 of the '721 patent recites:

> 1. In a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating an input bit stream, each carrier signal having a phase characteristic associated with the input bit stream, a method for scrambling the phase characteristics of the carrier signals comprising:

associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal;

computing a phase shift for each carrier signal based on the value associated with that carrier signal; and

combining the phase shift computed for each carrier signal with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristics of the plurality of carrier signals.

C. The Prior Art

Petitioner relies on the following prior art:

Alleged admitted prior art in the Specification of the '721 patent at col. 1, ll. 25–39, col. 3, ll. 18–29, and Fig. 1 (Ex. 1001, "Admitted Prior Art") (described at page 20 of the Petition);

U.S. Patent No. 5,694,415, issued Dec. 2, 1997 (Ex. 1009, "Suzuki '415");

U.S. Patent No. 5,903,614, issued May 11, 1999 (Ex. 1003, "Suzuki '614");

U.S. Patent No. 6,301,268 B1, filed Mar. 10, 1998, issued Oct. 9, 2001 (Ex. 1004, "Laroia");

U.S. Patent No. 6,781,951 B1, filed Oct. 22, 1999, issued Aug. 24, 2004 (Ex. 1008, "Fifield"); and

ANSI T1.413-1998, DRAFT AMERICAN NATIONAL STANDARD FOR TELECOMMUNICATIONS, NETWORK AND CUSTOMER INSTALLATION INTERFACES—ASYMMETRIC DIGITAL SUBSCRIBER LINE (ADSL) METALLIC INTERFACE (John Bingham & Frank Van der Putten, eds., 1998) (Ex. 1006, "T1.413").

D. The Asserted Grounds

Petitioner challenges claim 1 of the '721 patent on the following grounds:[1]

Reference(s)	Basis
Suzuki '614, Suzuki '415, and Admitted Prior Art	35 U.S.C. § 103(a)
Laroia, T1.413, and Admitted Prior Art	35 U.S.C. § 103(a)
Fifield and Suzuki '415	35 U.S.C. § 103(a)

E. Claim Interpretation

The Board interprets claims using the "broadest reasonable construction in light of the specification of the patent in which [they] appear[]." 37 C.F.R. § 42.100(b); *see* Office Patent Trial Practice Guide, 77 Fed. Reg. 48,756, 48,766 (Aug. 14, 2012); *In re Cuozzo Speed Techs., LLC*, 778 F.3d 1271, 1278–82 (Fed. Cir. 2015). Petitioner argues that no terms in claim 1 require interpretation. Pet. 18. Patent Owner proposes an interpretation for "a value determined independently of any input bit value." Prelim. Resp. 9–12. After reviewing the parties' papers, we determine that no claim terms require express interpretation for purposes of this Decision.

[1] Petitioner states that it "requests cancellation of claim 1 of the '721 patent as unpatentable under 35 U.S.C. §§ 102(b) and 103," but does not include any ground under 35 U.S.C. § 102(b) in its Petition. *See* Pet. 16–17.

II. DISCUSSION

A. Obviousness Based on Suzuki '614, Suzuki '415, and Admitted Prior Art

Petitioner contends that claim 1 is unpatentable over Suzuki '614, Suzuki '415, and Admitted Prior Art under 35 U.S.C. § 103(a). Pet. 30–38. Petitioner relies on Suzuki '614 for the limitations recited in the preamble of claim 1 (e.g., first and second transceivers, transmission signal having carrier signals) and "Suzuki '614 in combination with Suzuki '415" for the three steps of the recited method. *Id.* at 30–33. Petitioner provides a claim chart citing various portions of Suzuki '614 and Suzuki '415, and states that the claim chart is supported by the Declaration of Krista S. Jacobsen, Ph.D. *Id.* at 30, 34–38 (citing Ex. 1002 ¶¶ 158–93, App. A1). Petitioner also argues that "[t]o the extent that some claimed aspect of the transceiver or multicarrier modulation is considered missing in Suzuki '614 and Suzuki '415, it would have been obvious from the Admitted Prior Art in order to implement the multicarrier modulation and transmission disclosed in Suzuki '614," citing in particular the '721 patent's discussion of multicarrier transceivers using DMT modulation. *Id.* at 33 (citing Ex. 1002 ¶¶ 189–93).

We are not persuaded that Petitioner has established a reasonable likelihood of prevailing on its asserted ground based on Suzuki '614, Suzuki '415, and Admitted Prior Art. "Section 103(a) forbids issuance of a patent when '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.'" *KSR Int'l Co. v. Teleflex Inc.*, 550 U.S. 398, 405 (2007). A patent claim, however, "is not proved

obvious merely by demonstrating that each of its elements was, independently, known in the prior art." *Id.* at 418. "Rather, obviousness requires the additional showing that a person of ordinary skill at the time of the invention would have selected and combined those prior art elements in the normal course of research and development to yield the claimed invention." *Unigene Labs., Inc. v. Apotex, Inc.*, 655 F.3d 1352, 1360 (Fed. Cir. 2011). For an obviousness analysis, "it can be important to identify a reason that would have prompted a person of ordinary skill in the relevant field to combine the elements in the way the claimed new invention does." *KSR*, 550 U.S. at 418. Further, an assertion of obviousness "'cannot be sustained by mere conclusory statements; instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness.'" *Id.* (citing *In re Kahn*, 441 F.3d 977, 988 (Fed. Cir. 2006)).

Petitioner does not explain sufficiently in the Petition why a person of ordinary skill in the art would have had reason to combine the teachings of Suzuki '614, Suzuki '415, and Admitted Prior Art to achieve the method of claim 1. Petitioner merely alleges that the claim would have been "obvious" in view of the three items of prior art, and describes how Suzuki '614 and Suzuki '415 allegedly teach various aspects of the claims. *See* Pet. 30–33. For example, with respect to the step of "associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal," Petitioner acknowledges that Suzuki '614 does not "describe in detail" how the reference generates random phase shift data for each subcarrier, and argues that Suzuki '415 teaches the generation of M-bit random numbers, which, according to Petitioner, are "determined

independently of any input bit value" because they are random. *Id.* at 30–32 (citing Ex. 1009, col. 1, ll. 52–55, col. 3, ll. 25–30). Petitioner, however, does not identify in the Petition any reason why an ordinarily skilled artisan would have incorporated the phase shift calculations of Suzuki '415 into the system of Suzuki '614. The mere fact that Suzuki '614 does not explain its random phase shift data "in detail" does not mean that a person of ordinary skill in the art would have looked to the particular calculations of Suzuki '415. *See id.* at 31. Indeed, as Patent Owner correctly points out, Suzuki '614 only discloses the end result of phase shifts, without any detail as to how the phase shifts are calculated. *See* Prelim. Resp. 15–16; Ex. 1003, col. 6, l. 36–col. 7, l. 18, Fig. 6. Accordingly, Petitioner has not set forth, in the Petition, a rationale for combining the calculations of Suzuki '415 with Suzuki '614 in reaching a conclusion of obviousness.

Likewise, Petitioner does not explain sufficiently why a person of ordinary skill in the art would have had reason to combine any Admitted Prior Art teachings with those of Suzuki '614 and Suzuki '415. *See* Pet. 33. Petitioner merely states that to the extent any aspect of the claimed modulation is not taught by Suzuki '614 and Suzuki '415, it "would have been obvious from the Admitted Prior Art." *Id.* Accordingly, Petitioner has not provided, in the Petition, sufficient explanation of a reason to combine the various teachings of the prior art. *See* 37 C.F.R. § 42.104(b)(4)–(5); Prelim. Resp. 18–21.

We recognize that the Declaration of Dr. Jacobsen (Ex. 1002) includes additional discussion regarding the combination of Suzuki '614, Suzuki '415, and Admitted Prior Art. *See, e.g.*, Ex. 1002 ¶¶ 189–93. That analysis, however, is not discussed adequately in the Petition itself, as Petitioner only

includes blanket citations to thirty-six paragraphs and an eight-page appendix of the Declaration. *See* Pet. 30–33 (citing Ex. 1002 ¶¶ 158–93, App. A1). A petition seeking *inter partes* review must identify "[h]ow the construed claim is unpatentable under the statutory grounds identified" and "where each element of the claim is found in the prior art," and must explain the "relevance of the evidence to the challenge raised," because the Board may "give no weight to the evidence where a party has failed to state its relevance or to identify specific portions of the evidence that support the challenge." 37 C.F.R. § 42.104(b)(4)–(5); *see also* 37 C.F.R. § 42.22(a)(2) (a petition must include a "full statement of the reasons for the relief requested, including a detailed explanation of the significance of the evidence"). Dr. Jacobsen's analysis is not reflected in the Petition itself, and cannot be incorporated in the Petition by reference. *See* 37 C.F.R. § 42.6(a)(3) ("Arguments must not be incorporated by reference from one document into another document."); *Cisco Sys., Inc. v. C-Cation Techs., LLC*, Case IPR2014-00454, slip op. at 7–10 (PTAB Aug. 29, 2014) (Paper 12) (informative) (noting that "[o]ne purpose of the prohibition against incorporation by reference is to eliminate abuses" of the page limits established for the parties' substantive papers, and that citing "large portions of another document, without sufficient explanation of those portions, amounts to incorporation by reference"). Consequently, we do not consider information presented in the Declaration but not discussed sufficiently in the Petition.

Petitioner has not demonstrated a reasonable likelihood of prevailing on its assertion that claim 1 is unpatentable over Suzuki '614, Suzuki '415, and Admitted Prior Art.

B. Obviousness Based on Laroia, T1.413, and Admitted Prior Art

Petitioner's asserted ground of unpatentability based on Laroia, T1.413, and Admitted Prior Art under 35 U.S.C. § 103(a) suffers from the same deficiency as its ground based on Suzuki '614, Suzuki '415, and Admitted Prior Art. *See supra* Section II.A; Prelim. Resp. 28. Petitioner relies on Laroia for the majority of the limitations of claim 1, citing twenty paragraphs and a five-page appendix of Dr. Jacobsen's Declaration. *See* Pet. 39–44 (citing Ex. 1002 ¶¶ 194–213, App. B1). With respect to T1.413, Petitioner argues as follows:

> In addition, it would have been obvious to combine the network structures disclosed in T1.413 to implement them with the multicarrier modulation and transmission systems disclosed in Laroia. Laroia in combination with the T1.413 standard teach a multicarrier modulation transceiver, a multicarrier transceiver in a DSL system.

Id. at 39–40 (citations omitted). Thus, the only argument in the Petition as to why a person of ordinary skill in the art would have had reason to combine the teachings of T1.413 with those of Laroia is that it "would have been obvious" to combine the references. Such conclusory statements are insufficient. *See KSR*, 550 U.S. at 417–18; *Unigene*, 655 F.3d at 1360; *In re Chaganti*, 554 F. App'x 917, 922 (Fed. Cir. 2014) ("It is not enough to say that there would have been a reason to combine two references because to do so would 'have been obvious to one of ordinary skill.' Such circular reasoning is not sufficient—more is needed to sustain an obviousness rejection." (citation omitted)). Nor can Petitioner rely on the more detailed analysis of Dr. Jacobsen, as that analysis is not discussed or reflected in the arguments made in the Petition itself. *See* Pet. 39–44. Further, it is unclear what "network structures" in T1.413 Petitioner is relying on for the asserted

combination, as Petitioner cites four figures and four pages of the lengthy standard document without pointing out any specific features. *See id.* at 39, 42 (citing Ex. 1006, 10–13, Figs. 2–5). Petitioner has not shown sufficiently a reason to combine the teachings of Laroia and T1.413 or explained sufficiently what aspects of the references would be combined.

Finally, although the asserted ground is based on the combination of Laroia, T1.413, and Admitted Prior Art, Petitioner does not cite anything from the Admitted Prior Art in its analysis. *See id.* at 17, 39–44. Thus, Petitioner also has not shown sufficiently a reason to combine with respect to the Admitted Prior Art.

Accordingly, Petitioner has not demonstrated a reasonable likelihood of prevailing on its assertion that claim 1 is unpatentable over Laroia, T1.413, and Admitted Prior Art.

C. Obviousness Based on Fifield and Suzuki '415

Petitioner's asserted ground of unpatentability based on Fifield and Suzuki '415 under 35 U.S.C. § 103(a) is deficient as well. *See* Prelim. Resp. 30. Similar to its ground based on Suzuki '614, Suzuki '415, and Admitted Prior Art, Petitioner relies on Fifield for the limitations recited in the preamble of claim 1 (e.g., first and second transceivers, transmission signal having carrier signals), relies on "Fifield, in combination with Suzuki '415," for the three steps of the recited method, and cites twenty-five paragraphs and a nine-page appendix of Dr. Jacobsen's Declaration. Pet. 45–51 (citing Ex. 1002 ¶¶ 241–38, App. C1). In particular, Petitioner cites Suzuki '415's random number generation for the limitation of a "value determined independently of any input bit value." *Id.* at 46. Petitioner argues that

"[i]t would have been obvious to combine this disclosure of Suzuki '415 with Fifield in order to provide Fifield with a way of randomizing the phase shifts of its carriers," and that "[c]ombining Fifield with Suzuki '415's way of randomizing initial phase data of carriers will result in the 'substantial scrambling' described" in the Petition. *Id.* at 46–47. These statements, however, merely state the *result* of the asserted combination, i.e., Fifield's basic components performing the random number calculations described in Suzuki '415. They do not explain why a person of ordinary skill in the art would have considered making the combination. *See KSR*, 550 U.S. at 417–18; *Unigene*, 655 F.3d at 1360; *Chaganti*, 554 F. App'x at 922. Petitioner's conclusory statements and citations to Dr. Jacobsen's Declaration, without meaningful argument or explanation, are insufficient to meet its burden. Accordingly, Petitioner has not demonstrated a reasonable likelihood of prevailing on its assertion that claim 1 is unpatentable over Fifield and Suzuki '415.

D. Conclusion

We conclude that Petitioner has not demonstrated a reasonable likelihood that at least one of the challenged claims of the '721 patent is unpatentable based on the asserted grounds. Therefore, we do not institute an *inter partes* review on any of the asserted grounds as to any of the challenged claims.

III. ORDER

In consideration of the foregoing, it is hereby:

ORDERED that the Petition is denied as to all challenged claims of the '721 patent.

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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**

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 Transferred to Delaware from Alabama on the following

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
15-cv-121-RGA	7/17/2014	Transferred to Delaware from Alabama

PLAINTIFF	DEFENDANT
ADTRAN, Inc.	TQ Delta, LLC

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 See Attachment #1		
2		
3		
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In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☐ Amendment ☑ Answer ☐ Cross Bill ☐ Other Pleading	
3/13/2015		
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 See Attachment #2		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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

Attachment #1

Patent or Trademark No.	Date of Patent or Trademark	Holder of Patent or Trademark
1.U.S. 7,453,881 B2	11/18/2008	TQ Delta, LLC
2.U.S. 7,809,028 B2	10/05/2010	TQ Delta, LLC
3.U.S. 7,978,706 B2	7/12/2011	TQ Delta, LLC
4.U.S. 8,422,511 B2	4/16/2013	TQ Delta, LLC
5.U.S. 6,445,730 B1	9/03/2002	TQ Delta, LLC
6.U.S. 7,292,627 B2	11/6/2007	TQ Delta, LLC
7.U.S. 7,451,379 B2	11/11/2008	TQ Delta, LLC
8.U.S. 7,471,721 B2	12/30/2008	TQ Delta, LLC
9.U.S. 7,570,686 B2	8/4/2009	TQ Delta, LLC
10. U.S. 7,831,890 B2	11/09/2010	TQ Delta, LLC
11. U.S. 7,835,430 B2	11/16/2010	TQ Delta, LLC
12. U.S. 7,836,381 B1	11/16/2010	TQ Delta, LLC
13. U.S. 7,844,882 B2	11/30/2010	TQ Delta, LLC
14. U.S. 7,889,784 B2	2/15/2011	TQ Delta, LLC
15. U.S. 7,925,958 B2	04/12/2011	TQ Delta, LLC
16. U.S. 7,978,753 B2	07/12/2011	TQ Delta, LLC
17. U.S. 7,979,778 B2	07/12/2011	TQ Delta, LLC
18. U.S. 8,073,041 B1	12/6/2011	TQ Delta, LLC
19. U.S. 8,090,008 B2	1/3/2012	TQ Delta, LLC
20. U.S. 8,218,610 B2	7/10/2012	TQ Delta, LLC
21. U.S. 8,238,412 B2	08/07/2012	TQ Delta, LLC
22. U.S. 8,276,048 B2	09/25/2012	TQ Delta, LLC
23. U.S. 8,355,427 B2	1/15/2013	TQ Delta, LLC

24. U.S. 8,432,956 B2	4/30/2013	TQ Delta, LLC
25. U.S. 8,437,382 B2	5/7/2013	TQ Delta, LLC
26. U.S. 8,462,835 B2	6/11/2013	TQ Delta, LLC
27. U.S. 8,495,473 B2	7/23/2013	TQ Delta, LLC
28. U.S. 8,516,337 B2	08/20/2013	TQ Delta, LLC

Attachment #2

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 7,796,705 B2	9/14/2010	TQ Delta, LLC
2	US 8,335,956 B2	12/18/2012	TQ Delta, LLC
3	US 8,407,546 B2	3/26/2013	TQ Delta, LLC
4	US 8,468,411 B2	6/18/2013	TQ Delta, LLC
5	US 8,645,784 B2	2/4/2014	TQ Delta, LLC
6	US 8,595,577 B2	11/26/2013	TQ Delta, LLC

AO 120 (Rev. 08/10)

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

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

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	7/18/2014	District of Delaware

PLAINTIFF	DEFENDANT
TQ Delta, LLC	ADTRAN, Inc.

PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 See Attached		
2 32 Pats		
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DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
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Copy 2—Upon filing document adding patent(s), mail this copy to Director **Copy 4—Case file copy**

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2	US 8,073,041 B1	12/6/2011	TQ Delta, LLC
3	US 7,292,627 B2	11/6/2007	TQ Delta, LLC
4	US 7,471,721 B2	12/30/2008	TQ Delta, LLC
5	US 8,218,610 B2	7/10/2012	TQ Delta, LLC
6	US 8,355,427 B2	1/15/2013	TQ Delta, LLC
7	US 7,453,881 B2	11/18/2008	TQ Delta, LLC
8	US 7,809,028 B2	10/5/2010	TQ Delta, LLC
9	US 7,978,706 B2	7/12/2011	TQ Delta, LLC
10	US 8,422,511 B2	4/16/2013	TQ Delta, LLC
11	US 7,889,784 B2	2/15/2011	TQ Delta, LLC
12	US 7,835,430 B2	11/16/2010	TQ Delta, LLC
13	US 7,570,686 B2	8/4/2009	TQ Delta, LLC
14	US 8,238,412 B2	8/7/2012	TQ Delta, LLC
15	US 8,432,956 B2	4/30/2013	TQ Delta, LLC
16	US 7,451,379 B2	11/11/2008	TQ Delta, LLC
17	US 8,516,337 B2	8/20/2013	TQ Delta, LLC
18	US 7,979,778 B2	7/12/2011	TQ Delta, LLC
19	US 7,925,958 B2	4/12/2011	TQ Delta, LLC
20	US 8,462,835 B2	6/11/2013	TQ Delta, LLC
21	US 8,594,162 B2	11/26/2013	TQ Delta, LLC
22	US 7,978,753 B2	7/12/2011	TQ Delta, LLC
23	US 6,445,730 B1	9/3/2002	TQ Delta, LLC
24	US 8,611,404 B2	12/17/2013	TQ Delta, LLC
25	US 8,437,382 B2	5/7/2013	TQ Delta, LLC
26	US 7,836,381 B1	11/16/2010	TQ Delta, LLC
27	US 7,844,882 B2	11/30/2010	TQ Delta, LLC
28	US 8,276,048 B2	9/25/2012	TQ Delta, LLC
29	US 8,495,473 B2	7/23/2013	TQ Delta, LLC
30	US 8,607,126 B1	12/10/2013	TQ Delta, LLC
31	US 7,831,890 B2	11/9/2010	TQ Delta, LLC
32	US 8,625,660 B2	1/7/2014	TQ Delta, LLC

Birch, Melvin (Akima)

From: ded_nefreply@ded.uscourts.gov
Sent: Wednesday, November 20, 2013 4:56 PM
To: ded_ecf@ded.uscourts.gov
Subject: Activity in Case 1:13-cv-01835-RGA TQ Delta LLC v. Pace Americas Inc. Patent/Trademark Report to Commissioner

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*****NOTE TO PUBLIC ACCESS USERS*** Judicial Conference of the United States policy permits attorneys of record and parties in a case (including pro se litigants) to receive one free electronic copy of all documents filed electronically, if receipt is required by law or directed by the filer. PACER access fees apply to all other users. To avoid later charges, download a copy of each document during this first viewing. However, if the referenced document is a transcript, the free copy and 30 page limit do not apply.**

U.S. District Court

District of Delaware

Notice of Electronic Filing

The following transaction was entered by Farnan, Brian on 11/20/2013 at 4:56 PM EST and filed on 11/20/2013
Case Name: TQ Delta LLC v. Pace Americas Inc.
Case Number: 1:13-cv-01835-RGA
Filer:
Document Number: 7

Docket Text:
Report to the Commissioner of Patents and Trademarks for Patent/Trademark Number(s) US 8,090,008 B2; US 8,073,041 B1; US 7,292,627 B2; US 7,471,721 B2; US 8,218,610 B2; US 8,355,427 B2; US 7,453,881 B2; US 7,978,706 B2; US 8,422,511 B2; US 7,889,784 B2; US 7,835,430 B2; US 7,570,686 B2; US 8,238,412 B2; US 8,432,956 B2; US 7,451,379 B2; US 8,516,337 B2; US 7,979,778 B2; US 7,925,958 B2; US 8,462,835 B2; US 7,836,381 B1; US 7,844,882 B2; US 8,276,048 B2; US 8,495,473 B2; US 7,831,890 B2; . (Farnan, Brian)

1:13-cv-01835-RGA Notice has been electronically mailed to:

Brian E. Farnan bfarnan@farnanlaw.com, tfarnan@farnanlaw.com

Michael J. Farnan mfarnan@farnanlaw.com, tfarnan@farnanlaw.com

1:13-cv-01835-RGA Filer will deliver document by other means to:

The following document(s) are associated with this transaction:

From: ded_nefreply@ded.uscourts.gov
Sent: Wednesday, November 20, 2013 5:07 PM
To: ded_ecf@ded.uscourts.gov
Subject: Activity in Case 1:13-cv-01836-RGA TQ Delta LLC v. Zhone Technologies Inc. Patent/Trademark Report to Commissioner

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U.S. District Court

District of Delaware

Notice of Electronic Filing

The following transaction was entered by Farnan, Brian on 11/20/2013 at 5:07 PM EST and filed on 11/20/2013
Case Name: TQ Delta LLC v. Zhone Technologies Inc.
Case Number: 1:13-cv-01836-RGA
Filer:
Document Number: 7

Docket Text:
Report to the Commissioner of Patents and Trademarks for Patent/Trademark Number(s) US 8,090,008 B2; US 8,073,041 B1; US 7,292,627 B2; US 7,471,721 B2; US 8,218,610 B2; US 8,355,427 B2; US 7,453,881 B2; US 7,809,028 B2; US 7,978,706 B2; US 8,422,511 B2; US 7,796,705 B2; US 7,889,784 B2; US 7,835,430 B2; US 7,570,686 B2; US 8,238,412 B2; US 8,432,956 B2; US 7,451,379 B2; US 8,516,337 B2; US 7,979,778 B2; US 7,925,958 B2; US 8,462,835 B2; US 7,978,753 B2; US 6,445,730 B1; US 8,437,382 B2; US 7,836,381 B1; US 7,844,882 B2; US 8,276,048 B2; US 8,495,473 B2; US 7,831,890 B2; US 8,335,956 B2; US 8,468,411 B2; US 8,407,546 B2 . (Farnan, Brian)

1:13-cv-01836-RGA Notice has been electronically mailed to:

Brian E. Farnan bfarnan@farnanlaw.com, tfarnan@farnanlaw.com

Michael J. Farnan mfarnan@farnanlaw.com, tfarnan@farnanlaw.com

1:13-cv-01836-RGA Filer will deliver document by other means to:

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	12/9/2013	District of Delaware

PLAINTIFF	DEFENDANT
TQ Delta, LLC	ZyXEL Communications Corporation and ZyXEL Communications, Inc.

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	See Attached		
2			
3			
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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		
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In the above—entitled case, the following decision has been rendered or judgement issued:

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 8,090,008 B2	1/3/2012	TQ Delta, LLC
2	US 8,073,041 B1	12/6/2011	TQ Delta, LLC
3	US 7,292,627 B2	11/6/2007	TQ Delta, LLC
4	US 7,471,721 B2	12/30/2008	TQ Delta, LLC
5	US 8,218,610 B2	7/10/2012	TQ Delta, LLC
6.	US 8,355,427 B2	1/15/2013	TQ Delta, LLC
7	US 7,453,881 B2	11/18/2008	TQ Delta, LLC
8	US 7,809,028 B2	10/5/2010	TQ Delta, LLC
9	US 7,978,706 B2	7/12/2011	TQ Delta, LLC
10	US 8,422,511 B2	4/16/2013	TQ Delta, LLC
11	US 7,796,705 B2	9/14/2010	TQ Delta, LLC
12	US 7,889,784 B2	2/15/2011	TQ Delta, LLC
13	US 7,835,430 B2	11/16/2010	TQ Delta, LLC
14	US 7,570,686 B2	8/4/2009	TQ Delta, LLC
15	US 8,238,412 B2	8/7/2012	TQ Delta, LLC
16	US 8,432,956 B2	4/30/2013	TQ Delta, LLC
17	US 7,451,379 B2	11/11/2008	TQ Delta, LLC
18	US 8,516,337 B2	8/20/2013	TQ Delta, LLC
19	US 7,979,778 B2	7/12/2011	TQ Delta, LLC
20	US 7,925,958 B2	4/12/2011	TQ Delta, LLC
21	US 8,462,835 B2	6/11/2013	TQ Delta, LLC
22	US 7,978,753 B2	7/12/2011	TQ Delta, LLC
23	US 6,445,730 B1	9/3/2002	TQ Delta, LLC
24	US 8,437,382 B2	5/7/2013	TQ Delta, LLC
25	US 7,836,381 B1	11/16/2010	TQ Delta, LLC
26	US 7,844,882 B2	11/30/2010	TQ Delta, LLC
27	US 8,276,048 B2	9/25/2012	TQ Delta, LLC
28	US 8,495,473 B2	7/23/2013	TQ Delta, LLC
29	US 7,831,890 B2	11/9/2010	TQ Delta, LLC
30	US 8,335,956 B2	12/18/2012	TQ Delta, LLC
31	US 8,468,411 B2	6/18/2013	TQ Delta, LLC
32	US 8,407,546 B2	3/26/2013	TQ Delta, LLC

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
3:12-cv-1462-L	5/10/2012	Northern District of Texas, Dallas Division

PLAINTIFF	DEFENDANT
Boulle Ltd	De Boulle Diamond & Jewelry Inc

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	4,086,050	1/17/2012	Boulle Ltd
2			
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In the above—entitled case, the following patent(s)/ trademark(s) have been included:

DATE INCLUDED	INCLUDED BY ☑ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
12/9/2013		
PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1 3,078,625	4/11/2006	De Boulle Diamond & Jewelry Inc
2 3,078,627	4/11/2006	De Boulle Diamond & Jewelry Inc
3		
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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
Karen Mitchell	s/A. Lowe-Monserrate	12/10/2013

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**

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	11/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
TQ Delta, LLC	Pace Americas, Inc.

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

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

DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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

	PATENT OR TRADEMARK NO.	DATE OF PATENT OR TRADEMARK	HOLDER OF PATENT OR TRADEMARK
1	US 8,090,008 B2	1/3/2012	TQ Delta, LLC
2	US 8,073,041 B1	12/6/2011	TQ Delta, LLC
3	US 7,292,627 B2	11/6/2007	TQ Delta, LLC
4	US 7,471,721 B2	12/30/2008	TQ Delta, LLC
5	US 8,218,610 B2	7/10/2012	TQ Delta, LLC
6.	US 8,355,427 B2	1/15/2013	TQ Delta, LLC
7	US 7,453,881 B2	11/18/2008	TQ Delta, LLC
8	US 7,978,706 B2	7/12/2011	TQ Delta, LLC
9	US 8,422,511 B2	4/16/2013	TQ Delta, LLC
10	US 7,889,784 B2	2/15/2011	TQ Delta, LLC
11	US 7,835,430 B2	11/16/2010	TQ Delta, LLC
12	US 7,570,686 B2	8/4/2009	TQ Delta, LLC
13	US 8,238,412 B2	8/7/2012	TQ Delta, LLC
14	US 8,432,956 B2	4/30/2013	TQ Delta, LLC
15	US 7,451,379 B2	11/11/2008	TQ Delta, LLC
16	US 8,516,337 B2	8/20/2013	TQ Delta, LLC
17	US 7,979,778 B2	7/12/2011	TQ Delta, LLC
18	US 7,925,958 B2	4/12/2011	TQ Delta, LLC
19	US 8,462,835 B2	6/11/2013	TQ Delta, LLC

AO 120 (Rev. 08/10)

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

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

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

DOCKET NO.	DATE FILED	U.S. DISTRICT COURT
	11/4/2013	District of Delaware

PLAINTIFF	DEFENDANT
TQ Delta, LLC	Zhone Technologies, Inc.

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

DATE INCLUDED	INCLUDED BY ☐ Amendment ☐ Answer ☐ Cross Bill ☐ Other Pleading	
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DECISION/JUDGEMENT

CLERK	(BY) DEPUTY CLERK	DATE

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2	US 8,073,041 B1	12/6/2011	TQ Delta, LLC
3	US 7,292,627 B2	11/6/2007	TQ Delta, LLC
4	US 7,471,721 B2	12/30/2008	TQ Delta, LLC
5	US 8,218,610 B2	7/10/2012	TQ Delta, LLC
6.	US 8,355,427 B2	1/15/2013	TQ Delta, LLC
7	US 7,453,881 B2	11/18/2008	TQ Delta, LLC
8	US 7,809,028 B2	10/5/2010	TQ Delta, LLC
9	US 7,978,706 B2	7/12/2011	TQ Delta, LLC
10	US 8,422,511 B2	4/16/2013	TQ Delta, LLC
11	US 7,796,705 B2	9/14/2010	TQ Delta, LLC
12	US 7,889,784 B2	2/15/2011	TQ Delta, LLC
13	US 7,835,430 B2	11/16/2010	TQ Delta, LLC
14	US 7,570,686 B2	8/4/2009	TQ Delta, LLC
15	US 8,238,412 B2	8/7/2012	TQ Delta, LLC
16	US 8,432,956 B2	4/30/2013	TQ Delta, LLC
17	US 7,451,379 B2	11/11/2008	TQ Delta, LLC
18	US 8,516,337 B2	8/20/2013	TQ Delta, LLC
19	US 7,979,778 B2	7/12/2011	TQ Delta, LLC
20	US 7,925,958 B2	4/12/2011	TQ Delta, LLC
21	US 8,462,835 B2	6/11/2013	TQ Delta, LLC
22	US 7,978,753 B2	7/12/2011	TQ Delta, LLC
23	US 6,445,730 B1	9/3/2002	TQ Delta, LLC
24	US 8,437,382 B2	5/7/2013	TQ Delta, LLC

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/863,581	09/28/2007	Marcos C. Tzannes	6936-47-CON-2

CONFIRMATION NO. 1948

POWER OF ATTORNEY NOTICE

62574
Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

OC000000057585622

Date Mailed: 11/14/2012

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/07/2012.

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

/deelliott/

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/863,581	09/28/2007	Marcos C. Tzannes	

CONFIRMATION NO. 1948

POA ACCEPTANCE LETTER

62574
Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

OC000000057585835

Date Mailed: 11/14/2012

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 11/07/2012.

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

/deelliott/

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/863,581	09/28/2007	Marcos C. Tzannes	6936-47-CON-2

CONFIRMATION NO. 1948

POWER OF ATTORNEY NOTICE

62574
Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

Date Mailed: 11/14/2012

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/deelliott/

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

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

POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

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

I hereby appoint:

■ Practitioners associated with Customer Number: 62574

OR

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

Name	Registration Number	Name	Registration Number

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

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

■ The address associated with Customer Number: 62574

OR

☐

Firm or Individual Name			
Address			
City		State	Zip
Country			
Telephone		Email	

Assignee Name and Address: TQ DELTA, LLC
805 Las Cimas Parkway, Suite 240
Austin, Texas 78746

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

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

Signature	Mark K. Roche	Date	10/4/12
Name	Mark K. Roche	Telephone	512-609-1810
Title	Managing Director		

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

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

Electronic Acknowledgement Receipt

EFS ID:	14170452
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Joanne Vos
Filer Authorized By:	Jason Vick
Attorney Docket Number:	6936-47-CON-2
Receipt Date:	07-NOV-2012
Filing Date:	28-SEP-2007
Time Stamp:	14:20:32
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		EntityStatus_373c_w_POA.pdf	419344 1779d27e4c99da87a8c9dc4ea5acf99ca3fefd5f	yes	4

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Miscellaneous Incoming Letter	1	1
	Assignee showing of ownership per 37 CFR 3.73.	2	3
	Power of Attorney	4	4
Warnings:			
Information:			
	Total Files Size (in bytes):	419344	

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

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

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of: Marcos C. Tzannes	Patent No.: 7,471,721
Application No.: 11/863,581	Issued: December 30, 2008
Filed: September 28, 2007	Examiner: WILLIAMS, Lawrence
Atty. File No.: 6936-47-CON-2	Confirmation No.: 1948

For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

ASSERTION OF ENTITLEMENT TO SMALL ENTITY STATUS

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

Madam:

In accordance with MPEP §§ 509.02 and 509.03 and 37 CFR 1.27, this document is being filed to inform the U.S. Patent Office of the change of status for the above-identified patent from large entity status to small entity status. All fees paid to date have been paid as large entity status. No fees have yet been paid as small entity status. Due to the sale of the referenced patent, the Applicant is now entitled to small entity status.

We respectfully request that small entity status be granted for the above-referenced patent.

Please contact the undersigned if there are any questions regarding this notification.

Respectfully submitted,

SHERIDAN ROSS P.C.

Date: JAN 12

By: _____

Jason H. Vick
Reg. No. 45,285
1560 Broadway, Suite 1200
Denver, Colorado 80202
Telephone: 303-863-9700

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: TQ DELTA, LLC

Application No./Patent No.: 7,471,721 Filed/Issue Date: December 30, 2008

Titled: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

TQ DELTA, LLC, a Corporation

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

states that, for the patent application/patent identified above, it is (choose **one** of options 1, 2, 3 or 4 below):

1. ☑ The assignee of the entire right, title, and interest.

2. ☐ An assignee of less than the entire right, title, and interest (check applicable box):

   ☐ The extent (by percentage) of its ownership interest is _____%. Additional Statement(s) by the owners holding the balance of the interest must be submitted to account for 100% of the ownership interest.

   ☐ There are unspecified percentages of ownership. The other parties, including inventors, who together own the entire right, title and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

3. ☐ The assignee of an undivided interest in the entirety (a complete assignment from one of the joint inventors was made). The other parties, including inventors, who together own the entire right, title, and interest are:

   Additional Statement(s) by the owner(s) holding the balance of the interest must be submitted to account for the entire right, title, and interest.

4. ☐ The recipient, via a court proceeding or the like (*e.g.*, bankruptcy, probate), of an undivided interest in the entirety (a complete transfer of ownership interest was made). The certified document(s) showing the transfer is attached.

The interest identified in option 1, 2 or 3 above (not option 4) is evidenced by either (choose **one** of options A or B below):

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

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

1. From: Marcos C. Tzannes To: AWARE, INC.

   The document was recorded in the United States Patent and Trademark Office at

   Reel 010877, Frame 0307, or for which a copy thereof is attached.

2. From: AWARE, INC. To: TQ DELTA, LLC

   The document was recorded in the United States Patent and Trademark Office at

   Reel 029154, Frame 0937, or for which a copy thereof is attached.

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

STATEMENT UNDER 37 CFR 3.73(c)

3. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

4. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

5. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

6. From: _____ To: _____

The document was recorded in the United States Patent and Trademark Office at

Reel _____, Frame _____, or for which a copy thereof is attached.

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

☑ As required by 37 CFR 3.73(c)(1)(i), the documentary evidence of the chain of title from the original owner to the assignee was, or concurrently is being, submitted for recordation pursuant to 37 CFR 3.11.

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

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

Signature	7 Nov '12 Date
Jason H. Vick Printed or Typed Name	45,285 Title or Registration Number

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 7,471,721 B2
APPLICATION NO. : 11/863581
DATED : December 30, 2008
INVENTOR(S) : Marcos C. Tzannes

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

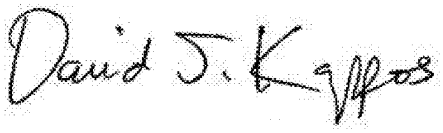
On the Title Page, please add:

item (60);
Provisional application No. 60/164,134, filed Nov. 9, 1999.

item (63);
Related U.S. Application Data:

Continuation of application No. 11/211,535, filed on Aug. 26, 2005, now Pat. No. 7,292,627, which is a continuation of application No. 09/710,310, filed on Nov. 9, 2000, now Pat. No. 6,961,369.

Signed and Sealed this
Twenty-second Day of March, 2011



David J. Kappos
Director of the United States Patent and Trademark Office

SPE RESPONSE FOR CERTIFICATE OF CORRECTION

Paper No.: 6

DATE : 11/30/10

TO SPE OF : ART UNIT 2611

SUBJECT : Request for Certificate of Correction for Appl. No.: 11863581 Patent No.: 7471721

Please respond to this request for a certificate of correction within 7 days.

FOR IFW FILES:

Please review the requested changes/corrections as shown in the **COCIN** document(s) in the IFW application image. No new matter should be introduced, nor should the scope or meaning of the claims be changed.

Please complete the response (see below) and forward the completed response to scanning using document code **COCX**.

FOR PAPER FILES:

Please review the requested changes/corrections as shown in the attached certificate of correction. Please complete this form (see below) and forward it with the file to:

Certificates of Correction Branch (C of C)
Randolph Square 9D40-D
Palm Location 7580
You can fax the Directors/SPE response to 571-270-9990

Lamonte Newsome
Certificates of Correction Branch
571-272-3421

Thank You For Your Assistance

The request for issuing the above-identified correction(s) is hereby:
Note your decision on the appropriate box.

- ☒ **Approved** — **All** changes apply.
- ☐ **Approved in Part** — Specify below which changes **do not** apply.
- ☐ **Denied** — State the reasons for denial below.

Comments: Corrections do not change scope of claims.

KM 12/1/2010

SPE Art Unit

PTOL-306 (REV. 7/03) U.S. DEPARTMENT OF COMMERCE Patent and Trademark Office

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

62574 7590 12/10/2010

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
WILLIAMS, LAWRENCE B	
ART UNIT	PAPER NUMBER
2611	

NOTIFICATION DATE	DELIVERY MODE
12/10/2010	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):

jvick@sheridanross.com

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
11863581	9/28/07	TZANNES, MARCOS C.	5550-47-CON-2

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
LAWRENCE B. WILLIAMS	
ART UNIT	**PAPER**
2611	6

DATE MAILED:

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

Commissioner for Patents

Attached SPE Response for Certiciate of Correction dated 12/1/2010.

/Mohammad H Ghayour/
Supervisory Patent Examiner, Art Unit 2611

/Lawrence B Williams/
Examiner, Art Unit 2611

PTO-90C (Rev.04-03)

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of: Marcos C. Tzannes

Patent No.: 7,471,721

Issued: December 30, 2008

Confirmation No.: 1948

Atty. File No.: 5550-47-CON-2

For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

REQUEST FOR CERTIFICATE OF CORRECTION OF PATENT FOR OFFICE'S MISTAKE (37 CFR 1.322)

Attn: Certificate of Corrections Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

This is a request for a Certificate of Correction under 37 C.F.R. 1.322. Attached is form PTO/SB/44. The **Related U.S. Application Data** was erroneously omitted from the cover page of the issued patent. The Related U.S. Application Data can be found on the Application Data Sheet which was filed with the application on September 28, 2007, the Updated Filing Receipt, date December 17, 2007, and the cover page of the published application.

Applicants believe no fees or petitions are required. However, if any such petitions or fees are necessary, the Commissioner is hereby authorized to charge to deposit account number 19-1970 any fees under 37 CFR § 1.16 and 1.17 that may be required by this paper and to credit any overpayment to that Account. If any extension of time is required in connection with the filing of this paper and has not been separately requested, such extension is hereby petitioned.

Respectfully submitted,

SHERIDAN ROSS P.C.

Date: 21 Nov 18

By: _____

Jason H. Vick
Reg. No. 45,285
1560 Broadway, Suite 1200
Denver, Colorado 80202
Telephone: 303-863-9700

PTO/SB/44 (09-07)
Approved for use through 08/31/2013. OMB 0651-0033
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 7,471,721 B2

APPLICATION NO.: 11/863,581

ISSUE DATE : December 30, 2008

INVENTOR(S) : Marcos C. Tzannes

It is certified that an error appears or errors appear in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the Cover Page, please add:

Related U.S. Application Data:

Continuation of application No. 11/211,535, filed on Aug. 26, 2005, now Pat. No. 7,292,627, which is a continuation of application No. 09/710,310, filed on Nov. 9, 2000,. now Pat. No. 6,961,369.

Provisional application No. 60/164,134, filed Nov. 9, 1999.

MAILING ADDRESS OF SENDER (Please do not use customer number below):

Jason H. Vick, c/o Sheridan Ross, P.C.
1560 Broadway, Suite 1200
Denver, CO 80202

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.

Electronic Acknowledgement Receipt	
EFS ID:	8912944
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Joanne Vos
Filer Authorized By:	Jason Vick
Attorney Docket Number:	5550-47-CON-2
Receipt Date:	24-NOV-2010
Filing Date:	28-SEP-2007
Time Stamp:	16:37:14
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	Request for Certificate of Correction	Request_For_Certificate_of_Correction.pdf	328498 b2a817ba38d409bf1c1e05bd533efa31d713f4d4	no	4
Warnings:					
Information:					

Total Files Size (in bytes):	328498

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

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

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	12/30/2008	7471721	5550-47-CON-2	1948

62574 7590 12/10/2008

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

ISSUE NOTIFICATION

The projected patent number and issue date are specified above.

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

The Patent Term Adjustment is 0 day(s). Any patent to issue from the above-identified application will include an indication of the adjustment on the front page.

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

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

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

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

Marcos C. Tzannes, Orinda, CA;

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

62574 7590 12/08/2008

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
WILLIAMS, LAWRENCE B	
ART UNIT	PAPER NUMBER
2611	

NOTIFICATION DATE	DELIVERY MODE
12/08/2008	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):

jvick@sheridanross.com

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
11863581	9/28/07	TZANNES, MARCOS C.	5550-47-CON-2

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
LAWRENCE B. WILLIAMS	
ART UNIT	**PAPER**
2611	5

DATE MAILED:

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

Commissioner for Patents

Reviewed and Initialed IDS dated 10/17/2008.
Attached: signed 1449

/Mohammad H Ghayour/
Supervisory Patent Examiner, Art Unit 2611

PTO-90C (Rev.04-03)

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	WILLIAMS, LAWRENCE B
Sheet	1	of	1	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/L.W./		WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	

Examiner Signature	/Lawrence Williams/	Date Considered	11/29/2008

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

62574 7590 12/04/2008

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
WILLIAMS, LAWRENCE B	
ART UNIT	PAPER NUMBER
2611	

NOTIFICATION DATE	DELIVERY MODE
12/04/2008	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):

jvick@sheridanross.com

UNITED STATES DEPARTMENT OF COMMERCE
U.S. Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450

APPLICATION NO./ CONTROL NO.	FILING DATE	FIRST NAMED INVENTOR / PATENT IN REEXAMINATION	ATTORNEY DOCKET NO.
11863581	9/28/07	TZANNES, MARCOS C.	5550-47-CON-2

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
LAWRENCE B. WILLIAMS	
ART UNIT	**PAPER**
2611	4

DATE MAILED:

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

Commissioner for Patents

Reviewed and initialed IDS dated 10/17/2008.
Attachment: Signed 1449

/Tesfaldet Bocure/
Primary Examiner, Art Unit 2611

PTO-90C (Rev.04-03)

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	WILLIAMS, LAWRENCE B
Sheet	1	of	1	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/L.W./		WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	/Lawrence Williams/ 11/21/2008

Examiner Signature		Date Considered	

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

Bib Data Sheet

CONFIRMATION NO. 1948

SERIAL NUMBER	FILING OR 371(c) DATE / RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/863,581	09/28/2007	375	2611	5550-47-CON-2

APPLICANTS
Marcos C. Tzannes, Orinda, CA;

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

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

IF REQUIRED, FOREIGN FILING LICENSE GRANTED
** 10/11/2007

Foreign Priority claimed	35 USC 119 (a-d) conditions met	Verified and Acknowledged	STATE OR COUNTRY	SHEETS DRAWING	TOTAL CLAIMS	INDEPENDENT CLAIMS
☐ yes ☒ no	☐ yes ☒ no ☐ Met after Allowance	Examiner's Signature Initials	CA	2	5	1

ADDRESS
62574

TITLE
SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

FILING FEE RECEIVED	FEES: Authority has been given in Paper No. _____ to charge/credit DEPOSIT ACCOUNT No. _____ for following:
1300	☐ All Fees ☐ 1.16 Fees (Filing) ☐ 1.17 Fees (Processing Ext. of time) ☐ 1.18 Fees (Issue) ☐ Other _____ ☐ Credit

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)

62574 7590 10/08/2008

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

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

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

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

TITLE OF INVENTION: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
nonprovisional	NO	$1510	$300	$0	$1810	01/08/2009

EXAMINER	ART UNIT	CLASS-SUBCLASS
WILLIAMS, LAWRENCE B	2611	375-222000

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

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

1 SHERIDAN ROSS P.C.
2 Jason H. Vick
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: Aware, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): Bedford, MA

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 19-1970 (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 20 Oct 08

Typed or printed name Jason H. Vick Registration No. 45,285

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.

Electronic Patent Application Fee Transmittal	
Application Number:	11863581
Filing Date:	28-Sep-2007
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Filer:	Jason Vick/Christine Jacquet
Attorney Docket Number:	5550-47-CON-2
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:				
Publ. Fee- early, voluntary, or normal	1504	1	300	300
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1510	1510

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

Electronic Acknowledgement Receipt	
EFS ID:	4144470
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Christine Jacquet
Filer Authorized By:	Jason Vick
Attorney Docket Number:	5550-47-CON-2
Receipt Date:	20-OCT-2008
Filing Date:	28-SEP-2007
Time Stamp:	18:14:15
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1810
RAM confirmation Number	3996
Deposit Account	191970
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 1.19 (Document supply fees) 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)	ISSUE_FEE_PYMNT.pdf	161123 8def5c212f689cee9326b55fb94790fb5877b093	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-06)	fee-info.pdf	32429 e9a4252a2100152475202de9380325a3533f326b	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	193552		

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

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

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:	)	Group Art Unit: 2611
	)	
Tzannes	)	Examiner: WILLIAMS, LAWRENCE B
	)	
Serial No.: 11/863,581	)	Confirmation No.: 1948
	)	
Filed: 09-28-2007	)	REQUEST FOR CONSIDERATION OF
	)	REFERENCE IN INFORMATION
Atty. File No.: 5550-47-CON-2	)	DISCLOSURE STATEMENT
	)	SUBMITTED OCTOBER 18, 2007
For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	)	Electronically Submitted

Mail Stop Issue Fee
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

On October 18, 2007, Applicant submitted an Information Disclosure Statement in the above-identified patent application. The Information Disclosure Statement is attached hereto as Exhibit A.

On February 6, 2008, the Examiner issued an Official Action for the above-identified case. The Official Action was accompanied by a List Of References Cited By Applicant And Considered By Examiner. This list included the aforementioned Information Disclosure Statement of October 18, 2007, but WIPO Patent Publication No. WO 99/29078 was not initialed. The List Of References Cited By Applicant And Considered By Examiner, is attached hereto as Exhibit B.

Due to the fact that the Information Disclosure Statement of October 18, 2007, was correctly submitted to the USPTO, Applicant hereby respectfully requests that WIPO Patent Publication No. WO 99/29078 be considered by the Examiner. For the convenience of the Examiner, a copy of WIPO Patent Publication No. WO 99/29078 and an empty 1449 form listing WIPO Patent Publication No. WO 99/29078 are enclosed herewith as Exhibit C.

Although no fees are believed due in connection with this communication, please charge any fees deemed necessary to Deposit Account No. 19-1970. If additional information is required please contact the undersigned.

Respectfully submitted,

SHERIDAN ROSS P.C.

By:_____

Jason H. Vick
Registration No. 45,285
1560 Broadway, Suite 1200
Denver, Colorado 80202-5141
(303) 863-9700

Date: 12 Oct 08

Exhibit A

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:	Group Art Unit: 2611
Tzannes	Confirmation No.: 1948
Serial No.: 11/863,581	Examiner: Not yet assigned
Filed: 09-28-2007	INFORMATION DISCLOSURE STATEMENT
Atty. File No.: 5550-47-CON-2	Electronically Submitted
For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	

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

Dear Sir:

The references cited on attached Form PTO-SB08 are being called to the attention of the Examiner.

☒ Copies of cited non-patent and/or foreign references nos. 22-24 are enclosed herewith.

☐ Copies of the cited U.S. patents and/or patent applications are enclosed herewith.

☒ Copies of the cited U.S. patents/patent application publications are not enclosed in accordance with 37 C.F.R. § 1.98(a).

☒ Copies of cited references nos. 14-21 are not enclosed, in accordance with 37 C.F.R. § 1.98(d), because the references were cited by or submitted to the U.S. Patent and Trademark Office in prior application Serial No. 11/211535 filed 08-26-2005, which is relied upon for an earlier filing date under 35 U.S.C. § 120.

☐ To the best of applicants' belief, the pertinence of the foreign-language references are believed to be summarized in the attached English abstracts and in the figures, although applicants do not necessarily vouch for the accuracy of the translation.

☒ Examiner's attention is drawn to the following co-pending applications,:

Serial No. 11/211535 filed 08-26-2005

Serial No. 11/860080 filed 09-24-2007

☐ Other:_____

Submission of the above information is not intended as an admission that any item is citable under the statutes or rules to support a rejection, that any item disclosed represents analogous art, or that those skilled in the art would refer to or recognize the pertinence of any reference without the benefit of hindsight, nor should an inference be drawn as to the pertinence of the references based on the order in which they are presented. Submission of this statement should not be taken as an indication that a search has been conducted, or that no better art exists.

It is respectfully requested that the cited information be expressly considered during the prosecution of this application and the references made of record therein.

FEES

☒	**37 CFR 1.97(b)**: No fee is believed due in connection with this submission, because the information disclosure statement submitted herewith is satisfies one of the following conditions ("X" indicates satisfaction): ☒ Within three months of the filing date of a national application other than a continued prosecution application under 37 CFR 1.53(d), or ☐ Within three months of the date of entry into the national stage of an international application as set forth in 37 CFR 1.491 or ☐ Before the mailing date of a first Office Action on the merits, or ☐ Before the mailing of a first Office action after the filing of a request for continued examination under 37 CFR 1.114. Although no fee is believed due, if any fee is deemed due in connection with this submission, please charge such fee to Deposit Account 19-1970.
☐	**37 CFR 1.97(c)**: The information disclosure statement transmitted herewith is being filed after all the above conditions (37 CFR 1.97(b)), but before the mailing date of one of the following conditions: (1) a final action under 37 C.F.R. 1.113 or (2) a notice of allowance under 37 C.F.R. 1.311, or (3) an action that otherwise closes prosecution in the application. This Information Disclosure Statement is accompanied by: ☐ A Certification (below) as specified by 37 C.F.R. 1.97(e). Although no fee is believed due, if any fee is deemed due in connection with this submission, please charge such fee to Deposit Account 19-1970. OR ☐ Please charge Deposit Account 19-1970 in the amount of $180.00 for the fee set forth in 37 C.F.R. 1.17(p) for submission of an information disclosure statement. Please credit any overpayment or charge any underpayment to Deposit Account 19-1970.
☐	**37 CFR 1.97(d)**: This Information Disclosure Statement is being submitted after the period specified in 37 CFR 1.97(c). ☐ This information Disclosure Statement includes a Certification (below) as specified by 37 C.F.R. 1.97(e) AND ☐ Applicants hereby requests consideration of the reference(s) disclosed herein. Please charge Deposit Account 19-1970 in the amount of $180.00 under 37 C.F.R. 1.17(p). Please credit any overpayment or charge any underpayment to Deposit Account 19-1970. Election to pay the fee should not be taken as an indication that applicant(s) cannot execute a certification.

Certification (37 C.F.R. 1.97(e))
(Applicable only if checked)

☐ The undersigned certifies that:

☐ Each item of information contained in this information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement. 37 C.F.R. 1.97(e)(1).

☐ A copy of the communication from the foreign patent office is enclosed.

OR

☐ No item of information contained in this information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned after making reasonable inquiry, no item of information contained in this Information Disclosure Statement was known to any individual designated in 37 C.F.R. 1.56(c) more than three months prior to the filing of this statement. 37 C.F.R. 1.97(e)(2).

Respectfully submitted,

SHERIDAN ROSS P.C.

By:_____

Jason H. Vick
Registration No. 45285
1560 Broadway, Suite 1200
Denver, Colorado 80202-5141
(303) 863-9700

Date: 18 Oct '07

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	1	of	2	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	3,955,141	05/01/76	Lyon et al.	
	2	4,985,900	01/01/91	Rhind et al.	
	3	5,748,677	05/01/98	Kumar	
	4	6,256,355	07/03/01	Sakoda et al.	
	5	6,507,585	01/01/03	Dobson	
	6	6,590,860	07/08/03	Sakoda et al.	
	7	6,704,317	03/01/04	Dobson	
	8	6,961,369	11/01/05	Tzannes	
	9	2005/0141410	06/30/05	Zhang et al.	
	10	2006/0002454	01/05/06	Tzannes	
	11	2006/0092902	05/04/06	Schmidt	
	12	2006/0140288	06/29/06	Holden	
	13	11/860080		Tzannes (09-24-2007)	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
	14	EP 0584534	03/02/94	ALCATEL ITALIA		
	15	EP 0719004	06/26/96	MATSUSHITA ELECTRIC IND CO LTD		
	16	GB 2330491	04/21/99	BRITISH BROADCASTING CORP		
	17	WO 98/32065	07/23/98	FORTRESS TECHNOLOGIES INC		
	18	WO 99/22463	05/06/99	MOTOROLA INC		

Examiner Signature		Date Considered	

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

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	2	of	2	Attorney Docket Number	5550-47-CON-2

	19	WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	
	20	Bauml R. W. et al.: "Reducing The Peak-To-Average Power Ratio Of Multicarrier Modulation By Selected Mapping" Electronics Letters, GB, IEE Stevenage, vol. 32, No. 22, Oct. 24, 1996, pp. 2056-2057, XP000643915 ISSN: 0013-5194
	21	Copy of Annex to Form PCT/ISA/206 for PCT/US00/30958, Mar. 23, 2001 (5550-47-PCT)
	22	International Search Report for International (PCT) Patent Application No. PCT/US00/30958, completed June 12, 2001 (5550-47-PCT)
	23	International Preliminary Examination Report for International (PCT) Patent Application No. PCT/US00/30958, completed March 4, 2002 (5550-47-PCT)
	24	Notice of Preliminary Rejection for Korean Patent Application No. 7005830/2002 dated November 22, 2006 (Attorney's Ref. No. 5550-47-PKR)

Examiner Signature		Date Considered	

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

Exhibit B

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	1	of	2	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/LW/	1	3,955,141	05/01/76	Lyon et al.	
	2	4,985,900	01/01/91	Rhind et al.	
	3	5,748,677	05/01/98	Kumar	
	4	6,256,355	07/03/01	Sakoda et al.	
	5	6,507,585	01/01/03	Dobson	
	6	6,590,860	07/08/03	Sakoda et al.	
	7	6,704,317	03/01/04	Dobson	
	8	6,961,369	11/01/05	Tzannes	
	9	2005/0141410	06/30/05	Zhang et al.	
	10	2006/0002454	01/05/06	Tzannes	
	11	2006/0092902	05/04/06	Schmidt	
/LW/	12	2006/0140288	06/29/06	Holden	
	13	11/860080		Tzannes (09-24-2007)	

FOREIGN PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/LW/	14	EP 0584534	03/02/94	ALCATEL ITALIA		
	15	EP 0719004	06/26/96	MATSUSHITA ELECTRIC IND CO LTD		
	16	GB 2330491	04/21/99	BRITISH BROADCASTING CORP		
	17	WO 98/32065	07/23/98	FORTRESS TECHNOLOGIES INC		
/LW/	18	WO 99/22463	05/06/99	MOTOROLA INC		

Examiner Signature	/Lawrence Williams/ (01/26/2008)	Date Considered	

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

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	2	of	2	Attorney Docket Number	5550-47-CON-2

	19	WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	
/LW/	20	Bauml R. W. et al.: "Reducing The Peak-To-Average Power Ratio Of Multicarrier Modulation By Selected Mapping" Electronics Letters, GB, IEE Stevenage, vol. 32, No. 22, Oct. 24, 1996, pp. 2056-2057, XP000643915 ISSN: 0013-5194
	21	Copy of Annex to Form PCT/ISA/206 for PCT/US00/30958, Mar. 23, 2001 (5550-47-PCT)
	22	International Search Report for International (PCT) Patent Application No. PCT/US00/30958, completed June 12, 2001 (5550-47-PCT)
	23	International Preliminary Examination Report for International (PCT) Patent Application No. PCT/US00/30958, completed March 4, 2002 (5550-47-PCT)
/LW/	24	Notice of Preliminary Rejection for Korean Patent Application No. 7005830/2002 dated November 22, 2006 (Attorney's Ref. No. 5550-47-PKR)

Examiner Signature	/Lawrence Williams/ (01/26/2008)	Date Considered	

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

Exhibit C

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	WILLIAMS, LAWRENCE B
Sheet	1	of	1	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
		WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	

Examiner Signature		Date Considered	

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

PCT WORLD INTELLECTUAL PROPERTY ORGANIZATION
International Bureau

INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : H04L 27/26 | A2

(11) International Publication Number: **WO 99/29078**

(43) International Publication Date: 10 June 1999 (10.06.99)

(21) International Application Number: PCT/SE98/02193

(22) International Filing Date: 1 December 1998 (01.12.98)

(30) Priority Data:
9704497-8 3 December 1997 (03.12.97) SE

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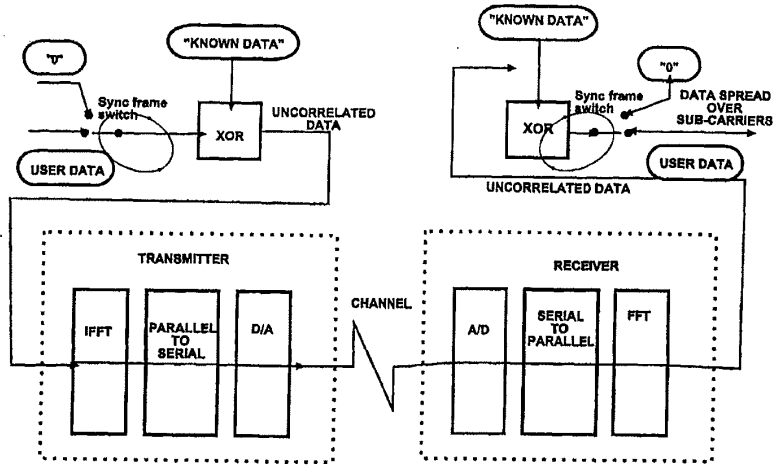

(57) Abstract

The present invention simplifies known data scramblers by making use of the synchronisation frames, normally used for measuring channel characteristics, as a source of pseudo-random data which can be combined with incoming user data. The present invention has particular application to multi-carrier transmission systems which employ DMT, or OFDM. Many of these transmission systems send known data, usually referred to as synchronisation frames, to measure channel characteristics such as signal to noise ratio. The known data contained in a synchronisation frame is selected to have a suitable statistical distribution, e.g. pseudo-random. In the data scrambler of the present invention, user data bits are combined with the known synchronisation frame data using an exclusive-OR function. This results in a statistically and computationally efficient scrambling of the user data.

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Improvements in, or Relating to, Data Scramblers

The present invention relates to data scramblers and descramblers, suitable for use with a multi-carrier transmission system, multi-carrier transmission systems incorporating data scramblers and de-scramblers, and methods for scrambling and descrambling data in multi-carrier transmission systems.

Most telecommunications transmission systems are designed to give optimum performance when uncorrelated data is transmitted over them. Unfortunately, user data is not usually uncorrelated and may, for example, include relatively long strings of binary "0"s, or "1"s. If such data is transmitted over a transmission system intended for uncorrelated data, it can result in saturation, i.e. too large a dynamic range, synchronisation drift, etc.. This problem has long been recognised by telecommunications engineers and the conventional solution is to scramble the incoming user data so that it behaves as though it was uncorrelated data.

Known data scramblers employ an algorithm to combine user data with a random data string, thereby producing an uncorrelated data stream for transmission.

The present invention simplifies known data scramblers by making use of the synchronisation frames, normally used for measuring channel characteristics, as a source of pseudo-random data which can be combined with incoming user data.

The present invention has particular application to multi-carrier transmission systems, including copper based transmission systems such as ADSL, VDSL and HDSL which employ DMT, and/or radio based transmission systems employing OFDM. Many of these transmission systems send known data, usually referred to as synchronisation frames, to measure channel characteristics such as signal to noise ratio. The known data contained in a synchronisation frame is selected to have a suitable statistical distribution, e.g. pseudo-random. In a typical DMT

system, used at the present time, the known synchronisation frame data comprises two bits per sub-carrier. In other words, a predetermined 4-QAM signal is transmitted on each sub-carrier.

In the present invention, user data bits are combined with the known synchronisation frame data bits, typically the two most significant bits, using an exclusive-OR function. This results in a statistically and computationally efficient scrambling of the user data.

According to a first aspect of the present invention, there is provided a data scrambler, for use in a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, characterised in that combiner means are provided to combine user data with frame synchronisation data.

Said combiner means may have a XOR function.

Said frame synchronisation data is pseudo random.

Said combiner means may be adapted to combine said user data with the two most significant bits of a synchronisation frame.

According to a second aspect of the present invention, there is provide a data descrambler, for use in a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, and transmitted data is scrambled using a data scrambler as claimed in any of claims 1 to 4, characterised in that combiner means are provided to combine received data with frame synchronisation data.

Said combiner means may have a XOR function.

Said frame synchronisation data may be pseudo random.

Said combiner means may be adapted to combine said received data with the two most significant bits of a synchronisation frame.

According to a third aspect of the present invention, there is provided a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, characterised in that said transmission system incorporates a data scrambler as set forth in any preceding paragraph, connected to said transmitter.

Said receiver may be connected to a data descrambler as set forth in any preceding paragraph.

Said multi-carrier transmission system may employ DMT.

Said multi-carrier transmission system may employ OFDM.

Means may be provided for transmitting frame synchronisation data from said data scrambler to said data descrambler.

According to a fourth aspect of the present invention, there is provided, in a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, a method of scrambling user data prior to transmission, characterised by combining user data with frame synchronisation data.

User data maybe combined with frame synchronisation data by mean of an XOR function.

Said frame synchronisation data may be pseudo random.

Said user data may be combined with the two most significant bits of a synchronisation frame.

According to a fifth aspect of the present invention, there is provided, In a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, a method of descrambling received data which has been scrambled by a scrambling method as set forth in preceding, characterised by combining received data with frame synchronisation data.

Received data may be combined with frame synchronisation data using an XOR function.

Said frame synchronisation data may be pseudo random.

Said received data may be combined with the two most significant bits of a synchronisation frame.

Said multi-carrier transmission system may employ DMT.

Said multi-carrier transmission system may employ OFDM.

Embodiments of the invention will now be described, by way of example, with reference to the accompanying drawing, in which:

Figure 1 illustrates data scramblers and descramblers, according to the present invention, in a multi-carrier transmission system

In order to facilitate an understanding of the present invention a glossary of terms used in the description of the present invention is provided below:

A/D:	Analogue to Digital
ADSL:	Asynchronous Digital Subscriber Line
D/A:	Digital to Analogue

DMT:	Digital Multi Tone
FFT:	Fast Fourier Transform
HDSL:	High bit rate Digital Subscriber Line
IFFT:	Inverse Fast Fourier Transform
OFDM:	Orthogonal Frequency Division Multiplex
QAM:	Quadrature Amplitude Modulation
VDSL:	Very high bit rate Digital Subscriber Line
XOR:	Exclusive OR

Figure 1 shows a transmitter and receiver, in a multi-carrier transmission system, linked by a communications channel. The communications channel may be a copper pair (VDSL etc.), or a radio channel (OFDM). Incoming user data, intended for transmission over the communications channel, is passed via a sync frame switch, to a XOR gate. The sync frame switch permits one of the inputs to the XOR gate to be switched between user data and a string of "0"s. The second input to the XOR gate receives the known synchronisation frame data. When the string of "0"s is passed to the XOR gate, the output from the XOR gate is the synchronisation data, i.e. the "known data" appears at the output of the XOR gate.

The incoming user data will almost certainly be far from random, i.e. it will be highly correlated. The incoming user data is combined with the "known data" in the XOR gate. The "known data" is pseudo random, i.e. uncorrelated. The output from the XOR gate will, therefore, also be uncorrelated, i.e. will itself be pseudo-random. This data has the necessary properties to permit good transmission over the transmission channel.

The scrambled data is then passed to the receiver where it is first

processed by an Inverse Fast Fourier Transform unit, IFFT, converted from parallel form to serial form, passed to a digital to analogue convertor, D/A, prior to QAM modulation and transmission over the channel. Details of the multiplexing techniques and modulation techniques used in multi-carrier transmission systems will be familiar to those skilled in the art and are not described in detail in this patent specification.

The signal received from the transmission channel is demodulated and demultiplexed in the receiver by, inter alia, an A/D convertor, a serial to parallel convertor, and a fast Fourier transform unit FFT. The received data is, of course, scrambled. The received scrambled data is passed to the XOR gate, where it is combined with the "known data", i.e. the same data that was mixed into the signal in the transmitter. The output from the XOR gate will contain the user data, or a string of "0"s depending on the setting of the sync frame switch in the transmitter. The sync frame switch in the receiver is used for synchronisation purposes, i.e. when the receiver is properly synchronised with the transmitter, and a sync frame is transmitted, rather than user data, the output from the XOR gate will be a string of "0"s. Details of transmitter and receiver synchronisation in multi-carrier systems will be well known to those skilled in the art.

It should, however, be noted that synchronisation frame data is stored in both the transmitter and receiver, so the receiver always has prior knowledge of the "known data" used by the transmitter.

In summary, the present invention scrambles user data by mixing that data with known data normally used in a synchronisation frame, typically the two most significant bits of the synchronisation frame data, using an exclusive-OR function. This results in both statistically and computationally efficient scrambling. Descrambling is achieved by the reverse process, i.e. combining the received scrambled data with the same known data used for scrambling in an exclusive-OR function.

The present invention results in a much improved statistical distribution of modulated sub-carriers, in a multi-carrier transmission system, compared to the

case where no scrambling is used for correlated, or null data situations.

As synchronisation data must be present in a multi-carrier receiver and transmitter for use in the synchronisation process, the scrambling technique of the present invention does not increase system complexity.

Transmission of the known data is very simple because it only needs to be combined with a string of "0"s.

The scrambler of the present invention can be used in all transmission systems that measure channel characteristics by sending known data from transmitter to receiver and use OFDM, DMT, or related multiplexing techniques to spread out the transmitted data over a number of sub-carriers, i.e. multi-carrier transmission techniques.

CLAIMS

1. A data scrambler, for use in a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, characterised in that combiner means are provided to combine user data with frame synchronisation data.

2. A data scrambler, as claimed in claim 1, characterised in that said combiner means has a XOR function.

3. A data scrambler, as claimed in either claim 1, or claim 2, characterised in that said frame synchronisation data is pseudo random.

4. A data scrambler, as claimed in any previous claim, characterised in that said combiner means is adapted to combine said user data with the two most significant bits of a synchronisation frame.

5. A data descrambler, for use in a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, and transmitted data is scrambled using a data scrambler as claimed in any of claims 1 to 4, characterised in that combiner means are provided to combine received data with frame synchronisation data.

6. A data descrambler, as claimed in claim 5, characterised in that said combiner means has a XOR function.

7. A data descrambler, as claimed in either claim 5, or claim 6, characterised in that said frame synchronisation data is pseudo random.

8. A data descrambler, as claimed in any of claims 5 to 7, characterised in that said combiner means is adapted to combine said received data with the two

most significant bits of a synchronisation frame.

9. A multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, characterised in that said transmission system incorporates a data scrambler as claimed in any of claims 1 to 4, connected to said transmitter.

10. A multi-carrier transmission system, as claimed in claim 9, characterised in that said receiver is connected to a data descrambler as claimed in any of claims 5 to 8.

11. A multi-carrier transmission system, as claimed in claim 10, characterised in that said multi-carrier transmission system employs DMT.

12. A multi-carrier transmission system, as claimed in claim 10, characterised in that said multi-carrier transmission system employs OFDM.

13. A multi-carrier transmission system, as claimed in any of claims 10 to 12, characterised in that means are provided for transmitting frame synchronisation data from said data scrambler to said data descrambler.

14. In a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, a method of scrambling user data prior to transmission, characterised by combining user data with frame synchronisation data.

15. A method, as claimed in claim 14, characterised by combining user data with frame synchronisation data by mean of an XOR function.

16. A method, as claimed in either claim 14, or claim 15, characterised by said frame synchronisation data being pseudo random.

17. A method, as claimed in any of claims 14 to 16, characterised by combining

said user data with the two most significant bits of a synchronisation frame.

18. In a multi-carrier transmission system in which synchronisation frame data is periodically transmitted from a transmitter to a receiver to measure transmission channel characteristics, a method of descrambling received data which has been scrambled by the method claimed in any of claims 14 to 17, characterised by combining received data with frame synchronisation data.

19. A method, as claimed in claim 18, characterised by combining received data with frame synchronisation data using an XOR function.

20. A method, as claimed in either claim 18, or claim 19, characterised by said frame synchronisation data being pseudo random.

21. A method, as claimed in any of claims 18 to 20, characterised by combining said received data with the two most significant bits of a synchronisation frame.

22. A method, as claimed in any of claims 14 to 21, characterised by said multi-carrier transmission system employing DMT.

23. A method, as claimed in any of claims 14 to 21, characterised by said multi-carrier transmission system employing OFDM.

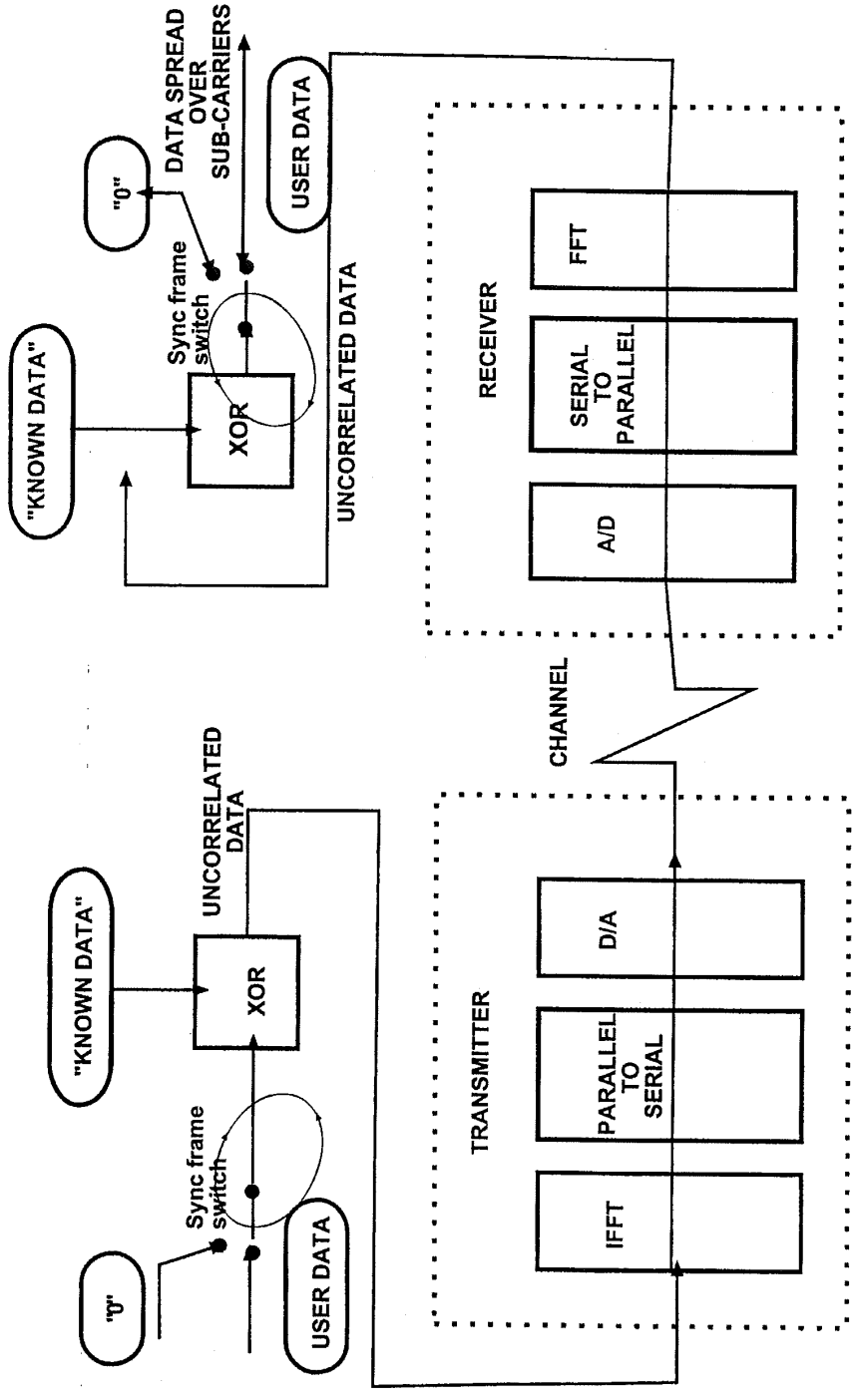
"0"
DATA SPREAD OVER SUB-CARRIERS
USER DATA
Sync frame switch
"KNOWN DATA"
XOR
UNCORRELATED DATA
RECEIVER
FFT
SERIAL TO PARALLEL
A/D
CHANNEL
UNCORRELATED DATA
"KNOWN DATA"
XOR
Sync frame switch
"0"
USER DATA
TRANSMITTER
D/A
PARALLEL TO SERIAL
IFFT

FIGURE 1

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WILLIAMS, LAWRENCE B	
ART UNIT	PAPER NUMBER
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

TITLE OF INVENTION: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

APPLN. TYPE	SMALL ENTITY	ISSUE FEE DUE	PUBLICATION FEE DUE	PREV. PAID ISSUE FEE	TOTAL FEE(S) DUE	DATE DUE
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❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

62574 7590 10/08/2008

EXAMINER	
WILLIAMS, LAWRENCE B	
ART UNIT	PAPER NUMBER
2611	

DATE MAILED: 10/08/2008

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

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 0 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 0 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.

PTOL-85 (Rev. 08/07) Approved for use through 08/31/2010.

Notice of Allowability	Application No. 11/863,581	Applicant(s) TZANNES, MARCOS C.	
	Examiner LAWRENCE B. WILLIAMS	Art Unit 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 *Terminal Disclaimer filed 8/5/2008* .

2. ☒ The allowed claim(s) is/are *1-5*.

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

   * Certified copies not received: _____.

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

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

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

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

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

Attachment(s)

1. ☐ Notice of References Cited (PTO-892)
2. ☐ Notice of Draftperson's Patent Drawing Review (PTO-948)
3. ☒ Information Disclosure Statements (PTO/SB/08), Paper No./Mail Date 4/30/2008
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 _____.

REASONS FOR ALLOWANCE

1. The following is an examiner's statement of reasons for allowance: The instant application discloses a method of scrambling the phase of characteristics of carrier signals. The closest prior art of record is applicant's US Patent 7,292,627 for which applicant has filed a Terminal Disclaimer. A search of prior art records has failed to teach or suggest, alone or in combination:

A method of scrambling the phase characteristics of the carrier signals comprising:

"associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal; computing a phase shift for each carrier signal based on the value associated with that carrier signal; and combining the phase shift computed for each carrier signal with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristics of the plurality of carrier signals" as disclosed in claim 1.

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

TERMINAL DISCLAIMER

2. The terminal disclaimer filed on 8/30/2008 disclaiming the terminal portion of any patent granted on this application which would extend beyond the expiration date of US Patent 7,292,627 has been reviewed and is accepted. The terminal disclaimer has been recorded.

CONCLUSION

3. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lawrence B Williams whose telephone number is 571-272-3037. The examiner can normally be reached on Monday-Friday (8:00-6:00).

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

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://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).

lbw
October 7, 2008

/Lawrence B Williams/

Examiner, Art Unit 2611

/Mohammad H Ghayour/

Supervisory Patent Examiner, Art Unit 2611

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11863581	TZANNES, MARCOS C.
	Examiner	Art Unit
	LAWRENCE B WILLIAMS	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	09/25/2008								
	1	=								
	2	=								
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	18	-								
	19	-								
	20	-								

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11863581	TZANNES, MARCOS C.
	Examiner	Art Unit
	LAWRENCE B WILLIAMS	2611

SEARCHED			
Class	Subclass	Date	Examiner
375	219, 220, 222, 226, 260, 327, 362	1/27/2008	LW
370	203, 342, 206		
Michael Horabik		9/4/2008	LW
Update Search		9/25/2008	LW

SEARCH NOTES		
Search Notes	Date	Examiner
EAST, NPL, Inventor	1/28/2008	LW
EAST, NPL, Inventor	9/25/2008	LW

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner
375	219, 222	9/25/2008	LW

	/L. B. W./ Examiner.Art Unit 2611

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	WILLIAMS, LAWRENCE B
Sheet	1	of	1	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/L.W./	1	JP H10(1998)-084329	03/31/98	NIPPON HOSO KYOKAI		(Translated Abstract and partial translation)
/L.W./	2	JP H08(1996)-321820	12/03/96	MATSUSHITA ELECTRIC IND CO LTD		(Translated Abstract)

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	
/L.W./	3	Notification of Reasons for Refusal (including translation) for Japanese Patent Application No. 2001-537217, date of dispatch, March 3, 2008 (Attorney's Ref. No. 5550-47-PJP)

Examiner Signature	/Lawrence Williams/	Date Considered	09/04/2008

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

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	11863581	TZANNES, MARCOS C.
	Examiner	**Art Unit**
	LAWRENCE B WILLIAMS	2611

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
375	222	H 0 4 B 1 / 38 (2006.01.01)	
CROSS REFERENCE(S)		H 0 4 B 17 / 00 (2006.01.01)	

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
375	219				

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

Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original	Final	Original
1	1	-	17												
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-	15														
-	16														

/LAWRENCE B WILLIAMS/ Examiner.Art Unit 2611 (Assistant Examiner)	9/25/2008 (Date)	**Total Claims Allowed:** 5
/MOHAMMAD H GHAYOUR/ Supervisory Patent Examiner.Art Unit 2611 (Primary Examiner)	09/29/2008 (Date)	O.G. Print Claim(s): 1 O.G. Print Figure: 1

Application Number	Application/Control No.	Applicant(s)/Patent under Reexamination
	11/863,581	TZANNES, MARCOS C.

Document Code - DISQ	Internal Document – DO NOT MAIL

TERMINAL DISCLAIMER	☒ APPROVED	☐ DISAPPROVED
Date Filed : 8/5/08	This patent is subject to a Terminal Disclaimer	

Approved/Disapproved by:
BRIAN

U.S. Patent and Trademark Office

PTO/SB/26 (08-08)
Approved for use through 08/31/2008. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

TERMINAL DISCLAIMER TO OBVIATE A DOUBLE PATENTING REJECTION OVER A "PRIOR" PATENT	Docket Number (Optional) 5550-47-CON-2

In re Application of: Marcos C. TZANNES

Application No.: 11/863,581

Filed: September 28, 2007

For: System and Method for Scrambling the Phase of the Carriers in a Multicarrier Communications System

The owner*, Aware, Inc, of 100 percent interest in the instant application hereby disclaims, except as provided below, the terminal part of the statutory term of any patent granted on the instant application which would extend beyond the expiration date of the full statutory term **prior patent** No. 7,292,627 as the term of said prior patent is defined in 35 U.S.C. 154 and 173, and as the term of said **prior patent** is presently shortened by any terminal disclaimer. The owner hereby agrees that any patent so granted on the instant application shall be enforceable only for and during such period that it and the **prior patent** are commonly owned. This agreement runs with any patent granted on the instant application and is binding upon the grantee, its successors or assigns.

In making the above disclaimer, the owner does not disclaim the terminal part of the term of any patent granted on the instant application that would extend to the expiration date of the full statutory term as defined in 35 U.S.C. 154 and 173 of the **prior patent**, "as the term of said **prior patent** is presently shortened by any terminal disclaimer," in the event that said **prior patent** later:

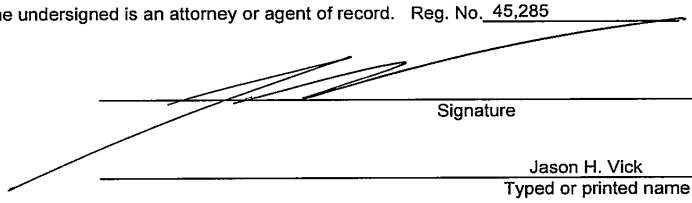
expires for failure to pay a maintenance fee;
is held unenforceable;
is found invalid by a court of competent jurisdiction;
is statutorily disclaimed in whole or terminally disclaimed under 37 CFR 1.321;
has all claims canceled by a reexamination certificate;
is reissued; or
is in any manner terminated prior to the expiration of its full statutory term as presently shortened by any terminal disclaimer.

Check either box 1 or 2 below, if appropriate.

1. ☐ For submissions on behalf of a business/organization (e.g., corporation, partnership, university, government agency, etc.), the undersigned is empowered to act on behalf of the business/organization.

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.

2. ☑ The undersigned is an attorney or agent of record. Reg. No. 45,285



Signature — 5 August 2008 (Date)

Jason H. Vick
Typed or printed name

303.764.3005
Telephone Number

☑ Terminal disclaimer fee under 37 CFR 1.20(d) included.

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

*Statement under 37 CFR 3.73(b) is required if terminal disclaimer is signed by the assignee (owner). Form PTO/SB/96 may be used for making this certification. See MPEP § 324.

Electronic Patent Application Fee Transmittal

Application Number:	11863581
Filing Date:	28-Sep-2007
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Filer:	Jason Vick
Attorney Docket Number:	5550-47-CON-2
Filed as Large Entity	

Utility 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:				
Statutory disclaimer	1814	1	130	130
Extension-of-Time:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Extension - 3 months with $0 paid	1253	1	1050	1050
Miscellaneous:				
		Total in USD ($)		**1180**

Electronic Acknowledgement Receipt	
EFS ID:	3732402
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick
Filer Authorized By:	
Attorney Docket Number:	5550-47-CON-2
Receipt Date:	05-AUG-2008
Filing Date:	28-SEP-2007
Time Stamp:	16:16:13
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$1180
RAM confirmation Number	1599
Deposit Account	191970
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 1.16 (National application filing, search, and examination fees) 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		Amendment5Aug2008.pdf	190537 33e2b6a0ddc02f608d823a51b2c4728fafdb0af6	yes	3

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

Warnings:					
Information:					
2	Extension of Time	EOT.pdf	142794 01d6c95e6a00280e473c131e036add685ba6f42f	no	1
Warnings:					
Information:					
3	Miscellaneous Incoming Letter	SignedTerminalDisclaimer.pdf	137869 160999da26a43cc3cda51ac6289d32746bce0f0e	no	1
Warnings:					
Information:					
4	Fee Worksheet (PTO-06)	fee-info.pdf	8351 591f2627285242a8417160732f698098c2cb2f43	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	479551		

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.

Attorney Docket No. 5550-47-CON-2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application for:

First Named Inventor: Marcos C. Tzannes

Art Unit: 2611

Appln. No.: 11/863,581

Examiner: L. WILLIAMS

For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

Confirmation No.: 1948

* * *

AMENDMENT

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

Sir:

Further to the February 6, 2008 Office Action, please amend the claims as follows. Please charge any fees to Deposit Account 19-1970.

Please amend the above-identified patent application as follows:

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

Remarks begin on page 3 of this paper.

Amendments to the Claims:

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

Listing of Claims:

1. (Original) In a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating an input bit stream, each carrier signal having a phase characteristic associated with the input bit stream, a method for scrambling the phase characteristics of the carrier signals comprising:

associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal;

computing a phase shift for each carrier signal based on the value associated with that carrier signal; and

combining the phase shift computed for each carrier signal with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristics of the plurality of carrier signals.

2. (Currently Amended) The method of claim 1, further comprising modulating bits of the input bit stream onto the carrier signals having the substantially scrambled phase characteristics to produce a transmission signal with a reduced peak-to-average power ratio (PAR).

3. (Currently Amended) The method of claim 1, further comprising independently deriving the value associated with each carrier signal at each transceiver.

4. (Currently Amended) The method of claim 1, further comprising transmitting the value associated with each carrier signal from one transceiver to the other transceiver.

5. (Currently Amended) The method of claim 1, further comprising maintaining synchronization between the transceivers using the value associated with each carrier signal.

6. - 20. (Canceled)

REMARKS

Applicants respectfully request reconsideration of this application as amended.

By this amendment, dependent claims 2-5 have been amended to improve grammar.

Submitted herewith is a Terminal Disclaimer thereby overcoming the nonstatutory double patenting rejections.

With all rejections having been overcome, Applicant believes that the pending claims are in condition for allowance and such disposition is respectfully requested. In the event that a telephone conversation would further prosecution and/or expedite allowance, the Examiner is invited to contact the undersigned.

Respectfully submitted,

Date: 5 Aug '08

By: _____
Jason H. Vick
Reg. No. 45,285

SHERIDAN ROSS P. C.
1560 BROADWAY, SUITE 1200
DENVER, COLORADO 80202
TELEPHONE: 303-863-9700
FAX: 303-863-0223

PTO/SB/22 (10-04)
Approved for use through 07/31/2006. OMB 0651-0031
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

PETITION FOR EXTENSION OF TIME UNDER 37 CFR § 1.136(a)
FY 2006
(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818))

Docket Number (Optional): 5550-47-CON-2

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage for first class mail in an envelope addressed to Mail Stop _____, Commissioner for Patents, P.O. Box 1450, Alexandria, Virginia 22313-1450, or being facsimile transmitted to the USPTO at _____, on _____.

Signature: _____

Name: _____

In re Application of Marcos C. TZANNES

Application Number: | Filed July 25, 2002

For: System and Method for Scrambling the Phase of the Carriers in a Mulitcarrier Communications System

Art Unit 2611 | Examiner I. Williams

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

The requested extension and fee are as follows (check time period desired and enter the appropriate fee below): (Should additional extensions be required, those extension(s) are hereby requested)

	Fee	Small Entity Fee	
☐ One month (37 CFR 1.17(a)(1))	$120	$60	$_____
☐ Two months (37 CFR 1.17(a)(2))	$450	$225	$_____
☒ Three months (37 CFR 1.17(a)(3))	$1050	$510	$1050
☐ Four months (37 CFR 1.17(a)(4))	$1590	$795	$_____
☐ Five months (37 CFR 1.17(a)(5))	$2160	$1080	$_____

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

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

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

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

☒ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 19-1970. I have enclosed a duplicate copy of this sheet.

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

I am the ☐ applicant/inventor

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

☒ attorney or agent of record. Registration Number: 45,285

☐ attorney or agent under 37 CFR 1.34(a).
Registration number if acting under ~~37 CFR~~ 1.34(a) _____.

_____ 5 August 2008
Signature Date

Jason H. Vick, Reg. No. 45,285 303.764.3005
Typed or printed name Telephone Number

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

☒ Total of 1 forms are submitted.

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 11/863,581	Filing Date 09/28/2007	☐ 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 ($)	FEE ($)		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), (i), or (m))	N/A	N/A	N/A			N/A	
☐ EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))	N/A	N/A	N/A			N/A	
TOTAL CLAIMS (37 CFR 1.16(i))	minus 20 =	*	X $ =		OR	X $ =	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	minus 3 =	*	X $ =			X $ =	
☐ APPLICATION SIZE FEE (37 CFR 1.16(s))	If the specification and drawings exceed 100 sheets of paper, the application size fee due is $250 ($125 for small entity) for each additional 50 sheets or fraction thereof. See 35 U.S.C. 41(a)(1)(G) and 37 CFR 1.16(s).						
☐ MULTIPLE DEPENDENT CLAIM PRESENT (37 CFR 1.16(j))							
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	

APPLICATION AS AMENDED – PART II

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

		(Column 1)		(Column 2)	(Column 3)					
	08/05/2008	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 5	Minus	** 20	= 0	X $ =		OR	X $50 =	0
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	= 0	X $ =		OR	X $210 =	0
	☐ Application Size Fee (37 CFR 1.16(s))									
	☐ FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))							OR		
						TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	**0**

* 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:
/THERESA LINDSAY/

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:	)	Group Art Unit: 2611
	)	
Tzannes	)	Confirmation No.: 1948
	)	
Serial No.: 11/863,581	)	Examiner: WILLIAMS, LAWRENCE B
	)	
Filed: 09-28-2007	)	INFORMATION DISCLOSURE STATEMENT
	)	
Atty. File No.: 5550-47-CON-2	)	Electronically Submitted
	)	
For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	)	

Mail Stop Amendment
Commissioner for Patents
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Alexandria, VA 22313-1450

Dear Sir:

The references cited on attached Form PTO-SB08 are being called to the attention of the Examiner.

☒ Copies of the cited non-patent and/or foreign references are enclosed herewith.

☐ Copies of the cited U.S. patents and/or patent applications are enclosed herewith.

☐ Copies of the cited U.S. patents/patent application publications are not enclosed in accordance with 37 C.F.R. § 1.98(a).

☐ Copies of the cited references are not enclosed, in accordance with 37 C.F.R. § 1.98(d), because the references were cited by or submitted to the U.S. Patent and Trademark Office in prior application Serial No. _____ filed _____, which is relied upon for an earlier filing date under 35 U.S.C. § 120.

☐ To the best of applicants' belief, the pertinence of the foreign-language references are believed to be summarized in the attached English abstracts and in the figures, although applicants do not necessarily vouch for the accuracy of the translation.

☒ Examiner's attention is drawn to the following co-pending application:

Serial No. 11/860080 filed 09-24-2007

☐ Other:_____

Submission of the above information is not intended as an admission that any item is citable under the statutes or rules to support a rejection, that any item disclosed represents analogous art, or that those skilled in the art would refer to or recognize the pertinence of any reference without the benefit of hindsight, nor should an inference be drawn as to the pertinence of the references based on the order in which they are presented. Submission of this statement should not be taken as an indication that a search has been conducted, or that no better art exists.

It is respectfully requested that the cited information be expressly considered during the prosecution of this application and the references made of record therein.

FEES

☐	**37 CFR 1.97(b)**: No fee is believed due in connection with this submission, because the information disclosure statement submitted herewith is satisfies one of the following conditions ("X" indicates satisfaction): ☐ Within three months of the filing date of a national application other than a continued prosecution application under 37 CFR 1.53(d), or ☐ Within three months of the date of entry into the national stage of an international application as set forth in 37 CFR 1.491 or ☐ Before the mailing date of a first Office Action on the merits, or ☐ Before the mailing of a first Office action after the filing of a request for continued examination under 37 CFR 1.114. Although no fee is believed due, if any fee is deemed due in connection with this submission, please charge such fee to Deposit Account 19-1970.
☒	**37 CFR 1.97(c)**: The information disclosure statement transmitted herewith is being filed after all the above conditions (37 CFR 1.97(b)), but before the mailing date of one of the following conditions: (1) a final action under 37 C.F.R. 1.113 or (2) a notice of allowance under 37 C.F.R. 1.311, or (3) an action that otherwise closes prosecution in the application. This Information Disclosure Statement is accompanied by: ☒ A Certification (below) as specified by 37 C.F.R. 1.97(e). Although no fee is believed due, if any fee is deemed due in connection with this submission, please charge such fee to Deposit Account 19-1970. OR ☐ Please charge Deposit Account 19-1970 in the amount of $180.00 for the fee set forth in 37 C.F.R. 1.17(p) for submission of an information disclosure statement. Please credit any overpayment or charge any underpayment to Deposit Account 19-1970.
☐	**37 CFR 1.97(d)**: This Information Disclosure Statement is being submitted after the period specified in 37 CFR 1.97(c). ☐ This information Disclosure Statement includes a Certification (below) as specified by 37 C.F.R. 1.97(e) AND ☐ Applicants hereby requests consideration of the reference(s) disclosed herein. Please charge Deposit Account 19-1970 in the amount of $180.00 under 37 C.F.R. 1.17(p). Please credit any overpayment or charge any underpayment to Deposit Account 19-1970. Election to pay the fee should not be taken as an indication that applicant(s) cannot execute a certification.

Certification (37 C.F.R. 1.97(e))
(Applicable only if checked)

☒ The undersigned certifies that:

☒ Each item of information contained in this information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement. 37 C.F.R. 1.97(e)(1).

☒ A copy of the communication from the foreign patent office is enclosed.

OR

☐ No item of information contained in this information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned after making reasonable inquiry, no item of information contained in this Information Disclosure Statement was known to any individual designated in 37 C.F.R. 1.56(c) more than three months prior to the filing of this statement. 37 C.F.R. 1.97(e)(2).

Respectfully submitted,

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Date: 31 Apr 08

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	WILLIAMS, LAWRENCE B
Sheet	1	of	1	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
	1	JP H10(1998)-084329	03/31/98	NIPPON HOSO KYOKAI		(Translated Abstract and partial translation)
	2	JP H08(1996)-321820	12/03/96	MATSUSHITA ELECTRIC IND CO LTD		(Translated Abstract)

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	
	3	Notification of Reasons for Refusal (including translation) for Japanese Patent Application No. 2001-537217, date of dispatch, March 3, 2008 (Attorney's Ref. No. 5550-47-PJP)

Examiner Signature		Date Considered	

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

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 10-084329
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SAITO TOMOHIRO
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(54) TRANSMISSION METHOD FOR OFDM MODULATION SIGNAL, OFDM TRANSMITTER AND RECEIVER

(57)Abstract:
PROBLEM TO BE SOLVED: To prevent production of distortion by spreading a reference phase of each carrier of the frequency orthogonal division multiplex (OFDM) system and changing the amplitude of each carrier of the OFDM without giving effect on transmitted information so as to suppress a peak level of signals.
SOLUTION: After multiplying a complex code series ejsk (Sk=pk2, p is an optional real number not being zero, 0≤k≤N, N is a total carrier number) with an input coded signal, inverse FFT is applied to the product to generate an OFDM modulation signal and it is transmitted. At a receiver side, a complex code series ejsk (Sk is the same as above) is multiplied with a signal resulting from FFT processing to a received signal and an OFDM demodulation signal is obtained. The information relating to the ejsk required for demodulation is included in the input coded information, or sent in advance from the transmitter side to the receiver side through other transmission line. Thus, the reference phases of each carrier of the OFDM are hardly arranged and the level of transmission signals is suppressed and the resulting signal is sent, then an operating point of amplifiers is set higher.

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1]In the transmitting side, it is a complex code sequence to an input encoded signal. [External Character 1]
e^{iS_k}

(-- the signal which they generated the OFDM modulation signal here and transmitted to it as reverse FFT of $S_k=pk^2$, the arbitrary real numbers whose p is not zero, 0 <=k<=N, and the N was carried out after they carried out the multiplication of total number of careers) here, and carried out FFT of the input signal in the receiver -- a complex code sequence [External Character 2]
e^{-iS_k}

A transmission method of an OFDM modulation signal carrying out the multiplication of (S_k is the same here to said S_k), and acquiring an OFDM demodulation signal.
[Claim 2]Said complex code sequence required for an OFDM recovery [in / on a transmission method of the OFDM signal according to claim 1, and / a receiver] [External Character 3]
e^{-iS_k}

the arbitrary real numbers $S_k=pk^2$ and whose p are not zero here. A transmission method of an OFDM modulation signal, wherein 0 <=k<=N and N include the information about the total number of careers in said input encoded signal or transmit it to a receiver beforehand from the transmitting side in transmission lines other than the transmission line for OFDM transmission concerned.
[Claim 3]It is a complex code sequence to an input encoded signal at least. [External Character 4]
e^{iS_k}

(-- the OFDM sending set which $S_k=pk^2$, the arbitrary real numbers whose p is not zero, 0 <=k<=N, and N are provided with the means which carries out the multiplication of total number of careers) here, and is characterized by things.
[Claim 4]It is a complex code sequence to a signal which carried out FFT of the input signal at least. [External Character 5]
e^{-iS_k}

(-- the OFDM receiving set which $S_k=pk^2$, the arbitrary real numbers whose p is not zero, 0 <=k<=N, and N are provided with the means which carries out the multiplication of total number of careers) here, and is characterized by things.
[Claim 5]In a transmission method of an OFDM modulation signal which generates a modulating signal of either BPSKOFDM and a QPSKOFDM modulating signal, and is transmitted, After carrying out the multiplication of two or more constants which make equal amplitude of positive [of a phase which said one of modulating signals can take], and a negative ingredient in an

amplitude peak period of one of said modulating signals according to a value of an input encoded signal, respectively, A transmission method of an OFDM modulation signal characterized by carrying out reverse FFT, generating an OFDM modulation signal, and making it transmit.
[Claim 6]In an OFDM sending set which generates a modulating signal of either BPSKOFDM and a QPSKOFDM modulating signal, and transmits, An OFDM sending set which is provided with a means which carries out the multiplication of two or more constants which make equal amplitude of positive [of a phase which said one of modulating signals can take at least], and a negative ingredient in an amplitude peak period of one of said modulating signals according to a value of an input encoded signal, respectively, and is characterized by things.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention]In a broadcasting satellite, in order to use the generating electric power by a solar cell, the output of a relay amplifier has restriction, but. This invention, A transmission method and an OFDM sending set of a frequency rectangular cross division multiplex (OFDM:Orthogonal Frequency Division Multiplexing) modulating signal suitable for using it for digital broadcasting in such a satellite system (as opposed to a ground system), etc., It is related with a receiving set.
[0002]
[Problem(s) to be Solved by the Invention]Conventionally, there are phase modulations, such as BPSK and QPSK, in the modulation method of each career of OFDM. In these modulation methods, the reference phase of each career by which multiplex was carried out is constant, and, in the case of BPSK, in the case of a binary and QPSK, the phase which each modulating signal can take is restricted with four value. Therefore, in the phase of each career, by this method, the peak of amplitude may occur on a set or the OFDM time base signal which becomes empty.
[0003]For example, in the relay amplifier for broadcast, while generating electric power and amplifier efficiency have restriction, in order to secure the rate of a service period, and the rate of a place, it is used near the saturation region. In order to secure the rate of a service period, and the rate of a place also in digital broadcasting using an OFDM modulation method, to take the high operating point of an amplifier is desired. However, it is one side, and if the high operating point is taken in this way, in the amplitude peak of an OFDM modulation signal, it will become easy to generate distortion.
[0004]In the situation which has restriction in the above generating electric power and amplifier efficiency, the purpose of this invention is to suppress the amplitude peak of an OFDM signal and to perform little transmission in the high operating point.
[0005]
[Means for Solving the Problem]It is going to control an amplitude peak of a signal by diffusing a reference phase of OFDM each career, or changing amplitude of OFDM each career, without affecting information which should be transmitted in this invention, in order to attain the above-mentioned purpose. In order to make diffusion of these reference phases thru/or change of amplitude perform, in this invention, the multiplication of the specific signal (S) is carried out so that an input encoded signal may not be affected at transmitted data (a case where it amends by a receiver so that it may not be affected is included), OFDM modulation is performed based on it, and each career is transmitted.
[0006]When carrying out signal (S) multiplication and diffusing a reference phase of each career now, a phase of each career becomes difficult to gather and can be transmitted by suppressing a peak of amplitude. In this case, in a receiver, the multiplication of the signal (S^*) corresponding to a signal (S) which carried out multiplication at the above-mentioned transmitting side is carried out to an OFDM demodulation signal, and right information is restored.
[0007]When each career does not have information in amplitude directions, such as BPSK and QPSK, in carrying out the multiplication of the signal (S) at the transmitting side, transmission

which suppressed a signal peak is performed by choosing a signal (S) which carries out multiplication so that amplitude of a career with which phases produce an amplitude peak together, and a career with an ingredient of an opposite phase may be enlarged -- things can be carried out. Here, since multiplication of a signal (S) can be performed only by calculation by a discrete time, it can respond flexibly with software.
[0008]That is, a transmission method of this invention OFDM modulation signal is a complex code sequence to an input encoded signal in the transmitting side. [External Character 6]
e^{jS_k}

(-- a signal which they generated an OFDM modulation signal here and transmitted to it as reverse FFT of $S_k=pk^2$, the arbitrary real numbers whose p is not zero, 0 <=k<=N, and the N was carried out after they carried out the multiplication of total number of careers) here, and carried out FFT of the input signal in a receiver -- a complex code sequence [External Character 7]
e^{-jS_k}

The multiplication of (S_k is the same here to said S_k) is carried out, and the OFDM demodulation signal was acquired.
[0009]Said complex code sequence which needs the transmission method of this invention OFDM modulation signal for the OFDM recovery in a receiver [External Character 8]
e^{-jS_k}

the arbitrary real numbers $S_k=pk^2$ and whose p are not zero here. 0 <=k<=N and N include the information about the total number of careers in said input encoded signal, or transmitted it to the receiver beforehand from the transmitting side in transmission lines other than the transmission line for OFDM transmission concerned.
[0010]this invention OFDM sending set is a complex code sequence to an input encoded signal at least. [External Character 9]
e^{jS_k}

($S_k=pk^2$, the arbitrary real numbers whose p is not zero, 0 <=k<=N, and N are provided with the means which carries out the multiplication of total number of careers) here
[0011]this invention OFDM receiving set is a complex code sequence to the signal which carried out FFT of the input signal at least. [External Character 10]
e^{-jS_k}

($S_k=pk^2$, the arbitrary real numbers whose p is not zero, 0 <=k<=N, and N are provided with the means which carries out the multiplication of total number of careers) here
[0012]A transmission method of this invention OFDM modulation signal, In a transmission method of an OFDM modulation signal which generates a modulating signal of either BPSKOFDM and a QPSKOFDM modulating signal, and is transmitted, After carrying out the multiplication of two or more constants which make equal amplitude of positive [of a phase which said one of modulating signals can take], and a negative ingredient in an amplitude peak period of one of said modulating signals according to a value of an input encoded signal, respectively, Reverse FFT is carried out, an OFDM modulation signal is generated, and it was made to transmit.
[0013]In an OFDM sending set which this invention OFDM sending set generates a modulating signal of either BPSKOFDM and a QPSKOFDM modulating signal, and transmits, It has a means which carries out the multiplication of two or more constants which make equal amplitude of positive [of a phase which said one of modulating signals can take at least], and a negative ingredient in an amplitude peak period of one of said modulating signals according to a value of an input encoded signal, respectively.
[0014]
[Embodiment of the Invention]With reference to an accompanying drawing, this invention is explained in detail based on an embodiment of the invention below. Drawing 1 is a transmission

code series (input encoded signal).
[External Character 11]

$\dot{X}_k$

**** – To the signal which carried out the parallel conversion, it is an example of a numerals system. [External Character 12]

$\dot{S}_k$

(book specification preceding paragraph shows one embodiment of the OFDM sending set by this invention which only carries out the multiplication of (having expressed with S)), and is transmitted. This embodiment is an embodiment which diffuses a phase to BPSKOFDM and controls a signal peak.
[0015]In drawing 1, it is a code sequence as an input encoded signal. [External Character 13]

$\dot{X}_k$

Direct in the serial/parallel conversion machine 1 – Carry out a parallel conversion and it is made a parallel signal, Furthermore, an OFDM modulation signal is acquired from an output terminal of the converter 3 via reverse FFT circuit (Invers Fast Fourier Transform circuit) 2 and the parallel serial change machine 3. It is a process of the usual OFDM modulation signal generation so far (however, when there is no multiplier 4 in drawing 1).
[0016]On the other hand, a code sequence which the multiplier 4 is inserted, respectively between each parallel line between the serial/parallel conversion machine 1 and the reverse FFT (IFFT) circuit 2, and is an input encoded signal as this invention is shown in drawing 1[External Character 14]

$\dot{X}_k$

Code sequence [External Character 15]

$\dot{S}_k$

Multiplication is performed in between and the multiplication result is supplied to reverse FFT circuit 2. The composition of drawing 1 is [in / are an example and / this invention] a code sequence. [External Character 16]

$\dot{X}_k$

It is alike and a code sequence. [External Character 17]

$\dot{S}_k$

What is necessary is just the composition by which multiplication is carried out to ******, and it is not necessary to follow circuit arrangement shown in drawing 1.
[0017]Here, it is an input code sequence. [External Character 18]

$\dot{X}_k$

It is a code sequence of ** and the binary (-either 1 or 1 is taken) of N pieces, and is a code sequence. [External Character 19]

$\dot{S}_k$

********** [External Character 20]

$\dot{X}_k$

A complex code sequence at least for ** to diffuse a phase [External Character 21]

$e^{i\dot{S}_k}$

It comes out. S_k is a known series beforehand in a receiver, for example, the time delay of each career is proportional to frequency -- as [Equation 1]
$S_k = p k^2$

However, the arbitrary real numbers whose p is not zero, 0 <=K<=N, and N are the total numbers of careers.
In this way, the input code sequence of a binary [External Character 22]
$\dot{X}_k$

A compound code sequence for ** and phase diffusion [External Character 23]
$e^{i S_k}$

Multiplication is mutually carried out by the multiplier 4. The OFDM modulation signal by which phase diffusion was carried out as a result of multiplication
[External Character 24]
$\dot{T}_k$

It is obtained by the output terminal of the ** parallel serial converter 3.
[0018]Drawing 2 (a) and (b) is a code sequence (complex code sequence) to the BPSKOFDM modulating-signal generate time mentioned above.
[External Character 25]
$\dot{S}_k$

An example of a constellation of each career of a modulating signal a time (the usual BPSKOFDM) of not carrying out multiplication and when multiplication is carried out by this invention is shown, respectively. Drawing 3 (a) and (b) shows an example of a signal wave form of an OFDM modulation signal corresponding to them, respectively. It turns out that it is transmitted as a signal (drawing 3 (b)) with which a phase of each career becomes difficult to gather compared with a case where phase diffusion of the time base waveform of a signal by which phase diffusion was carried out is not carried out (drawing 2 (b)), and a peak of amplitude was suppressed from drawing 2 and drawing 3.
[0019]A signal which carried out FFT of the input signal with which drawing 4 received a signal (that is, phase diffusion was carried out and transmitted) transmitted by an above-mentioned method
[External Character 26]
$\dot{R}_k$

It is alike and is a complex code sequence. [External Character 27]
$\dot{S}_k^*$

(-- this specification preceding paragraph -- only (S^*) -- a table -- the bottom --) -- carrying out multiplication -- a right received code series [External Character 28]
$\dot{X}_k$

One embodiment of an OFDM receiving set by this invention to restore is shown.
[0020]In drawing 4, it is an input signal.
[External Character 29]
$\dot{R}_k$

Direct in the serial/parallel conversion machine 5 - A parallel conversion is carried out, it is made a parallel signal, and an OFDM recovery is further carried out in FFT circuit 6. It is a complex code sequence to this OFDM demodulation signal to which it restored. [External

Character 30]
$\dot{S}_k^*$

Each multiplier 7 for carrying out multiplication is arranged between FFT circuit (fast Fourier Transform circuit) 6 and the parallel serial conversion circuit 8.
[0021]Complex code sequence [External Character 31]
$\dot{S}_k^*$

It is a complex code sequence at ** and the transmitting side at the time of OFDM modulation.
[External Character 32]
$e^{j S_k}$

The signal with which phase diffusion also of the receiver was carried out since multiplication was carried out and phase diffusion of the modulated wave was carried out will be received, and it is a right received code series as it is. [External Character 33]
$\dot{X}_k$

Specifically at the code sequence for carrying out reverse correction of it becoming impossible to restore, it is a complex code sequence. [External Character 34]
$e^{-j S_k}$

(S_k is a known series beforehand in a receiver, for example, is $S_k=k^2$;, however 0<=K<=N(N: total number of careers)). A code sequence restored eventually [External Character 35]
$\dot{X}_k$

It is a code sequence of 1 or 1 [−] of k **.
[0022]Thereby, it is an input signal.
[External Character 36]
$\dot{R}_k$

FFT is carried out by FFT6 through the ** serial/parallel conversion 5, and it is inputted into the multiplication terminal of the multiplier 7. On the other hand, it is a code sequence of a reverse correction sake about phase diffusion. [External Character 37]
$\dot{S}_k^*$

In ********, it is known beforehand and is inputted into a multiplication terminal of the multiplier 7. In an output multiplier, it is a received code series of a binary (−1, 1). [External Character 38]
$\dot{X}_k$

It ****** and is taken out via the parallel serial converter 8.
[0023]The complex code sequence which is needed above by a receiver for a right OFDM recovery [External Character 39]
$e^{-j S_k}$

It must be transmitted to a receiver in ** and a certain form. This is a complex code sequence.
[External Character 40]
$e^{-j S_k}$

The very thing is not transmitted but information which it can reproduce by a receiver should just be sent. As a transmission method, it is made to contain in an input encoded signal at the transmitting side, and transmits in a transmitted symbol, or may transmit in a transmission line different from it.
[0024]A code sequence used in this invention when performing OFDM modulation and a recovery

by drawing 1 and drawing 4, respectively [External Character 41]

$\dot{S}_k$

[External Character 42]

$\dot{S}_k^*$

** -- a transmission code series a peak is still more apt to break off even if this changes a transmission code series for every symbol by a known method at the transmitting side, and transmits by performing phase diffusion and it is made to carry out reverse correction by a receiver, although it was considered as a regularity (it does not change) thing in time [External Character 43]

$\dot{X}_k$

Being spread is possible.

[0025]In consideration of the case where the amplitude of each career of an OFDM signal has information in the above-mentioned example (actually, in BPSKOFDM of the above-mentioned example, it does not have, but in the case of the multiple value QAMOFDM, it has information), it is the transmitting side and is a complex code sequence. [External Character 44]

$\dot{S}_k$

Since multiplication is carried out, and the topology will be lost if phase diffusion is carried out, in order to recover this, it is a receiver, and it is a complex code sequence. [External Character 45]

$\dot{S}_k^*$

Multiplication was carried out.

[0026]On the other hand, in BPSKOFDM and QPSKOFDM, there is information only in the phase of each career and it does not have information in the amplitude direction of each career. Then, in BPSKOFDM, it is drawing 1, for example. [External Character 46]

$\dot{S}_k$

It carries out and is a transmission code series. [External Character 47]

$\dot{X}_k$

case $N/(2N_1)$ of ** 1, and a case of 1 [-] -- $N/(2N_2)$ -- the multiplication of the constant shall be carried out to a transmission code series (equivalent to an input encoded signal), respectively It is here, and N is symbol length and N_1 and N_2 is in a symbol, respectively.

[External Character 48]

$\dot{X}_k$

It is the number of ** 1 and-1. By carrying out like this, it is a transmission signal.

[External Character 49]

$\dot{T}_k$

Since a size of an ingredient 1, -1 or positive, and negative becomes equal at a ****** peak period, a peak of amplitude can be suppressed and transmitted like the above-mentioned example. In this case, in a receiver, since it does not have information in an amplitude direction of each career, reverse correction of career diffusion for right decoding is not needed.

[0027]

[Effect of the Invention]According to this invention, as explained above, also in the amplifier which has restriction in generating electric power, such as satellite broadcasting, it has the purpose of securing a hour rate and the rate of a place, and even if it makes it operate in the

higher operating point, it becomes possible to carry out little distorted OFDM transmission.

[Translation done.]

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(54)【発明の名称】　ＯＦＤＭ変調信号の伝送方法およびＯＦＤＭ送信装置、受信装置

(57)【要約】　（修正有）

【課題】　ＯＦＤＭ変調方式を用いたディジタル放送において、サービス時間率、場所率を確保するためには増幅器の動作点を高くとると、ＯＦＤＭ変調信号のピークにおいて歪みを発生し易くなる。

【解決手段】　送信側においては、入力符号化信号

$\dot{X}_k$

に複素符号系列

$e^{j S_k}$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算（４）した後逆ＦＦＴ（２）するようにしてＯＦＤＭ変調信号

$\dot{T}_k$

を生成して送信し、受信側においては、受信信号をＦＦＴした信号に複素符号系列

$e^{-j S_k}$

（ここに、S_k は上記S_k に同じ）を乗算してＯＦＤＭ復調出力信号を得るようにした。

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【特許請求の範囲】

【請求項１】　送信側においては、入力符号化信号に複素符号系列

【外１】

$$e^{jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算した後逆ＦＦＴするようにしてＯＦＤＭ変調信号を生成して送信し、受信側においては、受信信号をＦＦＴした信号に複素符号系列

【外２】

$$e^{-jS_k}$$

（ここに、S_k は前記 S_k に同じ）を乗算してＯＦＤＭ復調信号を得るようにしたことを特徴とするＯＦＤＭ変調信号の伝送方法。

【請求項２】　請求項１記載のＯＦＤＭ信号の伝送方法において、受信側におけるＯＦＤＭ復調のために必要な前記複素符号系列

【外３】

$$e^{-jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）に関する情報を、前記入力符号化信号に含ませ、または当該ＯＦＤＭ伝送用伝送路以外の伝送路にて送信側から受信側に予め伝送するようにしたことを特徴とするＯＦＤＭ変調信号の伝送方法。

【請求項３】　少なくとも入力符号化信号に複素符号系列

【外４】

$$e^{jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算する手段を具えてなることを特徴とするＯＦＤＭ送信装置。

【請求項４】　少なくとも受信信号をＦＦＴした信号に複素符号系列

【外５】

$$e^{-jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算する手段を具えてなることを特徴とするＯＦＤＭ受信装置。

【請求項５】　ＢＰＳＫＯＦＤＭおよびＱＰＳＫＯＦＤＭ変調信号のいずれかの変調信号を生成して送信するＯＦＤＭ変調信号の伝送方法において、前記いずれかの変調信号がとりうる位相の正と負の成分の振幅を、前記いずれかの変調信号の振幅ピーク時において等しくするような複数の定数を入力符号化信号の値に応じてそれぞれ乗算した後、逆ＦＦＴしてＯＦＤＭ変調信号を生成して送信するようにしたことを特徴とするＯＦＤＭ変調信号の伝送方法。

【請求項６】　ＢＰＳＫＯＦＤＭおよびＱＰＳＫＯＦＤＭ変調信号のいずれかの変調信号を生成して送信するＯＦＤＭ送信装置において、少なくとも前記いずれかの変調信号がとりうる位相の正と負の成分の振幅を、前記いずれかの変調信号の振幅ピーク時において等しくするような複数の定数を入力符号化信号の値に応じてそれぞれ乗算する手段を具えてなることを特徴とするＯＦＤＭ送信装置。

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【発明の詳細な説明】

【０００１】

【発明の属する技術分野】放送衛星においては、太陽電池による発生電力を使用するため、中継増幅器の出力に制限があるが、本発明は、そのような衛星系（地上系に対して）でのディジタル放送等に使用するのに適している周波数直交分割多重（ＯＦＤＭ：Orthogonal Frequency Division Multiplexing）変調信号の伝送方法およびＯＦＤＭ送信装置、受信装置に関する。

【０００２】

【発明が解決しようとする課題】従来、ＯＦＤＭの各キャリアの変調方式には、ＢＰＳＫ，ＱＰＳＫなどの位相変調がある。これらの変調方式では多重された各キャリアの基準位相は一定であり、各変調信号のとりうる位相はＢＰＳＫの場合２値、ＱＰＳＫの場合４値と限られている。従って、この方式では各キャリアの位相がそろいやすく、ＯＦＤＭ時間軸信号上に振幅のピークが発生する場合がある。

【０００３】例えば、放送用中継増幅器においては、発生電力、増幅器効率に制限があるなかでサービス時間率、場所率を確保するために飽和領域付近で使用されている。また、ＯＦＤＭ変調方式を用いたディジタル放送においてもサービス時間率、場所率を確保するためには増幅器の動作点を高くとることが望まれる。しかし一方で、このように動作点を高くとると、ＯＦＤＭ変調信号の振幅ピークにおいて歪みを発生し易くなる。

【０００４】本発明の目的は、上記のような発生電力、増幅器効率に制限がある状況において、ＯＦＤＭ信号の振幅ピークを抑え高い動作点で歪みの少ない伝送を行うことにある。

【０００５】

【課題を解決するための手段】上記目的を達成するため、本発明においては、伝送すべき情報に影響を与えることなく、ＯＦＤＭ各キャリアの基準位相を拡散させ、または、ＯＦＤＭ各キャリアの振幅を変化させることによって信号の振幅ピークを抑制しようとするものである。これら基準位相の拡散、ないし振幅の変化を行わせるために、本発明では、入力符号化信号に伝送情報に影響を与えないように（受信側で、影響を与えないように補正する場合を含む）特定の信号（Ｓ）を乗算し、それをもとにＯＦＤＭ変調を行い、各キャリアの伝送を行う。

【０００６】いま、信号（Ｓ）乗算して各キャリアの基

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準位相を拡散させる場合、各キャリアの位相はそろいにくくなり、振幅のピークを抑えて伝送を行うことができる。この場合、受信側において、上記送信側で乗算した信号（S）に対応した信号（S^*）をＯＦＤＭ復調信号に乗算して正しい情報を復元するようにする。

【０００７】また、各キャリアがＢＰＳＫ，ＱＰＳＫなど振幅方向に情報を持たない場合、送信側で信号（S）を乗算するにあたり、位相がそろって振幅ピークを生じるキャリアと逆位相の成分を持つキャリアの振幅を大きくするように乗算する信号（S）を選ぶことによって、信号ピークを抑えた伝送を行うことできる。ここで、信号（S）の乗算は離散時間での計算だけで行うことができるため、ソフトウェアによって柔軟に対応することができる。

【０００８】すなわち、本発明ＯＦＤＭ変調信号の伝送方法は、送信側においては、入力符号化信号に複素符号系列

【外６】

$$e^{jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算した後逆ＦＦＴするようにしてＯＦＤＭ変調信号を生成して送信し、受信側においては、受信信号をＦＦＴした信号に複素符号系列

【外７】

$$e^{-jS_k}$$

（ここに、S_k は前記 S_k に同じ）を乗算してＯＦＤＭ復調信号を得るようにしたことを特徴とするものである。

【０００９】また、本発明ＯＦＤＭ変調信号の伝送方法は、受信側におけるＯＦＤＭ復調のために必要な前記複素符号系列

【外８】

$$e^{-jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）に関する情報を、前記入力符号化信号に含ませ、または当該ＯＦＤＭ伝送用伝送路以外の伝送路にて送信側から受信側に予め伝送するようにしたことを特徴とするものである。

【００１０】また、本発明ＯＦＤＭ送信装置は、少なくとも入力符号化信号に複素符号系列

【外９】

$$e^{jS_k}$$

（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算する手段を具えてなることを特徴とするものである。

【００１１】また、本発明ＯＦＤＭ受信装置は、少なくとも受信信号をＦＦＴした信号に複素符号系列

【外１０】

$$e^{-jS_k}$$

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（ここに、$S_k = pk^2$，pはゼロでない任意の実数、$0 \leqq k \leqq N$，Nは総キャリア数）を乗算する手段を具えてなることを特徴とするものである。

【００１２】また、本発明ＯＦＤＭ変調信号の伝送方法は、ＢＰＳＫＯＦＤＭおよびＱＰＳＫＯＦＤＭ変調信号のいずれかの変調信号を生成して送信するＯＦＤＭ変調信号の伝送方法において、前記いずれかの変調信号がとりうる位相の正と負の成分の振幅を、前記いずれかの変調信号の振幅ピーク時において等しくするような複数の定数を入力符号化信号の値に応じてそれぞれ乗算した後、逆ＦＦＴしてＯＦＤＭ変調信号を生成して送信するようにしたことを特徴とするものである。

【００１３】また、本発明ＯＦＤＭ送信装置は、ＢＰＳＫＯＦＤＭおよびＱＰＳＫＯＦＤＭ変調信号のいずれかの変調信号を生成して送信するＯＦＤＭ送信装置において、少なくとも前記いずれかの変調信号がとりうる位相の正と負の成分の振幅を、前記いずれかの変調信号の振幅ピーク時において等しくするような複数の定数を入力符号化信号の値に応じてそれぞれ乗算する手段を具えてなることを特徴とするものである。

【００１４】

【発明の実施の形態】以下に添付図面を参照し、発明の実施の形態に基づいて本発明を詳細に説明する。図１は、送信符号系列（入力符号化信号）

【外１１】

$$\dot{X}_k$$

を直－並列変換した信号に、符号系例

【外１２】

$$\dot{S}_k$$

（本明細書前段では、単に（S）にて表した）を乗算して伝送する本発明によるＯＦＤＭ送信装置の一実施形態を示している。なお、本実施形態は、ＢＰＳＫＯＦＤＭに位相の拡散を行って信号ピークを抑制する実施形態である。

【００１５】図１において、入力符号化信号としての符号系列

【外１３】

$$\dot{X}_k$$

をシリアル－パラレル変換器１において直－並列変換して並列信号にし、さらに逆ＦＦＴ回路（Invers Fast Fourier Transform circuit）２およびパラレル－シリアル変化器３を介して変換器３の出力端子からＯＦＤＭ変調信号が得られる。ここまでは通常のＯＦＤＭ変調信号発生のプロセスである（但し、図１において乗算器４がない場合）。

【００１６】これに対し、本発明においては、図１に示すように、シリアル－パラレル変換器１と逆ＦＦＴ（I

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ＦＦＴ）回路２との間の各並列線の間にそれぞれ乗算器４を介挿し、入力符号化信号である符号系列

【外１４】

$$\dot{X}_k$$

と符号系列

【外１５】

$$\dot{S}_k$$

との間で乗算を行い、その乗算結果が逆ＦＦＴ回路２に供給されるようにする。なお、図１の構成は一例であり、本発明においては、符号系列

【外１６】

$$\dot{X}_k$$

に符号系列

【外１７】

$$\dot{S}_k$$

が相互に乗算されるような構成であればよく、図１に示す回路配置に従う必要はない。

【００１７】ここで、入力符号系列

【外１８】

$$\dot{X}_k$$

は、Ｎ個の２値（１，－１のいずれかをとる）の符号系列であり、符号系列

【外１９】

$$\dot{S}_k$$

は符号系列

【外２０】

$$\dot{X}_k$$

の位相を拡散するための複素符号系列

【外２１】

$$e^{jS_k}$$

である。（S_k は受信側で予め既知の系列であり、例えば、各キャリアの遅れ時間が周波数に比例するように、

【数１】

$$S_k = pk^2$$

ただし、ｐはゼロでない任意の実数、$0 \leqq K \leqq N$，Ｎは総キャリア数である。）

こうして、２値の入力符号系列

【外２２】

$$\dot{X}_k$$

は、位相拡散のための複合符号系列

【外２３】

$$e^{jS_k}$$

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と乗算器４によって相互に乗算される。乗算の結果、位相拡散されたＯＦＤＭ変調信号

【外２４】

$$\dot{T}_k$$

がパラレルーシリアル変換器３の出力端子に得られる。

【００１８】図２（ａ），（ｂ）は、上述したＢＰＳＫＯＦＤＭ変調信号生成時に符号系列（複素符号系列）

【外２５】

$$\dot{S}_k$$

を乗算しない（通常のＢＰＳＫＯＦＤＭ）ときと、本発明によって乗算したときの変調信号の各キャリアのコンスタレーションの一例をそれぞれ示している。また、図３（ａ），（ｂ）は、それらに対応したＯＦＤＭ変調信号の信号波形の一例をそれぞれ示している。図２および図３から、位相拡散された信号の時間軸波形は、位相拡散されない場合に比べ各キャリアの位相がそろいにくくなり（図２（ｂ））、振幅のピークが抑えられた信号（図３（ｂ））として伝送されることが分かる。

【００１９】図４は、上述の方法で送信された（すなわち、位相拡散して送信された）信号を受信した受信信号をＦＦＴした信号

【外２６】

$$\dot{R}_k$$

に複素符号系列

【外２７】

$$\dot{S}_k^*$$

（本明細書前段では、単に（S^*）で表した）を乗算して正しい受信符号系列

【外２８】

$$\dot{X}_k$$

を復元する本発明によるＯＦＤＭ受信装置の一実施形態を示している。

【００２０】図４において、受信信号

【外２９】

$$\dot{R}_k$$

をシリアルーパラレル変換器５において直一並列変換して並列信号にし、さらにＦＦＴ回路６においてＯＦＤＭ復調する。この復調されたＯＦＤＭ復調信号に複素符号系列

【外３０】

$$\dot{S}_k^*$$

を乗算するための各乗算器７がＦＦＴ回路（fast Fourier Transform circuit）６とパラレルーシリアル変換回

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路８との間に配置される。

【００２１】複素符号系列

【外３１】

$$\dot{S}_k^*$$

は、送信側でＯＦＤＭ変調時に複素符号系列

【外３２】

$$e^{j\theta_k}$$

を乗算し、変調波を位相拡散させたため、受信側でも位相拡散された信号が受信されてしまい、そのままでは正しい受信符号系列

【外３３】

$$\dot{X}_k$$

を復元できなくなるのを逆補正するための符号系列で、具体的には、複素符号系列

【外３４】

$$e^{-j\theta_k}$$

（S_k は受信側で予め既知の系列であり、例えば、$S_k = k^2$ ；ただし$0 \leqq K \leqq N$（Ｎ：総キャリア数））である。また、最終的に復元される符号系列

【外３５】

$$\dot{X}_k$$

はｋ個の１または－１の符号系列である。

【００２２】これにより、受信信号

【外３６】

$$\dot{R}_k$$

はシリアル－パラレル変換５を経てＦＦＴ６によりＦＦＴされ乗算器７の被乗算端子に入力される。一方、位相拡散を逆補正ための符号系列

【外３７】

$$\dot{S}_k^*$$

は受信側において予め既知であり、乗算器７の乗算端子に入力される。乗算器出力には２値（－１，１）の受信符号系列

【外３８】

$$\dot{X}_k$$

が復元され、パラレル－シリアル変換器８を介して取り出される。

【００２３】以上において、正しいＯＦＤＭ復調のために受信側で必要となる複素符号系列

【外３９】

$$e^{-j\theta_k}$$

は、何らかのかたちで受信側に伝送されなければならない。これは複素符号系列

【外４０】

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$$e^{-j\theta_k}$$

そのものを伝送するのでなく、それが受信側で再現できる情報が送られればよい。伝送方法としては、送信側で入力符号化信号に含ませ、伝送済みのシンボルの中で伝送しておくか、それとは別の伝送路で伝送してもよい。

【００２４】また、図１、図４でそれぞれＯＦＤＭ変調および復調を行う際に本発明において使用する符号系列

【外４１】

$$\dot{S}_k$$

【外４２】

$$\dot{S}_k^*$$

は時間的に一定（変化しない）ものとしたが、これは、送信符号系列を送信側で既知の方法でシンボルごとに変化させ位相拡散を行って伝送し、受信側で逆補正するようにしても、なおピークのたちやすい送信符号系列

【外４３】

$$\dot{X}_k$$

を拡散することが可能である。

【００２５】上述例においては、ＯＦＤＭ信号の各キャリアの振幅が情報をもつ場合を考慮して（実際には、上述例のＢＰＳＫＯＦＤＭの場合はもたないが、多値ＱＡＭＯＦＤＭの場合には情報をもつ）、送信側で複素符号系列

【外４４】

$$\dot{S}_k$$

を乗算して位相拡散させると、その位相情報が失われるため、これを回復させるために受信側で複素符号系列

【外４５】

$$\dot{S}_k^*$$

を乗算した。

【００２６】これに対し、ＢＰＳＫＯＦＤＭ，ＱＰＳＫＯＦＤＭなどでは各キャリアの位相のみに情報があり、各キャリアの振幅方向には情報をもたない。そこで、例えばＢＰＳＫＯＦＤＭの場合、図１の

【外４６】

$$\dot{S}_k$$

として、送信符号系列

【外４７】

$$\dot{X}_k$$

が１の場合Ｎ／（２N_1）、また、－１の場合Ｎ／（２N_2）なる定数をそれぞれ送信符号系列（入力符号化信号に相当）に乗算するものとする。ここで、Ｎはシンボル長、N_1，N_2 はそれぞれシンボル中の

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【外４８】

$$\dot{X}_k$$

の１，－１の個数である。こうすることにより、伝送信号

【外４９】

$$\dot{T}_k$$

の振幅ピーク時には１と－１あるいは正と負の成分の大きさが等しくなるため、前述例と同様に振幅のピークを抑えて伝送することができる。この場合、受信側では、各キャリアの振幅方向には情報をもたないため、正しい符号復元のためのキャリア拡散の逆補正を必要としない。

【００２７】

【発明の効果】以上説明したように、本発明によれば、衛星放送などの発生電力に制限のある増幅器においても、時間率、場所率を確保する目的をもって、より高い＊

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＊動作点で動作させても歪の少ないＯＦＤＭ伝送をすることが可能となる。

【図面の簡単な説明】

【図１】本発明によるＯＦＤＭ送信装置の一実施形態を示している。

【図２】従来および本発明によるＯＦＤＭ変調信号の各キャリアのコンスタレーションの一例を示している。

【図３】従来および本発明によるＯＦＤＭ変調信号の信号波形の一例を示している。

【図４】本発明によるＯＦＤＭ受信装置の一実施形態を示している。

【符号の説明】

１，５　シリアル－パラレル変換器

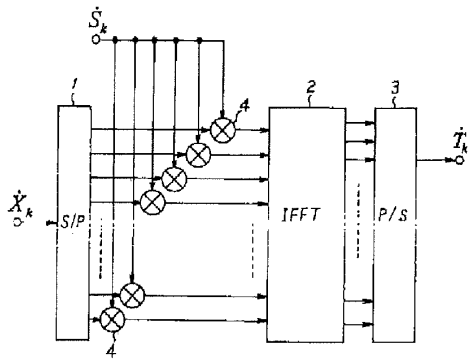
２　逆ＦＦＴ回路

３，８　パラレル－シリアル変換器

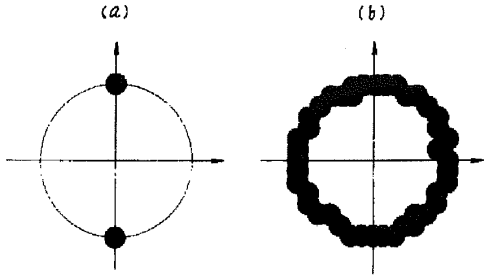
４，７　乗算器

６　ＦＦＴ回路

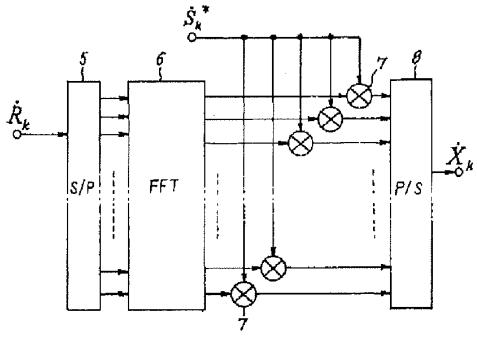
【図１】



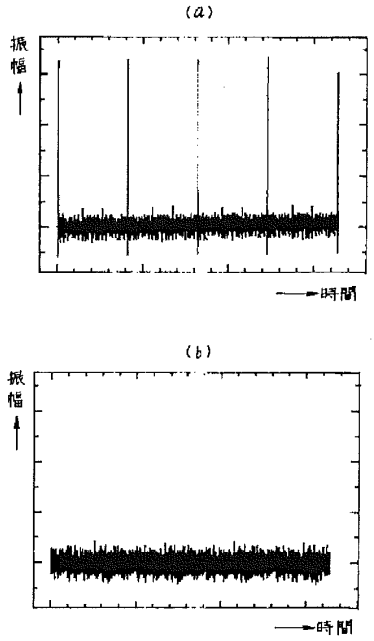
【図２】



【図４】



【図3】



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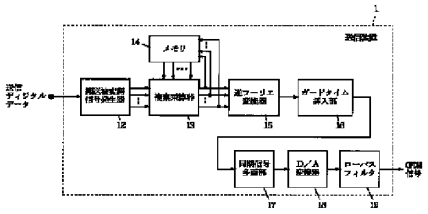
(54) **TRANSMISSION METHOD FOR ORTHOGONAL FREQUENCY DIVISION/ MULTIPLEX SIGNAL AND ITS TRANSMITTER AND/RECEIVER**

(57) Abstract:

PURPOSE: To effectively remove waveform distortion occurred in a data component on the frequency axis of respective symbols by means of a multipath and the like at the time of transmitting an OFDM signals.

CONSTITUTION: In a transmission device 1, a complex multiplier 13 complex-multiplies a carrier modulation signal group by a complex number signal group which has a previously decided special pattern and in which the phase changes at random. An inverse Fourier transformer 15 executes inverse Fourier transform against the output of the complex multiplier 13, and transforms a digital signal multiplexed on the frequency axis into the OFDM signal of a time axis. A guard time insertion part 16 adds front guard time to the front parts of the respective symbols of the OFDM signal and rear guard time to rear parts. Data similar to the trailing end part of the corresponding symbol is included in front guard time, and data similar to the front end part of the corresponding symbol is included in rear guard time. The OFDM signals to which front guard time and rear guard time are added are transformed into analog signals and are transmitted to a reception-side. The reception-side executes a processing inverse to a transmission-side and therefore distortion owing to time delay is removed.



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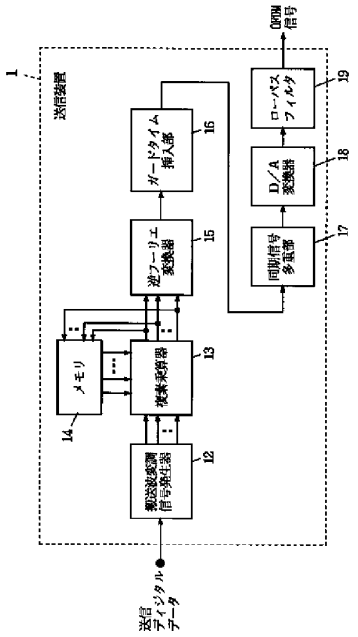
最終頁に続く

(54)【発明の名称】　直交周波数分割多重信号の伝送方法ならびにその送信装置および受信装置

(57)【要約】

【課題】　ＯＦＤＭ信号を伝送する際に、マルチパス等によって各シンボルの周波数軸上のデータ成分に生じる波形歪みを効果的に除去することである。

【解決手段】　送信装置において、複素乗算器１３は、搬送波変調信号群と、予め定められた特定パターンを有しかつその位相がランダムに変化している複素数信号群とを複素乗算する。逆フーリエ変換器１５は、複素乗算器１３の出力に対して逆フーリエ変換を施し、周波数軸上で多重されたディジタル信号を、時間軸上のＯＦＤＭ信号に変換する。ガードタイム挿入部１６は、ＯＦＤＭ信号の各シンボルの前部に前部ガードタイムを、後部に後部ガードタイムを付加する。前部ガードタイムには対応するシンボルの後端部と同じデータが含められ、後部ガードタイムには対応するシンボルの前端部と同じデータが含められる。前部ガードタイムおよび後部ガードタイムが付加されたＯＦＤＭ信号は、アナログ信号に変換された後、受信側に伝送される。受信側で送信側と逆の処理を行うことにより、時間遅延による歪みが除去される。



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【特許請求の範囲】

【請求項１】　有線または無線の伝送路を介し、送信側から受信側に対して、所定長のシンボル毎に直交周波数分割多重信号を伝送する方法であって、

周波数軸上で互いに直交する複数のキャリアの位相と振幅とを決定する搬送波変調信号群をシンボル毎に逆フーリエ変換することにより、時間軸上の前記直交周波数分割多重信号に変換する第１のステップと、

前記直交周波数分割多重信号の各シンボルに対し、その前部にその後端部と同じデータを含む前部ガードタイムを付加するとともに、その後部にその前端部と同じデータを含む後部ガードタイムを付加して、前記受信側に送信する第２のステップとを備える、直交周波数分割多重信号の伝送方法。

【請求項２】　前記搬送波変調信号群と、基準複素数信号群とを周波数軸上で複素乗算する第３のステップをさらに備え、

前記第１のステップは、前記第３のステップで得られた複素乗算結果を、前記直交周波数分割多重信号に変換する、請求項１に記載の直交周波数分割多重信号の伝送方法。

【請求項３】　前記第３のステップは、前記搬送波変調信号群の各シンボルについて、その一定シンボル前に複素乗算した結果を、前記基準複素数信号群として各前記搬送波変調信号群に複素乗算する、請求項２に記載の直交周波数分割多重信号の伝送方法。

【請求項４】　予め定められた特定パターンを有し、かつ各信号の位相がランダムに変化している複素数信号群をシンボル毎に発生する第４のステップをさらに備え、

前記第３のステップは、前記搬送波変調信号群の各シンボルについて、前記第４のステップで得られた複素数信号群を、前記基準複素数信号群として使用し、

前記第１のステップは、常時は前記第３のステップで得られた複素乗算結果を前記直交周波数分割多重信号に変換し、定期的に前記基準複素数信号群を前記直交周波数分割多重信号に変換する、請求項２に記載の直交周波数分割多重信号の伝送方法。

【請求項５】　所定長のシンボル毎に前記送信側から送信されてきた前記直交周波数分割多重信号を、前記搬送波変調信号群に対応する受信搬送波変調信号群に変換する第５のステップと、

前記第５のステップで得られた受信信号群を、所定の基準複素数信号群により、周波数軸上で複素除算する第６のステップとを備える、請求項２に記載の直交周波数分割多重信号の伝送方法。

【請求項６】　有線または無線の伝送路を介し、受信側に、所定長のシンボル毎に直交周波数分割多重信号を送信する装置であって、

基準複素数信号群を記憶するメモリ手段と、

周波数軸上で互いに直交する複数のキャリアの位相と振

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幅とを決定する搬送波変調信号群と、前記メモリ手段に記憶された前記基準複素数信号群とを周波数軸上で複素乗算し、送信搬送波変調信号群を出力する複素乗算手段と、

前記複素乗算手段から出力される送信搬送波変調信号群に対して、各シンボル毎に逆フーリエ演算を施すことにより、当該送信搬送波変調信号群を、時間軸上の前記直交周波数分割多重信号に変換する逆フーリエ変換手段と、

前記逆フーリエ変換手段から出力される前記直交周波数分割多重信号の各シンボルに対し、その前部にその後端部と同じデータを含む前部ガードタイムを付加するとともに、その後部にその前端部と同じデータを含む後部ガードタイムを付加するガードタイム付加手段と、

前記前部ガードタイムおよび前記後部ガードタイムの付加された前記直交周波数分割多重信号を、各シンボル毎に前記受信側に送信する送信手段とを備える、直交周波数分割多重信号の送信装置。

【請求項７】　前記メモリ手段は、前記複素乗算手段の一定シンボル前の複素乗算結果を、前記基準複素数信号群として記憶する、請求項６に記載の直交周波数分割多重信号の送信装置。

【請求項８】　前記メモリ手段は、予め定められた複素数信号群を、前記基準複素数信号群として記憶し、

前記複素乗算手段は、前記搬送波変調信号群と、前記メモリ手段に記憶された前記基準複素数信号群とを周波数軸上で複素乗算して出力し、

前記逆フーリエ変換手段は、常時はシンボル毎に前記複素乗算手段から出力された複素乗算結果を前記直交周波数分割多重信号に変換し、定期的に前記メモリ手段から出力された前記基準複素数信号群を前記直交周波数分割多重信号に変換する、請求項６に記載の直交周波数分割多重信号の送信装置。

【請求項９】　前記メモリ手段は、前記基準複素数信号群として疑似雑音信号を発生する疑似雑音信号発生手段の出力を保持していることを特徴とする、請求項８に記載の直交周波数分割多重信号の送信装置。

【請求項１０】　前記メモリ手段は、前記基準複素数信号群として周波数掃引信号を発生する周波数掃引信号発生手段の出力を保持していることを特徴とする、請求項８に記載の直交周波数分割多重信号の送信装置。

【請求項１１】　有線または無線の伝送路を介し、送信側から所定長のシンボル毎に送信されてくる直交周波数分割多重信号を受信する装置であって、

時間軸上の前記直交周波数分割多重信号に対して、シンボル毎にフーリエ変換演算を施すことにより、当該直交周波数分割多重信号を、周波数軸上の受信搬送波変調信号群に変換するフーリエ変換手段と、

前記フーリエ変換手段から一定シンボル毎に出力された受信搬送波変調信号群を、受信基準複素数信号群として

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記憶するメモリ手段と、
前記フーリエ変換手段から出力された受信搬送波変調信号群を、前記メモリ手段に記憶された受信基準複素数信号群により、周波数軸上で複素除算する複素除算手段とを備える、直交周波数分割多重信号の受信装置。
【請求項１２】　有線または無線の伝送路を介し、送信側から受信側に対して、所定長のシンボル毎に直交周波数分割多重信号を伝送する方法であって、
周波数軸上で互いに直交する複数のキャリアの位相と振幅とを決定するための搬送波変調信号群をシンボル毎に生成する第１のステップと、
予め定められた特定パターンを有し、かつ各信号の位相がランダムに変化している複素数信号群を発生する第２のステップと、
前記搬送波変調信号群と前記複素数信号群とをシンボル毎に周波数軸上で複素乗算することにより、当該搬送波変調信号群の各信号の位相をランダム化する第３のステップと、
常時は前記第３のステップで各信号の位相がランダム化された搬送波変調信号群をシンボル毎に逆フーリエ変換して時間軸上の前記直交周波数分割多重信号に変換し、定期的に前記複素数信号群を逆フーリエ変換して前記直交周波数分割多重信号に変換し、それぞれを前記受信側に送信する第４のステップとを備える、直交周波数分割多重信号の伝送方法。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、直交周波数分割多重（Ｏｒｔｈｏｇｏｎａｌ　ＦｒｅｑｕｅｎｃｙＤｉｖｉｓｉｏｎ　Ｍｕｌｔｉｐｌｅｘｉｎｇ；以下、ＯＦＤＭと称す）伝送方法に関し、より特定的には、有線または無線の伝送路を介し、送信側と受信側との間で、所定長のシンボルと当該シンボル間に配置された所定長のガードタイムとを含む直交周波数分割多重信号を用いてデータを伝送する方法に関する。
【０００２】
【従来の技術】周知のごとく、ＯＦＤＭ伝送方式は、符号化したデータを分割して、数百以上の搬送波に振り分け、これを多重して伝送する方式である。近年、移動体向けディジタル音声放送や、地上ディジタルテレビ放送等において、ＯＦＤＭ信号を用いた通信が着目されている。なぜならば、ＯＦＤＭ信号は、多量のデータの高速伝送が可能で、波形等価器なしでも反射波による特性劣化が少なく、その信号波形がランダム雑音に近い形となるので、他のサービスに混信妨害を与えにくい等の特質を有しているからである。
【０００３】このようなＯＦＤＭ信号を用いた伝送方式は、１９９３年１０月１日付け発行のＮＩＫＫＥＩ　ＥＬＥＣＴＲＯＮＩＣＳ　ＢＯＯＫＳ「データ圧縮とディジタル変調」の第２０７～２２２頁において、郵政省，

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通信総合研究所の福地一により書かれた「数百以上の搬送波を使うＯＦＤＭディジタル放送の移動受信に向く」に開示されている。
【０００４】図１３は上記先行文献に開示された従来のＯＦＤＭ信号の送信装置の構成を示すブロック回路図であり、図１４は図１３の送信装置から送信されるＯＦＤＭ信号の構成を示す図である。図１３において、送信装置５は、直並列変換器５２と、逆フーリエ変換器５３と、並直列変換器５４と、Ｄ／Ａ変換器５５と、ローパスフィルタ５６とを備える。なお、図１４において、（ａ）はＯＦＤＭ信号の直接波を示し、（ｂ）はＯＦＤＭ信号の反射波を示し、（ｃ）はＯＦＤＭ信号の合成波を示し、（ｄ）は時間窓Ｗを示している。
【０００５】送信装置５の直並列変換器５２には、入力シンボル列が供給されている。入力シンボル列は、ディジタル変調された送信データであり、１伝送シンボル中には複数のデータ値が含まれている。なお、ディジタル変調方式としては、ＱＰＳＫ（ｑｕａｄｒｉｐｈａｓｅ　ｐｈａｓｅ　ｓｈｉｆｔ　ｋｅｙｉｎｇ）変調や、１６ＱＡＭ（ｑｕａｄｒａｔｕｒｅ　ａｍｐｌｉｔｕｄｅ　ｍｏｄｕｌａｔｉｏｎ）等が採用される。直並列変換器５２は、入力シンボル列を、１シンボル毎に、直並列変換して、より低速な複数のシンボル列にする。ここでの並列度は、逆フーリエ変換回路５３で使用する複数の搬送波（相互に位相が直交している）の数（数十～数千、たとえば５１２）と同じになる。このような操作により、直並列変換器５２は、逆フーリエ変換回路５３で使用する複数の搬送波のそれぞれの振幅および位相を決定するための搬送波変調信号群を出力する。
【０００６】逆フーリエ変換回路５３は、搬送波変調信号群を、１シンボル毎に、周波数軸上に並ぶ各搬送波に割り当て（これによって、１シンボル分のデータが周波数軸上で多重された信号となる）、これらに対して一括的に逆フーリエ変換を施すことにより、時間軸上の多重信号（この段階では、並列のディジタル信号である）に変換する。
【０００７】並直列変換器５４は、時間軸上の多重信号を並直列変換することにより、離散的なＯＦＤＭ信号を生成する。Ｄ／Ａ変換回路５５は、離散的なＯＦＤＭ信号を、アナログのＯＦＤＭベースバンド信号に変換する。ローパスフィルタ５６は、エイリアシングによるチャネル間干渉が生じないようにするため、ＯＦＤＭベースバンド信号に帯域制限をかける。
【０００８】上記のような一連の操作の結果、送信装置５は、伝送路に対し、図１４に示すようなガードタイムG_mとシンボルS_mとを含むＯＦＤＭ信号を出力する。図示しない復調装置は、伝送路を介して受信したＯＦＤＭ信号に対して変調装置５と逆の信号処理を行い、入力シンボル列と同じ出力シンボル列を再生する。
【０００９】

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【発明が解決しようとする課題】ところで、伝送路上では、いわゆるマルチパスが発生する。このため、受信装置側では、送信装置から送信されてきたＯＦＤＭ信号の直接波と、直接波から時間遅延した反射波とを重なって受信する。シンボルＳｍ を例にとると、直接波（図１４（ａ）参照）にマルチパスによる反射波（図１４（ｂ）参照）が重なった場合、合成波（図１４（ｃ）参照）のシンボルＳｍ の前端部に反射波のガードタイムＧｍ との干渉部αｍ が生じ、ガードタイムＧｍ の前端部に反射波のシンボルＳｍ-1 との干渉部βｍ が生じる。このとき、干渉部βｍ は、時間窓Ｗからはずれているため、シンボルＳｍ のフーリエ変換には影響を及ぼさない。しかしながら、干渉部αｍ は、時間窓Ｗ内に生じ、かつガードタイムＧｍ のデータ成分が「０」であるため、フーリエ変換後の各シンボルＳｍ の周波数軸上のデータ成分に波形歪みを生じるという第１の問題点があった。

【００１０】また、伝送路の遅延特性や、送信側のＤ／Ａ変換器および受信側のＡ／Ｄ変換器のクロックが一致していないことに起因してサンプリングのタイミングにずれが生じる等の理由から、送信装置から受信装置に到達するまでの間に、ＯＦＤＭ信号に時間遅延が発生する。このため、受信装置では、時間窓Ｗを時間軸上で調整する必要があるという第２の問題点もあった。

【００１１】また、直並列変換器５２から出力される搬送波変調信号群は、その位相が相互に異なっているだけでなく、その位相がすべて同一の場合もありうる。例えば、ディジタル音声放送では無音状態を１シンボル期間を超えて送信する場合に、地上ディジタルテレビ放送では一色の映像を１シンボル期間を超えて送信する場合に、搬送波変調信号群の位相がすべて同一になる。また、有音状態を送信する場合や、多色の映像を送信する場合においても、ＱＰＳＫ変調や、１６ＱＡＭ等のようなディジタル変調方式では、位相の異なる信号点の配点数が限られるため、搬送波変調信号群の位相がすべて同一になりやすい。

【００１２】このように、搬送波変調信号群の位相がすべて同一になった場合、この搬送波変調信号群を逆フーリエ変換すると、時間軸上で各搬送波の節が一致し、加算増加箇所が時間軸上で一箇所に集中するため、時間軸上のＯＦＤＭ信号の信号波形がインパルス状になり、電力集中が生じる。この様子を図１５に示す。

【００１３】図１５（ａ）は、相互に直交するｎ本の搬送波をそれぞれ変調するｎ個の搬送波変調信号群の複素平面上での位相がすべて同一の場合を示している。図１５（ｂ）は、図１５（ａ）のｎ個の搬送波変調信号群で変調されたｎ本の搬送波を時間軸上で多重した状態を示している。このように搬送波変調信号群の位相がすべて同一の場合には、ＯＦＤＭ信号は、インパルス状の波形信号になる。なお、図１５（ｃ）は、相互に直交するｎ本の搬送波をそれぞれ変調するｎ個の搬送波変調信号群の複素平面上での位相がランダムな場合を示している。また、図１５（ｄ）は、図１５（ｃ）のｎ個の搬送波変調信号群で変調されたｎ本の搬送波を時間軸上で多重した状態を示している。このように、搬送波変調信号群の位相がすべて異なる場合には、ＯＦＤＭ信号は、時間軸上に平均的に拡散され、ランダム状の波形信号になる。

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【００１４】上記のように、搬送波変調信号群の位相がすべて同一になった場合、ＯＦＤＭ信号がインパルス状になり、最大電力が極端に大きくなるため、ＯＦＤＭ信号は、送受信装置や伝送路に含まれる中継増幅器（衛星やＣＡＴＶなど）等の非線形性の影響を受けやすくなるという第３の問題点もあった。この場合、ＯＦＤＭ信号がインパルス状になっても、非線形性の影響を与えないように、送受信装置や中継増幅器等のダイナミックレンジを大きくすることも考えられるが、送受信装置や中継増幅器等が高価になるという別の問題が発生する。

【００１５】それ故に、本発明の目的は、マルチパスにより反射波が直接波に重なった場合でも、フーリエ変換後の各シンボルの周波数軸上のデータ成分に波形歪みを生じないＯＦＤＭ信号の伝送方法ならびにその送信装置および受信装置を提供することである。本発明の他の目的は、送信側から受信側に到達するまでの間に、ＯＦＤＭ信号に時間遅延が発生しても、時間窓の時間軸上での調整が容易なＯＦＤＭ信号の伝送方法ならびにその送信装置および受信装置を提供することである。本発明のさらに他の目的は、安価な構成で、ＯＦＤＭ信号に対する非線形性の影響を軽減したＯＦＤＭ信号の伝送方法ならびにその送信装置および受信装置を提供することである。

【００１６】

【課題を解決するための手段および発明の効果】本発明の第１の局面は、有線または無線の伝送路を介し、送信側から受信側に対して、所定長のシンボル毎に直交周波数分割多重信号を伝送する方法に向けられており、周波数軸上で互いに直交する複数のキャリアの位相と振幅とを決定する搬送波変調信号群をシンボル毎に逆フーリエ変換することにより、時間軸上の直交周波数分割多重信号に変換する第１のステップと、直交周波数分割多重信号の各シンボルに対し、その前部にその後端部と同じデータを含む前部ガードタイムを付加するとともに、その後部にその前端部と同じデータを含む後部ガードタイムを付加して、受信側に送信する第２のステップとを備えている。

【００１７】上記のように、第１の局面では、ＯＦＤＭ信号の各シンボルを送信する際に、各シンボルの前部および後部に、そのシンボルの一部と同じデータを含む前部ガードタイムおよび後部ガードタイムを付加するようにしているので、受信側では、フーリエ変換時における時間窓が受信信号のシンボル区間から多少ずれても、時間軸上に並ぶ１シンボル区間内のすべてのデータ成分を

再生することができる。従って、送信側から受信側に到達するまでの間に、ＯＦＤＭ信号に時間遅延が発生しても、時間窓をシンボル区間に正確に一致させる必要がなくなり、時間窓の時間軸上での調整が容易になる。また、マルチパスにより直接波のシンボル区間と反射波のガードタイムとが重なっても、受信側でフーリエ変換後の周波数軸上に現れる各データ成分の振幅位相歪みは、各シンボル間ですべて一様なものとなる。したがって、簡単な演算処理（乗算、加算等）によって、受信側での１シンボル区間の周波数軸上のデータ成分から、容易にそれらの波形歪みを除去することが可能となる。

【００１８】上記第１の局面において、好ましい実施形態では、搬送波変調信号群と基準複素数信号群とを周波数軸上で複素乗算し、この複素乗算結果をＯＦＤＭ信号に変換して、受信側に伝送するようにしている。また、受信側では、送信側から送信されてきたＯＦＤＭ信号を受信搬送波変調信号群に変換し、この受信搬送波変調信号群を、基準複素数信号群により、周波数軸上で複素除算するようにしている。これによって、送信側と受信側との間でＯＦＤＭ信号に時間遅延が発生しても、受信側で時間遅延の影響のない復調データを得ることができる。

【００１９】なお、搬送波変調信号群に複素乗算される基準複素数信号群としては、搬送波変調信号群の各シンボルについて、その一定シンボル前に複素乗算した結果を用いても良い。

【００２０】また、予め定められた特定パターンを有し、かつ各信号の位相がランダムに変化している複素数信号群を、基準複素数信号群として用いても良い。ただし、この場合、常時は第３のステップで得られた複素乗算結果がＯＦＤＭ信号に変換され、定期的に基準複素数信号群がＯＦＤＭ信号に変換される。これによって、搬送波変調信号群の各信号の絶対基準位相がランダムな値になり、逆フーリエ変換によって得られたＯＦＤＭ信号に電力の時間集中がおこるのを抑制できる。従って、送信装置、受信装置および伝送路のダイナミックレンジを大きくする必要がなく、安価な構成で、送受信器や中継増幅器等の非線形性がＯＦＤＭ信号に与える影響を軽減することができる。

【００２１】本発明の第２の局面は、有線または無線の伝送路を介し、受信側に、所定長のシンボル毎に直交周波数分割多重信号を送信する装置に向けられており、基準複素数信号群を記憶するメモリ手段と、周波数軸上で互いに直交する複数のキャリアの位相と振幅とを決定する搬送波変調信号群と、メモリ手段に記憶された基準複素数信号群とを周波数軸上で複素乗算し、送信搬送波変調信号群を出力する複素乗算手段と、複素乗算手段から出力される送信搬送波変調信号群に対して、各シンボル毎に逆フーリエ演算を施すことにより、当該送信搬送波変調信号群を、時間軸上の直交周波数分割多重信号に変換する逆フーリエ変換手段と、逆フーリエ変換手段から出力される直交周波数分割多重信号の各シンボルに対し、その前部にその後端部と同じデータを含む前部ガードタイムを付加するとともに、その後部にその前端部と同じデータを含む後部ガードタイムを付加するガードタイム付加手段と、前部ガードタイムおよび後部ガードタイムの付加された直交周波数分割多重信号を、各シンボル毎に受信側に送信する送信手段とを備えている。

【００２２】上記第２の局面において、好ましい実施形態では、メモリ手段は、複素乗算手段の一定シンボル前の複素乗算結果を、基準複素数信号群として記憶している。

【００２３】上記第２の局面において、他の好ましい実施形態では、メモリ手段は、予め定められた複素数信号群を、基準複素数信号群として記憶する。また、複素乗算手段は、搬送波変調信号群と、メモリ手段に記憶された基準複素数信号群とを周波数軸上で複素乗算して出力する。さらに、逆フーリエ変換手段は、常時はシンボル毎に複素乗算手段から出力された複素乗算結果を直交周波数分割多重信号に変換し、定期的にメモリ手段から出力された基準複素数信号群を直交周波数分割多重信号に変換する。

【００２４】上記第２の局面において、メモリ手段は、基準複素数信号群として、疑似雑音信号を発生する疑似雑音信号発生手段の出力を保持しても良いし、周波数掃引信号を発生する周波数掃引信号発生手段の出力を保持しても良い。

【００２５】本発明の第３の局面は、有線または無線の伝送路を介し、送信側から所定長のシンボル毎に送信されてくる直交周波数分割多重信号を受信する装置に向けられており、時間軸上の直交周波数分割多重信号に対して、シンボル毎にフーリエ変換演算を施すことにより、当該直交周波数分割多重信号を、周波数軸上の受信搬送波変調信号群に変換するフーリエ変換手段と、フーリエ変換手段から一定シンボル毎に出力された受信搬送波変調信号群を、受信基準複素数信号群として記憶するメモリ手段と、フーリエ変換手段から出力された受信搬送波変調信号群を、メモリ手段に記憶された受信基準複素数信号群により、周波数軸上で複素除算する複素除算手段とを備えている。

【００２６】本発明の第４の局面は、有線または無線の伝送路を介し、送信側から受信側に対して、所定長のシンボル毎に直交周波数分割多重信号を伝送する方法に向けられており、周波数軸上で互いに直交する複数のキャリアの位相と振幅とを決定するための搬送波変調信号群をシンボル毎に生成する第１のステップと、予め定められた特定パターンを有し、かつ各信号の位相がランダムに変化している複素数信号群を発生する第２のステップと、搬送波変調信号群と複素数信号群とをシンボル毎に周波数軸上で複素乗算することにより、当該搬送波変調

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信号群の各信号の位相をランダム化する第３のステップと、常時は第３のステップで各信号の位相がランダム化された搬送波変調信号群をシンボル毎に逆フーリエ変換して時間軸上の直交周波数分割多重信号に変換し、定期的に複素数信号群を逆フーリエ変換して直交周波数分割多重信号に変換し、それぞれを受信側に送信する第４のステップとを備えている。

【００２７】

【発明の実施の形態】以下、本発明の実施形態に係るＯＦＤＭ信号の伝送方法ならびにその送信装置および受信装置について、図面を参照しながら説明する。

【００２８】図１は本発明の第１の実施形態の送信装置を示すブロック図であり、図２は本発明の第１の実施形態の受信装置の構成を示すブロック図であり、図３は本発明で用いるＯＦＤＭ信号の構成の一例を示す図である。なお、図３において、（ａ）はＯＦＤＭ信号の直接波を示し、（ｂ）はＯＦＤＭ信号の反射波を示し、（ｃ）は時間遅延が生じた場合のＯＦＤＭ信号の直接波を示し、（ｄ）は時間遅延が生じた場合のＯＦＤＭ信号の反射波を示し、（ｅ）は時間窓Ｗを示している。

【００２９】図１の送信装置１と、図２の受信装置２とは、同軸ケーブルや、光ファイバケーブル等の伝送路（図示せず）で接続されている。このような送信装置１および受信装置２は、たとえばディジタルＣＡＴＶシステムにおいて用いられる。送信装置１は、ＯＦＤＭ信号を用い、受信装置２に対して、たとえばテレビの多チャンネル分の映像データを伝送するように構成されている。

【００３０】図１において、送信装置１は、搬送波変調信号発生器１２と、複素乗算器１３と、メモリ１４と、逆フーリエ変換器１５と、ガードタイム挿入部１６と、同期信号多重部１７と、Ｄ／Ａ変換器１８と、ローパスフィルタ１９とを備えている。

【００３１】送信装置１の搬送波変調信号発生器１２には、受信装置２に送信すべき送信ディジタルデータ（ビットストリーム信号）が入力されている。搬送波変調信号発生器１２は、入力された送信ディジタルデータを、ディジタル変調すると共に、１シンボル区間毎に直並列変換し、相互に直交するｎ本（ｎ＝数十～数千、たとえば５１２）の搬送波を変調するためのｎ個の搬送波変調信号を含む搬送波変調信号群に変換する。なお、ディジタル変調方式としては、ＱＰＳＫ変調や、１６ＱＡＭ等が採用される。この段階での搬送波変調信号群は、従来の直並列変換器５２（図１３参照）から出力される搬送波変調信号群と同様である。搬送波変調信号発生器１２から出力される搬送波変調信号群は、複素乗算器１３に与えられる。メモリ１４は、複素乗算器１３から出力される搬送波変調信号群Ｄ’ｍを１シンボル分記憶することができる。また、メモリ１４は、複素乗算器１３に搬送波変調信号群Ｄｍが入力されたときに、内部に記憶している１シンボル前の搬送波変調信号群Ｄ’ｍ-1 を、所定の基準複素数信号群として、複素乗算器１３に出力する。複素乗算器１３は、入力された送信信号群Ｄｍと、１シンボル前の基準複素数信号群Ｄ’ｍ-1 とを、周波数軸上で、複素乗算することにより、搬送波変調信号群

Ｄ’ｍ（Ｄ’ｍ＝Ｄｍ×Ｄ’ｍ-1 ）

を作成する。

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【００３２】より具体的に説明すると、複素乗算器１３に入力された搬送波変調信号群（ｎ個の搬送波変調信号を含む）のうち、ｋ（ｋ＝１，２，…，ｎ）番目の搬送波変調信号の実数部をＤｍ［ｋ］ｒｅａｌとし、その虚数部をＤｍ［ｋ］ｉｍａｇとし、メモリ１４に記憶したｋ番目の搬送波変調信号の実数部をＤ’ｍ-1［ｋ］ｒｅａｌとし、その虚数部をＤ’ｍ-1［ｋ］ｉｍａｇとした場合、複素乗算器１３は、各搬送波変調信号の実数部および虚数部それぞれについて、乗算処理を行い、

Ｄ’ｍ［ｋ］ｒｅａｌ＝Ｄｍ［ｋ］ｒｅａｌ×Ｄ’ｍ-1［ｋ］ｒｅａｌ

Ｄ’ｍ［ｋ］ｉｍａｇ＝Ｄｍ［ｋ］ｉｍａｇ×Ｄ’ｍ-1［ｋ］ｉｍａｇ

を出力する。メモリ１４は、複素乗算器１３から出力された実数および虚数の搬送波変調信号Ｄ’ｍ（Ｄ’ｍ［ｋ］ｒｅａｌおよびＤ’ｍ［ｋ］ｉｍａｇを含む）を記憶保持する。図４に示すように、メモリ１４および複素乗算器１３は、上記のような動作を繰り返し実行する。

【００３３】逆フーリエ変換器１５は、複素乗算器１３から出力される搬送波変調信号群Ｄ’ｍ中のそれぞれの搬送波変調信号を、シンボル区間毎に、順次周波数軸上に並ぶ各搬送波に割り当て、これらに対して一括的に逆フーリエ変換を施し、さらに並直列変換を行うことにより、周波数軸上で各データ成分が多重された搬送波変調信号群を、時間軸上で各データ成分が多重されたＯＦＤＭ信号Ｄ’ｍtに変換する。

【００３４】ガードタイム挿入部１６は、逆フーリエ変換器１５から出力されるディジタルのＯＦＤＭ信号Ｄ’ｍtを、各シンボル区間毎に、一旦、内部のバッファに蓄える。次に、ガードタイム挿入回路１６は、各シンボルＳｍ に対して、その前部に前部ガードタイムＧｈｍを、その後部に後部ガードタイムＧｅｍを、それぞれ付加する（図３参照）。なお、前部ガードタイムＧｈｍの時間長ｔｇ１および後部ガードタイムＧｅｍの時間長ｔｇ２は、それぞれ伝送路で発生するマルチパスによる直接波と間接波との時間差および送信装置１のＤ／Ａ変換器１８と受信装置２のＡ／Ｄ変換器２２との間のサンプリングのずれによる時間遅延を考慮して定められる。また、前部ガードタイムＧｈｍには、対応するシンボルＳｍ の後端部Ｓｅｍと同じデータＤ’ｅｍｔ が含められ、後部ガードタイムＧｅｍには、対応するシンボルＳｍ の前端部Ｓｈｍと同じデータＤ’ｈｍｔ が含められる。これにより、実質的なシン

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ボル長が、ｔｇ１＋ｔｓ＋ｔｇ２に延長されることになる。ガードタイム挿入部１６は、前部ガードタイムＧｈｍ、シンボルＳｍ、後部ガードタイムＧｅｍを使用して、データＤ’ｅｍｔ、Ｄ’ｍ、Ｄ’ｈｍｔを順次出力する。

【００３５】同期信号多重部１７は、シンボルの区切りを示すため、シンボル毎に、同期信号を、ガードタイムの付加されたＯＦＤＭ信号に時間軸上で多重し、Ｄ／Ａ変換器１８に出力する。同期信号は、たとえば、図５（ａ）に示すようにＯＦＤＭ信号に対し、周期的に既知の無変調搬送波と抑圧信号等とから構成する。

【００３６】Ｄ／Ａ変換器１８は、同期信号多重部１７から出力される、ガードタイムおよび同期信号が付加されたディジタルデータのＯＦＤＭ信号を、アナログのＯＦＤＭベースバンド信号に変換する。ローパスフィルタ１９は、エイリアシングによるチャネル間干渉が生じないようにするため、ＯＦＤＭベースバンド信号に帯域制限をかける。

【００３７】上記のような一連の操作の結果、送信装置１は、伝送路に対して、ガードタイムおよび同期信号を含むＯＦＤＭ信号を出力する。

【００３８】図２において、受信装置２は、ローパスフィルタ２１と、Ａ／Ｄ変換器２２と、エンベロープ検波器２３と、同期再生部２４と、フーリエ変換器２５と、メモリ２６と、複素除算器２７と、送信データ再生器２８とを備えている。

【００３９】ローパスフィルタ２１は、伝送路を介して受信したＯＦＤＭ信号から、不要な高周波域のスペクトル成分を除去する。

【００４０】ここで、マルチパスや伝送路の遅延特性等による時間遅延Δｔを考慮し、受信装置２において受信したＯＦＤＭ信号をＺＤ’ｍｔとする。なお、Ｚは、

Ｚ＝ｅｘｐｊ２πｆｃΔｔ

であり、信号の遅延分を表している。

【００４１】Ａ／Ｄ変換器２２は、アナログのＯＦＤＭ信号の前部ガードタイムＧｈｍ、シンボルＳｍ、後部ガードタイムＧｅｍにそれぞれ含まれるデータＺＤ’ｅｍｔ、ＺＤ’ｍｔ、ＺＤ’ｈｍｔを、ディジタルのＯＦＤＭ信号に変換する。

【００４２】エンベロープ検波器２３は、ＯＦＤＭ信号をエンベロープ検波することにより、図５（ｂ）に示すエンベロープ検波信号を、シンボル毎に出力する。同期再生部２４は、エンベロープ検波器２３から出力されたエンベロープ検波信号に基づいて、図５（ｃ）に示す基準タイミング信号を、シンボル毎に出力する。この基準タイミング信号は、フーリエ変換器２５およびメモリ２６に入力される。

【００４３】フーリエ変換器２５は、基準タイミング信号に同期して、Ａ／Ｄ変換器２２から出力されるＯＦＤＭ信号を、シンボル長ｔｓと同じ長さの時間窓Ｗ（図３（ｅ）参照）を介して覗くことにより、各シンボルの必

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要なデータ部分だけを抽出する。また、フーリエ変換器２５は、この抽出されたデータ部分に対して、フーリエ変換演算を施すことにより、時間軸上のＯＦＤＭ信号を、周波数軸上の受信搬送波変調信号群に変換する。

【００４４】メモリ２６は、フーリエ変換器２５から出力される受信搬送波変調信号群を、１シンボル分記憶する。ここで、送信装置１からデータＤ’ｍが送られてきた場合、メモリ２６には、それに対応するデータとして、データＺＤ’ｍが格納されることになる。データＺＤ’ｍは、データＤ’ｍにマルチパスや伝送路等によって生じた時間遅延分Ｚを加えたものである。すなわち、

ＺＤ’ｍ＝Ｄ’ｍ×ｅｘｐｊ２πｆｃΔｔ

となる。メモリ２６は、基準タイミング信号に同期して、データＺＤ’ｍを複素除算器２７に出力する。複素除算器２７は、同期を確立した上で、フーリエ変換器２５から出力されるシンボルＳｍ+1 のデータＺＤ’ｍ+1 を、メモリ２６に保持されているデータＺＤ’ｍによって複素除算する。すなわち、複素除算器２７は、

ＺＤ’ｍ+1 ／ＺＤ’ｍ＝Ｄ’ｍ+1 ／Ｄ’ｍ＝Ｄｍ+1

の演算を行う。図６に示すように、フーリエ変換器２５、メモリ２６および複素除算器２７は、上記のような動作を繰り返し実行する。

【００４５】前述したように、マルチパスに起因して、図３（ａ）に示す直接波と図３（ｂ）に示す反射波との間に、相対的な時間遅延が生じる。また、送信装置１のＤ／Ａ変換器１８と受信装置２のＡ／Ｄ変換器２２とにおけるサンプリングタイミングが異なることに起因して、直接波および反射波にそれぞれ固有の時間遅延が発生する（図３（ｃ）および図３（ｄ）参照）。フーリエ変換器２５において、基準タイミング信号は、これらの時間遅延を考慮していないため、図３（ｅ）に示すように、時間軸上における受信側の時間窓Ｗの位置は、受信信号のシンボル区間からずれている。

【００４６】しかしながら、受信側のフーリエ変換器２５で、時間窓Ｗが正確なシンボル区間からずれていても、前部ガードタイムＧｈｍおよび後部ガードタイムＧｅｍには、それぞれデータＺＤ’ｅｍｔおよびＺＤ’ｈｍｔが含まれているため、時間窓Ｗを介して覗いたデータには、１シンボル区間に本来含まれるべき時間軸上のすべてのデータＺＤ’ｍｔが含まれていることになる。このため、この時間遅延および反射波の重なりは、周波数軸上において各データ成分毎に一様な振幅位相歪みとなって現れる。また、時間遅延および反射波の特性が一様であれば、各シンボル区間毎に振幅位相歪みの大きさは等しくなる。本実施形態では、複素除算器２７は、フーリエ変換器２５から出力されたシンボルＳｍ+1 のデータＺＤ’ｍ+1 を、メモリ２６に保持されているデータＺＤ’ｍで複素除算することにより、データの遅延分Ｚをキャンセルし、遅延の無い元の搬送波変調信号群Ｄｍ+1 を得ている。すなわち、複素除算器２７が、

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ＺＤ’ｍ+1 ／ＺＤ’ｍ ＝Ｄ’ｍ+1 ／Ｄ’ｍ ＝Ｄｍ+1

の演算を行うことにより、振幅位相歪みは打ち消されることとなり、各シンボルについて、位相・振幅歪みのないデータＤｍ が得られる。

【００４７】以上のように、上記実施形態では、各シンボルの前後にそのシンボルの後端部および前端部と同じデータを含むガードタイムを付加して送信するようにしているので、受信側では、時間窓W内に直接波および反射波の両方について、時間軸上に並ぶ１シンボル区間内のすべてのデータ成分を再生することができる。このため、マルチパスにより反射波が直接波に重なり、直接波のシンボル区間と反射波のガードタイムとが重なっても、フーリエ変換後に周波数軸上に現れる各データ成分の振幅位相歪みは、すべて一様なものとなる。したがって、送信側および受信側で適当な演算処理（乗算、除算）を実行することで、１シンボル区間の周波数軸上の受信搬送波変調信号群から、容易に波形歪みを除去することができる。

【００４８】また、上記実施形態では、送信側と受信側との間で、ＯＦＤＭ信号に時間遅延が発生しても、周波数軸上で受信搬送波変調信号群を所定の基準複素数信号群で複素乗算、複素除算することにより、時間遅延のない復調データを得ることができる。その結果、時間窓をシンボル区間に正確に一致させる必要がなくなる。

【００４９】送信データ再生器２８は、複素除算器２７から出力された受信搬送波変調信号群Ｄｍ の信号点を複素平面上にマッピングし、信号点を判定することにより、送信装置１の送信ディジタル信号群と同値の受信ディジタル信号群を得る。前述したように、受信搬送波変調信号群Ｄｍ からは、位相歪みや振幅歪みが除去されている。したがって、送信データ再生器２８は、複素平面上へのマッピング位置から、正確かつ容易に元のデータを判定することができる。

【００５０】なお、本願発明者は、計算機を使用して、マルチパスによる遅延波の影響と、時間軸遅延の影響とについて、従来のシステムと本実施形態のシステムとを比較するシミュレーションを行った。なお、このシミュレーションは、キャリア数が５１２本、２５６番目のキャリアのデータだけが振幅「１」，位相「０」、他のキャリアのデータはすべて「０」を条件として実施された。

【００５１】図７は、マルチパスによる遅延波の影響について、従来のシステムと本実施形態のシステムとを比較したシミュレーション結果を示す図である。なお、図７において、（ａ），（ｂ），（ｃ），（ｄ）は、それぞれ、従来のシステムにおける直接波，間接波，合成波，合成波をフーリエ演算することにより周波数軸上の信号に変換した場合のデータ歪みを示している。また、図７において、（ｅ），（ｆ），（ｇ），（ｈ）は、それぞれ、本実施形態のシステムにおける直接波，間接波，合成波，合成波をフーリエ演算することにより周波数軸上の信号に変換した場合のデータ歪みを示している。

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【００５２】従来のシステムでは、ガードタイムにいかなるデータも挿入されていないため（図７（ｂ）のα１参照）、合成波の時間窓W中に干渉部α２が発生している（図７（ｃ）参照）。したがって、合成波を時間窓Wでフーリエ演算することにより周波数軸上の信号に変換すると、図７（ｄ）に示すように、２５６番目のキャリアのデータのスペクトルが拡がるとともに、他のキャリアの本来「０」であったはずのデータに歪みが生じる。したがって、送信データ再生器２８で誤判定が起き易くなる。さらに、他のキャリアについても、送信データ再生器２８で誤判定が起き易くなる。一方、本実施形態のシステムでは、ガードタイムにデータが挿入されているので、他のキャリアのデータに影響を及ぼさない。

【００５３】図８は、伝送路等による時間遅延の影響について、従来のシステムと本実施形態のシステムとを比較したシミュレーション結果を示す図である。図８において、（ａ）は２５６番目のキャリアのデータだけが振幅「１」，位相「０」の場合のスペクトルを示し、（ｂ）は（ａ）のデータを逆フーリエ演算することにより時間軸上の信号に変換した場合の信号波形を示している。また、図８において、（ｃ），（ｄ）は、それぞれ、従来のシステムにおける時間遅延を生じた合成波，合成波をフーリエ演算することにより周波数軸上の信号に変換した場合のデータ歪みを示している。また、図８において、（ｅ），（ｆ）は、それぞれ、本実施形態のシステムにおける時間遅延を生じた合成波，合成波をフーリエ演算することにより周波数軸上の信号に変換した場合のデータ歪みを示している。

【００５４】従来のシステムでは、ガードタイムにいかなるデータも挿入されていないため（図８（ｃ）のα１参照）、図７（ｃ）の場合と同様に、合成波の時間窓W中に干渉部α２が発生する。したがって、図８（ｄ）に示すように、合成波を時間窓Wでフーリエ演算することにより周波数軸上の信号に変換すると、２５６番目のキャリアのデータのスペクトルが拡がるとともに、他のキャリアの本来「０」であったはずのデータに歪みが生じる。したがって、他のキャリアについても、送信データ再生器２８で誤判定が起こり易くなる。一方、本実施形態では、ガードタイムにデータが挿入されているので、他のキャリアのデータに影響を及ぼさない。

【００５５】図９は、本発明の第２の実施形態の送信装置の構成を示すブロック図である。なお、図９の送信装置３において、図１の送信装置１の構成と対応する部分には、同一の参照番号を付し、その説明を省略する。図９の実施形態で注目すべき点は、メモリ１４が、特定パターン発生器３１の出力、すなわち、予め定められた特定パターンを有し、かつ各信号の位相が相互にランダム

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に変化している複素数信号群D0 を保持していることである。このような複素数信号群D0 は、たとえば0～1の間のレベルの疑似ランダム信号を発生するＰＮ系列疑似ランダム信号発生器と、この疑似ランダム信号と２πとを乗算する乗算器とを備え、位相が0から２π間でランダムな値を持ち、かつ振幅が1の単位ベクトル信号を生成する疑似雑音信号発生器により形成することができる。また、このような複素数信号群は、位相が0から２πまでのランダムな値を持った既知の周波数掃引信号を発生する、周波数掃引信号発生器により形成することもできる。

【００５６】複素乗算器１３は、各シンボル区間のデータＤm が入力される毎に、データＤm とデータD0 とを周波数軸上で複素乗算して、データＤ’m （Ｄ’m ＝Ｄm ×D0 ）を作成し、搬送波変調信号群中の各搬送波変調信号の相互の位相を特定パターンにランダム化する。

【００５７】図１０は、複素乗算器１３における複素乗算の動作を示す図である。特に、図１０（ａ）は変調方式に１６値ＱＡＭを用いた場合の搬送波変調信号の取り得る信号点配置を示し、図１０（ｂ）は位相がランダムに変化する単位ベクトルｉを示し、図１０（ｃ）は位相を特定パターンにランダム化された搬送波変調信号を示している。

【００５８】図１０（ａ）において、今、一つの搬送波に割り当てられる搬送波変調信号群中の一つの搬送波変調信号が、複素平面上の信号点Ａに配点されたと仮定する。信号点Ａは、その実数部が3、その虚数部が1の大きさを持つ。また、単位ベクトルｉは、この時、位相角３π／４を持ったと仮定する。複素乗算の結果、図１０（ｃ）に示す搬送波変調信号Ａ’が得られる。搬送波変調信号Ａ’は、実数部が－２．８、虚数部が１．４となり、１６値ＱＡＭの配置にはない信号点をとることになる。このように、単位ベクトルｉの位相がランダムに変化するため、搬送波変調信号発生器１２から出力された搬送波変調信号群中の各搬送波変調信号の位相が、たとえ同一であっても、複素乗算器１３は、位相が相互にランダム化された搬送波変調信号群を、逆フーリエ変換器１５に出力する。

【００５９】複素乗算器１３は、このような動作を所定の期間繰り返す。また、複素乗算器１３は、定期的にデータD0 だけを出力する。この時の一連の動作を、図１１に示す。すなわち、データD0 が挿入されるシンボルをS0 とすると、送信装置３は、図１２に示すように、定期的にシンボルS0 のデータD0 を、その他の場合はシンボルＳm のデータＤ’m を出力することになる。逆フーリエ変換器１５は、搬送波変調信号群Ｄ’m を、シンボル毎に、周波数軸上に並ぶ各搬送波に割り当て、これらに対して一括的に逆フーリエ変換および並直列変換を施すことにより、ディジタルのＯＦＤＭ信号に変換する。この結果、搬送波変調信号群の絶対基準位相が、0

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から２πまでのランダムな値になり、逆フーリエ変換器１５から出力されたＯＦＤＭ信号に電力集中が起こるのを抑制できる。したがって、送信装置、受信装置のダイナミックレンジを大きくする必要がなく、安価な構成で、ＯＦＤＭ信号への送受信器や中継増幅器等の非線形性からの影響を軽減することができる。送信装置３における他の回路ブロック、すなわちガードタイム挿入部１６～ローパスフィルタ１９は、送信装置１の場合と同様に動作する。

【００６０】なお、ガードタイム挿入部１６は、シンボルＳm の場合と同様に、シンボルS0 の後端部と同じデータ成分D0 を対応する前部ガードタイムに挿入するとともに、シンボルS0 の前端部と同じデータ成分を対応する後部ガードタイムに挿入している。

【００６１】図９に示す送信装置３を用いた場合、基本的には、図２に示す受信装置２と同じ構成の受信装置を用いることができる。ただし、受信装置のメモリ２６には、送信装置３のメモリ１４に記憶される基準複素数信号群D0 の受信データＺD0を記憶させることになる。

【００６２】上記した図９の実施形態においても、前述した第１の実施形態と同様の効果が得られる。すなわち、マルチパスにより反射波が直接波に重なり、直接波のシンボル区間と反射波のガードタイムとが重なっても、フーリエ変換後に周波数軸上に現れる受信搬送波変調信号群の振幅位相歪みがすべて一様なものとなり、その除去を簡単な演算処理（乗算、除算）で行える。また、送信側と受信側との間でＯＦＤＭ信号に時間遅延が発生しても、時間遅延の影響のない復調データを得ることができ、時間窓の時間軸上の調整が容易になる。

【００６３】なお、上述の各実施形態は、有線の伝送路を介してデータを伝送するようにしているが、本発明はこれに限定されることなく、無線の伝送路を介してデータを伝送するようにしてもよい。また、上述の各実施形態では、多チャンネル分のテレビの映像データを各搬送波に乗せるようにしたが、１チャンネル分の映像データを時間分割して並列に並び替え、各搬送波に割り当てるようにしてもよい。さらに、映像データに替えて、音声データ、テキストデータ等を各搬送波にのせるようにしてもよい。さらに、ＣＡＴＶに替えて、ＬＡＮ、ＷＡＮ等の他のシステムにおいて本発明を実施してもよい。

【００６４】さらに、図９の送信装置３では、メモリ１４から出力された基準複素数信号群を、定期的に、複素乗算器１３を介して逆フーリエ変換器１５に入力するようにしたが、基準複素数信号群を、逆フーリエ変換器１５に直接入力してもよい。

【００６５】さらに、図９の送信装置３では、搬送波変調信号群に含める基準複素数信号群として、予め定められた特定パターンを有し、かつその位相が相互にランダムに変化している複素数信号群D0 を使用したが、ＯＦＤＭ信号に生じる電力集中が生じないような状況下で

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は、搬送波変調信号群に含める基準複素数信号群として、予め定められた特定パターンを有し、かつ各信号の位相が相互に同一の複素数信号群を使用しても良い。この場合でも、第１の実施形態と同様、簡単な演算処理（乗算、除算）を行うことで、振幅位相歪みを除去できる。

【図面の簡単な説明】

【図１】本発明の第１の実施形態の送信装置の構成を示すブロック図である。

【図２】本発明の第１の実施形態の受信装置の構成を示すブロック図である。

【図３】図１の送信装置１から送信されるＯＦＤＭ信号の構成を示す図である。

【図４】図１のメモリ１４と、複素乗算器１３との動作を示す図である。

【図５】図１の送信装置１から出力されたＯＦＤＭ信号に対する受信装置２のエンベロープ検波器２３と同期再生部２４との動作を示す図である。

【図６】図２のメモリ２６と、複素除算器２７との動作を示す図である。

【図７】マルチパスによる遅延波の影響について、従来のシステムと第１の実施形態のシステムとを比較したシミュレーション結果を示す図である。

【図８】伝送路等による時間遅延の影響について、従来のシステムと第１の実施形態のシステムとを比較したシミュレーション結果を示す図である。

【図９】本発明の第２の実施形態の送信装置の構成を示すブロック図である。

【図１０】図９の複素乗算器１３における搬送波変調信号群と複素数信号群との複素乗算の様子を示す図である。

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【図１１】図９のメモリ１４と複素乗算器１３との動作を示す図である。

【図１２】図９のＯＦＤＭ信号の送信装置から送信されるＯＦＤＭ信号の構成を示す信号構成図である。

【図１３】従来のＯＦＤＭ信号の送信装置の構成を示すブロック図である。

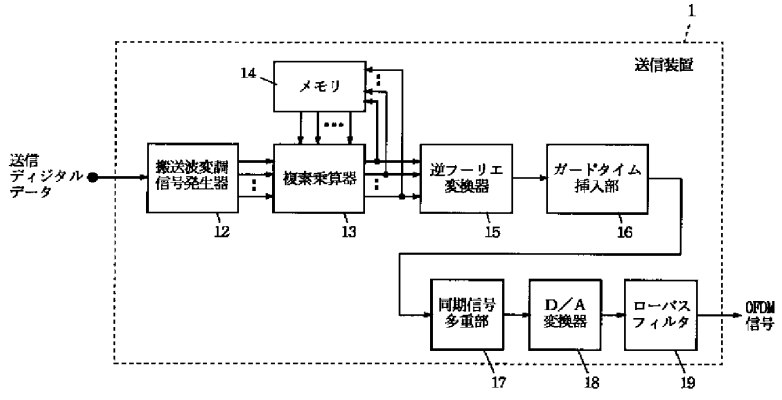
【図１４】図１３の送信装置５から送信されるＯＦＤＭ信号の構成を示す図である。

【図１５】相互に直交する搬送波に割り当てられた搬送波変調信号群の位相状態とＯＦＤＭ信号との関係を示す信号波形図である。

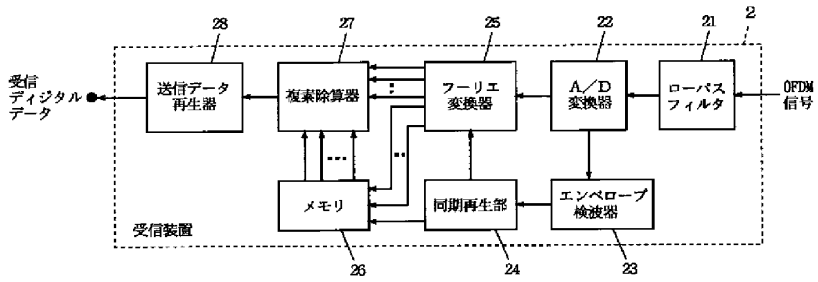
【符号の説明】

１，３…送信装置
１２…搬送波変調信号発生器
１３…複素乗算器
１４…メモリ
１５…逆フーリエ変換器
１６…ガードタイム挿入部
１７…同期信号多重部
１８…Ｄ／Ａ変換器
１９…ローパスフィルタ
３１…特定パターン発生器
２…受信装置
２１…ローパスフィルタ
２２…Ａ／Ｄ変換器
２３…エンベロープ検波器
２４…同期再生部
２５…フーリエ変換器
２６…メモリ
２７…複素除算器
２８…送信データ再生器

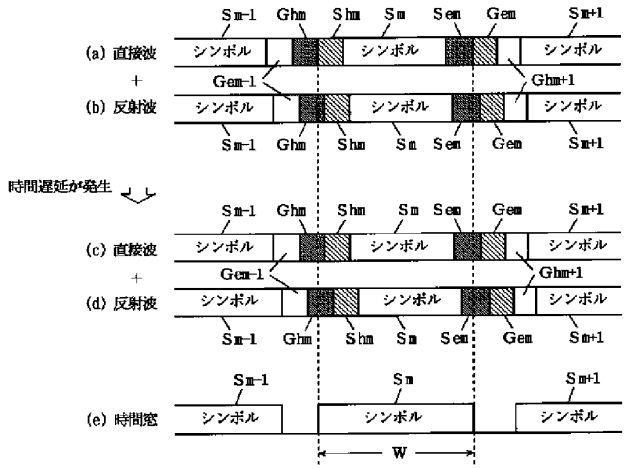
【図１】



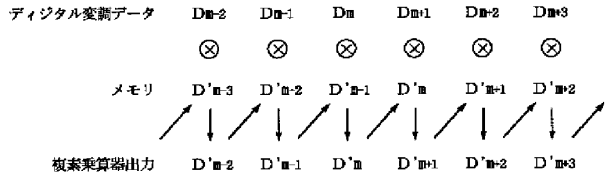
【図２】



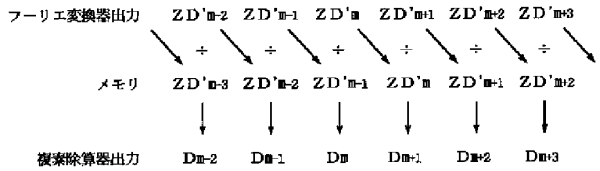
【図３】



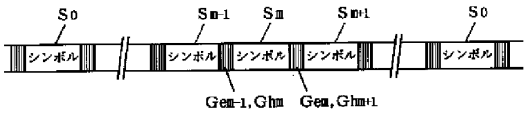
【図４】



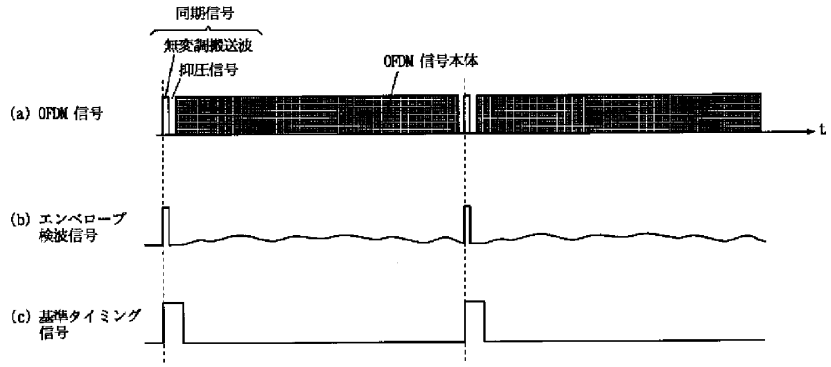
【図６】



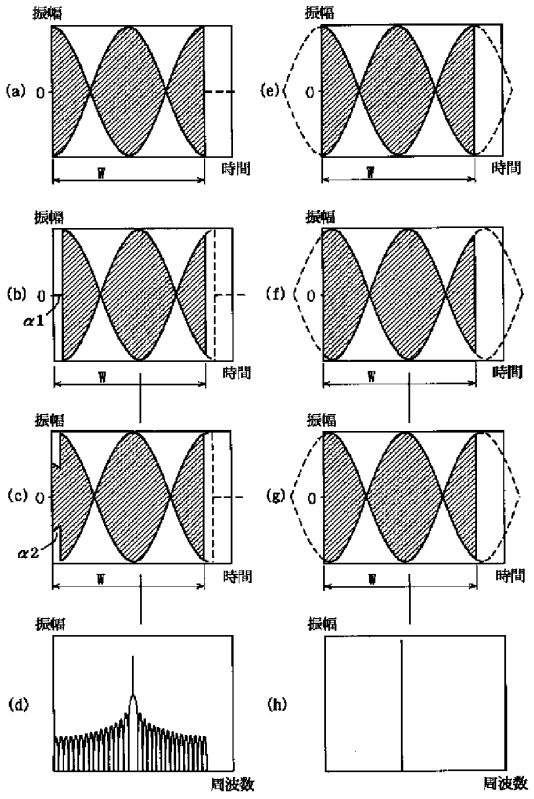
【図１２】



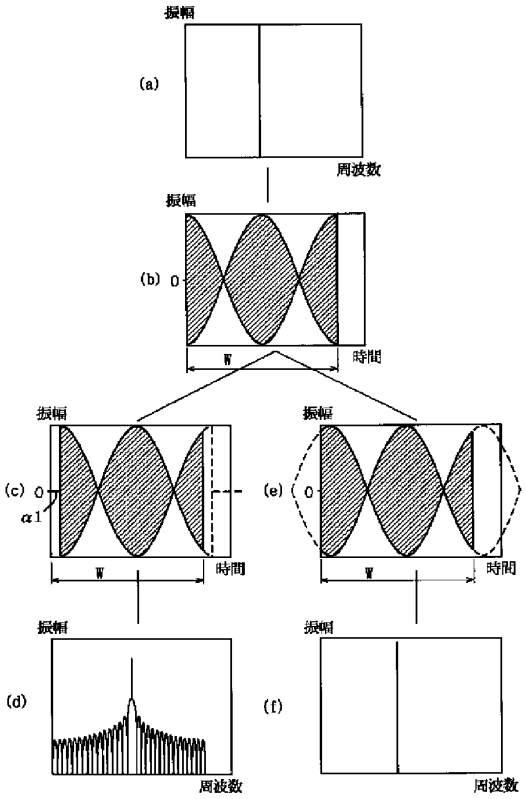
【図５】


同期信号
無変調搬送波
抑圧信号
OFDM 信号本体
(a) OFDM 信号
t
(b) エンベロープ
検波信号
(c) 基準タイミング
信号

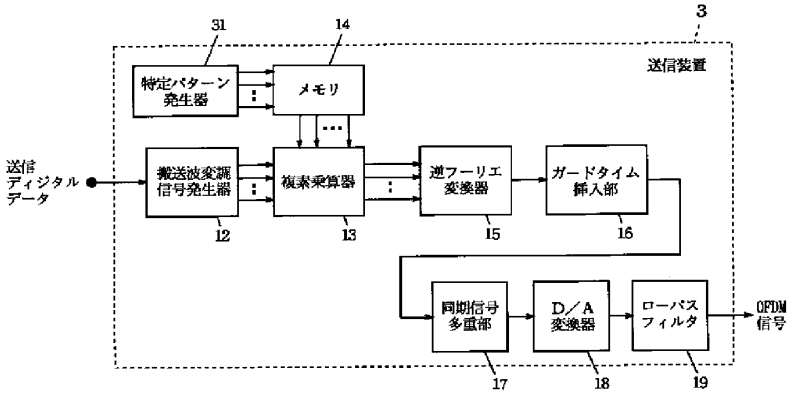
【図７】


振幅
(a)
0
W
時間
(e)
(b)
α1
(f)
(c)
α2
(g)
(d)
周波数
(h)

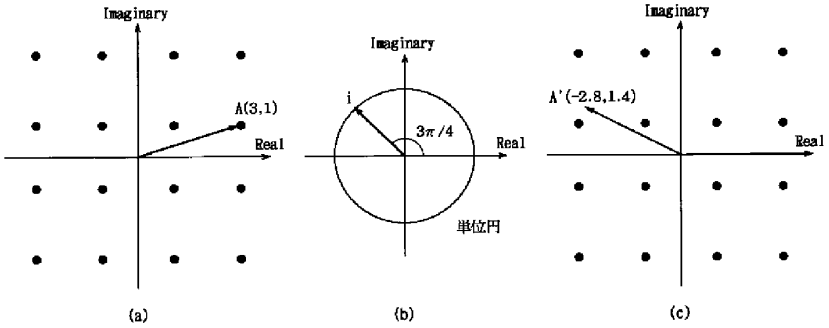
【図８】


振幅
(a)
周波数
(b)
0
W
時間
(c)
α1
(e)
(d)
(f)

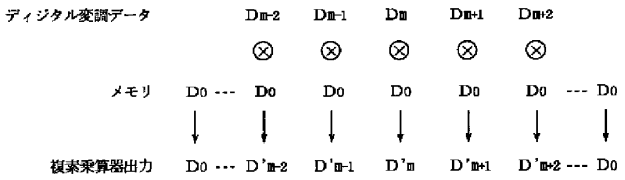
【図９】



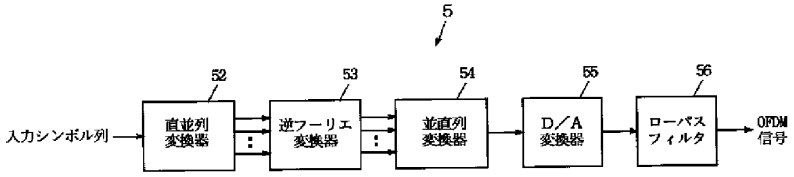
【図１０】



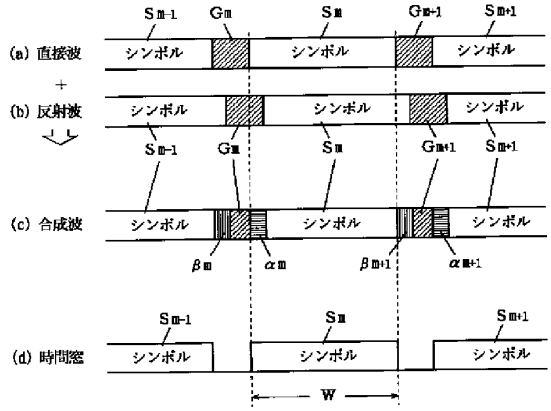
【図１１】



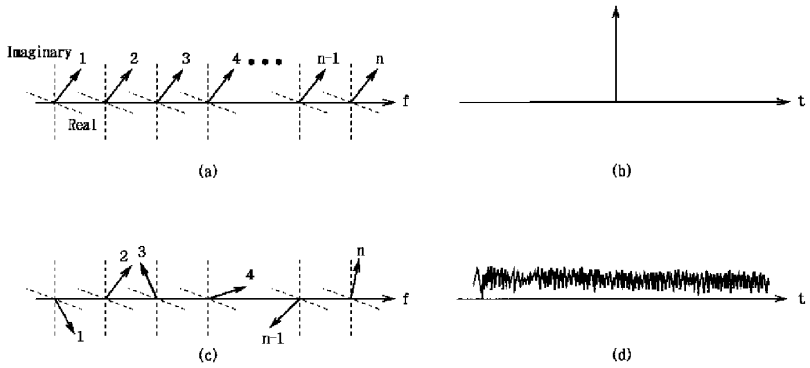
【図１３】



【図１４】



【図１５】



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Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Debra Kesner
Filer Authorized By:	Jason Vick
Attorney Docket Number:	5550-47-CON-2
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Time Stamp:	16:03:32
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		IDS_02.pdf	340324 b282a3cc277f29ad8e984a058a721b3e cf94fd9d	yes	4

	Multipart Description/PDF files in .zip description			
	Document Description	Start	End	
	Information Disclosure Statement Letter	1	3	
	Information Disclosure Statement (IDS) Filed	4	4	
Warnings:				
Information:				
2	Foreign Reference	JP_H10_1998_-084329.pdf	1648963 40c9155ecb0146a20291f62f095a0a7d62cf0c00	no	18
Warnings:				
Information:				
3	Foreign Reference	JP8321820A.pdf	1472960 24ac2b63d7fa8eb73096977d4f0bb76e9ad5da48	no	15
Warnings:				
Information:				
4	NPL Documents	5550-47-PJP_OA_3-3-08.pdf	239891 51dea09ec4c4130a741e3d331e1e8cfa31a67233	no	4
Warnings:				
Information:				
		Total Files Size (in bytes):	3702138		

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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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United States Patent and Trademark Office
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APPLICATION NUMBER	FILING OR 371(c) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2

CONFIRMATION NO. 1948

62574
Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO80202

Title: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

Publication No. US-2008-0069253-A1
Publication Date: 03/20/2008

NOTICE OF PUBLICATION OF APPLICATION

The above-identified application will be electronically published as a patent application publication pursuant to 37 CFR 1.211, et seq. The patent application publication number and publication date are set forth above.

The publication may be accessed through the USPTO's publically available Searchable Databases via the Internet at www.uspto.gov. The direct link to access the publication is currently http://www.uspto.gov/patft/.

The publication process established by the Office does not provide for mailing a copy of the publication to applicant. A copy of the publication may be obtained from the Office upon payment of the appropriate fee set forth in 37 CFR 1.19(a)(1). Orders for copies of patent application publications are handled by the USPTO's Office of Public Records. The Office of Public Records can be reached by telephone at (703) 308-9726 or (800) 972-6382, by facsimile at (703) 305-8759, by mail addressed to the United States Patent and Trademark Office, Office of Public Records, Alexandria, VA 22313-1450 or via the Internet.

In addition, information on the status of the application, including the mailing date of Office actions and the dates of receipt of correspondence filed in the Office, may also be accessed via the Internet through the Patent Electronic Business Center at www.uspto.gov using the public side of the Patent Application Information and Retrieval (PAIR) system. The direct link to access this status information is currently http://pair.uspto.gov/. Prior to publication, such status information is confidential and may only be obtained by applicant using the private side of PAIR.

Further assistance in electronically accessing the publication, or about PAIR, is available by calling the Patent Electronic Business Center at 1-866-217-9197.

Pre-Grant Publication Division, 703-605-4283

UNITED STATES PATENT AND TRADEMARK OFFICE

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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2	1948

62574 7590 02/06/2008

Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

EXAMINER	
WILLIAMS, LAWRENCE B	
ART UNIT	PAPER NUMBER
2611	

MAIL DATE	DELIVERY MODE
02/06/2008	PAPER

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

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

Office Action Summary	Application No.	Applicant(s)	
	11/863,581	TZANNES, MARCOS C.	
	Examiner	Art Unit	
	Lawrence B. Williams	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 *28 September 2007*.

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

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

Disposition of Claims

4)☒ Claim(s) *1-5* is/are pending in the application.

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

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-5* is/are rejected.

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

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

Application Papers

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

10)☒ The drawing(s) filed on *28 September 2007* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

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

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

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

Priority under 35 U.S.C. § 119

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

a)☐ All b)☐ Some * c)☐ None of:

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

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

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

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

Attachment(s)

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

DETAILED ACTION

Double Patenting

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

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

Effective January 1, 1994, a registered attorney or agent of record may sign a terminal disclaimer. A terminal disclaimer signed by the assignee must fully comply with 37 CFR 3.73(b).

2. Claim 1 is rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 1 and 5 of U.S. Patent No. 7,292,627. Although the conflicting claims are not identical, they are not patentably distinct from each other because the limitations of claim 1 of the instant application are encompassed in claims 1 and 5 of US Patent 7,292,267.

Claim 1 of the instant application discloses in a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating an input bit stream (disclosed in lines 1-3 of claim 1, and claim 5 of US Patent 7,292,627 B2. Maintaining synchronization with a second transceiver

inherently implies the system including a first and second transceiver), each carrier signal having a phase characteristic associated with the input bit stream, a method for scrambling the phase characteristics of the carrier signals comprising (lines 3-5): associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal (lines 6-8); computing a phase shift for each carrier signal based on the value associated with that carrier signal (lines 9-10); and combining the phase shift computed for each carrier signal with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristics of the plurality of carrier signals (lines 11-14). Though claim 1 of the co-pending application does not explictly teach a second transceiver, claim 5 of US Patent 7,292,627 B2 discloses the limitation, "the method of claim 1 further comprising maintaining synchronization between the transceiver and a second receiver" which obviously implies "the multicarrier modulation system including a first transceiver in communication with a second transceiver" as disclosed in claim 1 of the instant application.

3. Claims 2-5 are rejected on the ground of nonstatutory obviousness-type double patenting as being unpatentable over claims 2-5 of U.S. Patent No. 7,292,627. Although the conflicting claims are not identical, they are not patentably distinct from each other because the limitations of claim 2-5 of the instant application are encompassed in claims 2-5 of US Patent 7,292,267.

Claim 2 of the instant application discloses the method of claim 1 further comprising modulating bits of the input bit stream onto the carrier signals having the substantially scrambled phase characteristics to produce a transmission signal with a reduced peak-to-average power ratio (PAR) disclosed in claim 2 of US Patent 7,292,627.

Claim 3 of the instant application discloses the method of claim 1 further comprising independently deriving the value associated with each carrier signal at each transceiver disclosed in claim 3 of US Patent 7,292,627.

Claim 4 of the instant application discloses the method of claim 1 further comprising transmitting the value associated with each carrier signal from one transceiver to the other transceiver disclosed in claim 4 of US Patent 7,292,627.

Claim 5 of the instant application discloses the method of claim 1 further comprising maintaining synchronization between the transceivers using the value associated with each carrier signal disclosed in claim 5 of US Patent 7,292,627.

Allowable Subject Matter

4. Claims 1-5 would be allowable if accompanied by a Terminal Disclaimer to overcome the Double Patenting rejections cited above.

Conclusion

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

a.) Schmidt discloses in US 2006/0092902 A1 Methods, Apparatus And Systems For Terrestrial Wireless Broadcast Of Digital Data To Stationary Receivers.

b.) Holden discloses in US 2006/0140288 A1 System And Method For Transmission And Reception Of Multicarrier Data Signals.

c.) Zhang et al. discloses in US 2005/0141410 A1 Method Of Reducing Peak-To-Average Ratio In Multi-Carrier Communications Systems.

d.) Sakoda et al. discloses in US Patent 6,256,355 B1 Transmitter, Receiver, Communication Method And Radio Communication System.

e.) Sakoda et al. discloses in US Patent 6,590,860 B1 Receiving Device And Signal Reception Method.

f.) Hayashino et al. discloses in US Patent 5,682,376 Method and Transmitting Orthogonal Frequency Division Multiplex Signal, And Transmitter And Receiver Employed Thereof.

g.) Bauml et al. discloses in Electronics Letters, Reducing Peak-to-Average Power Ratio of Multicarrier Modulation By Selected Mapping.

6. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Lawrence B Williams whose telephone number is 571-272-3037. The examiner can normally be reached on Monday-Friday (8:00-6:00).

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

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://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).

Lawrence B. Williams

lbw
February 3, 2008

MOHAMMED GHAYOUR
SUPERVISORY PATENT EXAMINER

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	1	of	2	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
/LW/	1	3,955,141	05/01/76	Lyon et al.	
	2	4,985,900	01/01/91	Rhind et al.	
	3	5,748,677	05/01/98	Kumar	
	4	6,256,355	07/03/01	Sakoda et al.	
	5	6,507,585	01/01/03	Dobson	
	6	6,590,860	07/08/03	Sakoda et al.	
	7	6,704,317	03/01/04	Dobson	
	8	6,961,369	11/01/05	Tzannes	
	9	2005/0141410	06/30/05	Zhang et al.	
	10	2006/0002454	01/05/06	Tzannes	
	11	2006/0092902	05/04/06	Schmidt	
/LW/	12	2006/0140288	06/29/06	Holden	
	13	11/860080		Tzannes (09-24-2007)	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
/LW/	14	EP 0584534	03/02/94	ALCATEL ITALIA		
	15	EP 0719004	06/26/96	MATSUSHITA ELECTRIC IND CO LTD		
	16	GB 2330491	04/21/99	BRITISH BROADCASTING CORP		
	17	WO 98/32065	07/23/98	FORTRESS TECHNOLOGIES INC		
/LW/	18	WO 99/22463	05/06/99	MOTOROLA INC		

Examiner Signature	/Lawrence Williams/ (01/26/2008)	Date Considered	

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

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	2	of	2	Attorney Docket Number	5550-47-CON-2

	19	WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	
/LW/	20	Bauml R. W. et al.: "Reducing The Peak-To-Average Power Ratio Of Multicarrier Modulation By Selected Mapping" Electronics Letters, GB, IEE Stevenage, vol. 32, No. 22, Oct. 24, 1996, pp. 2056-2057, XP000643915 ISSN: 0013-5194
	21	Copy of Annex to Form PCT/ISA/206 for PCT/US00/30958, Mar. 23, 2001 (5550-47-PCT)
	22	International Search Report for International (PCT) Patent Application No. PCT/US00/30958, completed June 12, 2001 (5550-47-PCT)
	23	International Preliminary Examination Report for International (PCT) Patent Application No. PCT/US00/30958, completed March 4, 2002 (5550-47-PCT)
/LW/	24	Notice of Preliminary Rejection for Korean Patent Application No. 7005830/2002 dated November 22, 2006 (Attorney's Ref. No. 5550-47-PKR)

Examiner Signature	/Lawrence Williams/ (01/26/2008)	Date Considered	

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

Notice of References Cited	Application/Control No. 11/863,581	Applicant(s)/Patent Under Reexamination TZANNES, MARCOS C.	
	Examiner Lawrence B. Williams	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-2006/0092902 A1	05-2006	Schmidt, Mark S.	370/342
*	B	US-2006/0140288 A1	06-2006	Holden, Roger	375/260
*	C	US-2005/0141410 A1	06-2005	Zhang et al.	370/206
*	D	US-6,256,355 B1	07-2001	Sakoda et al.	375/259
*	E	US-6,590,860 B1	07-2003	Sakoda et al.	370/203
*	F	US-5,682,376	10-1997	Hayashino et al.	370/206
*	G	US-7,292,627	11-2007	Tzannes, Marcos C.	375/222
	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					
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NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	Bauml et al., Reducing the peak-to-average power ratio of multicarrier modulation by selected mapping, 24 October 1999, Electronics Letters, Vol. 32, pg(s). 2056-2057
	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.

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BIB DATA SHEET

CONFIRMATION NO. 1948

SERIAL NUMBER	FILING or 371(c) DATE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
11/863,581	09/28/2007 RULE	375	2611	5550-47-CON-2

APPLICANTS
Marcos C. Tzannes, Orinda, CA;

**** CONTINUING DATA ***************************
This application is a CON of 11/211,535 08/26/2005 PAT 7,292,627
which is a CON of 09/710,310 11/09/2000 PAT 6,961,369
which claims benefit of 60/164,134 11/09/1999

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

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****
10/11/2007

Foreign Priority claimed ☐ Yes ☑ No 35 USC 119(a-d) conditions met ☐ Yes ☑ No Verified and Acknowledged /LAWRENCE B WILLIAMS/ Examiner's Signature	☐ Met after Allowance Initials	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
		CA	2	5	1

ADDRESS
Jason H. Vick
Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202
UNITED STATES

TITLE
SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

FILING FEE RECEIVED	FEES: Authority has been given in Paper	☐ All Fees
1000	No._____ to charge/credit DEPOSIT ACCOUNT	☐ 1.16 Fees (Filing)
	No._____ for following:	☐ 1.17 Fees (Processing Ext. of time)
		☐ 1.18 Fees (Issue)
		☐ Other _____
		☐ Credit

Index of Claims

Application/Control No.	Applicant(s)/Patent under Reexamination
11/863,581	TZANNES, MARCOS C.
Examiner	**Art Unit**
Lawrence B. Williams	2611

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

Claim		Date
Final	Original	1/27/08
	1	√
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Claim		Date
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Search Notes	Application/Control No.	Applicant(s)/Patent under Reexamination
	11/863,581	TZANNES, MARCOS C.
	Examiner	Art Unit
	Lawrence B. Williams	2611

SEARCHED			
Class	Subclass	Date	Examiner
375	220, 222	1/27/2008	LW
	219, 226		
	260, 327		
	362		
370	203, 342		
	206		

INTERFERENCE SEARCHED			
Class	Subclass	Date	Examiner

SEARCH NOTES (INCLUDING SEARCH STRATEGY)		
	DATE	EXMR
EAST, NPL, Inventor	1/28/2008	LW

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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
11/863,581	09/28/2007	2611	1000	5550-47-CON-2	5	1

CONFIRMATION NO. 1948

UPDATED FILING RECEIPT

62574
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Sheridan Ross, PC
Suite # 1200
1560 Broadway
Denver, CO 80202

OC000000027232668

Date Mailed: 12/17/2007

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Applicant(s)

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Assignment For Published Patent Application

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Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 11/211,535 08/26/2005 PAT 7,292,627
which is a CON of 09/710,310 11/09/2000 PAT 6,961,369
which claims benefit of 60/164,134 11/09/1999

Foreign Applications

If Required, Foreign Filing License Granted: 10/11/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 11/863,581**

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Title

SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

Preliminary Class

375

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Date Mailed. 12/13/2007

NOTICE OF NEW OR REVISED PROJECTED PUBLICATION DATE

The above-identified application has a new or revised projected publication date. The current projected publication date for this application is 03/20/2008. If this is a new projected publication date (there was no previous projected publication date), the application has been cleared by Licensing & Review or a secrecy order has been rescinded and the application is now in the publication queue.

If this is a revised projected publication date (one that is different from a previously communicated projected publication date), the publication date has been revised due to processing delays in the USPTO or the abandonment and subsequent revival of an application. The application is anticipated to be published on a date that is more than six weeks different from the originally-projected publication date.

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PART 1 - ATTORNEY/APPLICANT COPY

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:	)	Group Art Unit: 2611
	)	
TZANNES	)	Confirmation No.: **1948**
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Serial No.: 11/863,581	)	
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Filed: September 28, 2007	)	RESPONSE TO NOTICE TO FILE
	)	CORRECTED APPLICATION PAPERS
Atty. File No.: 5550-47-CON-2	)	
	)	
For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	)	

Mail Stop Missing Parts
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Dear Sir:

In response to the Notice to File Corrected Application Papers mailed October 16, 2007, in connection with the above-identified application, enclosed for filing is a substitute specification. The margins and erasure marks have been removed and amendments from the parent case have been incorporated. The substitute specification contains no new matter in accordance with 37 CFR § 1.125(b). Please charge any underpayment or credit any overpayment to Deposit Account No. 19-1970.

Respectfully submitted,

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Date: 5 Dec 07

A System and Method for Scrambling the Phase of the Carriers in a Multicarrier Communications System

Related Application

This application claims the benefit of the filing date of copending U.S. Provisional Application, Serial No. 60/164,134, filed November 9, 1999, entitled "A Method For Randomizing The Phase Of The Carriers In A Multicarrier Communications System To Reduce The Peak To Average Power Ratio Of The Transmitted Signal," the entirety of which provisional application is incorporated by reference herein.

Field of the Invention

This invention relates to communications systems using multicarrier modulation. More particularly, the invention relates to multicarrier communications systems that lower the peak-to-average power ratio (PAR) of transmitted signals.

Background of the Invention

In a conventional multicarrier communications system, transmitters communicate over a communication channel using multicarrier modulation or Discrete Multitone Modulation (DMT). Carrier signals (carriers) or sub-channels spaced within a usable frequency band of the communication channel are modulated at a symbol (i.e., block) transmission rate of the system. An input signal, which includes input data bits, is sent to a DMT transmitter, such as a DMT modem. The DMT transmitter typically modulates the phase characteristic, or phase, and amplitude of the carrier signals using an Inverse Fast Fourier Transform (IFFT) to generate a time domain signal, or transmission signal, that represents the input signal. The DMT transmitter transmits the transmission signal, which is a linear combination of the multiple carriers, to a DMT receiver over the communication channel.

The phase and amplitude of the carrier signals of DMT transmission signal can be considered random because the phase and amplitude result from the modulation of an arbitrary sequence of input data bits comprising the transmitted information. Therefore, under the condition that the modulated data bit stream is random, the DMT transmission signal can be approximated as having a Gaussian probability distribution. A bit scrambler is often used in the DMT transmitter to scramble the input data bits before the bits are modulated to assure that the transmitted data bits are random and, consequently, that the

modulation of those bits produces a DMT transmission signal with a Gaussian probability distribution.

With an appropriate allocation of transmit power levels to the carriers or sub-channels, such a system provides a desirable performance. Further, generating a transmission signal with a Gaussian probability distribution is important in order to transmit a transmission signal with a low peak-to-average ratio (PAR), or peak-to-average power ratio. The PAR of a transmission signal is the ratio of the instantaneous peak value (i.e., maximum magnitude) of a signal parameter (e.g., voltage, current, phase, frequency, power) to the time-averaged value of the signal parameter. In DMT systems, the PAR of the transmitted signal is determined by the probability of the random transmission signal reaching a certain peak voltage during the time interval required for a certain number of symbols. An example of the PAR of a transmission signal transmitted from a DMT transmitter is 14.5 dB, which is equivalent to having a 1E-7 probability of clipping. The PAR of a transmission signal transmitted and received in a DMT communication system is an important consideration in the design of the DMT communication system because the PAR of a signal affects the communication system's total power consumption and component linearity requirements of the system.

If the phase of the modulated carriers is not random, then the PAR can increase greatly. Examples of cases where the phases of the modulated carrier signals are not random are when bit scramblers are not used, multiple carrier signals are used to modulate the same input data bits, and the constellation maps, which are mappings of input data bits to the phase of a carrier signal, used for modulation are not random enough (i.e., a zero value for a data bit corresponds to a 90 degree phase characteristic of the DMT carrier signal and a one value for a data bit corresponds to a -90 degree phase characteristic of the DMT carrier signal). An increased PAR can result in a system with high power consumption and/or with high probability of clipping the transmission signal. Thus, there remains a need for a system and method that can effectively scramble the phase of the modulated carrier signals in order to provide a low PAR for the transmission signal.

Summary of the Invention

The present invention features a system and method that scrambles the phase characteristics of the modulated carrier signals in a transmission signal. In one aspect, a value is associated with each carrier signal. A phase shift is computed for each carrier signal based on the value associated with that carrier signal. The value is determined independently of any input bit value carried by that carrier signal. The phase shift computed for each carrier signal is combined with the phase characteristic of that carrier signal to substantially scramble the phase characteristics of the carrier signals.

In one embodiment, the input bit stream is modulated onto the carrier signals having the substantially scrambled phase characteristic to produce a transmission signal with a reduced peak-to-average power ratio (PAR). The value is derived from a predetermined parameter, such as a random number generator, a carrier number, a DMT symbol count, a superframe count, and a hyperframe count. In another embodiment, a predetermined transmission signal is transmitted when the amplitude of the transmission signal exceeds a certain level.

In another aspect, the invention features a method wherein a value is associated with each carrier signal. The value is determined independently of any input bit value carried by that carrier signal. A phase shift for each carrier signal is computed based on the value associated with that carrier signal. The transmission signal is demodulated using the phase shift computed for each carrier signal.

In another aspect, the invention features a system comprising a phase scrambler that computes a phase shift for each carrier signal based on a value associated with that carrier signal. The phase scrambler also combines the phase shift computed for each carrier signal with the phase characteristic of that carrier signal to substantially scramble the phase characteristic of the carrier signals. In one embodiment, a modulator, in communication with the phase scrambler, modulates bits of an input signal onto the carrier signals having the substantially scrambled phase characteristics to produce a transmission signal with a reduced PAR.

Description of the Drawings

The invention is pointed out with particularity in the appended claims. The advantages of the invention described above, as well as further advantages of the invention, may be better understood by reference to the following description taken in conjunction with the accompanying drawings, in which:

FIG. 1 is a block diagram of an embodiment of a digital subscriber line communications system including a DMT (discrete multitone modulation) transceiver, in communication with a remote transceiver, having a phase scrambler for substantially scrambling the phase characteristics of carrier signals; and

FIG. 2 is a flow diagram of an embodiment of a process for scrambling the phase characteristics of the carrier signals in a transmission signal.

Detailed Description

FIG. 1 shows a digital subscriber line (DSL) communication system 2 including a discrete multitone (DMT) transceiver 10 in communication with a remote transceiver 14 over a communication channel 18 using a transmission signal 38 having a plurality of carrier signals. The DMT transceiver 10 includes a DMT transmitter 22 and a DMT receiver 26. The remote transceiver 14 includes a transmitter 30 and a receiver 34. Although described with respect to discrete multitone modulation, the principles of the invention apply also to other types of multicarrier modulation, such as, but not limited to, orthogonally multiplexed quadrature amplitude modulation (OQAM), discrete wavelet multitone (DWMT) modulation, and orthogonal frequency division multiplexing (OFDM).

The communication channel 18 provides a downstream transmission path from the DMT transmitter 22 to the remote receiver 34, and an upstream transmission path from the remote transmitter 30 to the DMT receiver 26. In one embodiment, the communication channel 18 is a pair of twisted wires of a telephone subscriber line. In other embodiments, the communication channel 18 can be a fiber optic wire, a quad cable, consisting of two pairs of twisted wires, or a quad cable that is one of a star quad cable, a Dieselhorst-Martin quad cable, and the like. In a wireless communication system wherein the transceivers 10, 14 are wireless modems, the communication channel 18 is the air through which the transmission signal 38 travels between the transceivers 10, 14.

By way of example, the DMT transmitter 22 shown in FIG. 1 includes a quadrature amplitude modulation (QAM) encoder 42, a modulator 46, a bit allocation table (BAT) 44, and a phase scrambler 66. The DMT transmitter 22 can also include a bit scrambler 74, as described further below. The remote transmitter 30 of the remote transceiver 14 comprises equivalent components as the DMT transmitter 22. Although this embodiment specifies a detailed description of the DMT transmitter 22, the inventive concepts apply also to the receivers 34, 36 which have similar components to that of the DMT transmitter 22, but perform inverse functions in a reverse order.

The QAM encoder 42 has a single input for receiving an input serial data bit stream 54 and multiple parallel outputs to transmit QAM symbols 58 generated by the QAM encoder 42 from the bit stream 54. In general, the QAM encoder 42 maps the input serial bit-stream 54 in the time domain into parallel QAM symbols 58 in the frequency domain. In particular, the QAM encoder 42 maps the input serial data bit stream 54 into N parallel quadrature amplitude modulation (QAM) constellation points 58, or QAM symbols 58, where N represents the number of carrier signals generated by the modulator 46. The BAT 44 is in communication with the QAM encoder 42 to specify the number of bits carried by each carrier signal. The QAM symbols 58 represent the amplitude and the phase characteristic of each carrier signal.

The modulator 46 provides functionality associated with the DMT modulation and transforms the QAM symbols 58 into DMT symbols 70 each comprised of a plurality of time-domain samples. The modulator 46 modulates each carrier signal with a different QAM symbol 58. As a result of this modulation, carrier signals have phase and amplitude characteristics based on the QAM symbol 58 and therefore based on the input-bit stream 54. In particular, the modulator 46 uses an inverse fast Fourier transform (IFFT) to change the QAM symbols 58 into a transmission signal 38 comprised of a sequence of DMT symbols 70. The modulator 46 changes the QAM symbols 58 into DMT symbols 70 through modulation of the carrier signals. In another embodiment, the modulator 46 uses the inverse discrete Fourier transform (IDFT) to change the QAM symbols 58 into DMT symbols 70. In one embodiment, a pilot tone is included in the transmission signal 38 to provide a reference signal for coherent demodulation of the carrier signals in the remote receiver 34 during reception of the transmission signal 38.

The modulator 46 also includes a phase scrambler 66 that combines a phase shift computed for each QAM-modulated carrier signal with the phase characteristic of that carrier signal. Combining phase shifts with phase characteristics, in accordance with the principles of the invention, substantially scrambles the phase characteristics of the carrier signals in the transmission signal 38. By scrambling the phase characteristics of the carrier signals, the resulting transmission signal 38 has a substantially minimized peak-to-average (PAR) power ratio. The phase scrambler 66 can be part of or external to the modulator 46. Other embodiments of the phase scrambler 66 include, but are not limited to, a software program that is stored in local memory and is executed on the modulator 46, a digital signal processor (DSP) capable of performing mathematical functions and algorithms, and the like. The remote receiver 34 similarly includes a phase scrambler 66' for use when demodulating carrier signals that have had their phase characteristics adjusted by the phase scrambler 66 of the DMT transceiver 10.

To compute a phase shift for each carrier signal, the phase scrambler 66 associates one or more values with that carrier signal. The phase scrambler 66 determines each value for a carrier signal independently of the QAM symbols 58, and, therefore, independently of the bit value(s) modulated onto the carrier signal. The actual value(s) that the phase scrambler 66 associates with each carrier signal can be derived from one or more predefined parameters, such as a pseudo-random number generator (pseudo-RNG), a DMT carrier number, a DMT symbol count, a DMT superframe count, a DMT hyperframe count, and the like, as described in more detail below. Irrespective of the technique used to produce each value, the same technique is used by the DMT transmitter 22 and the remote receiver 34 so that the value associated with a given carrier signal is known at both ends of the communication channel 18.

The phase scrambler 66 then solves a predetermined equation to compute a phase shift for the carrier signal, using the value(s) associated with that carrier signal as input that effects the output of the equation. Any equation suitable for computing phase shifts can be used to compute the phase shifts. When the equation is independent of the bit values of the input serial bit stream 54, the computed phase shifts are also independent of such bit values.

In one embodiment (shown in phantom), the DMT transmitter 22 includes a bit scrambler 74, which receives the input serial bit stream 54 and outputs data bits 76 that are substantially scrambled. The substantially scrambled bits 76 are then passed to the QAM encoder 42. When the bit scrambler 74 is included in the DMT transmitter 22, the operation of the phase scrambler 66 further assures that the transmission signal 38 has a Gaussian probability distribution and, therefore, a substantially minimized PAR.

FIG. 2 shows embodiments of a process used by the DMT transmitter 22 for adjusting the phase characteristic of each carrier signal and combining these carrier signals to produce the transmission signal 38. The DMT transmitter 22 generates (step 100) a value that is associated with a carrier signal. Because the value is being used to alter the phase characteristics of the carrier signal, both the DMT transmitter 22 and the remote receiver 34 must recognize the value as being associated with the carrier signal. Either the DMT transmitter 22 and the remote receiver 34 independently derive the associated value, or one informs the other of the associated value. For example, in one embodiment the DMT transmitter 22 can derive the value from a pseudo-RNG and then transmit the generated value to the remote receiver 34. In another embodiment, the remote receiver 34 similarly derives the value from the same pseudo-RNG and the same seed as used by the transmitter (i.e., the transmitter pseudo-RNG produces the same series of random numbers as the receiver pseudo-RNG).

As another example, the DMT transmitter 22 and the remote receiver 34 can each maintain a symbol counter for counting DMT symbols. The DMT transmitter 22 increments its symbol counter upon transmitting a DMT symbol; the remote receiver 34 upon receipt. Thus, when the DMT transmitter 22 and the remote receiver 34 both use the symbol count as a value for computing phase shifts, both the DMT transmitter 22 and remote receiver 34 "know" that the value is associated with a particular DMT symbol and with each carrier signal of that DMT symbol.

Values can also be derived from other types of predefined parameters. For example, if the predefined parameter is the DMT carrier number, then the value associated with a particular carrier signal is the carrier number of that signal within the DMT symbol. The number of a carrier signal represents the location of the frequency of the carrier signal relative to the frequency of other carrier signals within a DMT symbol. For example, in one

embodiment the DSL communication system 2 provides 256 carrier signals, each separated by a frequency of 4.3125 kHz and spanning the frequency bandwidth from 0 kHz to 1104 kHz. The DMT transmitter 22 numbers the carrier signals from 0 to 255. Therefore, "DMT carrier number 50" represents the 51st DMT carrier signal which is located at the frequency of 215.625 kHz (i.e., 51 x 4.3125 kHz).

Again, the DMT transmitter 22 and the remote receiver 34 can know the value that is associated with the carrier signal because both the DMT transmitter 22 and the remote receiver 34 use the same predefined parameter (here, the DMT carrier number) to make the value-carrier signal association. In other embodiments (as exemplified above with the transmitter pseudo-RNG), the DMT transmitter 22 can transmit the value to the remote receiver 34 (or vice versa) over the communication channel 18.

In other embodiments, other predefined parameters can be used in conjunction with the symbol count. One example of such a predefined parameter is the superframe count that increments by one every 69 DMT symbols. One exemplary implementation that achieves the superframe counter is to perform a modulo 68 operation on the symbol count. As another example, the DMT transmitter 22 can maintain a hyperframe counter for counting hyperframes. An exemplary implementation of the hyperframe count is to perform a modulo 255 operation on the superframe count. Thus, the hyperframe count increments by one each time the superframe count reaches 255.

Accordingly, it is seen that some predefined parameters produce values that vary from carrier signal to carrier signal. For example, when the predefined parameter is the DMT carrier number, values vary based on the frequency of the carrier signal. As another example, the pseudo-RNG generates a new random value for each carrier signal.

Other predefined parameters produce values that vary from DMT symbol 70 to DMT symbol 70. For example, when the predefined parameter is the symbol count, the superframe count, or hyperframe count, values vary based on the numerical position of the DMT symbol 70 within a sequence of symbols, superframes, or hyperframes. Predefined parameters such as the pseudo-RNG, symbol count, superframe count, and superframe can also be understood to be parameters that vary values over time. Any one or combination of the predefined parameters can provide values for input to the equation that computes a phase shift for a given carrier signal.

In one embodiment, the phase scrambling is used to avoid clipping of the transmission signal 38 on a DMT symbol 70 by DMT symbol 70 basis. In this embodiment, the DMT transmitter 22 uses a value based on a predefined parameter that varies over time, such as the symbol count, to compute the phase shift. It is to be understood that other types of predefined parameters that vary the values associated with carrier signals can be used to practice the principles of the invention. As described above, the transceivers 10, 14 may communicate (step 110) the values to synchronize their use in modulating and demodulating the carrier signals.

The DMT transmitter 22 then computes (step 115) the phase shift that is used to adjust the phase characteristic of each carrier signal. The amount of the phase shift combined with the phase characteristic of each QAM-modulated carrier signal depends upon the equation used and the one or more values associated with that carrier signal.

The DMT transmitter 22 then combines (step 120) the phase shift computed for each carrier signal with the phase characteristic of that carrier signal. By scrambling the phase characteristics of the carrier signals, the phase scrambler 66 reduces (with respect to unscrambled phase characteristics) the combined PAR of the plurality of carrier signals and, consequently, the transmission signal 38. The following three phase shifting examples, PS #1-PS #3, illustrate methods used by the phase scrambler 66 to combine a computed phase shift to the phase characteristic of each carrier signal.

Phase Shifting Example #1

Phase shifting example #1 (PS #1) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $N \times \frac{\pi}{3,}$ modulo (mod) 2π. In this example, a carrier signal having a carrier number N equal to 50 has a phase shift added to the phase characteristic of that carrier signal equal to $50 \times \frac{\pi}{3} (\text{mod } 2\pi) = \frac{2}{3}\pi$. The carrier signal with a carrier number N equal to 51 has a phase shift added to the phase characteristic of that carrier signal equal to $51 \times \frac{\pi}{3}$ (mod2π)=π. The carrier signal with the carrier number N equal to 0 has no phase shift added to the phase characteristic of that carrier signal.

Phase Shifting Example #2

Phase shifting example #2 (PS #2) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $(N+M)\times\frac{\pi}{4}$, mod 2π, where M is the symbol count. In this example, a carrier signal having a carrier number N equal to 50 on DMT symbol count M equal to 8 has a phase shift added to the phase characteristic of that carrier signal equal to $(50+8)\times\frac{\pi}{4}(\text{mod } 2\pi)=\frac{\pi}{2}$. The carrier signal with the same carrier number N equal to 50 on the next DMT symbol count M equal to 9 has a phase shift added to the phase characteristic of that carrier signal equal to $(50+9)\times\frac{\pi}{4}(\text{mod } 2\pi)=\frac{3\pi}{4}$.

Phase Shifting Example #3

Phase shifting example #3 (PS #3) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $(X_N)\times\frac{\pi}{6}, \text{mod } 2\pi$, where X_N is an array of N pseudo-random numbers. In this example, a carrier signal having a carrier number N equal to 5 and X_N equal to [3, 8, 1, 4, 9, 5, . . .] has a phase shift added to the phase characteristic of the carrier signal that is equal to $(9)\times\frac{\pi}{6}(\text{mod } 2\pi)=\frac{3\pi}{2}$ (Note that 9 is the 5th value in X_N.) The carrier signal with a carrier number N equal to 6 has a phase shift added to the phase characteristic of the carrier signal equal to $(5)\times\frac{\pi}{6}(\text{mod } 2\pi)=\frac{5\pi}{6}$.

It is to be understood that additional and/or different phase shifting techniques can be used by the phase scrambler 66, and that PS #1, #2, and #3 are merely illustrative examples of the principles of the invention. The DMT transmitter 22 then combines (step 130) the carrier signals to form the transmission signal 38. If the transmission signal is not clipped, as described below, the DMT transmitter 22 consequently transmits (step 160) the transmission signal 38 to the remote receiver 34.

Clipping of Transmission Signals

A transmission signal 38 that has high peak values of voltage (i.e., a high PAR) can induce non-linear distortion in the DMT transmitter 22 and the communication channel 18. One form of this non-linear distortion of the transmission signal 38 that may occur is the limitation of the amplitude of the transmission signal 38 (i.e., clipping). For example, a particular DMT symbol 70 clips in the time domain when one or more time domain samples in that DMT symbol 70 are larger than the maximum allowed digital value for the DMT symbols 70. In multicarrier communication systems when clipping occurs, the transmission signal 38 does not accurately represent the input serial data bit signal 54.

In one embodiment, the DSL communication system 2 avoids the clipping of the transmission signal 38 on a DMT symbol 70 by DMT symbol 70 basis. The DMT transmitter 22 detects (step 140) the clipping of the transmission signal 38. If a particular DMT symbol 70 clips in the time domain to produce a clipped transmission signal 38, the DMT transmitter 22 substitutes (step 150) a predefined transmission signal 78 for the clipped transmission signal 38.

The predefined transmission signal 78 has the same duration as a DMT symbol 70 (e.g., 250 ms) in order to maintain symbol timing between the DMT transmitter 22 and the remote receiver 34. The predefined transmission signal 78 is not based on (i.e., independent of) the modulated input data bit stream 54; it is a bit value pattern that is recognized by the remote receiver 34 as a substituted signal. In one embodiment, the predefined transmission signal 78 is a known pseudo-random sequence pattern that is easily detected by the remote receiver 34. In another embodiment, the predefined transmission signal 78 is an "all zeros" signal, which is a zero voltage signal produced at the DMT transmitter 22 output (i.e., zero volts modulated on all the carrier signals). In addition to easy detection by the remote receiver 34, the zero voltage signal reduces the power consumption of the DMT transmitter 22 when delivered by the DMT transmitter 22. Further, a pilot tone is included in the predefined transmission signal 78 to provide a reference signal for coherent demodulation of the carrier signals in the remote receiver 34 during reception of the predefined transmission signal 78.

After the remote receiver 34 receives the transmission signal 38, the remote receiver 34 determines if the transmission signal 38 is equivalent to the predefined transmission signal 78. In one embodiment, when the remote receiver 34 identifies the predefined transmission signal 78, the remote receiver 34 ignores (i.e., discards) the predefined transmission signal 78.

Following the transmission of the predefined transmission signal 78, the phase scrambler 66 shifts (step 120) the phase characteristic of the QAM-modulated carrier signals (based on one of the predefined parameters that varies over time). For example, consider that a set of QAM symbols 58 produces a DMT symbol 70 comprising a plurality of time domain samples, and that one of the time domain samples is larger than the maximum allowed digital value for the DMT symbol 70. Therefore, because the transmission signal 38 would be clipped when sent to the remote receiver 34, the DMT transmitter 22 sends the predefined transmission signal 78 instead.

After transmission of the predefined transmission signal 78, the DMT transmitter 22 again attempts to send the same bit values that produced the clipped transmission signal 38 in a subsequent DMT symbol 70'. Because the generation of phase shifts in this embodiment is based on values that vary over time, the phase shifts computed for the subsequent DMT symbol 70' are different than those that were previously computed for the DMT symbol 70 with the clipped time domain sample. These different phase shifts are combined to the phase characteristics of the modulated carrier signals to produce carrier signals of the subsequent DMT symbol 70' with different phase characteristics than the carrier signals of the DMT symbol 70 with the clipped time domain sample.

DMT communication systems 2 infrequently produce transmission signals 38 that clip (e.g., approximately one clip every 10^7 time domain samples 70). However, if the subsequent DMT symbol 70' includes a time domain sample that clips, then the predefined transmission signal 78 is again transmitted (step 150) to the remote receiver 34 instead of the clipped transmission signal 38. The clipping time domain sample may be on the same or on a different carrier signal than the previously clipped DMT symbol 70. The DMT transmitter 22 repeats the transmission of the predefined transmission signal 78 until the DMT transmitter 22 produces a subsequent DMT symbol 70' that is not clipped. When the DMT transmitter 22 produces a DMT symbol 70' that is not clipped, the DTM transmitter 22 transmits (step 160)

the transmission signal 38 to the remote receiver 34. The probability of a DMT symbol 70 producing a transmission signal 38 that clips in the time domain depends on the PAR of the transmission signal 38.

For example, the following phase shifting example, PST #4, illustrates the method used by the phase scrambler 66 to combine a different phase shift to the phase characteristic of each carrier signal to avoid the clipping of the transmission signal 38.

Phase Shifting Example #4

Phase shifting example #4 (PS #4) corresponds to adjusting the phase characteristic of the carrier signal associated with a carrier number N by $\frac{\pi}{3} \times (M + N)$, mod 2π, where M is the DMT symbol count. In this example, if the DMT symbol 70 clips when the DMT symbol count M equals 5, the predefined transmission signal 78 is transmitted instead of the current clipped transmission signal 38. On the following DMT symbol period, the DMT count M equals 6, thereby causing a different set of time domain samples to be generated for the subsequent DMT symbol 70', although the QAM symbols 58 used to produce both DMT symbols 70, 70' are the same.

If this different set of time domain samples (and consequently the transmission signal 38) is not clipped, the DMT transmitter 22 sends the transmission signal 38. If one of the time domain samples in the different set of time domain samples 70 (and consequently the transmission signal 38) is clipped, then the DMT transmitter 22 sends the predefined transmission signal 78 again. The process continues until a DMT symbol 70 is produced without a time domain sample 70 that is clipped. In one embodiment, the transmitter 22 stops attempting to produce a non-clipped DMT symbol 70' for the particular set of QAM symbols 58 after generating a predetermined number of clipped DMT symbols 70'. At that moment, the transmitter 22 can transmit the most recently produced clipped DMT symbol 70' or the predetermined transmission signal 78.

The PAR of the DSL communication system 2 is reduced because the predefined transmission signal 78 is sent instead of the transmission signal 38 when the DMT symbol 70 clips. For example, a DMT communication system 2 that normally has a clipping probability of 10^{-7} for the time domain transmission signal 38 can therefore operate with a 10^{-5} probability of clipping and a lower PAR equal to 12.8 dB (as compared to 14.5 dB). When

operating at a 10^{-5} probability of clipping, assuming a DMT symbol 70 has 512 time-domain samples 70, the DMT transmitter 22 experiences one clipped DMT symbol 70 out of every $\frac{10^5}{512}$, or 195 DMT symbols 70. This results in the predefined (non-data carrying) transmission signal 78 being transmitted, on average, once every 195 DMT symbols. Although increasing the probability of clipping to 10^{-5} results in approximately a 0.5% (1/195) decrease in throughput, the PAR of the transmission signal 38 is reduced by 1.7 dB, which reduces transmitter complexity in the form of power consumption and component linearity.

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the following claims. For example, although the specification uses DSL to describe the invention, it is to be understood that various form of DSL can be used, e.g., ADSL, VDSL, SDSL, HDSL, HDSL2, or SHDSL. It is also to be understood that the principles of the invention apply to various types of applications transported over DSL systems (e.g., telecommuting, video conferencing, high speed Internet access, video-on demand).

Abstract

A system and method that scrambles the phase characteristic of a carrier signal are described. The scrambling of the phase characteristic of each carrier signal includes associating a value with each carrier signal and computing a phase shift for each carrier signal based on the value associated with that carrier signal. The value is determined independently of any input bit value carried by that carrier signal. The phase shift computed for each carrier signal is combined with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristic of the carrier signals. Bits of an input signal are modulated onto the carrier signals having the substantially scrambled phase characteristic to produce a transmission signal with a reduced PAR.

Electronic Acknowledgement Receipt	
EFS ID:	2550872
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Christine Jacquet
Filer Authorized By:	Jason Vick
Attorney Docket Number:	5550-47-CON-2
Receipt Date:	05-DEC-2007
Filing Date:	28-SEP-2007
Time Stamp:	16:12:39
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		RESP_CORRECT_APP_PAPERS_CLEAN_SPEC.pdf	1742175 ca17d0e75ae32344d843e69038eaa573a2b0b175	yes	16

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Applicant Response to Pre-Exam Formalities Notice	1	1
	Specification	2	16
Warnings:			
Information:			
	Total Files Size (in bytes):	1742175	

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

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

New International Application Filed with the USPTO as a Receiving Office
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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re the Application of:	)	Group Art Unit: 2611
Tzannes	)	Confirmation No.: 1948
Serial No.: 11/863,581	)	Examiner: Not yet assigned
Filed: 09-28-2007	)	INFORMATION DISCLOSURE STATEMENT
Atty. File No.: 5550-47-CON-2	)	Electronically Submitted
For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	)	

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

Dear Sir:

The references cited on attached Form PTO-SB08 are being called to the attention of the Examiner.

☒ Copies of cited non-patent and/or foreign references nos. 22-24 are enclosed herewith.

☐ Copies of the cited U.S. patents and/or patent applications are enclosed herewith.

☒ Copies of the cited U.S. patents/patent application publications are not enclosed in accordance with 37 C.F.R. § 1.98(a).

☒ Copies of cited references nos. 14-21 are not enclosed, in accordance with 37 C.F.R. § 1.98(d), because the references were cited by or submitted to the U.S. Patent and Trademark Office in prior application Serial No. 11/211535 filed 08-26-2005, which is relied upon for an earlier filing date under 35 U.S.C. § 120.

☐ To the best of applicants' belief, the pertinence of the foreign-language references are believed to be summarized in the attached English abstracts and in the figures, although applicants do not necessarily vouch for the accuracy of the translation.

☒ Examiner's attention is drawn to the following co-pending applications,:

Serial No. 11/211535 filed 08-26-2005

Serial No. 11/860080 filed 09-24-2007

☐ Other:_____

Submission of the above information is not intended as an admission that any item is citable under the statutes or rules to support a rejection, that any item disclosed represents analogous art, or that those skilled in the art would refer to or recognize the pertinence of any reference without the benefit of hindsight, nor should an inference be drawn as to the pertinence of the references based on the order in which they are presented. Submission of this statement should not be taken as an indication that a search has been conducted, or that no better art exists.

It is respectfully requested that the cited information be expressly considered during the prosecution of this application and the references made of record therein.

FEES

☒	**37 CFR 1.97(b)**: No fee is believed due in connection with this submission, because the information disclosure statement submitted herewith is satisfies one of the following conditions ("X" indicates satisfaction): ☒ Within three months of the filing date of a national application other than a continued prosecution application under 37 CFR 1.53(d), or ☐ Within three months of the date of entry into the national stage of an international application as set forth in 37 CFR 1.491 or ☐ Before the mailing date of a first Office Action on the merits, or ☐ Before the mailing of a first Office action after the filing of a request for continued examination under 37 CFR 1.114. Although no fee is believed due, if any fee is deemed due in connection with this submission, please charge such fee to Deposit Account 19-1970.
☐	**37 CFR 1.97(c)**: The information disclosure statement transmitted herewith is being filed after all the above conditions (37 CFR 1.97(b)), but before the mailing date of one of the following conditions: (1) a final action under 37 C.F.R. 1.113 or (2) a notice of allowance under 37 C.F.R. 1.311, or (3) an action that otherwise closes prosecution in the application. This Information Disclosure Statement is accompanied by: ☐ A Certification (below) as specified by 37 C.F.R. 1.97(e). Although no fee is believed due, if any fee is deemed due in connection with this submission, please charge such fee to Deposit Account 19-1970. OR ☐ Please charge Deposit Account 19-1970 in the amount of $180.00 for the fee set forth in 37 C.F.R. 1.17(p) for submission of an information disclosure statement. Please credit any overpayment or charge any underpayment to Deposit Account 19-1970.
☐	**37 CFR 1.97(d)**: This Information Disclosure Statement is being submitted after the period specified in 37 CFR 1.97(c). ☐ This information Disclosure Statement includes a Certification (below) as specified by 37 C.F.R. 1.97(e) AND ☐ Applicants hereby requests consideration of the reference(s) disclosed herein. Please charge Deposit Account 19-1970 in the amount of $180.00 under 37 C.F.R. 1.17(p). Please credit any overpayment or charge any underpayment to Deposit Account 19-1970. Election to pay the fee should not be taken as an indication that applicant(s) cannot execute a certification.

Certification (37 C.F.R. 1.97(e))
(Applicable only if checked)

☐ The undersigned certifies that:

☐ Each item of information contained in this information disclosure statement was first cited in any communication from a foreign patent office in a counterpart foreign application not more than three months prior to the filing of this statement. 37 C.F.R. 1.97(e)(1).

☐ A copy of the communication from the foreign patent office is enclosed.

OR

☐ No item of information contained in this information disclosure statement was cited in a communication from a foreign patent office in a counterpart foreign application, and, to the knowledge of the undersigned after making reasonable inquiry, no item of information contained in this Information Disclosure Statement was known to any individual designated in 37 C.F.R. 1.56(c) more than three months prior to the filing of this statement. 37 C.F.R. 1.97(e)(2).

Respectfully submitted,

SHERIDAN ROSS P.C.

By:_____

Jason H. Vick
Registration No. 45285
1560 Broadway, Suite 1200
Denver, Colorado 80202-5141
(303) 863-9700

Date: 18 Oct '07

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	1	of	2	Attorney Docket Number	5550-47-CON-2

U.S. PATENT DOCUMENTS					
Examiner Initials*	Cite No.[1]	Document Number Number-kind Code [2] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee of Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
	1	3,955,141	05/01/76	Lyon et al.	
	2	4,985,900	01/01/91	Rhind et al.	
	3	5,748,677	05/01/98	Kumar	
	4	6,256,355	07/03/01	Sakoda et al.	
	5	6,507,585	01/01/03	Dobson	
	6	6,590,860	07/08/03	Sakoda et al.	
	7	6,704,317	03/01/04	Dobson	
	8	6,961,369	11/01/05	Tzannes	
	9	2005/0141410	06/30/05	Zhang et al.	
	10	2006/0002454	01/05/06	Tzannes	
	11	2006/0092902	05/04/06	Schmidt	
	12	2006/0140288	06/29/06	Holden	
	13	11/860080		Tzannes (09-24-2007)	

FOREIGN PATENT DOCUMENTS						
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3]; Number[4]; Kind Code[5] *(if known)*	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear	T[6]
	14	EP 0584534	03/02/94	ALCATEL ITALIA		
	15	EP 0719004	06/26/96	MATSUSHITA ELECTRIC IND CO LTD		
	16	GB 2330491	04/21/99	BRITISH BROADCASTING CORP		
	17	WO 98/32065	07/23/98	FORTRESS TECHNOLOGIES INC		
	18	WO 99/22463	05/06/99	MOTOROLA INC		

Examiner Signature		Date Considered	

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

Substitute for form 1449A/PTO				Complete if Known	
INFORMATION DISCLOSURE STATEMENT BY APPLICANT				Application Number	11/863,581
				Filing Date	09-28-2007
				First Named Inventor	Tzannes
				Art Unit	2611
				Examiner Name	Not yet assigned
Sheet	2	of	2	Attorney Docket Number	5550-47-CON-2

	19	WO 99/29078	06/10/99	TELIA AB		

OTHER ART (Including Author, Title, Date, Pertinent Pages, etc.)		
Examiner Initials*	Cite No.[1]	
	20	Bauml R. W. et al.: "Reducing The Peak-To-Average Power Ratio Of Multicarrier Modulation By Selected Mapping" Electronics Letters, GB, IEE Stevenage, vol. 32, No. 22, Oct. 24, 1996, pp. 2056-2057, XP000643915 ISSN: 0013-5194
	21	Copy of Annex to Form PCT/ISA/206 for PCT/US00/30958, Mar. 23, 2001 (5550-47-PCT)
	22	International Search Report for International (PCT) Patent Application No. PCT/US00/30958, completed June 12, 2001 (5550-47-PCT)
	23	International Preliminary Examination Report for International (PCT) Patent Application No. PCT/US00/30958, completed March 4, 2002 (5550-47-PCT)
	24	Notice of Preliminary Rejection for Korean Patent Application No. 7005830/2002 dated November 22, 2006 (Attorney's Ref. No. 5550-47-PKR)

Examiner Signature		Date Considered	

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

Electronic Acknowledgement Receipt

EFS ID:	2336880
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Debra Kesner
Filer Authorized By:	Jason Vick
Attorney Docket Number:	5550-47-CON-2
Receipt Date:	18-OCT-2007
Filing Date:	28-SEP-2007
Time Stamp:	12:11:57
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		IDS_01.pdf	457912 7e756c2117609003c04027df1fe6613c50a9d29a	yes	5

	Multipart Description/PDF files in .zip description				
	Document Description		Start	End	
	Information Disclosure Statement Letter		1	3	
	Information Disclosure Statement (IDS) Filed		4	5	
Warnings:					
Information:					
2	NPL Documents	5550-47-PCT_Search_Report.pdf	207210 fde804da2cecf174e0d00f3a5556afa753bd2afb	no	6
Warnings:					
Information:					
3	NPL Documents	5550-47-PCT_IPER.pdf	254373 f0cc0f24d93aaf6927e25ae3344f3755192fcc91	no	6
Warnings:					
Information:					
4	NPL Documents	5550-47-PKR_Rejection.pdf	293800 ab883fb5d197f76d615b217a2a822de34cd82c6b	no	3
Warnings:					
Information:					
		Total Files Size (in bytes):	1213295		

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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.

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
11/863,581	09/28/2007	Marcos C. Tzannes	5550-47-CON-2

CONFIRMATION NO. 1948

62574
SHERIDAN ROSS P C
SUITE 1200
1560 BROADWAY
DENVER, CO 80202

FORMALITIES LETTER

OC000000026264553

Date Mailed: 10/16/2007

NOTICE TO FILE CORRECTED APPLICATION PAPERS

Filing Date Granted

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

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

- A substitute specification excluding claims in compliance with 37 CFR 1.52, 1.121(b)(3), and 1.125 is required. The substitute specification must be submitted with markings and be accompanied by a clean version (without markings) as set forth in 37 CFR 1.125(c) and a statement that the substitute specification contains no new matter (see 37 CFR 1.125(b)). Since a preliminary amendment was present on the filing date of the application and such amendment is part of the original disclosure of the application, the substitute specification must include all of the desired changes made in the preliminary amendment. See 37 CFR 1.115 and 1.215.

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

Replies should be mailed to:

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

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/meday/

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

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/863,581	09/28/2007	2611	1000	5550-47-CON-2	5	1

CONFIRMATION NO. 1948

62574
SHERIDAN ROSS P C
SUITE 1200
1560 BROADWAY
DENVER, CO 80202

FILING RECEIPT

Date Mailed: 10/16/2007

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 write to the Office of Initial Patent Examination's Filing Receipt Corrections. 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)

Marcos C. Tzannes, Orinda, CA;

Assignment For Published Patent Application

AWARE, INC., Bedford, MA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 11/211,535 08/26/2005
which is a CON of 09/710,310 11/09/2000 PAT 6,961,369
which claims benefit of 60/164,134 11/09/1999

Foreign Applications

If Required, Foreign Filing License Granted: 10/11/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US 11/863,581**

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

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

Preliminary Class

375

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

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Title 37, Code of Federal Regulations, 5.11 & 5.15

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NOT GRANTED

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

UNITED STATES PATENT AND TRADEMARK OFFICE

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

APPLICATION NUMBER	FILING or 371(c) DATE	GRP ART UNIT	FIL FEE REC'D	ATTY.DOCKET.NO	TOT CLAIMS	IND CLAIMS
11/863,581	09/28/2007	2611	1000	5550-47-CON-2	5	1

CONFIRMATION NO. 1948

62574
SHERIDAN ROSS P C
SUITE 1200
1560 BROADWAY
DENVER, CO80202

FILING RECEIPT

Date Mailed: 10/12/2007

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 write to the Office of Initial Patent Examination's Filing Receipt Corrections. 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)

Marcos C. Tzannes, Orinda, CA;

Assignment For Published Patent Application

AWARE, INC., Bedford, MA

Power of Attorney: None

Domestic Priority data as claimed by applicant

This application is a CON of 11/211,535 08/26/2005
which is a CON of 09/710,310 11/09/2000 PAT 6,961,369
which claims benefit of 60/164,134 11/09/1999

Foreign Applications

If Required, Foreign Filing License Granted: 10/11/2007

The country code and number of your priority application, to be used for filing abroad under the Paris Convention, is **US11/863,581**

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

Non-Publication Request: No

Early Publication Request: No

Title

SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM

Preliminary Class

375

PROTECTING YOUR INVENTION OUTSIDE THE UNITED STATES

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

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

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

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

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

LICENSE FOR FOREIGN FILING UNDER

Title 35, United States Code, Section 184

Title 37, Code of Federal Regulations, 5.11 & 5.15

GRANTED

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

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NOT GRANTED

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

Attorney Docket No. 5550-47-CON-2

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application for:

First Named Inventor: Marcos C. Tzannes **Art Unit:**

Appln. No.: **Examiner:**

For: SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM **Confirmation No.:**

* * *

PRELIMINARY AMENDMENT

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

Sir:

Prior to the initial review of the above-identified patent application by the Examiner, please enter the following Preliminary Amendment. Please charge any fees to Deposit Account 19-1970.

Please amend the above-identified patent application as follows:

Amendments to the Specification begin on page 2

Amendments to the Claims are reflected in the listing of claims which begins on page 3 of this paper.

Remarks begin on page 4 of this paper.

Amendments to the Specification:

Please amend the paragraph at page 13, line 2 as follows:

Phase shifting example #3 (PS #3) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $(X_N)\times\frac{\pi}{6}, \mathrm{mod}\, 2\pi$, where X_N is an array of N pseudo-random numbers. In this example, a carrier signal having a carrier number N equal to 5 and X_N equal to [3, 8, 1, 4, 9, 5, . . .] has a phase shift added to the phase characteristic of the carrier signal that is equal to ~~$(9)\times\frac{\pi}{6}(\mathrm{mod}\, 2\pi)=\frac{\pi}{3}$~~ $(9)\times\frac{\pi}{6}(\mathrm{mod}\, 2\pi)=\frac{3\pi}{2}$ (Note that 9 is the 5th value in X_N.) The carrier signal with a carrier number N equal to 6 has a phase shift added to the phase characteristic of the carrier signal equal to ~~(5) $\times\frac{\pi}{6}(\mathrm{mod}\, 2\pi)=\frac{5\pi}{3}$~~ $(5)\times\frac{\pi}{6}(\mathrm{mod}\, 2\pi)=\frac{5\pi}{6}$.

Amendments to the Claims:

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

Listing of Claims:

1. (Original) In a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating an input bit stream, each carrier signal having a phase characteristic associated with the input bit stream, a method for scrambling the phase characteristics of the carrier signals comprising:

associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal;

computing a phase shift for each carrier signal based on the value associated with that carrier signal; and

combining the phase shift computed for each carrier signal with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristics of the plurality of carrier signals.

2. (Original) The method of claim 1 further comprising modulating bits of the input bit stream onto the carrier signals having the substantially scrambled phase characteristics to produce a transmission signal with a reduced peak-to-average power ratio (PAR).

3. (Original) The method of claim 1 further comprising independently deriving the value associated with each carrier signal at each transceiver.

4. (Original) The method of claim 1 further comprising transmitting the value associated with each carrier signal from one transceiver to the other transceiver.

5. (Original) The method of claim 1 further comprising maintaining synchronization between the transceivers using the value associated with each carrier signal.

6-20. (Canceled)

REMARKS

The specification has also been amended to correct a mathematical calculation mistake.

Claims 6-20 are canceled without prejudice or disclaimer.

Applicant believes that the pending claims are in condition for allowance and such disposition is respectfully requested. In the event that a telephone conversation would further prosecution and/or expedite allowance, the Examiner is invited to contact the undersigned.

Respectfully submitted,

Date: 28 Sept '07

By: _____
Jason H. Vick
Reg. No. 45,285

SHERIDAN ROSS P. C.
1560 BROADWAY, SUITE 1200
DENVER, COLORADO 80202
TELEPHONE: 303-863-9700
FAX: 303-863-0223

Electronic Patent Application Fee Transmittal	
Application Number:	
Filing Date:	
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Filer:	Jason Vick/Christine Jacquet
Attorney Docket Number:	5550-47-CON2
Filed as Large Entity	

Utility Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	300	300
Utility Search Fee	1111	1	500	500
Utility Examination Fee	1311	1	200	200
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1000**

Electronic Acknowledgement Receipt	
EFS ID:	2255393
Application Number:	11863581
International Application Number:	
Confirmation Number:	1948
Title of Invention:	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM
First Named Inventor/Applicant Name:	Marcos C. Tzannes
Customer Number:	62574
Filer:	Jason Vick/Christine Jacquet
Filer Authorized By:	Jason Vick
Attorney Docket Number:	5550-47-CON2
Receipt Date:	28-SEP-2007
Filing Date:	
Time Stamp:	13:33:48
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment was successfully received in RAM	$1000
RAM confirmation Number	1920
Deposit Account	191970
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 1.16 and 1.17	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1	Application Data Sheet	ADS_FORM.pdf	1041571 7425f0fddeaa8ed14d614530312c190ff3e3d1b6	no	4
Warnings:					
Information:					
2		PAT_APP_DRAW_DEC.pdf	2195089 9a1468bfb8e29768cf0a1574ba49e8b970a188c9	yes	27

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Specification	1	18
	Claims	19	21
	Abstract	22	22
	Drawings	23	24
	Oath or Declaration filed	25	27

Warnings:					
Information:					
3		AMEND_PRELIM.pdf	255278 a26e4c8bd203d571f7625181d747d86420e60383	yes	4

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

Warnings:					
Information:					
4	Fee Worksheet (PTO-06)	fee-info.pdf	8423 4bdc251def1ddd02d07f6e6aa2f17a694ae76e98	no	2
Warnings:					

Information:	
Total Files Size (in bytes):	3500361

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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.

PTO/SB/14 (07-07)
Approved for use through 06/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	5550-47-CON-2
	Application Number	
Title of Invention	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	

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

Secrecy Order 37 CFR 5.2

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

Applicant Information:

Applicant 1 Remove

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

Prefix	Given Name	Middle Name	Family Name	Suffix
	Marcos	C.	Tzannes	

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

City	Orinda	State/Province	CA	Country of Residence i	US

Citizenship under 37 CFR 1.41(b) i US

Mailing Address of Applicant:

Address 1	121 La Espiral
Address 2	

City	Orinda	State/Province	CA
Postal Code	94563	Country i	US

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

Correspondence Information:

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

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

Customer Number	62574		
Email Address	srlaw@sheridanross.com	Add Email	Remove Email

Application Information:

Title of the Invention	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM		
Attorney Docket Number	5550-47-CON-2	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	2	Suggested Figure for Publication (if any)	

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	5550-47-CON-2
	Application Number	
Title of Invention	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	

Publication Information:

☐ Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐ **Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S. C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

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

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	62574		

Domestic Benefit/National Stage Information:

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

Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	Continuation of	11211535	2005-08-26
Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
11211535	Continuation of	09710310	2000-11-09
Prior Application Status			Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
09710310	non provisional of	60164134	1999-11-09

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

Foreign Priority Information:

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

Remove

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

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	5550-47-CON-2
	Application Number	
Title of Invention	SYSTEM AND METHOD FOR SCRAMBLING THE PHASE OF THE CARRIERS IN A MULTICARRIER COMMUNICATIONS SYSTEM	

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

Assignee Information:

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

Assignee 1 Remove

If the Assignee is an Organization check here. ☒

Organization Name	Aware, Inc.		
Mailing Address Information:			
Address 1	40 Middlesex Turnpike		
Address 2			
City	Bedford	**State/Province**	MA
Country [i]	US	Postal Code	01730
Phone Number		Fax Number	
Email Address			

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

Signature:

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

Signature	/Jason H. Vick/			Date (YYYY-MM-DD)	2007-09-28
First Name	Jason H.	Last Name	Vick	Registration Number	45285

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

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

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

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

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

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

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

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

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

A System and Method for Scrambling the Phase of the Carriers in a Multicarrier Communications System

Related Application

This application claims the benefit of the filing date of copending U.S. Provisional Application, Serial No. 60/164,134, filed November 9, 1999, entitled "A Method For Randomizing The Phase Of The Carriers In A Multicarrier Communications System To Reduce The Peak To Average Power Ratio Of The Transmitted Signal," the entirety of which provisional application is incorporated by reference herein.

Field of the Invention

This invention relates to communications systems using multicarrier modulation. More particularly, the invention relates to multicarrier communications systems that lower the peak-to-average power ratio (PAR) of transmitted signals.

Background of the Invention

In a conventional multicarrier communications system, transmitters communicate over a communication channel using multicarrier modulation or Discrete Multitone Modulation (DMT). Carrier signals (carriers) or sub-channels spaced within a usable frequency band of the communication channel are modulated at a symbol (i.e., block) transmission rate of the system. An input signal, which includes input data bits, is sent to a DMT transmitter, such as a DMT modem. The DMT transmitter typically modulates the phase characteristic, or phase, and amplitude of the

carrier signals using an Inverse Fast Fourier Transform (IFFT) to generate a time domain signal, or transmission signal, that represents the input signal. The DMT transmitter transmits the transmission signal, which is a linear combination of the multiple carriers, to a DMT receiver over the communication channel.

The phase and amplitude of the carrier signals of DMT transmission signal can be considered random because the phase and amplitude result from the modulation of an arbitrary sequence of input data bits comprising the transmitted information. Therefore, under the condition that the modulated data bit stream is random, the DMT transmission signal can be approximated as having a Gaussian probability distribution. A bit scrambler is often used in the DMT transmitter to scramble the input data bits before the bits are modulated to assure that the transmitted data bits are random and, consequently, that the modulation of those bits produces a DMT transmission signal with a Gaussian probability distribution.

With an appropriate allocation of transmit power levels to the carriers or sub-channels, such a system provides a desirable performance. Further, generating a transmission signal with a Gaussian probability distribution is important in order to transmit a transmission signal with a low peak-to-average ratio (PAR), or peak-to-average power ratio. The PAR of a transmission signal is the ratio of the instantaneous peak value (i.e., maximum magnitude) of a signal parameter (e.g., voltage, current, phase, frequency, power) to the time-averaged value of the signal parameter. In DMT systems, the PAR of the transmitted signal is determined by the probability of the random transmission signal reaching a certain peak voltage during the time interval required for a certain number of symbols. An example of the PAR of a transmission signal transmitted from a DMT transmitter is 14.5 dB, which is equivalent to having a 1E-7 probability of clipping. The PAR of a

transmission signal transmitted and received in a DMT communication system is an important consideration in the design of the DMT communication system because the PAR of a signal affects the communication system's total power consumption and component linearity requirements of the system.

If the phase of the modulated carriers is not random, then the PAR can increase greatly. Examples of cases where the phases of the modulated carrier signals are not random are when bit scramblers are not used, multiple carrier signals are used to modulate the same input data bits, and the constellation maps, which are mappings of input data bits to the phase of a carrier signal, used for modulation are not random enough (i.e., a zero value for a data bit corresponds to a 90 degree phase characteristic of the DMT carrier signal and a one value for a data bit corresponds to a –90 degree phase characteristic of the DMT carrier signal). An increased PAR can result in a system with high power consumption and/or with high probability of clipping the transmission signal. Thus, there remains a need for a system and method that can effectively scramble the phase of the modulated carrier signals in order to provide a low PAR for the transmission signal.

Summary of the Invention

The present invention features a system and method that scrambles the phase characteristics of the modulated carrier signals in a transmission signal. In one aspect, a value is associated with each carrier signal. A phase shift is computed for each carrier signal based on the value associated with that carrier signal. The value is determined independently of any input bit value carried by that carrier signal. The phase shift computed for each carrier signal is combined with the phase characteristic of that carrier signal to substantially scramble the phase characteristics of the carrier signals.

In one embodiment, the input bit stream is modulated onto the carrier signals having the substantially scrambled phase characteristic to produce a transmission signal with a reduced peak-to-average power ratio (PAR). The value is derived from a predetermined parameter, such as a random number generator, a carrier number, a DMT symbol count, a superframe count, and a hyperframe count. In another embodiment, a predetermined transmission signal is transmitted when the amplitude of the transmission signal exceeds a certain level.

In another aspect, the invention features a method wherein a value is associated with each carrier signal. The value is determined independently of any input bit value carried by that carrier signal. A phase shift for each carrier signal is computed based on the value associated with that carrier signal. The transmission signal is demodulated using the phase shift computed for each carrier signal.

In another aspect, the invention features a system comprising a phase scrambler that computes a phase shift for each carrier signal based on a value associated with that carrier signal. The phase scrambler also combines the phase shift computed for each carrier signal with the phase characteristic of that carrier signal to substantially scramble the phase characteristic of the carrier signals. In one embodiment, a modulator, in communication with the phase scrambler, modulates bits of an input signal onto the carrier signals having the substantially scrambled phase characteristics to produce a transmission signal with a reduced PAR.

Description of the Drawings

The invention is pointed out with particularity in the appended claims. The advantages of the invention described above, as well as further advantages of the invention, may be better understood

by reference to the following description taken in conjunction with the accompanying drawings, in which:

Fig. 1 is a block diagram of an embodiment of a digital subscriber line communications system including a DMT (discrete multitone modulation) transceiver, in communication with a remote transceiver, having a phase scrambler for substantially scrambling the phase characteristics of carrier signals; and

Fig. 2 is a flow diagram of an embodiment of a process for scrambling the phase characteristics of the carrier signals in a transmission signal.

Detailed Description

Fig. 1 shows a digital subscriber line (DSL) communication system 2 including a discrete multitone (DMT) transceiver 10 in communication with a remote transceiver 14 over a communication channel 18 using a transmission signal 38 having a plurality of carrier signals. The DMT transceiver 10 includes a DMT transmitter 22 and a DMT receiver 26. The remote transceiver 14 includes a transmitter 30 and a receiver 34. Although described with respect to discrete multitone modulation, the principles of the invention apply also to other types of multicarrier modulation, such as, but not limited to, orthogonally multiplexed quadrature amplitude modulation (OQAM), discrete wavelet multitone (DWMT) modulation, and orthogonal frequency division multiplexing (OFDM).

The communication channel 18 provides a downstream transmission path from the DMT transmitter 22 to the remote receiver 34, and an upstream transmission path from the remote transmitter 30 to the DMT receiver 26. In one embodiment, the communication channel 18 is a pair of twisted wires of a telephone subscriber line. In other embodiments, the communication channel 18 can be a fiber optic wire, a quad cable, consisting of two pairs of twisted wires, or a quad cable

that is one of a star quad cable, a Dieselhorst-Martin quad cable, and the like. In a wireless communication system wherein the transceivers 10, 14 are wireless modems, the communication channel 18 is the air through which the transmission signal 38 travels between the transceivers 10, 14.

By way of example, the DMT transmitter 22 shown in Fig. 1 includes a quadrature amplitude modulation (QAM) encoder 42, a modulator 46, a bit allocation table (BAT) 44, and a phase scrambler 66. The DMT transmitter 22 can also include a bit scrambler 74, as described further below. The remote transmitter 30 of the remote transceiver 14 comprises equivalent components as the DMT transmitter 22. Although this embodiment specifies a detailed description of the DMT transmitter 22, the inventive concepts apply also to the receivers 34, 36 which have similar components to that of the DMT transmitter 22, but perform inverse functions in a reverse order.

The QAM encoder 42 has a single input for receiving an input serial data bit stream 54 and multiple parallel outputs to transmit QAM symbols 58 generated by the QAM encoder 42 from the bit stream 54. In general, the QAM encoder 42 maps the input serial bit-stream 54 in the time domain into parallel QAM symbols 58 in the frequency domain. In particular, the QAM encoder 42 maps the input serial data bit stream 54 into N parallel quadrature amplitude modulation (QAM) constellation points 58, or QAM symbols 58, where N represents the number of carrier signals generated by the modulator 46. The BAT 44 is in communication with the QAM encoder 42 to specify the number of bits carried by each carrier signal. The QAM symbols 58 represent the amplitude and the phase characteristic of each carrier signal.

The modulator 46 provides functionality associated with the DMT modulation and transforms the QAM symbols 58 into DMT symbols 70 each comprised of a plurality of time-

domain samples. The modulator 46 modulates each carrier signal with a different QAM symbol 58. As a result of this modulation, carrier signals have phase and amplitude characteristics based on the QAM symbol 58 and therefore based on the input-bit stream 54. In particular, the modulator 46 uses an inverse fast Fourier transform (IFFT) to change the QAM symbols 58 into a transmission signal 38 comprised of a sequence of DMT symbols 70. The modulator 46 changes the QAM symbols 58 into DMT symbols 70 through modulation of the carrier signals. In another embodiment, the modulator 46 uses the inverse discrete Fourier transform (IDFT) to change the QAM symbols 58 into DMT symbols 70. In one embodiment, a pilot tone is included in the transmission signal 38 to provide a reference signal for coherent demodulation of the carrier signals in the remote receiver 34 during reception of the transmission signal 38.

The modulator 46 also includes a phase scrambler 66 that combines a phase shift computed for each QAM-modulated carrier signal with the phase characteristic of that carrier signal. Combining phase shifts with phase characteristics, in accordance with the principles of the invention, substantially scrambles the phase characteristics of the carrier signals in the transmission signal 38. By scrambling the phase characteristics of the carrier signals, the resulting transmission signal 38 has a substantially minimized peak-to-average (PAR) power ratio. The phase scrambler 66 can be part of or external to the modulator 46. Other embodiments of the phase scrambler 66 include, but are not limited to, a software program that is stored in local memory and is executed on the modulator 46, a digital signal processor (DSP) capable of performing mathematical functions and algorithms, and the like. The remote receiver 34 similarly includes a phase scrambler 66' for use when demodulating carrier signals that have had their phase characteristics adjusted by the phase scrambler 66 of the DMT transceiver 10.

To compute a phase shift for each carrier signal, the phase scrambler 66 associates one or more values with that carrier signal. The phase scrambler 66 determines each value for a carrier signal independently of the QAM symbols 58, and, therefore, independently of the bit value(s) modulated onto the carrier signal. The actual value(s) that the phase scrambler 66 associates with each carrier signal can be derived from one or more predefined parameters, such as a pseudo-random number generator (pseudo-RNG), a DMT carrier number, a DMT symbol count, a DMT superframe count, a DMT hyperframe count, and the like, as described in more detail below. Irrespective of the technique used to produce each value, the same technique is used by the DMT transmitter 22 and the remote receiver 34 so that the value associated with a given carrier signal is known at both ends of the communication channel 18.

The phase scrambler 66 then solves a predetermined equation to compute a phase shift for the carrier signal, using the value(s) associated with that carrier signal as input that effects the output of the equation. Any equation suitable for computing phase shifts can be used to compute the phase shifts. When the equation is independent of the bit values of the input serial bit stream 54, the computed phase shifts are also independent of such bit values.

In one embodiment (shown in phantom), the DMT transmitter 22 includes a bit scrambler 74, which receives the input serial bit stream 54 and outputs data bits 76 that are substantially scrambled. The substantially scrambled bits 76 are then passed to the QAM encoder 42. When the bit scrambler 74 is included in the DMT transmitter 22, the operation of the phase scrambler 66 further assures that the transmission signal 38 has a Gaussian probability distribution and, therefore, a substantially minimized PAR.

Fig. 2 shows embodiments of a process used by the DMT transmitter 22 for adjusting the phase characteristic of each carrier signal and combining these carrier signals to produce the transmission signal 38. The DMT transmitter 22 generates (step 100) a value that is associated with a carrier signal. Because the value is being used to alter the phase characteristics of the carrier signal, both the DMT transmitter 22 and the remote receiver 34 must recognize the value as being associated with the carrier signal. Either the DMT transmitter 22 and the remote receiver 34 independently derive the associated value, or one informs the other of the associated value. For example, in one embodiment the DMT transmitter 22 can derive the value from a pseudo-RNG and then transmit the generated value to the remote receiver 34. In another embodiment, the remote receiver 34 similarly derives the value from the same pseudo-RNG and the same seed as used by the transmitter (i.e., the transmitter pseudo-RNG produces the same series of random numbers as the receiver pseudo-RNG).

As another example, the DMT transmitter 22 and the remote receiver 34 can each maintain a symbol counter for counting DMT symbols. The DMT transmitter 22 increments its symbol counter upon transmitting a DMT symbol; the remote receiver 34 upon receipt. Thus, when the DMT transmitter 22 and the remote receiver 34 both use the symbol count as a value for computing phase shifts, both the DMT transmitter 22 and remote receiver 34 "know" that the value is associated with a particular DMT symbol and with each carrier signal of that DMT symbol.

Values can also be derived from other types of predefined parameters. For example, if the predefined parameter is the DMT carrier number, then the value associated with a particular carrier signal is the carrier number of that signal within the DMT symbol. The number of a carrier signal represents the location of the frequency of the carrier signal relative to the frequency of other carrier

signals within a DMT symbol. For example, in one embodiment the DSL communication system 2 provides 256 carrier signals, each separated by a frequency of 4.3125 kHz and spanning the frequency bandwidth from 0 kHz to 1104 kHz. The DMT transmitter 22 numbers the carrier signals from 0 to 255. Therefore, "DMT carrier number 50" represents the 51st DMT carrier signal which is located at the frequency of 215.625 kHz (i.e., 51 x 4.3125 kHz).

Again, the DMT transmitter 22 and the remote receiver 34 can know the value that is associated with the carrier signal because both the DMT transmitter 22 and the remote receiver 34 use the same predefined parameter (here, the DMT carrier number) to make the value-carrier signal association. In other embodiments (as exemplified above with the transmitter pseudo-RNG), the DMT transmitter 22 can transmit the value to the remote receiver 34 (or vice versa) over the communication channel 18.

In other embodiments, other predefined parameters can be used in conjunction with the symbol count. One example of such a predefined parameter is the superframe count that increments by one every 69 DMT symbols. One exemplary implementation that achieves the superframe counter is to perform a modulo 68 operation on the symbol count. As another example, the DMT transmitter 22 can maintain a hyperframe counter for counting hyperframes. An exemplary implementation of the hyperframe count is to perform a modulo 255 operation on the superframe count. Thus, the hyperframe count increments by one each time the superframe count reaches 255.

Accordingly, it is seen that some predefined parameters produce values that vary from carrier signal to carrier signal. For example, when the predefined parameter is the DMT carrier number, values vary based on the frequency of the carrier signal. As another example, the pseudo-RNG generates a new random value for each carrier signal.

Other predefined parameters produce values that vary from DMT symbol 70 to DMT symbol 70. For example, when the predefined parameter is the symbol count, the superframe count, or hyperframe count, values vary based on the numerical position of the DMT symbol 70 within a sequence of symbols, superframes, or hyperframes. Predefined parameters such as the pseudo-RNG, symbol count, superframe count, and superframe can also be understood to be parameters that vary values over time. Any one or combination of the predefined parameters can provide values for input to the equation that computes a phase shift for a given carrier signal.

In one embodiment, the phase scrambling is used to avoid clipping of the transmission signal 38 on a DMT symbol 70 by DMT symbol 70 basis. In this embodiment, the DMT transmitter 22 uses a value based on a predefined parameter that varies over time, such as the symbol count, to compute the phase shift. It is to be understood that other types of predefined parameters that vary the values associated with carrier signals can be used to practice the principles of the invention. As described above, the transceivers 10, 14 may communicate (step 110) the values to synchronize their use in modulating and demodulating the carrier signals.

The DMT transmitter 22 then computes (step 115) the phase shift that is used to adjust the phase characteristic of each carrier signal. The amount of the phase shift combined with the phase characteristic of each QAM-modulated carrier signal depends upon the equation used and the one or more values associated with that carrier signal.

The DMT transmitter 22 then combines (step 120) the phase shift computed for each carrier signal with the phase characteristic of that carrier signal. By scrambling the phase characteristics of the carrier signals, the phase scrambler 66 reduces (with respect to unscrambled phase characteristics) the combined PAR of the plurality of carrier signals and, consequently, the

transmission signal 38. The following three phase shifting examples, PS #1 – PS #3, illustrate methods used by the phase scrambler 66 to combine a computed phase shift to the phase characteristic of each carrier signal.

Phase Shifting Example #1

Phase shifting example #1 (PS #1) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $N \times \frac{\pi}{3}$, modulo (mod) 2π. In this example, a carrier signal having a carrier number N equal to 50 has a phase shift added to the phase characteristic of that carrier signal equal to $50 \times \frac{\pi}{3} (\mathrm{mod}\, 2\pi) = \frac{2}{3}\pi$. The carrier signal with a carrier number N equal to 51 has a phase shift added to the phase characteristic of that carrier signal equal to $51 \times \frac{\pi}{3} (\mathrm{mod}\, 2\pi) = \pi$. The carrier signal with a carrier number N equal to 0 has no phase shift added to the phase characteristic of that carrier signal.

Phase Shifting Example #2

Phase shifting example #2 (PS #2) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $(N + M) \times \frac{\pi}{4}$, mod 2π, where M is the symbol count. In this example, a carrier signal having a carrier number N equal to 50 on DMT symbol count M equal to 8 has a phase shift added to the phase characteristic of that carrier signal equal to $(50+8) \times \frac{\pi}{4} (\mathrm{mod}\, 2\pi) = \frac{\pi}{2}$. The carrier signal with the same carrier number N equal to 50 on the next DMT symbol count M equal to 9 has a phase shift added to the phase characteristic of that carrier signal equal to $(50+9) \times \frac{\pi}{4} (\mathrm{mod}\, 2\pi) = \frac{3\pi}{4}$.

Phase Shifting Example #3

Phase shifting example #3 (PS #3) corresponds to adjusting the phase characteristic of the QAM-modulated carrier signal associated with a carrier number N by $(X_N)\times\frac{\pi}{6}$, mod 2π, where X_N is an array of N pseudo-random numbers. In this example, a carrier signal having a carrier number N equal to 5 and X_N equal to [3, 8, 1, 4, 9, 5, ...] has a phase shift added to the phase characteristic of the carrier signal that is equal to $(9)\times\frac{\pi}{6}(\text{mod}\,2\pi)=\frac{\pi}{3}$. (Note that 9 is the 5th value in X_N.) The carrier signal with a carrier number N equal to 6 has a phase shift added to the phase characteristic of the carrier signal equal to $(5)\times\frac{\pi}{6}(\text{mod}\,2\pi)=\frac{5\pi}{3}$.

It is to be understood that additional and/or different phase shifting techniques can be used by the phase scrambler 66, and that PS #1, #2, and #3 are merely illustrative examples of the principles of the invention. The DMT transmitter 22 then combines (step 130) the carrier signals to form the transmission signal 38. If the transmission signal is not clipped, as described below, the DMT transmitter 22 consequently transmits (step 160) the transmission signal 38 to the remote receiver 34.

Clipping of Transmission Signals

A transmission signal 38 that has high peak values of voltage (i.e., a high PAR) can induce non-linear distortion in the DMT transmitter 22 and the communication channel 18. One form of this non-linear distortion of the transmission signal 38 that may occur is the limitation of the amplitude of the transmission signal 38 (i.e., clipping). For example, a particular DMT symbol 70 clips in the time domain when one or more time domain samples in that DMT symbol 70 are larger than the maximum allowed digital value for the DMT symbols 70. In multicarrier communication

systems when clipping occurs, the transmission signal 38 does not accurately represent the input serial data bit signal 54.

In one embodiment, the DSL communication system 2 avoids the clipping of the transmission signal 38 on a DMT symbol 70 by DMT symbol 70 basis. The DMT transmitter 22 detects (step 140) the clipping of the transmission signal 38. If a particular DMT symbol 70 clips in the time domain to produce a clipped transmission signal 38, the DMT transmitter 22 substitutes (step 150) a predefined transmission signal 78 for the clipped transmission signal 38.

The predefined transmission signal 78 has the same duration as a DMT symbol 70 (e.g., 250 ms) in order to maintain symbol timing between the DMT transmitter 22 and the remote receiver 34. The predefined transmission signal 78 is not based on (i.e., independent of) the modulated input data bit stream 54; it is a bit value pattern that is recognized by the remote receiver 34 as a substituted signal. In one embodiment, the predefined transmission signal 78 is a known pseudo-random sequence pattern that is easily detected by the remote receiver 34. In another embodiment, the predefined transmission signal 78 is an "all zeros" signal, which is a zero voltage signal produced at the DMT transmitter 22 output (i.e., zero volts modulated on all the carrier signals). In addition to easy detection by the remote receiver 34, the zero voltage signal reduces the power consumption of the DMT transmitter 22 when delivered by the DMT transmitter 22. Further, a pilot tone is included in the predefined transmission signal 78 to provide a reference signal for coherent demodulation of the carrier signals in the remote receiver 34 during reception of the predefined transmission signal 78.

After the remote receiver 34 receives the transmission signal 38, the remote receiver 34 determines if the transmission signal 38 is equivalent to the predefined transmission signal 78. In

one embodiment, when the remote receiver 34 identifies the predefined transmission signal 78, the remote receiver 34 ignores (i.e., discards) the predefined transmission signal 78.

Following the transmission of the predefined transmission signal 78, the phase scrambler 66 shifts (step 120) the phase characteristic of the QAM-modulated carrier signals (based on one of the predefined parameters that varies over time). For example, consider that a set of QAM symbols 58 produces a DMT symbol 70 comprising a plurality of time domain samples, and that one of the time domain samples is larger than the maximum allowed digital value for the DMT symbol 70. Therefore, because the transmission signal 38 would be clipped when sent to the remote receiver 34, the DMT transmitter 22 sends the predefined transmission signal 78 instead.

After transmission of the predefined transmission signal 78, the DMT transmitter 22 again attempts to send the same bit values that produced the clipped transmission signal 38 in a subsequent DMT symbol 70'. Because the generation of phase shifts in this embodiment is based on values that vary over time, the phase shifts computed for the subsequent DMT symbol 70' are different than those that were previously computed for the DMT symbol 70 with the clipped time domain sample. These different phase shifts are combined to the phase characteristics of the modulated carrier signals to produce carrier signals of the subsequent DMT symbol 70' with different phase characteristics than the carrier signals of the DMT symbol 70 with the clipped time domain sample.

DMT communication systems 2 infrequently produce transmission signals 38 that clip (e.g., approximately one clip every 10^7 time domain samples 70). However, if the subsequent DMT symbol 70' includes a time domain sample that clips, then the predefined transmission signal 78 is again transmitted (step 150) to the remote receiver 34 instead of the clipped transmission signal 38. The clipping time domain sample may be on the same or on a different carrier signal than the

previously clipped DMT symbol 70. The DMT transmitter 22 repeats the transmission of the predefined transmission signal 78 until the DMT transmitter 22 produces a subsequent DMT symbol 70' that is not clipped. When the DMT transmitter 22 produces a DMT symbol 70' that is not clipped, the DTM transmitter 22 transmits (step 160) the transmission signal 38 to the remote receiver 34. The probability of a DMT symbol 70 producing a transmission signal 38 that clips in the time domain depends on the PAR of the transmission signal 38.

For example, the following phase shifting example, PST #4, illustrates the method used by the phase scrambler 66 to combine a different phase shift to the phase characteristic of each carrier signal to avoid the clipping of the transmission signal 38.

Phase Shifting Example #4

Phase shifting example #4 (PS #4) corresponds to adjusting the phase characteristic of the carrier signal associated with a carrier number N by $\frac{\pi}{3} \times (M + N)$, mod 2π, where M is the DMT symbol count. In this example, if the DMT symbol 70 clips when the DMT symbol count M equals 5, the predefined transmission signal 78 is transmitted instead of the current clipped transmission signal 38. On the following DMT symbol period, the DMT count M equals 6, thereby causing a different set of time domain samples to be generated for the subsequent DMT symbol 70', although the QAM symbols 58 used to produce both DMT symbols 70, 70' are the same.

If this different set of time domain samples (and consequently the transmission signal 38) is not clipped, the DMT transmitter 22 sends the transmission signal 38. If one of the time domain samples in the different set of time domain samples 70 (and consequently the transmission signal 38) is clipped, then the DMT transmitter 22 sends the predefined transmission signal 78 again. The process continues until a DMT symbol 70 is produced without a time domain sample 70 that is

clipped. In one embodiment, the transmitter 22 stops attempting to produce a non-clipped DMT symbol 70' for the particular set of QAM symbols 58 after generating a predetermined number of clipped DMT symbols 70'. At that moment, the transmitter 22 can transmit the most recently produced clipped DMT symbol 70' or the predetermined transmission signal 78.

The PAR of the DSL communication system 2 is reduced because the predefined transmission signal 78 is sent instead of the transmission signal 38 when the DMT symbol 70 clips. For example, a DMT communication system 2 that normally has a clipping probability of 10^{-7} for the time domain transmission signal 38 can therefore operate with a 10^{-5} probability of clipping and a lower PAR equal to 12.8 dB (as compared to 14.5 dB). When operating at a 10^{-5} probability of clipping, assuming a DMT symbol 70 has 512 time-domain samples 70, the DMT transmitter 22 experiences one clipped DMT symbol 70 out of every $\frac{10^5}{512}$, or 195 DMT symbols 70. This results in the predefined (non-data carrying) transmission signal 78 being transmitted, on average, once every 195 DMT symbols. Although increasing the probability of clipping to 10^{-5} results in approximately a 0.5% (1/195) decrease in throughput, the PAR of the transmission signal 38 is reduced by 1.7 dB, which reduces transmitter complexity in the form of power consumption and component linearity.

While the invention has been shown and described with reference to specific preferred embodiments, it should be understood by those skilled in the art that various changes in form and detail may be made therein without departing from the spirit and scope of the invention as defined by the following claims. For example, although the specification uses DSL to describe the invention, it is to be understood that various form of DSL can be used, e.g., ADSL, VDSL, SDSL, HDSL, HDSL2, or SHDSL. It is also to be understood that the principles of the invention apply to

various types of applications transported over DSL systems (e.g., telecommuting, video conferencing, high speed Internet access, video-on demand).

What is Claimed:

1. In a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating an input bit stream, each carrier signal having a phase characteristic associated with the input bit stream, a method for scrambling the phase characteristics of the carrier signals comprising:

associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal;

computing a phase shift for each carrier signal based on the value associated with that carrier signal; and

combining the phase shift computed for each carrier signal with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristics of the plurality of carrier signals.

2. The method of claim 1 further comprising modulating bits of the input bit stream onto the carrier signals having the substantially scrambled phase characteristics to produce a transmission signal with a reduced peak-to-average power ratio (PAR).

3. The method of claim 1 further comprising independently deriving the value associated with each carrier signal at each transceiver.

4. The method of claim 1 further comprising transmitting the value associated with each carrier signal from one transceiver to the other transceiver.

5. The method of claim 1 further comprising maintaining synchronization between the transceivers using the value associated with each carrier signal.

6. The method of claim 1 wherein the value varies with each carrier signal.

7. The method of claim 1 wherein the value varies with each DMT symbol.

8. The method of claim 1 wherein the value is derived from a predetermined parameter.

9. The method of claim 8 wherein the predefined parameter is a carrier number.

10. The method of claim 8 wherein the predefined parameter is a symbol count.

11. The method of claim 8 wherein the predefined parameter is a hyperframe count.

12. The method of claim 8 wherein the predefined parameter is a superframe count.

13. The method of claim 1 further comprising scrambling the bits of the input bit stream.

14. The method of claim 1 further comprising transmitting a predetermined transmission signal when the amplitude of the transmission signal exceeds a certain level.

15. The method of claim 14 wherein the predetermined transmission signal comprises a predetermined pattern of bits.

16. The method of claim 14 wherein the predetermined transmission signal comprises a pilot tone.

17. The method of claim 16 wherein the pilot tone is used to maintain timing synchronization between the first transceiver and the second transceiver.

18. The method of claim 15 wherein each bit value in the predetermined pattern of bits is a zero value.

19. The method of claim 15 wherein the predetermined pattern of bits is a pseudo-random sequence pattern.

20. In a multicarrier modulation system including a first transceiver in communication with a second transceiver using a transmission signal having a plurality of carrier signals for modulating an input bit stream, each carrier signal having a phase characteristic with the input bit stream, a method for scrambling the phase characteristics of the carrier signals comprising:

associating each carrier signal with a value determined independently of any input bit value carried by that carrier signal;

computing a phase shift for each carrier signal based on the value associated with that carrier signal; and

demodulating the transmission signal using the phase shift computed for each carrier signal.

Abstract

A system and method that scrambles the phase characteristic of a carrier signal are described. The scrambling of the phase characteristic of each carrier signal includes associating a value with each carrier signal and computing a phase shift for each carrier signal based on the value associated with that carrier signal. The value is determined independently of any input bit value carried by that carrier signal. The phase shift computed for each carrier signal is combined with the phase characteristic of that carrier signal so as to substantially scramble the phase characteristic of the carrier signals. Bits of an input signal are modulated onto the carrier signals having the substantially scrambled phase characteristic to produce a transmission signal with a reduced PAR.

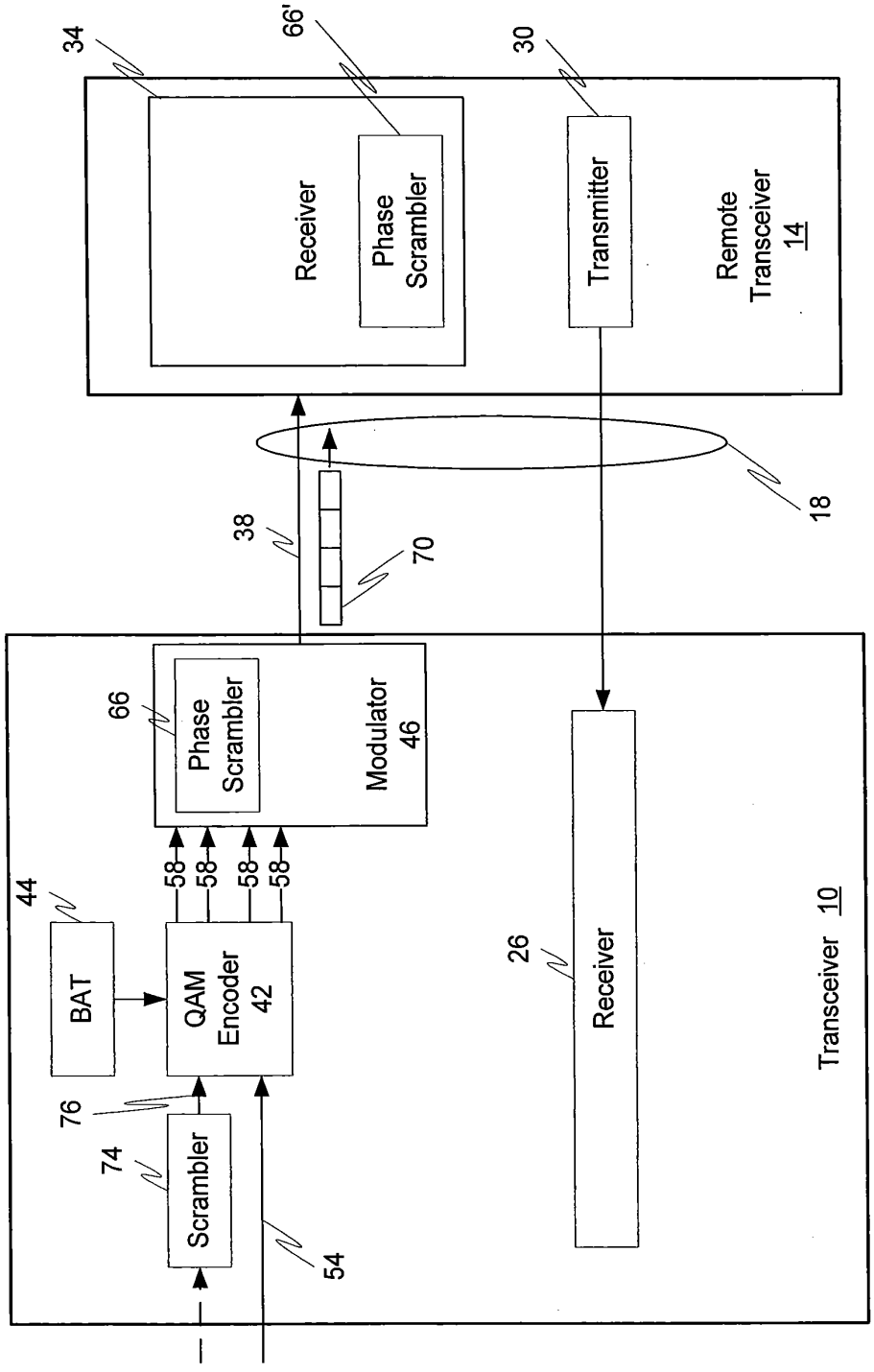
34
66'
30
Receiver
Phase Scrambler
Transmitter
Remote Transceiver 14
18
38
70
66
Phase Scrambler
Modulator 46
58
58
58
58
44
BAT
QAM Encoder 42
76
74
Scrambler
54
26
Receiver
Transceiver 10

Fig. 1

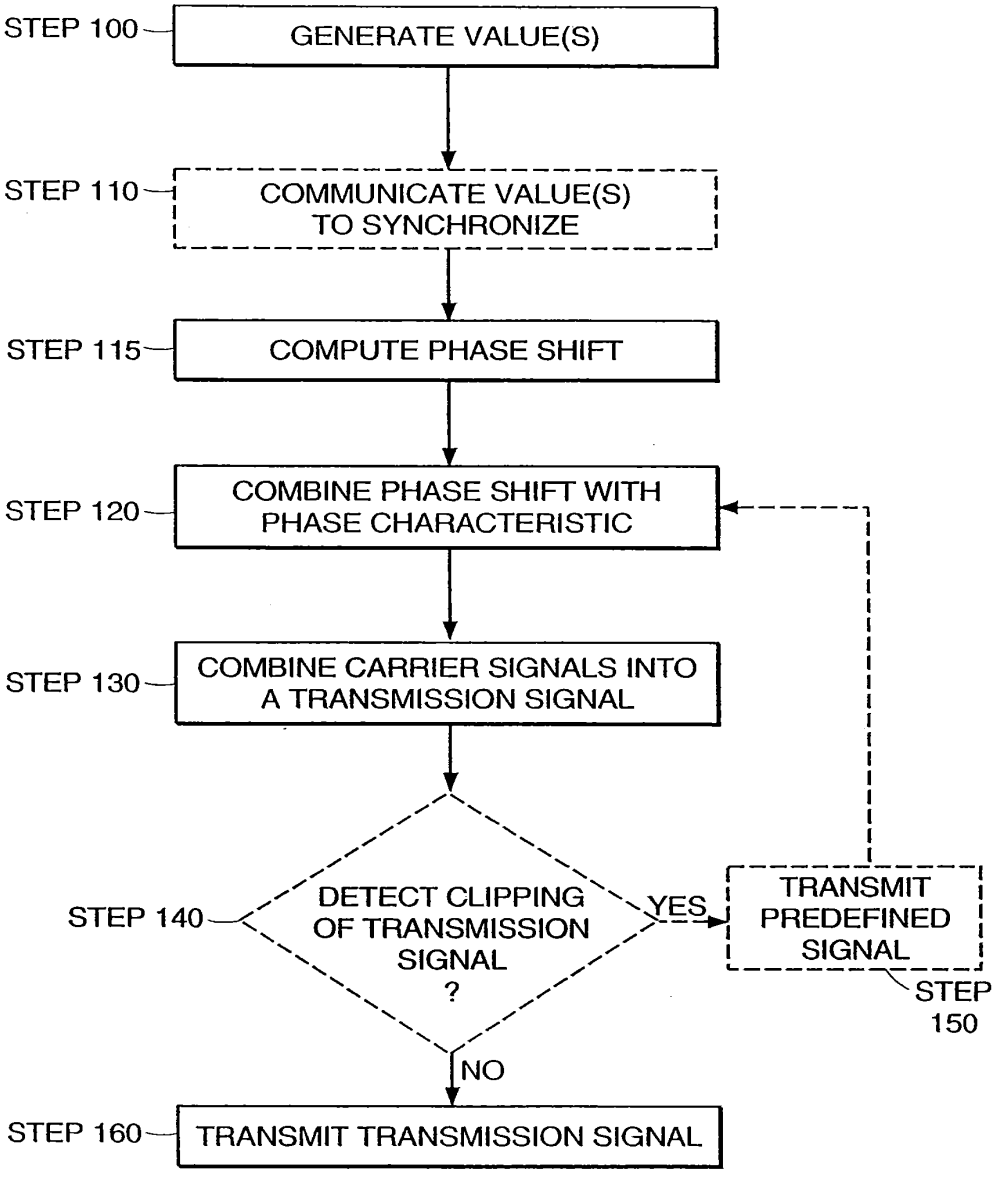
STEP 100
GENERATE VALUE(S)
STEP 110
COMMUNICATE VALUE(S) TO SYNCHRONIZE
STEP 115
COMPUTE PHASE SHIFT
STEP 120
COMBINE PHASE SHIFT WITH PHASE CHARACTERISTIC
STEP 130
COMBINE CARRIER SIGNALS INTO A TRANSMISSION SIGNAL
STEP 140
DETECT CLIPPING OF TRANSMISSION SIGNAL ?
YES
TRANSMIT PREDEFINED SIGNAL
STEP 150
NO
STEP 160
TRANSMIT TRANSMISSION SIGNAL

FIG. 2

DECLARATION AND POWER OF ATTORNEY FOR UTILITY OR DESIGN PATENT APPLICATION		
	Attorney Docket No.	AWR-017 (457/19)
	First Named Inventor	Tzannes
	COMPLETE IF KNOWN	
	Application Serial Number	Not Yet Assigned
	Filing Date	Herewith
	Group Art Unit	Not Yet Assigned
	Examiner Name	Not Yet Assigned

☒ Declaration Submitted with Initial Filing ☐ Declaration Submitted after Initial Filing (surcharge 37 CFR 1.16(e) required)

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

A System And Method For Scrambling The Phase Of The Carriers In A Multicarrier Communications System

(Title of the Invention)

the specification of which

☒ is attached hereto

OR

☐ was filed on (MM/DD/YYYY) [ ] as United States Application Serial Number or PCT International Application Number [ ] and was amended on (MM/DD/YYYY) [ ] *(if applicable)*.

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

I acknowledge the duty to disclose to the Patent Office all information known by me to be material to patentability as defined in 37 CFR 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐

☐ Additional foreign application numbers are listed on a supplemental priority data sheet attached hereto.

I hereby claim the benefit under 35 U.S.C. 119(e) of any United States provisional application(s) listed below.

Application Serial Number(s)	Filing Date (MM/DD/YYYY)	
60/164,134	11/09/1999	☐ Additional provisional application serial numbers are listed on a supplemental priority data sheet attached hereto.

DECLARATION – Utility or Design Patent Application

I hereby claim the benefit under 35 U.S.C. 120 of any United States application(s), or 365(c), of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application or PCT Parent Serial Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(if applicable)*

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority data sheet attached hereto.

As a named inventor, I hereby appoint the following registered practitioners to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: ☐ Customer Number

OR

☒ Registered practitioner(s) name/registration number listed below

Place Customer Number Bar Code Label Here

Name	Registration Number	Name	Registration Number
Steven M. Bauer	31,481	Thomas C. Meyers	36,989
John V. Bianco	36,748	Joseph B. Milstein	42,897
Isabelle A.S. Blundell	43,321	David G. Miranda	42,898
Maureen A. Bresnahan	44,559	Ronda P. Moore	44,244
Michael H. Brodowski	41,640	Indranil Mukerji	P-46,944
Jennifer A. Camacho	43,526	Edmund R. Pitcher	27,829
Joseph A. Capraro, Jr.	36,471	Michael A. Rodriguez	41,274
John J. Cotter	38,116	Jamie H. Rose	45,054
John V. Forcier	42,545	R. Stephen Rosenholm	45,283
Steven J. Frank	33,497	Christopher W. Stamos	35,370
Brian M. Gaff	44,691	Joseph P. Sullivan	45,349
Michael J. Giannetta	42,574	Robert J. Tosti	35,393
Duncan A. Greenhalgh	38,678	Thomas A. Turano	35,722
William G. Guerin	41,047	Michael J. Twomey	38,349
Jonathan A. Harris	44,744	Christine C. Vito	39,061
Ira V. Heffan	41,059	Patrick R.H. Waller	41,418
Danielle L. Herritt	43,670	Daniel A. Wilson	45,508
Douglas J. Kline	35,574	Yin P. Zhang	44,372
John D. Lanza	40,060		
Kurt W. Lockwood	40,704		

☐ Additional registered practitioners named on supplemental Registered Practitioner Information sheet attached hereto.

Direct all correspondence to:

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Testa, Hurwitz & Thibeault, LLP
High Street Tower
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Fax No.: (617) 248-7100

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 18 U.S.C. 1001 and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Name of Sole or First Inventor:	☐ A petition has been filed for this unsigned inventor							
Given Name (first and middle [if any])			Family Name or Surname					
Marcos C.			Tzannes					
Inventor's Signature						Date	Nov 9, 2000	
Residence	City Orinda		State CA		Country USA		Citizenship	USA
Post Office Address	121 LaEspiral							
P.O. Address (line 2)	City Orinda		State CA		ZIP 94563		Country	USA
☐ Additional inventors are being named on the _____ supplemental Additional Inventor(s) sheet(s) attached hereto.								
Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor							
Given Name (first and middle [if any])			Family Name or Surname					
Inventor's Signature						Date		
Residence	City		State		Country		Citizenship	
Post Office Address								
P.O. Address (line 2)	City		State		ZIP		Country	
Name of Additional Joint Inventor, if any:	☐ A petition has been filed for this unsigned inventor							
Given Name (first and middle [if any])			Family Name or Surname					
Inventor's Signature						Date		
Residence	City		State		Country		Citizenship	
Post Office Address								
P.O. Address (line 2)	City		State		ZIP		Country	

9/28/07

PTO/SB/06 (12-04)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE

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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

11/863,581

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)		OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))							300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))							500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))							200
TOTAL CLAIMS (37 CFR 1.16(i))	5 minus 20 =		X 25=		OR	X 50=	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =		X 100=			X 200=	
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))			N/A			N/A	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1000

APPLICATION AS AMENDED – PART II

AMENDMENT A

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

AMENDMENT B

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

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

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

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9/28/07

PTO/SB/06 (12-04)
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PATENT APPLICATION FEE DETERMINATION RECORD
Substitute for Form PTO-875

11/863,581

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY FEE ($)		OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
BASIC FEE (37 CFR 1.16(a), (b), or (c))							300
SEARCH FEE (37 CFR 1.16(k), (i), or (m))							500
EXAMINATION FEE (37 CFR 1.16(o), (p), or (q))							200
TOTAL CLAIMS (37 CFR 1.16(i))	5 minus 20 =		X 25=		OR	X 50=	
INDEPENDENT CLAIMS (37 CFR 1.16(h))	1 minus 3 =		X 100=			X 200=	
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))			N/A			N/A	
* If the difference in column 1 is less than zero, enter "0" in column 2.			TOTAL			TOTAL	1000

APPLICATION AS AMENDED – PART II

09-28-07

AMENDMENT A		(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)		OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 5	Minus	** 20	=	X =		OR	X =	
	Independent (37 CFR 1.16(h))	* 1	Minus	*** 3	=	X =		OR	X =	
	Application Size Fee (37 CFR 1.16(s))							OR		
	FIRST PRESENTATION OF MULTIPLE DEPENDENT CLAIM (37 CFR 1.16(j))					N/A		OR	N/A	
						TOTAL ADD'T FEE		OR	TOTAL ADD'T FEE	

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

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

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