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PATENT
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NEW PROVISIONAL APPLICATION TRANSMITTAL LETTER

Sir:

Transmitted herewith for filing is the Provisional Patent Application of Inventor(s):

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For: Multicarrier Modulation System with Remote Diagnostic Transmission Mode

Enclosed are the following papers required to obtain a filing date under 37 C.F.R. §1.53(c):

0 Sheets of Informal Drawings
5 Pages of Specification, Drawings & Tables
0 Claims

The following papers, if indicated by an ☒, are also enclosed:

☐ A Declaration and Power of Attorney
☐ An Assignment of the invention
☐ An Information-Disclosure Statement, Form PTO-1449 and a copy of each cited reference
☐ A Small-Entity Declaration
☒ A Certificate of Express Mailing, Express Mail Label No. EE437022889US

Basic Fee: $150

☒ A check in the amount of $150 is enclosed to cover the Filing Fee.

Please address all communications and telephone calls to the undersigned.

Respectfully submitted,

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UNITED STATES PROVISIONAL PATENT APPLICATION

of

David M. Krinsky and Robert E. Pizzano, Jr.

for a

MULTICARRIER MODULATION SYSTEM WITH REMOTE DIAGNOSTIC TRANSMISSION MODE

Multicarrier Modulation System with Remote Diagnostic Transmission Mode

by

David M. Krinsky and Robert E. Pizzano, Jr.

Overview of the Invention

Exchange of diagnostic and test information between transceivers is an important part of an ADSL deployment. In cases when the transceiver connection is not performing as expected (e.g. the data rate is low, there are many bit errors, a data link is not possible, etc) it is important to be able to get diagnostic and test information from the remote modem without having to send a technician to the remote modem site to collect and analyze the data. Dispatching a technician to a remote site (also known as a "truck roll") is very expensive and time consuming.

This invention describes a method of exchanging diagnostic and test information between two transceivers in a simple and robust manner. The information is exchanged by putting the transceivers into a new *Diagnostic (Diag) Link mode*. In this Diag Link mode information is communicated using a signaling mechanism that has a very high immunity to noise and therefore can operate effectively even in the cases when the transceivers could not actually achieve a good connection under their normal operational mode. As an example if the transceivers fail to complete initialization and do not enter normal steady state mode (where the diagnostic and test information would be exchanged in the prior art) the transceiver can enter this robust Diag Link mode. In the Diag Link mode the transceivers exchange the diagnostic and test information that is required for the technician to determine the cause of the failure without having to go to the remote site to collect data. The information exchanged includes (but is not limited to) signal to noise ration (SNR) information, equalizer information, programmable gain setting information, bit allocation information (number of bits allocated to each carrier), transmitted and received power information, margin information, status and rate information, telephone line condition information (e.g. length of line, number and location of bridged taps, wire gauge, etc) etc. Many of these parameters are specified in ADSL standards in the ITU (G.992.1 and G.992.1) and ANSI (T1.413). Others are specific to the transceiver implementation. Others are specific to the installation and deployment environment. As other new important parameters are found to be critical in determining the cause of a specific failure or problem they can be easily added to the list of information parameters exchanged in the Diag Link mode.

Preferred Embodiment of the Invention

This preferred embodiment describes the communication of diagnostic information from the remote terminal (RT) transceiver to the central office (CO) transceiver. Transmission of information from the RT to the CO is important because the ADSL service provider located in the CO can then easily determine problems without a truck roll. Obviously the invention described can be applied to communication in the other direction (CO to RT) as well.

Transceivers with Diag Link mode capability complete a portion (e.g. 90%) of normal standard training procedure and then enter into the Diag Link mode. The transition into Diag Link mode is done by transmitting a message from the CO modem to the RT

modem indicating that the transceivers are to enter into Diag Link mode instead of transitioning into normal steady state data transmission. In the Diag Link mode the RT transceiver sends the diagnostic information in the form of a collection of information bits that are modulated by using 1 bit per DMT symbol modulation as is used in the C-Rates1 message in the ITU and ANSI ADSL standards (the DMT symbol may or may not include a cyclic prefix). In this message encoding scheme a bit with value 0 is mapped to the REVERB1 signal and bit with a value of 1 mapped to a SEGUE1 signal. REVERB1 and SEGUE1 are defined in the ITU and ANSI ADSL standards. The REVERB1 signal is generated by modulating all of the carriers in the multicarrier system with a known pseudo-random sequence thus generating a wideband modulated signal. The SEGUE1 signal is generated from a carrier by carrier 180 degree phase reversal of the REVERB1 signal. Since both signals are wideband and known in advance, the receiver can easily detect the REVERB1 and SEGUE1 signal using a simple matched filter in the presence of large amounts of noise and other disturbances.

Table 1: Diag Link Message

Variable	Length	Start Address
snrdB_table1	256	0
snrdB_table3	256	256
sync_correlation	512	512
rx_fdq	512	1024
rx_gs	256	1536
rx_bat	256	1792
rx_trb	64	2048
TDQSetting_Taps	32	2112
rms_squared1	10	2144
PGA_gain	4	2154
CutbackSetting	2	2158
MarginDesired	4	2160
RATEArray	4	2164
STATArray	2	2168
ADPTArray	4	2170
PSDMArray	4	2174
Future Use	1822	2178

Table1 shows an example of a message that is sent by the RT to the CO during the Diag Link mode transmission mode. In this example, the RT sends a 4000 word (byte) message to the CO. The variables (snrdB_table1, snrdB_table3, sync_correlation, etc) represent the type of diagnostic and test information that is used to analyze the condition of the link. These variables are actually arrays with different length depending on the information they contain. For example snrdB_table1 is a 256 length array containing the SNR of each of the 256 carrier in the multicarrier ADSL modem as measured during a specific stage of initialization. As described in the previous section the message can

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