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13281 U.S. PTO

PROVISIONAL PATENT APPLICATION COVER SHEET15364 U.S. PTO
60/591104

072704

This is a request for filing a PROVISIONAL APPLICATION for patent under 37 C.F.R. §1.53(c).

Docket Number		58268.00398		Type a plus sign (+) inside this box →		+	
INVENTOR(S)/APPLICANT(S)							
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TITLE OF THE INVENTION (280 characters max)							
BACKWARD-COMPATIBLE LONG TRAINING SEQUENCES FOR WIRELESS COMMUNICATION NETWORKS							
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STATE		VA		ZIP CODE		22182-2700 COUNTRY U.S.A.	
ENCLOSED APPLICATION PARTS (check all that apply)							
☒ Specification - Number of Pages <u>12</u>				☐ Applicant Qualifies for Small Entity Status			
☐ Drawing(s) - Number of Sheets _____				☐ Other (specify) _____			
METHOD OF PAYMENT (check one)							
☒ Check No. <u>011738</u> is enclosed to cover the Provisional filing fees						PROVISIONAL FILING FEE AMOUNT(S)	
☒ The Commissioner is hereby authorized to charge any fee deficiency or credit any overpayment to Counsel's Deposit Account No. 50-2222						\$160.00	

The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.



No



Yes, the name of the U.S. Government agency and the Government contract number are:

Respectfully submitted,

SIGNATURE

PRINTED NAME Douglas H. Goldhush

REGISTRATION NO. 33,125

Date: July 27, 2004



Additional inventors are being named on separately numbered sheets attached hereto.

DHG:scc

PROVISIONAL APPLICATION FILING ONLY

TITLE OF THE INVENTION:

BACKWARD-COMPATIBLE LONG TRAINING SEQUENCES FOR
WIRELESS COMMUNICATION NETWORKS

BACKGROUND OF THE INVENTION:

Field of the Invention:

The invention is directed to backward compatible training sequences for communication systems which are compliant with standards such as IEEE™ 802.11n, yet which are backward compatible with previous communication system standards such as IEEE 802.11a and 802.11g.

Description of the Related Art:

Numerous standards exists which enable different devices to communicate with each other in wireless communication networks. Two such standards are IEEE standard 802.11a and 802.11g. The present invention is directed to utilizing long training sequences with a minimum peak-to-average power ratio which can be used by "legacy" stations in order to estimate channel impulse response and to estimate carrier frequency offset between transmitter and receiver.

Existing standards of such as IEEE 802.11a and 802.11g operate in the 5 Gigahertz band the 2.4 Gigahertz band, respectively. New implementations of wireless communication protocol enable higher speed throughput, while also enabling slower or "legacy" stations which might be only compliant with 802.11a or 802.11g to communicate in systems which are operating at higher speeds.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S):

Long training sequences are known in the art. Long training sequences are typically used for synchronization, and for training channels in such communication systems.

802.11a and 802.11g typically utilize training sequences at subcarrier indices of -26...+26. An inverse Fourier transform, whether it be an inverse fast Fourier (IFFT) transform or inverse discrete Fourier transform (IDFT) are used to generate time-domain sequences for long training sequences. The present invention expands the LTS such that a minimum peak-to-average power ratio (PAPR) is achieved, thereby decreasing power back-off. So the invention utilizes the same subcarrier values as 802.11a/g, using the 52 active subcarriers provided by indices -26 to +26, with the 0-index subcarrier (which maps to the carrier frequency) set to 0. Additional subcarriers are selected, using, for example, 56 and 63 active-subcarrier sequences having a minimum PAPR. The invention utilizes the same +1 or -1 BPSK (binary phase shift keying) encoding for each new subcarrier. The additional subcarrier indices are illustrated on attached slides 7-10. The sequence illustrated on slide 7 utilizes 56 active subcarriers (-28 to +28), and the sequence on slide 9 includes 63 active subcarriers (-32 to +31). The illustrated sequences have the minimum PAPR of all of the 16 or 2048 possibilities for 4 or 11 additional subcarrier positions when viewed with respect to the original 52 active subcarriers of 802.11a/g. Slide 10 indicates the mapping of subcarriers to a 64-point IDFT (Inverse Discrete Fourier Transform) or IFFT (Inverse Fast Fourier Transform).

802.11a/g-Backward-Compatible Long Training Sequences



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Design Goal

- **The design goal is to find long training sequences (LTSs) of minimum peak-to-average power ratio (PAPR) which may be used by legacy stations for**
 - estimating the channel impulse response
 - estimating the carrier frequency offset between transmitter and receiver.
- **A new LTS is usable (as above) by legacy stations if the values at subcarrier indices -26..+26 inclusive are identical to those of the 802.11a/g LTS.**
 - Subcarriers from -32..-27 and +27..+31 may hold any value.
 - Orthogonality is not affected, since a 64-point orthogonal transform (inverse discrete Fourier transform, or inverse fast Fourier transform) is used to generate the time-domain sequence.
 - The output of an autocorrelator (for computing the carrier frequency offset) is not affected by the extra subcarriers.



Design Goal (2)

- **Two different numbers of active subcarriers are under consideration for 802.11n:**
 - 56 active subcarriers
 - 63 active subcarriers (“extended long training” or ELTS)
- **802.11a/g uses 52 active subcarriers**
 - (indices -26 to +26, with the 0-index subcarrier, which is at the carrier frequency, set to 0).
- **Let’s say that we want to use the same subcarrier values for positions -26..+26.**
 - Now, we can perform a search to find the 56- and 63-active-subcarrier sequences that have minimum PAPR.
 - We use the same +1 or -1 BPSK encoding for each new subcarrier.



Background: 802.11a/g OFDM LTS

The LTS for 802.11a/g is given by the following vector of constellation points, one for each subcarrier:

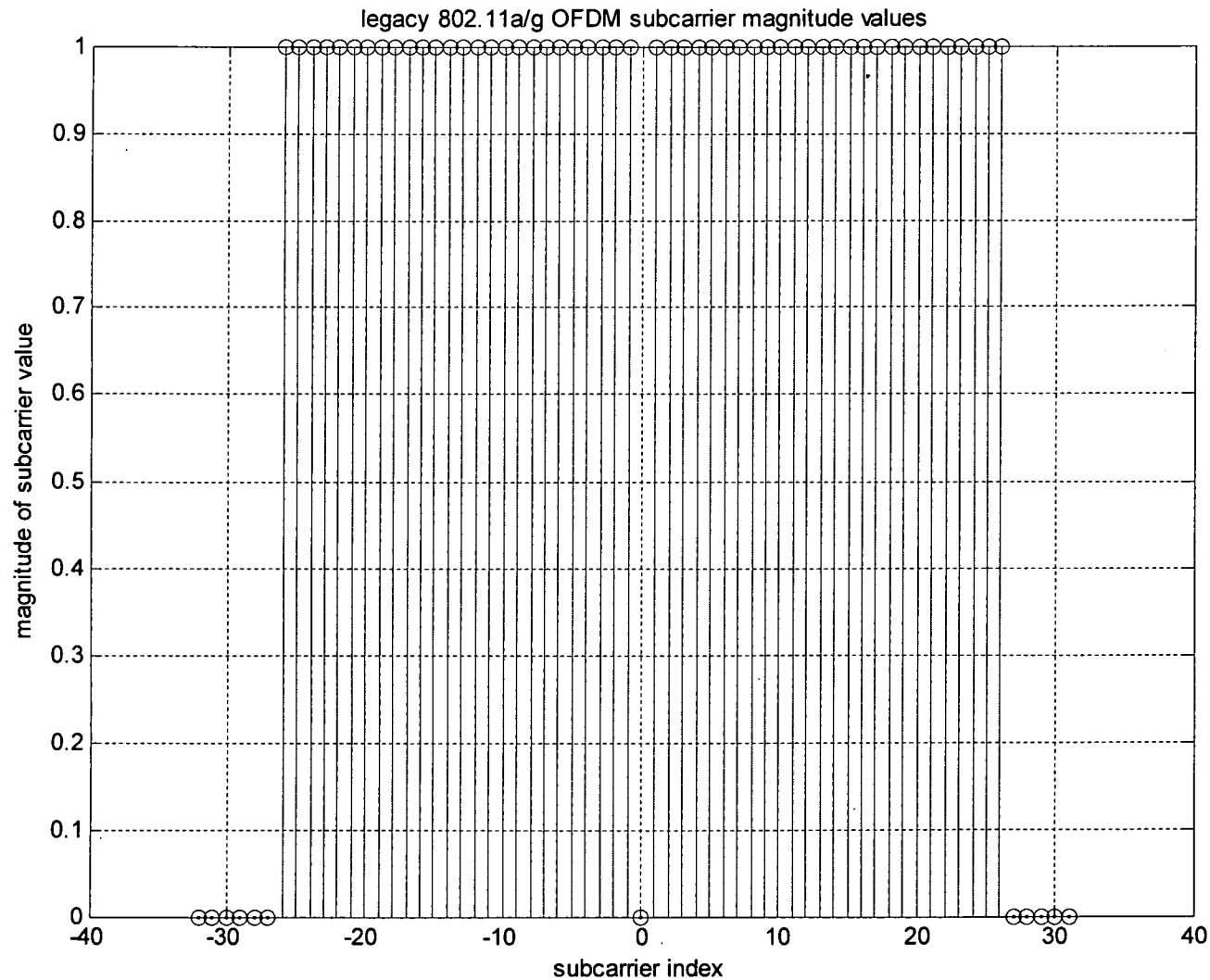
$$\mathbf{S}_{-26..+26} = \begin{bmatrix} 1 & 1 & -1 & -1 & 1 & 1 & -1 & 1 & -1 & 1 & 1 & 1 & 1 & 1 & -1 & -1 & 1 & 1 & -1 & 1 & -1 & 1 & 1 & 1 & 1 & 0 & \dots \\ 1 & -1 & -1 & 1 & 1 & -1 & 1 & -1 & 1 & -1 & -1 & -1 & -1 & 1 & 1 & -1 & -1 & 1 & -1 & 1 & -1 & 1 & 1 & 1 & 1 \end{bmatrix}$$

i.e., 52 BPSK constellation points.



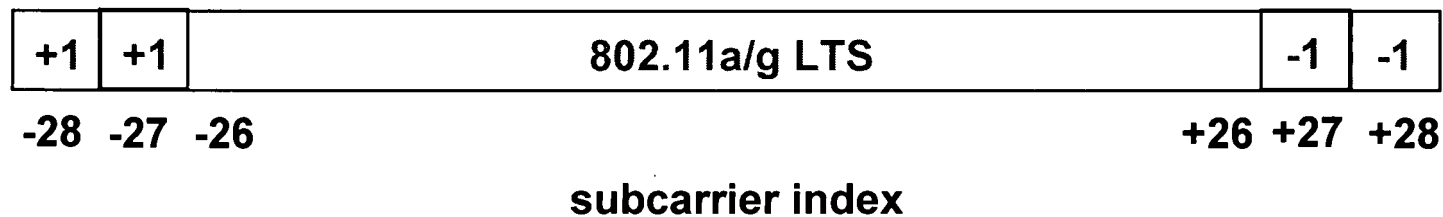


Background: 802.11a/g OFDM LTS (3)



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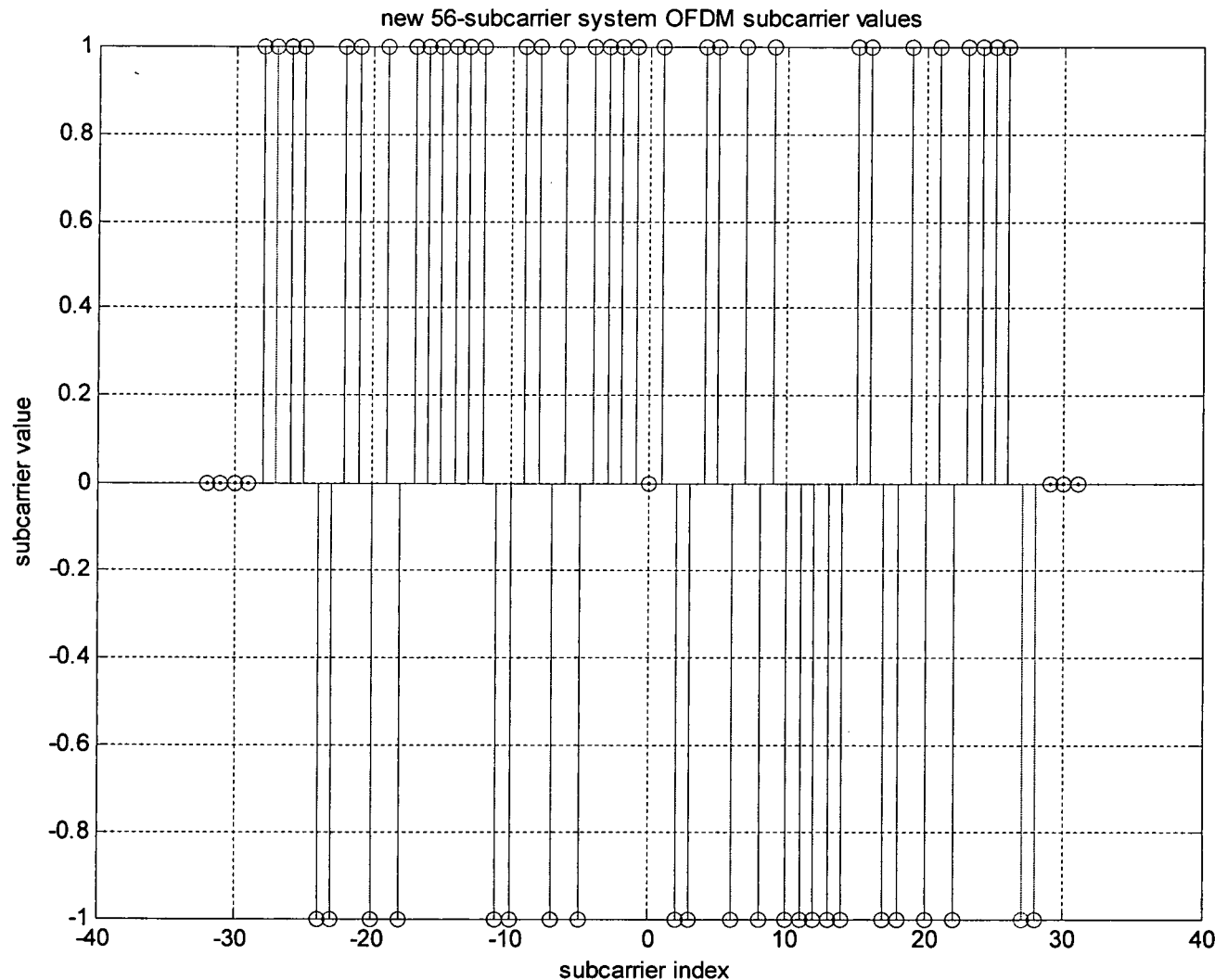
New LTS for 56 Active Subcarriers



This sequence has the minimum PAPR (3.6 dB) of the 16 possibilities for the 4 new subcarrier positions.



New LTS for 56 Active Subcarriers (2)



Each subcarrier is 312.5 kHz wide and index 0 corresponds to the carrier frequency.

Values in red are the new subcarriers at the edge of the legacy subcarriers.



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New LTS for 63 Active Subcarriers

-1	-1	+1	+1	+1	+1	802.11a/g LTS						+1	-1	-1	+1	-1		
-32	-31	-30	-29	-28	-27	-26							+26	+27	+28	+29	+30	+31
subcarrier index																		

This sequence has the minimum PAPR (3.6 dB) of the 2048 possibilities for the 11 new subcarrier positions.



Mapping of Subcarriers to 64-Point IDFT or IFFT Inputs

