Exhibit 1003

U.S. Patent Application Publication No. 2006/0218593 to Amir S. Afshary et al.

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US 20060218593A1

(19) **United States**

(12) **Patent Application Publication** (10) **Pub. No.: US 2006/0218593 A1**

Afshary et al. (43) **Pub. Date: Sep. 28, 2006**

(54) **DIGITAL COAXIAL CABLE LAN**

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(21) Appl. No.: **11/325,093**

(22) Filed: **Jan. 3, 2006**

Related U.S. Application Data

(63) Continuation of application No. 09/164,427, filed on Sep. 30, 1998.

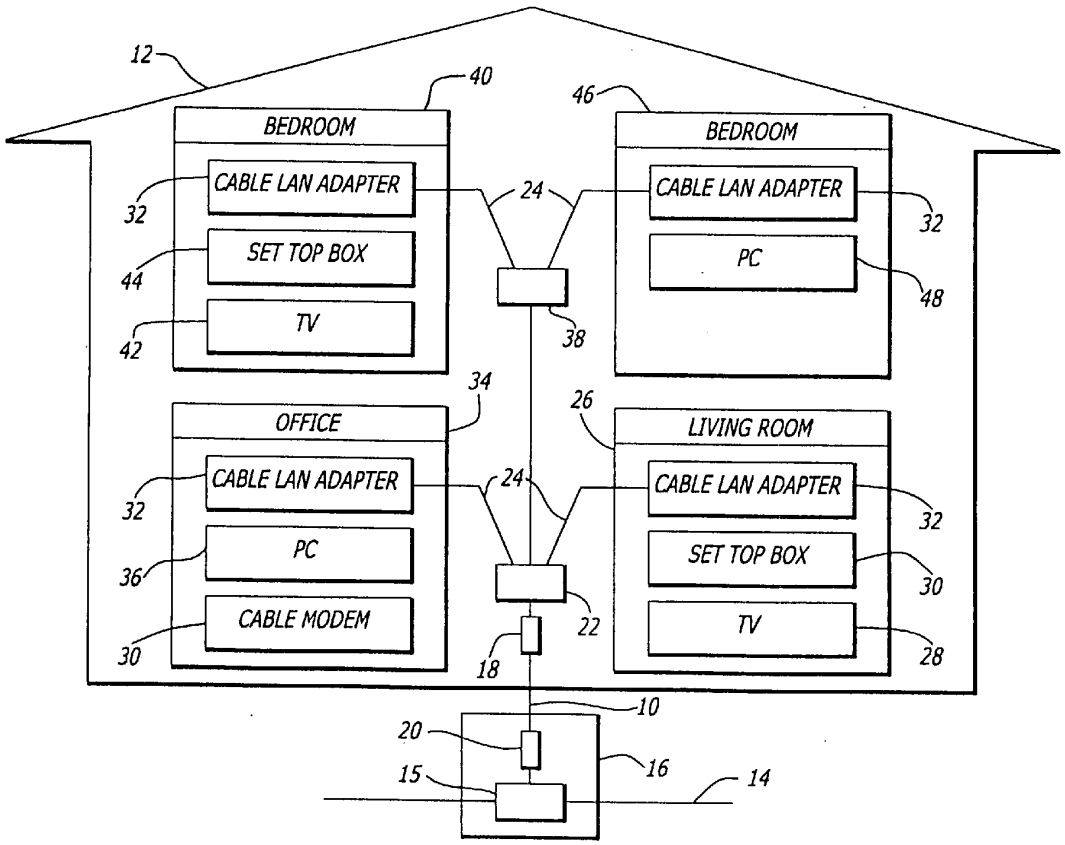
Publication Classification

(51) **Int. Cl.**
H04N 7/18 (2006.01)

(52) **U.S. Cl.** **725/74**; 725/78

(57) **ABSTRACT**

The invention relates to a coaxial cable local area network (LAN) for digitally communicating client generated data between clients of the cable LAN. The cable LAN has adapters in communication with both the clients and other adapters of the cable LAN. Connected through coaxial cable, these adapters generate and communicate data transmitting signals that take advantage of the operating frequency spectrum of the coaxial cable so as to not interfere with the operating frequency of the client data within the coaxial cable. Other features are disclosed.



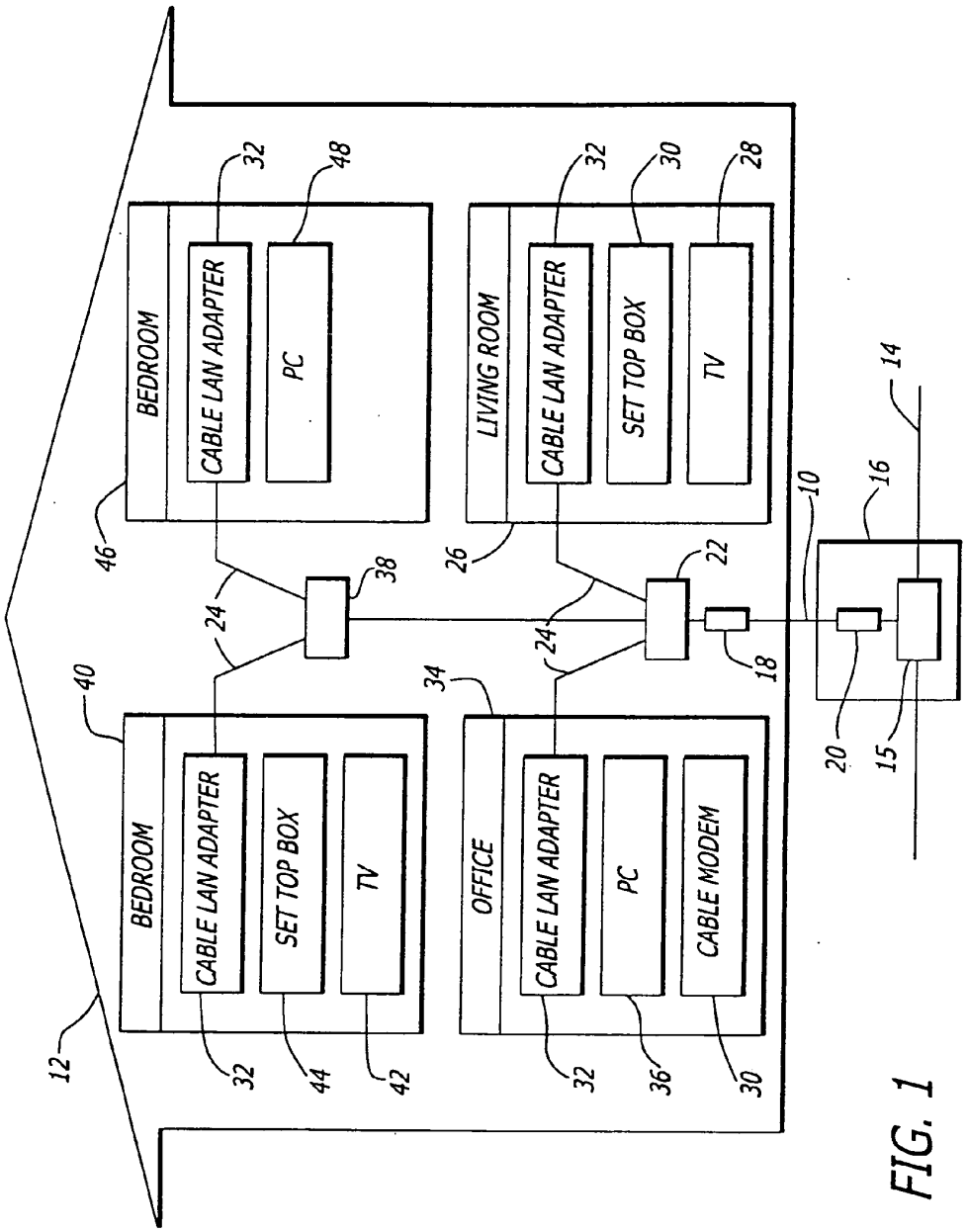

BEDROOM
CABLE LAN ADAPTER
PC
LIVING ROOM
CABLE LAN ADAPTER
SET TOP BOX
TV
BEDROOM
CABLE LAN ADAPTER
SET TOP BOX
TV
OFFICE
CABLE LAN ADAPTER
PC
CABLE MODEM
10
12
14
15
16
18
20
22
24
26
28
30
32
34
36
38
40
42
44
46
48

FIG. 1

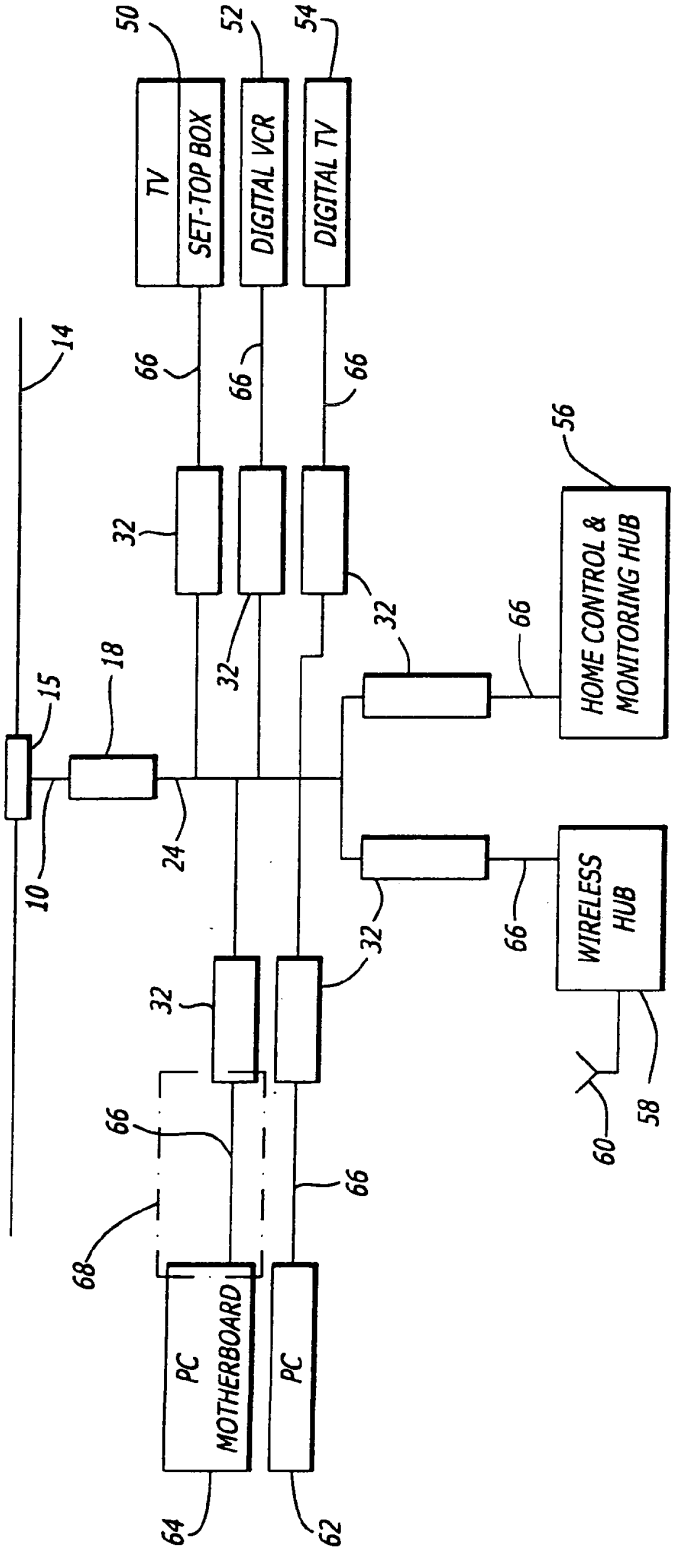

50
52
54
TV
SET-TOP BOX
DIGITAL VCR
DIGITAL TV
14
66
66
66
56
32
32
32
HOME CONTROL & MONITORING HUB
66
18
15
10
24
WIRELESS HUB
66
32
32
66
60
58
68
PC MOTHERBOARD
PC
64
62

FIG. 2

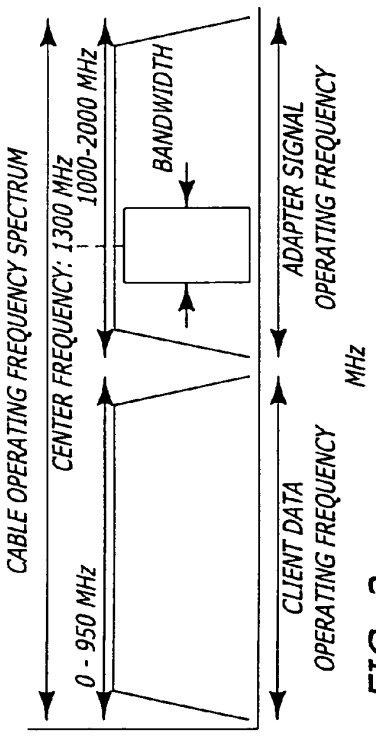

CABLE OPERATING FREQUENCY SPECTRUM
CENTER FREQUENCY: 1300 MHz
1000-2000 MHz
BANDWIDTH
0 - 950 MHz
CLIENT DATA OPERATING FREQUENCY
ADAPTER SIGNAL OPERATING FREQUENCY
MHz

FIG. 3

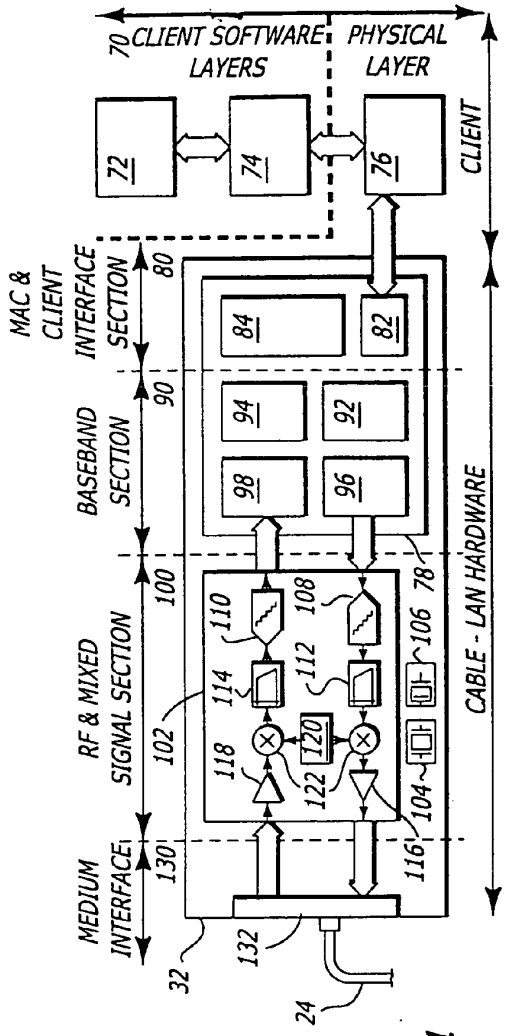

70
CLIENT SOFTWARE LAYERS
PHYSICAL LAYER
CLIENT
72
74
76
MAC & CLIENT INTERFACE SECTION
80
84
82
BASEBAND SECTION
90
94
92
98
96
RF & MIXED SIGNAL SECTION
100
78
110
108
106
114
112
102
118
120
122
104
MEDIUM INTERFACE
130
116
CABLE - LAN HARDWARE
32
132
24

FIG. 4

DIGITAL COAXIAL CABLE LAN

BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention relates generally to networking and more particularly to data distribution through a coaxial cable at frequencies that take advantage of the operating frequency spectrum of the coaxial cable so as to not interfere with the operating frequency of the client data within the coaxial cable.

[0003] 2. Background Information

[0004] Conventional homes contain many electronic devices that generate data or operate on data received internally, from other devices, or from sources outside of the home. For example, content devices such as televisions, video cassette recorders, personal computers, and stereos as well as monitor and control devices such as climate-control devices, security devices, and home automation devices all generate or use data. In-home local area networks (LANs) may be used to distribute such data around the home, both to and from these devices.

[0005] As home based LANs become more popular for in-home networking, the ability to transmit high-bandwidth data including digital video remains difficult to implement. Several alternative mediums for in-home networking are known. For example, current solutions that do not require new wiring include AC power lines, telephone lines, and wireless communication. There are also options that require installing new wires such as CAT-5 twisted pair, fiber optic, and IEEE 1394 (fire-wire). In general, the solutions that do not require new wires suffer from low bandwidth or high cost. Solutions that require new wires suffer from being expensive as well as technology that has not been proven over time as compared to coaxial cables. Table I lists some of these alternative mediums with their limitations.

TABLE 1

Alternative Mediums

MEDIUM	LIMITATIONS
AC power-lines	Unregulated Low bit-rate (Harsh environment) Data security issues Perceived usage hazards
Telephone lines	RF interference RF emissions regulations
Wireless	Limited bandwidth Expensive Data security issues Transmission disruption due to movement
New wires	Installation costs Maintenance costs

[0006] Thus, there is a need to transmit data around the home and elsewhere in cost-effective, quick, and secure fashion.

SUMMARY OF THE INVENTION

[0007] The invention relates to a coaxial cable local area network (LAN) for digitally communicating client generated data between clients of the cable LAN. The cable LAN has adapters in communication with both the clients and other adapters of the cable LAN. Connected through coaxial cable, these adapters generate and communicate data transmitting signals that take advantage of the operating frequency spectrum of the coaxial cable so as to not interfere with the operating frequency of the client data within the coaxial cable. Other features are disclosed.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] **FIG. 1** is an illustration of an in-home coaxial cable LAN in accordance with an embodiment of the invention.

[0009] **FIG. 2** is a schematic illustration of a coaxial cable LAN in accordance with an embodiment of the invention.

[0010] **FIG. 3** illustrates an operating frequency of the client data and the adapter signal in accordance with an embodiment of the invention.

[0011] **FIG. 4** is a schematic of an architecture of a cable LAN adapter in accordance with an embodiment of the invention.

DETAILED DESCRIPTION OF THE INVENTION

[0012] The invention discloses a coaxial cable local area network (LAN) for communicating data between clients of the cable LAN. The benefits of the cable LAN is the ability transmit data in cost-effective, secure fashion, without interfering with cable service company operations.

[0013] For purposes of explanation, specific embodiments are set forth to provide a thorough understanding of the present invention. However, it will be understood by one skilled in the art, from reading this disclosure, that the invention may be practiced without these details. Moreover, well-known elements, devices, process steps and the like are not set forth in detail in order to avoid obscuring the present invention.

[0014] Reference is now made to **FIGS. 1 through 4** to illustrate the embodiments of the invention. **FIG. 1** is an illustration of an in-home coaxial cable LAN. As shown, drop cable **10** enters home **12** after it is tapped off main trunk **14** through cable service company splitter **15** within distribution box **16**. Near the point at which drop cable **10** enters home **12**, low pass filter (LPF) **18** is installed by the user, upstream of the in-home cable LAN network and downstream of any cable service company supplied low pass filter **20**.

[0015] A cable LAN isolator such as LPF **18** preferably is installed by the user downstream of cable service company splitter **15**, even when a low pass filter is provided by the cable service company as shown by low pass filter **20** in **FIG. 1**. The need for such a device can be attributed to several operational limitations such as security, performance improvement of premise network, and legal compliance. Here, LPF **18** maintains security for the cable LAN, works to improve the performance of the cable LAN, and prevents signals generated within the cable LAN from interfering with cable service company operations.

[0016] By restricting spurious signals or cable LAN signals to the premise of the user, LPF **18** maintains security by preventing such signals from getting back to the public cable

network. Although LPF **18** is shown installed within the physical premise of home **12**, LPF **18** may be secured elsewhere to maintain security. For example, installing LPF **18** within a lock box external to home **12** would maintain security. LPF **18** will also reflect cable LAN transmitted signals back into the network of the cable LAN. Thus, where splitter **22** is located close to LPF **18**, the return loss characteristics of LPF **18** may be helpful in coupling the cable LAN signal power from one arm of splitter **22** to another arm of splitter **22**. This, in turn, would decrease the amount of power needed to transmit cable LAN signals and thus improve the performance of the invention. Moreover, by preventing signals generated within the cable LAN from interfering with cable service company signals within main trunk **14**, LPF **18** serves legal compliance requirements.

[**0017**] Depending on the type of cable system, LPF **18** will have different cut-off frequencies. For example, one cable system only requires that the low pass filter have a cut off frequency of less than 1000 MHz whereas older cable systems require that the low pass filter have a cut off frequency of less than 450 MHz.

[**0018**] Coaxial cable splitters permit more than one client to receive identical data by dividing the cable into two or more cable wires. Thus, from the point at which drop cable **10** enters home **12**, drop cable **10** is split by splitter **22** into different cable wires **24**, each cable wire **24** being routed to different rooms in home **12**. Within living room **26** of **FIG. 1** is living room television (TV) **28** having set top box (STB) **30**. Set top box **30** includes boxes that provide interactive television through high speed internet data access. Coupled between cable wire **24** and set top box **30** is cable LAN adapter **32**. Cable wire **24** is also routed to office **34**. Within office **34** is office personal computer (PC) **36** having an internet gateway. The internet gateway may be personal computer **36** having high speed access to the internet, where the high speed access may be achieved through the shown a cable modem **30**, as well as other connection such as asymmetric digital subscriber loop (ADSL) modem, an integrated service digital network (ISDN), a T1 line, and a multimedia cable network system (MCNS) cable modem. Coupled between cable wire **24** and personal computer **36** is a second cable LAN adapter **32**.

[**0019**] Cable wire **24** is also routed to bedroom **40** and to bedroom **46**. To communicate with cable LAN adapter **32** in bedroom **40** and bedroom **46**, cable wire **24** is further divided from splitter **22** by splitter **38** into two cable wires **24**. Within bedroom **40** is bedroom TV **42** having set top box **44**. Coupled between cable wire **24** and set top box **44** is a third cable LAN adapter **32**. Within bedroom **46** is bedroom PC **48** coupled to a fourth cable LAN adapter **32**. To complete the cable LAN network, cable wire **24** from splitter **38** is connected to cable LAN adapter **32** in bedroom **46**. The number and arrangement of rooms and clients in home **12** is not particular to an embodiment of the invention. Home **12** may have different rooms, in different numbers and arrangements, each having different clients.

[**0020**] Typical clients of the cable LAN network are shown in **FIG. 2**. These clients may include digital TV set top box **50**, digital video cassette recorder (VCR) **52**, digital TV **54**, home control and monitoring hub **56**, wireless hub **58** with bridge **60**, personal computer **62**, and personal computer motherboard **64**. Bridge **60** of wireless hub **58** is capable of communicating with different wireless devices. For example, one such wireless device may be a remote-control device that can be used for multiple clients on the network such as PC's, set top boxes, and digital TV's.

[**0021**] As shown in **FIG. 2**, client interface **66** couples cable LAN adapter **32** to a client. Adapter **32** serves to connect these clients to the network of cable wires **24**. Client interface **66** may be any suitable computer interface, such as a Peripheral Component Interconnect (PCI) adapter card, Universal Serial Bus (USB), or buses meeting the Institute of Electronic and Electrical Engineering standard for a high performance serial bus, IEEE 1394. Adapter **32** may also be coupled to a client by other techniques. For example, adapter **32** may be housed in a client of the cable-LAN network such as indicated by dashed lines **68** for PC motherboard **64**.

[**0022**] In the preferred embodiment, there is at least one cable wire **24** couple between a pair of adapters **32**. In tests run on signal attenuation due to cable length, coaxial cable wire **24** that totaled less than 1000 feet in length operated within acceptable attenuation loss limits. Longer lengths are possible and are a function of at least the hardware and software of adapter **32**.

[**0023**] The overall operation can be understood from **FIG. 2**. In the overall operation, a first client, such as PC **62**, communicates digital data to a first cable LAN adapter **32** through client interface **66**. After processing the data for transmission, the first cable LAN adapter **32** communicates the processed data to a second cable LAN adapter **32** through coaxial cable wire **24**. On receiving the data, the second adapter **32** further processes the transmitted data to a form usable by a second client, such as digital TV **54**, and transmits that data to second client digital TV **54** through client interface **66**. First cable LAN adapter **32** may also communicate this same data to other adapters **32**, that, in turn, may transmit the received data to their associated client.

[**0024**] **FIG. 3** illustrates an operating frequency of the client data and the adapter signal. Coaxial cables are currently being used by data suppliers to communicated data such as television and internet data to individual homes. These cables themselves are a very clear, clean medium capable of handling operating frequencies of up to 2000 MHz. However, most of this operating frequency spectrum goes unused by data suppliers since initially there was little need for frequencies higher than 450 MHz and, as need for higher operating frequencies slowly increased, costs to changing the infrastructure of the data suppliers became the prohibiting factor.

[**0025**] The lower region identified in **FIG. 3** as 0-950 MHz is where conventional cable TV, digital cable TV, and cable modem services are offered. Where this is the case, the cable LAN signal operating frequency may be located within the higher region identified as 1000-2000 MHz at the center frequency of 1300 MHz with a bandwidth of 5 MHz. Here, the cable LAN utilizes the operating frequency spectrum not used by conventional cable services. The same is true for other forms of data such climate-control data, security data, home automation data, Moving Picture Experts Group 2 (MPEG-2) high resolution digital video data, audio data, or internet data.

[**0026**] In the preferred embodiment, a signal generated by adapter **32** downstream of LPF **18** rapidly transmits data

from one adapter to another adapter as a carrier modulated digital signal. The carrier modulated digital signal may be generated in conjunction with using Quadrature Phase Shift Keying (QPSK) modulation typically employed on satellite technology. Since QPSK modulation operates at 2 bits per hertz, the signal speed would be 10 megabits per second (Mbps) for a 5 MHz bandwidth. Modulation is further discussed below.

[0027] A significant advantage of this invention is the large bandwidths that may be applied in transmitting data. For example, within the 1000-2000 MHz region shown in **FIG. 3**, bandwidths of 5 MHz, 10 MHz, 20 MHz, 50 MHz, or higher are possible. By using bandwidths larger than 5 MHz, the signal speed increases. With coaxial cabling, speeds greater than 100 Mbps can be achieved. Preferably, the signal speed will be greater than 10 Mbps when necessary to quickly distribute digital video and other types of high-bandwidth data within the home.

[0028] As depicted in **FIG. 3**, the signal operating frequency could be anywhere above 1000 MHz. However, Cable LAN's operating region is not limited to this. For example, in older homes that use older type coaxial cable and older type splitters, normal cable operations are maintained below 450 MHz. In this case, the signal operating frequency of the cable LAN would preferably be between 600 to 800 MHz, but need not be. Since the signal operating frequency is subject at the lower end to the client data operating frequency, the signal operating frequency could be just at the border or fringe of the rated or actual data operating frequency being utilized within the coaxial cable. Operating at the border or fringe of the data operating frequency takes advantage of the operating frequency spectrum of the coaxial cable so as to not interfere with the operating frequency of the data, thereby permitting the signal and data other than that carried by the signal to be communicated within the coaxial cable at the same time, within the same space. Being adaptable enough to operate at this periphery of the data operating frequency makes the cable LAN flexible enough to operate on any coaxial cable system, despite the different limitations such as older network components, different geographies, different service providers, and different regulations. Moreover, since the signal operating frequency is subject at the higher end only to the operating frequency spectrum of the coaxial cable, the signal bandwidth may be much greater than 5 MHz, thereby increasing the signal speed. A 100 MHz bandwidth, for example, results in a signal speed of 200 Mbps. In this way, the large operating bandwidth makes the cable LAN ideal for quickly transmitting high-resolution digital video (such as MPEG-2) and other high speed data.

[0029] **FIG. 4** is a schematic of an architecture of cable LAN adapter **32**. As seen in **FIG. 4**, client software layers **70** is comprised of cable LAN protocol layers/stacks **72** and interface software/driver stack **74**. Analog or digital data from a first client is processed as necessary through that client's software layer into a digital format. This digitized data is then communicated to cable LAN adapter **32** associated with that first client for processing through the hardware sections of the cable LAN adapter. In accordance with an embodiment of the cable LAN adapter of the invention, cable LAN adapter **32** partitions into four hardware sections: I. MAC & Client Interface Section **80**; II. Baseband Section **90**; III. RF & Mixed Signal Section **100**; and IV. Medium Interface Section **130**.

I. MAC & Client Interface Section

[0030] As part of broadband application specific integrated circuit (ASIC) **78**, Media Access Control (MAC) & Client Interface section **80** operates both as a burst controller and as a protocol device to coordinate events—such as when to receive the data from the client and when to transmit data to the client—between the client and Baseband section **90** of cable LAN adapter **32**.

[0031] Client interface **76** is the front line communication link between adapter **32** and the particular client. Preferably, the client interface logic communicates with the client, communicates with the modulator, processes the particular data from the client and the modulator, and keeps track of time. Given the variety of clients that may occupy the cable LAN, it is important to utilize a universal client interface.

[0032] As shown in **FIG. 4**, the hardware of client interface **76** may be a stand alone component coupled by coaxial cable between interface (I/F) core **82** of broadband ASIC **78** and the in/out (I/O) port of the client. Such stand alone components include a Universal Serial Bus (USB) attachment or attachments meeting the Institute of Electronic and Electrical Engineering (IEEE) standard for a high performance serial bus, IEEE 1394. Client interface **76** may also be integrated into MAC & Client Interface section **80** of cable LAN adapter **32** or housed into the motherboard of a client such as a personal computer (PC) or a set top box (STB). Moreover, through an expansion card such as a Peripheral Component Interconnect (PCI) adapter card, client interface **76** may be housed internally to adapter **32** or to a client.

[0033] If data copyright protection is a concern, client interface **76** can be coupled to a dongle security system key consisting of a serialized erasable programmable read-only memory (EPROM) and some drivers in a D-25 connector shell connected to the I/O port of either adapter **32** or the client. With a dongle security system key installed, users can make as many communications or "copies" of the data as they want but must respond with the dongle's programmed validation code for each copy, thereby accounting for each copy made. To allow daisy-chained dongles, the dongles can be designed to pass data through the I/O port and to monitor for magic codes (and combinations of status lines) with little interference to devices further down the line.

[0034] Burst controller **84** of MAC & Client Interface section **80** is a time division multiple access (TDMA) scheme that supports both isochronous and asynchronous data through burst control as well as accounts for high interrupt latency on the PC. Isochronous service guarantees the reserved bandwidth while asynchronous service provides a conventional LAN type of service that is ideal for data sharing applications.

II. Baseband Section

[0035] From MAC & Client Interface section **80**, the digital data is communicated to Baseband section **90** that is part of broadband ASIC **78**. In Baseband section **90**, the data is encoded and modulated.

[0036] To encode the data, Forward Error Correction (FEC) encoder **92** is used. Preferably, FEC encoder **92** is a

Reed-Solomon Error Correction Code (R-S ECC) encoder. The advantage of using a RS ECC encoder is that the RS ECC encoder may be reused in the FEC decoder **94**, thereby dramatically reducing the complexity of syndrome calculation and thus reducing processing speed burden on the syndrome block. On interacting with FEC encoder **92**, parity bits (or bytes) are added to the data to permit detection of data that becomes corrupted in transit as well as permit correction of the same. Other bits that may be added include network control data that specifies the routing, content data that specifies the what is being transmitted, as well as other known parity bits.

[**0037**] Once through FEC encoder **92**, the data encounters modulator **96**. Modulator **96** remaps the digital data and presents the data in an analog wave form to permit the data to be transmitted within the coaxial cable. It is important for cable LAN adapter **32** to be screened from noise and hardy enough to work in any environment while remaining inexpensive. Thus, in order to keep costs low and the system robust, the architecture design of adapter **32** uses a digital modulation scheme such as Frequency Shift Keying (FSK) modulation or Binary Phase Shift Keying (BPSK) modulation. Moreover, although data may be transmitted within the coaxial cable continuously, discontinuously, or a combination thereof, modulation is done preferably in a discontinuous, burst fashion to accommodate network type data with minimum receiver setup time. Other acceptable modulation schemes include Quadrature Phase Shift Keying (QPSK) digital modulation.

III. RF & Mixed Signal Section

[**0038**] From Baseband section **90**, the data encounters Radio Frequency (RF) and Mixed Signal section **100**. The RF & Mixed Signal section consists of a complementary metal-oxide semiconductor (CMOS) RF chip **102**, crystal oscillator **104**, and crystal oscillator **106**. Crystal oscillator **104** and crystal oscillator **106** generate the clock that runs CMOS RF chip **102**. As shown in **FIG. 4**, CMOS RF chip **102** comprises mixed-signal section having digital to analog converter (DAC) **108** and analog to digital converter (ADC) **110**, up converter **112** and down converter **114**, power amplifier (PA) **116** and a low noise amplifier (LNA) **118**, and Low (LO) frequency synthesizer (SYN) timing circuit **120** that couples the converters to their respective amplifiers through mixer **122**.

[**0039**] Within DAC **108**, the digital data from modulator **96** is converted to an analog signal having an intermediate frequency (IF) of around 44 MHz. To bring the signal operating frequency to the desired transmitting frequency, here 1300 MHz as seen in **FIG. 3**, the analog signal is processed by up converter **112**. Up converter **112** generates a carrier modulated digital signal on which to transmit client data through the coaxial cable network. The power is amplified in PA **116**, wherein the signal is then sent to Medium Interface section **130**.

IV. Medium Interface Section

[**0040**] In accordance with an embodiment of the invention, Medium Interface section **130** interfaces with cable wire **24** through switch **132** that operates to either transmit or receive signals. A single pole double throw (SPDT) transmission switch would accomplish this. Through switch **132**, the signal is transmitted into cable wire **24**. Although **FIG. 4** shows a one signal frequency design channel, more than one signal frequency may be used.

[**0041**] With the signal transmitted from a first adapter **32**, at least a designated second adapter **32** will receive the signal. On receiving the transmitted data through cable wire **24**, second adapter **32** reverses the process by converting the transmitted data into a form usable by a second client and transmitting that data to that client. From switch **132** of **FIG. 4**, LNA **118** focuses the signal so that down converter **114** may convert the signal to an intermediate frequency (IF) of around 44 MHz. The analog signal is then converted to a digital signal in ADC **110**.

[**0042**] At this point in the process, filtering may be necessary. As the signal travels within the coaxial cable network, reflection from low pass filter **18** may compensate for signal attenuation due to splitters in the coaxial cable network, but may also cause a reflection mismatch between the signal and the reflected signal. Filters within Baseband section **90** filter out such reflected signals. From there, the signal is demodulated at demodulator **98** with the data then being decoded and corrected at FEC decoder **94**. The digital data is then sent to the second client through MAC & Client Interface section **80**.

[**0043**] A specific embodiment of the cable LAN according to the invention has been described for the purpose of illustrating the manner in which the invention may be made and used. It should be understood that implementation of other variations and modifications of the invention and its various aspects will be apparent to those skilled in the art, who may develop a variation of structural details without departing from the principles of the present invention. For example, the components of the cable LAN adapter, either individually or in combination, can be housed in an integrated circuit. The cable LAN has been describe in reference to use in a private home, but may be used for any enterprise that has cabling equal to or superior than that found in a typical private home, including a small office/home office (SOHO).

What is claimed is:

1.-**26**. (canceled)

27. An interface component for communicating between a client device and a local area network (LAN), the interface component comprising:

a universal client interface to communicate a signal between a cable LAN adapter and the client device; and

the cable LAN adapter comprising:

a broadband application specific integrated circuit (ASIC) to encode and to modulate the signal received from the universal client interface and to decode and to demodulate the signal received from a radio frequency and mixed signal, section (RF&MSS);

the RF&MSS to convert the encoded and modulated signal received from the ASIC to a carrier modulated digital signal with a transmission frequency, the transmission frequency greater than a signal cut-off frequency defined for conventional coaxial cable services, and the RF&MSS to convert the carrier modulated digital signal received from a transmis-

sion switch to the encoded and modulated signal transmitted to the ASIC; and

the transmission switch to transmit the carrier modulated digital signal through a coaxial cable to at least one other cable LAN adapter and to transmit the carrier modulated digital signal to the RF&MSS.

28. The interface component of claim 27, wherein the universal client interface is a Universal Serial Bus (USB) attachment or an attachment meeting the IEEE 1394 standard.

29. The interface component of claim 27, wherein the universal client interface is integrated into the cable LAN adapter.

30. The interface component of claim 27, wherein the universal client interface is housed in any of a personal computer, a set top box, or the cable LAN adapter.

31. The interface component of claim 27, wherein the universal client interface is coupled to a dongle security system.

32. The interface component of claim 31, wherein the dongle security system is a serialized erasable programmable read-only memory.

33. The interface component of claim 27, wherein the ASIC comprises:

an interface core to communicate with the universal client interface and with a burst controller;

the burst controller to communicate with a baseband section; and

the baseband section to encode and to modulate the signal and to decode and to demodulate the encoded and modulated signal.

34. The interface component of claim 33, wherein the burst controller supports both isochronous and asynchronous data.

35. The interface component of claim 33, wherein the burst controller uses a time division multiple access scheme.

36. The interface component of claim 33, wherein the baseband section comprises:

an encoder coupled to a modulator, the encoder to receive the signal from the burst controller and to encode the signal;

the modulator coupled to the RF&MSS, the modulator to modulate the encoded signal and to send the encoded and modulated signal to the RF&MSS;

a demodulator coupled to a decoder, the demodulator to receive the encoded and modulated signal from the RF&MSS and to demodulate the encoded and modulated signal; and

the decoder coupled to the burst controller, the decoder to decode the encoded signal and to send the signal to the burst controller.

37. The interface component of claim 36, wherein the encoder is a Forward Error Correction (FEC) encoder.

38. The interface component of claim 37, wherein the FEC encoder is a Reed-Solomon Error Correction Code encoder.

39. The interface component of claim 36, wherein the decoder is a Forward Error Correction (FEC) decoder.

40. The interface component of claim 39, wherein the FEC decoder is a Reed-Solomon Error Correction Code decoder.

41. The interface component of claim 36, wherein the modulator and the demodulator modulate in a discontinuous, burst fashion.

42. The interface component of claim 36, wherein the modulator and the demodulator modulate using a Frequency Shift Keying digital modulation scheme.

43. The interface component of claim 36, wherein the modulator and the demodulator modulate using a Binary Phase Shift Keying digital modulation scheme.

44. The interface component of claim 36, wherein the modulator and the demodulator modulate using a Quadrature Phase Shift Keying digital modulation scheme.

45. The interface component of claim 27, wherein the RF&MSS comprises a complementary metal-oxide semiconductor (CMOS) radio frequency (RF) chip.

46. The interface component of claim 45, wherein the CMOS RF chip comprises:

a digital to analog converter (DAC) to receive the encoded and modulated signal from the ASIC and to convert the encoded and modulated signal to an analog waveform with an intermediate frequency;

an up converter coupled to the DAC, the up converter to convert the analog waveform to the carrier modulated digital signal;

a first mixer coupled to the up converter and to a power amplifier, the power amplifier to amplify the carrier modulated digital signal received from the up converter and to send the carrier modulated digital signal to the transmission switch;

a low noise amplifier (LNA) to receive the carrier modulated digital signal from the transmission switch;

a second mixer coupled to the LNA;

a down converter coupled to the second mixer, the down converter to convert the carrier modulated digital signal to the analog waveform; and

an analog to digital converter (ADC) coupled to the down converter, the ADC to convert the analog waveform to the encoded and modulated signal and to send the encoded and modulated signal to the ASIC.

47. The interface component of claim 27, wherein the transmission frequency is greater than 450 MHz.

48. The interface component of claim 47, wherein the transmission frequency is greater than 950 MHz.

49. The interface component of claim 48, wherein the transmission frequency is 1300 MHz.

50. The interface component of claim 27, wherein the transmission switch is a single pole double throw transmission switch.

51. A method for transmitting information from a client device to a local area network (LAN), the method comprising:

communicating a signal from the client device to a cable LAN adapter with a universal client interface;

encoding the signal in the cable LAN adapter;

modulating the encoded signal in the cable LAN adapter;

converting the encoded and modulated signal to a carrier modulated digital signal in the cable LAN adapter, the carrier modulated digital signal having a transmission frequency, the transmission frequency greater than a signal cut-off frequency defined for conventional coaxial cable services; and

transmitting the carrier modulated digital signal through a coaxial cable to at least one other cable LAN adapter.

52. The method of claim 51, wherein the universal client interface is a Universal Serial Bus (USB) attachment or an attachment meeting the IEEE 1394 standard.

53. The method of claim 51, wherein the universal client interface is integrated into the cable LAN adapter.

54. The method of claim 51, wherein the universal client interface is housed in any of a personal computer, a set top box, or the cable LAN adapter.

55. The method of claim 51, wherein the universal client interface is coupled to a dongle security system.

56. The method of claim 55, wherein the dongle security system is a serialized erasable programmable read-only memory.

57. The method of claim 51, wherein the encoded and modulated signal supports both isochronous and asynchronous data.

58. The method of claim 51, wherein the encoded and modulated signal uses a time division multiple access scheme.

59. The method of claim 51, wherein the transmission frequency is greater than 450 MHz.

60. The method of claim 59, wherein the transmission frequency is greater than 950 MHz.

61. The method of claim 60, wherein the transmission frequency is 1300 MHz.

62. The method of claim 51, wherein encoding the signal uses a Forward Error Correction (FEC) encoder.

63. The method of claim 62, wherein the FEC encoder is a Reed-Solomon Error Correction Code encoder.

64. The method of claim 51, wherein modulating the encoded signal is performed in a discontinuous, burst fashion.

65. The method of claim 51, wherein modulating the encoded signal uses a Frequency Shift Keying digital modulation scheme.

66. The method of claim 51, wherein modulating the encoded signal uses a Binary Phase Shift Keying digital modulation scheme.

67. The method of claim 51, wherein modulating the encoded signal uses a Quadrature Phase Shift Keying digital modulation scheme.

68. An apparatus for transmitting information from a client device to a local area network (LAN), the apparatus comprising:

a universal client interface communicating a signal from the client device to a cable LAN apparatus; and

the cable LAN apparatus comprising:

an encoding means for encoding the signal, the encoding means converting the signal to an encoded signal;

a modulating means for modulating the encoded signal, the modulating means converting the signal to an encoded and modulated signal;

a converting means for converting the encoded and modulated signal to a carrier modulated digital signal having a transmission frequency, the transmission frequency greater than a signal cut-off frequency defined for conventional coaxial cable services; and

a transmitting means for transmitting the carrier modulated digital signal through a coaxial cable to at least one other cable LAN apparatus.

69. The method of claim 68, wherein the universal client interface is a Universal Serial Bus (USB) attachment or an attachment meeting the IEEE 1394 standard.

70. The apparatus of claim 68, wherein the universal client interface is integrated into the cable LAN adapter.

71. The apparatus of claim 68, wherein the universal client interface is housed in any of a personal computer, a set top box, or the cable LAN adapter.

72. The apparatus of claim 68, wherein the universal client interface is coupled to a dongle security system.

73. The apparatus of claim 72, wherein the dongle security system is a serialized erasable programmable read-only memory.

74. The apparatus of claim 68, wherein the encoding means supports both isochronous and asynchronous data.

75. The apparatus of claim 68, wherein the encoding means uses a time division multiple access scheme.

76. The apparatus of claim 68, wherein the transmission frequency is greater than 450 MHz.

77. The apparatus of claim 76, wherein the transmission frequency is greater than 950 MHz.

78. The apparatus of claim 77, wherein the transmission frequency is 1300 MHz.

79. The apparatus of claim 68, wherein the encoding means uses a Forward Error Correction (FEC) encoder.

80. The apparatus of claim 79, wherein the FEC encoder is a Reed-Solomon Error Correction Code encoder.

81. The apparatus of claim 68, wherein the modulating means is performed in a discontinuous, burst fashion.

82. The apparatus of claim 68, wherein the modulating means uses a Frequency Shift Keying digital modulation scheme.

83. The apparatus of claim 68, wherein the modulating means uses a Binary Phase Shift Keying digital modulation scheme.

84. The apparatus of claim 68, wherein the modulating means uses a Quadrature Phase Shift Keying digital modulation scheme.

* * * * *

Exhibit 1010

U.S. Patent 6,782,043 to Dehghan et al.

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US006782043B1

(12) **United States Patent**
Dehghan et al.

(10) **Patent No.: US 6,782,043 B1**
(45) **Date of Patent: Aug. 24, 2004**

(54) **METHOD AND APPARATUS FOR ESTIMATING THE LENGTH OF A TRANSMISSION LINE**

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(73) Assignee: **LSI Logic Corporation**, Milpitas, CA (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/484,630**

(22) Filed: **Jan. 18, 2000**

(51) **Int. Cl.**[7] **H04B 17/00**
(52) **U.S. Cl.** **375/224**; 375/348; 375/288; 375/229; 375/133
(58) **Field of Search** 375/224, 133, 375/229, 233, 232, 288, 348, 377

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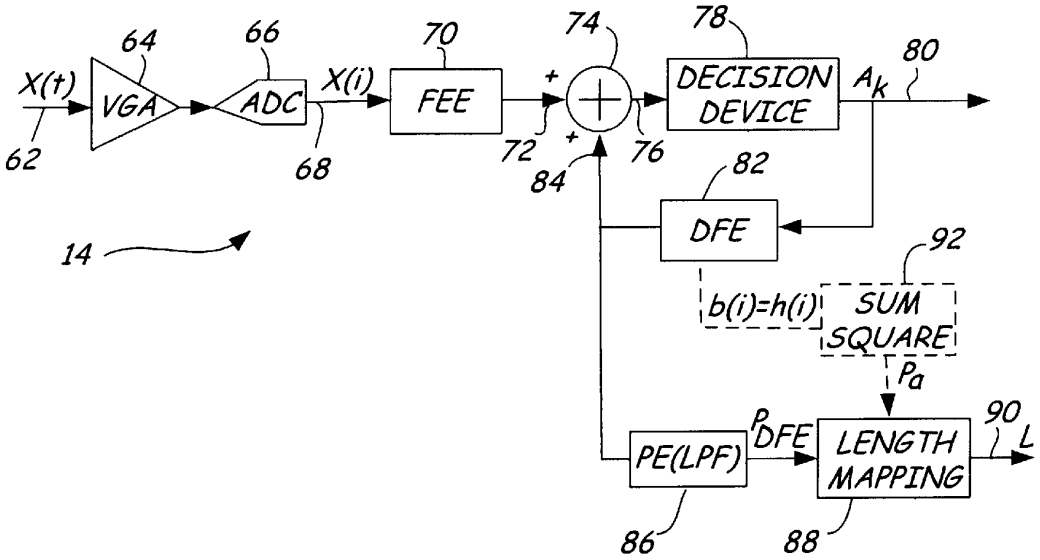
* cited by examiner

Primary Examiner—Stephen Chin
Assistant Examiner—Guillermo Muñoz
(74) *Attorney, Agent, or Firm*—Westman, Champlin & Kelly

(57) **ABSTRACT**

A method and apparatus for estimating the length of a transmission line is provided. The transmission line extends between a transmitter and a receiver and has a low-pass filter characteristic and an impulse response. The method and apparatus receive a data signal from the transmission line at the receiver and estimate the length of the transmission line as a function of the received data signal and the impulse response.

16 Claims, 2 Drawing Sheets



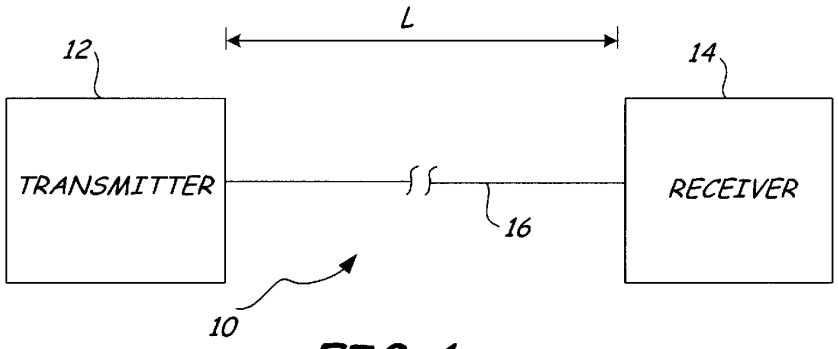

L
12
14
TRANSMITTER
RECEIVER
16
10

FIG. 1

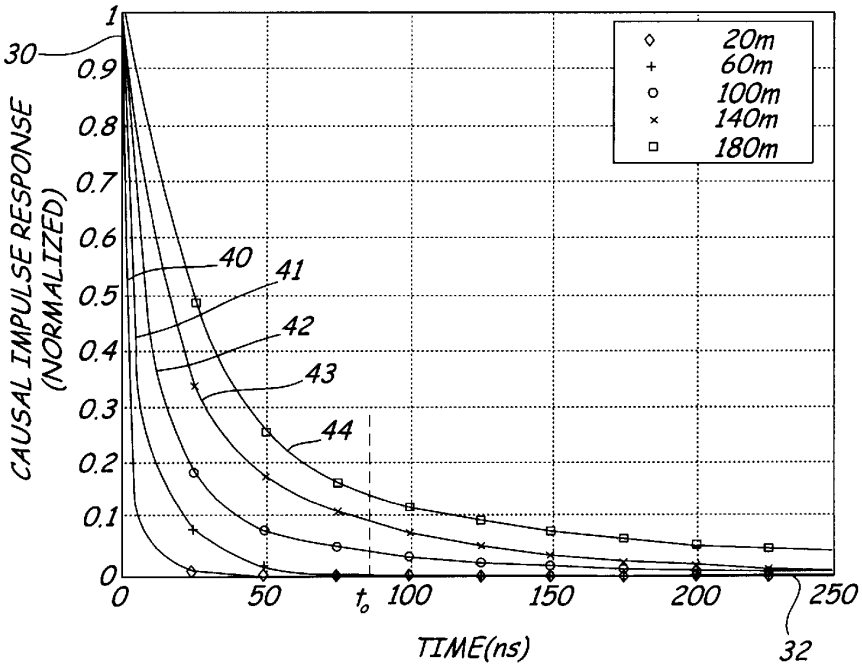

30
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
CAUSAL IMPULSE RESPONSE (NORMALIZED)
20m
60m
100m
140m
180m
40
41
42
43
44
0
50
t_o
100
150
200
250
TIME(ns)
32

FIG. 2

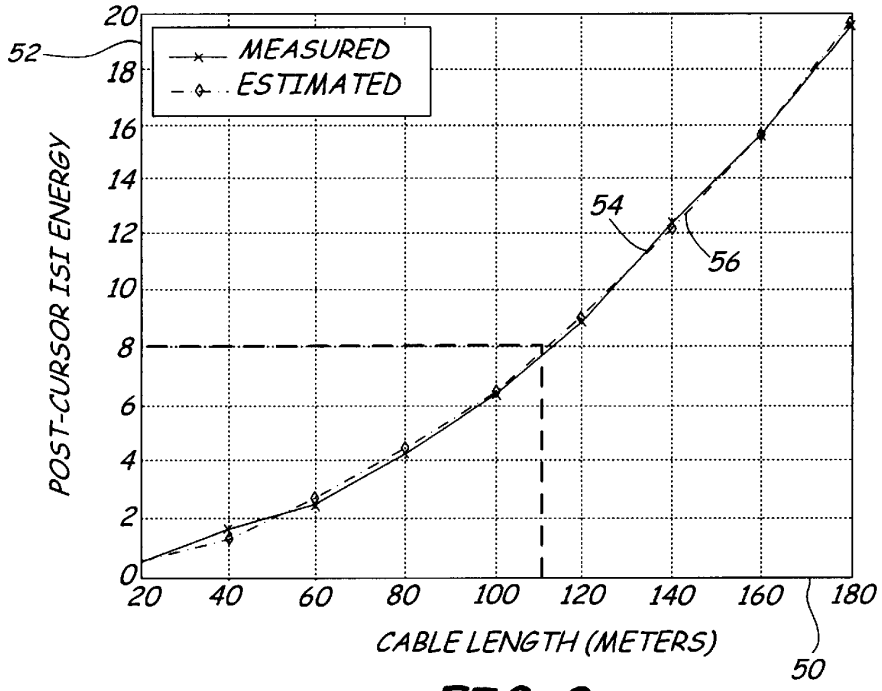

MEASURED
ESTIMATED
52
54
56
POST-CURSOR ISI ENERGY
CABLE LENGTH (METERS)
50
0
2
4
6
8
10
12
14
16
18
20
20
40
60
80
100
120
140
160
180

FIG. 3

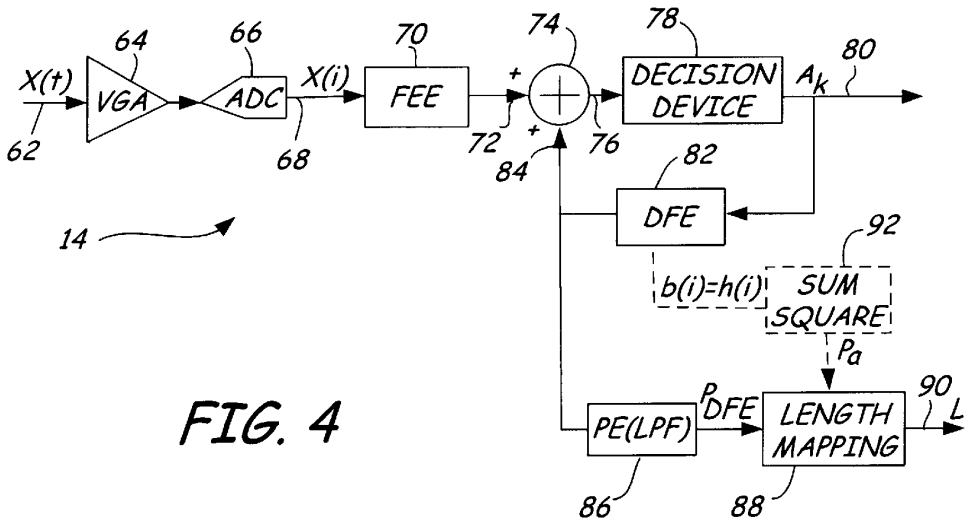

X(t)
62
VGA
64
ADC
66
68
X(i)
FEE
70
+
72
+
84
74
76
DECISION DEVICE
78
A_k
80
DFE
82
14
b(i)=h(i)
SUM SQUARE
92
P_a
PE(LPF)
86
P_{DFE}
LENGTH MAPPING
88
90
L

FIG. 4

METHOD AND APPARATUS FOR ESTIMATING THE LENGTH OF A TRANSMISSION LINE

BACKGROUND OF THE INVENTION

The present invention relates to data transmission channels and, more particularly, to a method and apparatus for estimating the length of a transmission line having a low-pass filter characteristic.

In a typical Communication system, analog signals are transmitted from a transmitter to a receiver through a transmission channel. A typical receiver includes an amplifier, an analog-to-digital (A/D) converter and an automatic gain controller. The amplifier amplifies the received AC analog signal, which is then converted by the A/D converter into a series of digital values that can be processed. The automatic gain controller monitors the signal power and adjusts the amplifier gain to restore the received signal to desired power level.

Various types of channels have been used, such as "twisted pair" wire line channels. Such channels are commonly used in digital subscriber loops, home, local and wide area networks, and other applications. It is often desired to have the transmitter or receiver optimized for the length of the channel to mitigate channel effects, such as attenuation of the data signals being passed through the channel.

An existing method of estimating the length of a twisted pair wire line channel is to observe and estimate the received signal power. With this method, the receiver contains a power estimation circuit, which is essentially a power meter, that approximates the signal strength at the receiver. Taking advantage of the fact that the received signal power, P_r, is effected by attenuation of the signal in the cable, which increases with cable length, the received signal power estimate is translated to a channel length estimate Equation 1 shows that the channel length estimate, L, is a function of the received signal power, P_r:

$$L=f(P_r) \quad \text{Eq. 1}$$

The existing method takes advantage of the relation between received signal power and cable length and it drives the cable length estimate from the received signal power, assuming that longer cables introduce more attenuation and hence lower signal strength at the receiver.

The inventors of the present application have found that the main disadvantage of the existing method is that it does not account for fluctuations and variations in the received signal power level due to sources other than cable attenuation. Such sources can include variable gain amplifier (VGA) and/or automatic gain control (AGC) power error, P_{agc}, cable connector loss P_c and cable-termination mismatch, P_m. The signal power at the receiver can be characterized by:

$$P_r=P_a+P_{agc}+P_c+P_{m+} \quad \text{Eq. 2}$$

where P_r is the total signal power reduction and P_a is the reduction in received signal power by attenuation in the cable channel due to Inter-Symbol Interference (ISI) or the low-pass filter nature of a twisted pair cable. The non-cable-attenuation sources of power reduction can be significant, which results in an inaccurate estimate of the cable length. This is especially true for shorter cables where P_a can be much smaller than the other non-cable-attenuation, length independent sources of power reduction.

Improved methods and devices for more accurately and efficiently estimating the cable length in a data transmission channel having a low-pass filter characteristic are desired.

SUMMARY OF THE INVENTION

One aspect of the present invention relates to a method of estimating the length of a communications channel transmission line that extends between a transmitter and a receiver and has a low-pass filter characteristic and an impulse response. The method includes receiving a data signal by the receiver from the transmission line and estimating the length of the transmission line as a function of the data signal received by the receiver and the impulse response.

Another aspect of the present invention relates to a channel length estimator, which includes a channel input for coupling to a transmission line having a length. A decision feedback equalizer is coupled to the channel input and includes a plurality of steady-state feedback tap coefficients and an equalizer output. A power estimator is coupled either to the steady-state feedback tap coefficients or to the equalizer output and has an estimated power output. A channel length mapping circuit is coupled to the estimated power output and is adapted to map the estimated power output to an estimate of the transmission line length. Yet another aspect of the present invention relates to a data communications receiver for coupling to a transmission line that has a low-pass filter characteristic and an impulse response. The receiver includes a receiver input, which is adapted to receive a data signal from the transmission line, a receiver output and a detected symbol flow path from the, receiver input to the receiver output. The receiver further includes a length estimator coupled to the detected symbol flow path for estimating the length of the transmission line as a function of the data signal received from the transmission line and the impulse response.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of a data communication system according to one embodiment of the present invention.

FIG. **2** is a graph showing normalized impulse response of a typical Cat-5 twisted pair cable for various lengths.

FIG. **3** is a graph showing the relationship between cable length and measured post-cursor Inter-Symbol Interference (ISI) power.

FIG. **4** is a block diagram of a communications receiver according to one embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is a block diagram of a data communication system according to one embodiment of the present invention. Data communication system **10** includes a transmitter **12**, a receiver **14** and a channel **16** for passing data from transmitter **12** to receiver **14**. Channel **16** can include any type of channel having a low-pass filter characteristic. For example, channel **16** can include a single-ended transmission line "wire" or a pair of differential transmission line "wires", such as a typical Cat-5 "twisted-pair" cable. Several types of transmission lines exhibit low-pass filter characteristics, such as those with copper wires, copper composite wires and wires with other similar materials.

Certain functions in receiver **14** require a knowledge of the length, L, of channel **16**. As discussed above, existing methods and algorithms for estimating the channel length L

are based on an estimate of the received signal power at receiver **14**. These methods do not account for inaccuracies in the channel length estimate due to sources of signal power reduction that are not related to attenuation within channel **16**.

With the present invention, the length L of channel **16** is estimated as a function of the impulse response of channel **16**, rather than an estimate of the total power reduction as shown in Equation 2 above. The length L of channel **16** is uniquely a function of the cable's attenuation only, as provided in the following equation:

$$L=g(P_a) \quad \text{Eq. 3}$$

When looking at the cable's impulse response, it has been found that the cable's attenuation, and thus the cable length, is a unique function of the post-cursor (after the initial pulse) portion of the impulse response, which is known as the Inter-Symbol Interference (ISI) magnitude.

FIG. **2** is a graph showing the normalized impulse response of a typical Cat-5 twisted pair cable for various lengths. Y-axis **30** represents the normalized causal impulse response (CIR), and X-axis **32** represents time in nanoseconds. Lines **40–44** represent the normalized CIR of Cat-5 twisted pair cables having lengths of 20 meters, 60 meters, 100 meters, 140 meters and 180 meters, respectively. For each line **40–44**, the entire curve represents a combination of the pulse itself, at t=0, and the ISI, after t=0. The impulse response's region of support extends from t=0 until the respective line **40–44** crosses X-axis **32**. Although FIG. **2** shows the CIR of Cat-5 twisted pair cables, other types of twisted pair cables can have the same overall impulse response, with the CIR's region of support and magnitude increasing with decreasing quality and vise versa.

It is evident from curves **40–44** that the normalized post-cursor ISI magnitude (the CIR after t=0) and duration increases with cable length. The cable length is therefore a direct function of the CIR amplitude.

Curves **40–44** show the low-pass nature of channel **16**. The impulse responses are always positive and monotonically decreasing and can be crudely approximated with an inverse exponential function. It can be shown that for a typical twisted pair cable, a unique one-to-one function Φ exists that can map the amplitude of the CIR, h(t), at any time t_0, to the length of the cable, as represented by the following equation:

$$L=\Phi(h(t_0))0<t_0<T \quad \text{Eq. 4}$$

where T is the duration of the CIR (from t=0 to the time at which the CIR crosses X-axis **32**). The above relation can be generalized to a mapping of any function of the channel's impulse response to the cable length:

$$L=\Phi(\xi(h(t))) \quad \text{Eq. 5}$$

In other words, the actual impulse of the channel is not required in order to estimate the cable length L. Rather, any equation that is a unique function of the impulse response can be used. One example of such a function can be the mapping of post-cursor channel ISI power to cable length, as shown in the following equation:

$$L=\Psi\left(\int_0^\infty h^2(t)\cdot dt\right) \quad \text{Eq. 6}$$

where the term within the parenthesis is post-cursor channel ISI power. The post-cursor ISI power is a unique function of the channel impulse response h(t).

For a digital implementation, the above equation can be rewritten as:

$$L=\Psi_d\left(\sum_{i=0}^{\infty} h^2(iT)\right) \quad \text{Eq. 7}$$

where the summation term represents the CIR power. The first sample, i=0, is very large and can be excluded for increased transformation sensitivity, if desired. With the i=0 term excluded, the summation in Equation 7 represents the ISI power only.

FIG. **3** is a graph showing the relationship between the cable length, on X-axis **50** and the post-cursor ISI power of FIG. **2**, on Y-axis **52**. Curve **54** represents the measured ISI power as a function of cable length for a typical twisted pair cable, and curve **56** represents an analytical fit of the measured data with the second order polynomial,

$$P_{pc\text{-}ISI}=0.005*L_2+0.0141*L \quad \text{Eq. 8}$$

It can be seen from FIG. **3** that the actual ISI power and the estimated fit are very close. Therefore, the polynomial shown in the above equation can be exploited for accurate and efficient cable length estimation purposes. If the ISI power within the received data signal is known, the above polynomial can be used to calculate an estimate of the cable length.

Looking at FIG. **3**, for example if the measured post-cursor ISI power (i.e. the summation term in Equation 7) is equal to "8", then the cable length is approximately 110 m. This mapping can be solved through the polynomial given in Equation 8 or through a representative look-up table.

An estimate of the cable length can therefore be based solely on an estimate of the channel ISI or, equivalently, the channel CIR. This method of estimating cable length can be used in any system where the CIR information is known. The CIR information can include previously known information about the channel or can be locally estimated within receiver **14** (shown in FIG. **1**) during operation of the receiver. In the absence of a previously known CIR, receiver **14** can include any adaptive system, such as a decision feedback equalizer, that can give an estimate of the channel CIR or its causal portion. The local estimate of the channel CIR can then be used to estimate the channel cable length.

The following discussion describes two examples of methods for estimating the cable length as a function of the ISI power, according to alternate embodiments of the present invention.

1. Estimate of CIR is Available at Receiver

If an estimate of the channel impulse response, h(t), is available at receiver **14**, such as when the receiver has an equalizer adapted to the particular channel, the channel length estimator in the receiver can simply use the relation:

$$P_a=\sum_{i=-\infty}^{\infty} h^2(i) \quad \text{Eq. 9}$$

Since h(i) is known, all that is needed in the receiver is a device that squares each h(i) and adds them together. The resulting calculation of P_a can then be mapped to an estimate of the cable length through an analytical expression such as that provided in Equation 8 or through a look-up table.

Taking advantage of the fact that most of the ISI energy of a twisted pair cable is causal (i.e., after t=0 in FIG. **2**), the

above expression can be simplified to:

$$P_a = \sum_{i=1}^{\infty} h^2(i) \quad \text{Eq. 10}$$

The above equation is an accurate estimate of the total post-cursor ISI power representing the received signal power attenuation P_a in the cable without effects of timing error.

An easier but less accurate method of estimating the signal power attenuation P_a is to use only a limited number of samples of the ISI power given in the above expression, as shown in Equation 11:

$$P_a = \sum_{i=1}^{N} h^2(i) \quad \text{Eq. 11}$$

where N>1. The calculation shown in Equation 11 can be implemented in hardware, software, or a combination of both hardware an software. For example, a digital signal processor can be used. The calculated estimate of the received signal power attenuation P_a due to cable length can then be easily mapped to an estimate of the cable length. In one embodiment, only one or two samples of the ISI power is used for each symbol received by receiver **14**.

2. Receiver **14** Locally Estimates the Channel CIR or its Causal Portion.

In the absence of a previously specified CIR, receiver **14** can include an adaptive system, such as a decision feedback equalizer, that can give an estimate of the CIR or ISI, which is sufficient to estimate the cable length.

A. Using DFE Feedback Tap Coefficients

If a decision feedback equalizer (DFE) scheme is used in receiver **14**, with a non-overlapping feed forward equalizer (FFE) and DFE taps, the estimate of the causal ISI power is readily available since the DFE's steady-state feedback tap coefficients are equal to the CIR of the channel in a mean square sense. The DFE's feedback tap coefficients can be squared and then summed together to obtain an estimate of the post-cursor ISI power and, thus, the cable attenuation P_a per equation 11.

B. Using DFE Output

A simpler and more efficient method of estimating the received signal power attenuation P_a is to estimate the power ,P_{DFE}, at the output of the decision feedback equalizer. It can be shown that under certain conditions, this power is exactly equivalent to that of Equation 11 for an N-tap decision feedback equalizer.

If the signal received at receiver **14** (or at the input to the DFE), is denoted by x(i) and the steady state feedback tap coefficients within the DFE are denoted by b(i), then the power at the output of the DFE is:

$$P_{DFE} = E\left(\sum_{i=1}^{N} b(i)\cdot x(n-i)\right)^2 \quad \text{Eq. 12}$$

where n is a variable'similar to time in a time-forward sense, N is the number of taps in the DFE and E represents the expected value of the summation term in Equation 12, squared. Expanding Equation 12 produces:

$$P_{DFE} = \sum_{i=1}^{N}\sum_{j=1}^{N} b(i)\cdot b(j)\cdot E(x(n-i)\cdot x(n-j)) \quad \text{Eq. 13}$$

Assuming the transmitted data sequence, and hence its estimate x(i) at receiver **14** is wide-sense stationary, the above equation can be re-written as:

$$P_{DFE} = \sum_{i=1}^{N}\sum_{j=1}^{N} b(i)\cdot b(j)\cdot r_x(i-j) \quad \text{Eq. 14}$$

where r_x is the auto-correlation of the transmitted data sequence. The above equation can be re-written as:

$$P_{DFE} = \sum_{k=1}^{N} r_a(k)\sum_{i=1}^{N} b(i)\cdot b(i-k) \quad \text{Eq. 15}$$

The second summation term in Equation 15 represents the channel auto-correlation function. The relationship in Equation 15 shows that the DFE power content P_{DFE} is equal to the cross product of the transmitted data sequence auto-correlation function and the causal portion of the channel's auto-correlation function.

Assuming a proper convergence of the DFE (i.e., b(i)=h (i)), Equation 15 can be re-written as:

$$P_{DFE} = r_0\cdot P_a + \sum_{k\neq 0} r(k)\sum_{i=1}^{N} b(i)\cdot b(i-k) \quad \text{Eq. 16}$$

In Equation 16, the received signal power attenuation variable P_a has been substituted for the ISI power term

$$\sum_{i=1}^{N} h^2(i).$$

If the transmitted data sequence x(i)is uncorrelated, than the second term in Equation 16 will be zero. This will make Equation 16 similar to Equation 11 with a known scaling factor r_0, which is equal to the transmitted signal power. The DFE power content P_{DFE} can therefore be readily mapped to a corresponding cable length estimate using the proper relationship.

If the transmitted data sequence is correlated, then the second term in Equation 16 will be non-zero. The DFE power P_{DFE} will then be the cross product of the data and channel auto-correlation functions. Taking advantage of the well-behaved nature of the CIR (monotonically decreasing with time and always increasing CIR samples with cable length as evident from FIG. **2**), a unique one-to-one mapping can be found between the cable length and the channel auto-correlation function so than the second term in Equation 16 can be subtracted out. Without loss of generality, a suitable mapping can be determined for any previously specified data auto-correlation function.

FIG. **4** is a block diagram of receiver **14** having a cable length estimator according to one embodiment of the present invention. Receiver **14** includes a data input **62** for receiving a transmitted analog data signal x(t) from channel **16** (shown in FIG. **1**). Variable gain amplifier (VGA) **64** receives the transmitted analog data signal x(t) and amplifies the signal

by a selected gain factor to produce an amplified analog data signal that is provided to the input of analog-to-digital (A/D) converter **66**. The gain applied by VGA **64** is selected by an automatic gain controller (not shown) as is well-known in the art.

A/D converter **66** converts the amplified analog data signal into a series of digital values x(i) on output **68**. The digital values x(i) are applied to a feed forward equalizer (FFE) **70**, which is an adaptive equalizer that compensates for Inter-Symbol Interference due to the characteristics of channel **16** and receiver **14**. The output of FFE **70** is coupled to a first addend input **72** of a summing element **74**. Summing element **74** has an output **76**, which is coupled to the input of a decision device or "slicer" **78**. Decision device **78** generates an estimate A_k of the actual transmitted symbol for each received symbol in data signal x(t) based on a decision or slicing mechanism, as is known in the art. For example, if a received symbol was close to a "1", decision device **78** would declare the detected symbol A_k as a "1". If the received symbol was close to a "−1", decision device **78** would declare the detected symbol A_k as a "−1.".

The detected symbols. A_k are then applied to receiver output **80** and to the input of decision feedback equalizer (DFE) **82**. DFE **82** is similar to FFE **70** and includes an adaptive equalizer, which compensates the string of detected symbols A_k for ISI, as is known in the art. As discussed above, DFE **82** has N taps with feedback tap coefficients, b(i), which are ideally equal to h(i) of the channel impulse response after equalizer convergence. The output of DFE **82** is coupled to a second addend input **84** of summation element **74** and to the input of power estimator **86**. Power estimator **86** can include an integrator or a low-pass filter, for example. Power estimator **86** essentially integrates the output of DFE **82** to measure the power content P_{DFE} according to Equation 12 above.

As shown in Equation 16, the measured DFE power P_{DFE} is directly proportional to the received signal power attenuation P_a within cable **16** and can be easily mapped to a corresponding cable length estimate by length mapping device **88**.

In one embodiment, length mapping device **88** includes a look-up table, which associates each of a plurality of different values of P_{DFE} with a corresponding estimate of the length L of transmission channel **16**. Length mapping device **88** then provides the length estimate to output **90**, where the estimate can be used by various functions in receiver **14**. In an alternative embodiment, length mapping device **88** implements an analytical expression, such as equation **8**, which translates P_{DFE} into the corresponding length estimate L. The analytical expression can be implemented in a hardware circuit or a digital signal processor, for example.

In an alternative embodiment, receiver **14** takes advantage of the fact that the steady-state feedback tap coefficients, b(i), of DFE **82**, which are equal to the causal portion of the channel impulse response, h(i), are readily available within DFE **82**. Each of the N feedback tap coefficients are provided to the input of sum square device **92** (shown in phantom), which squares each coefficient and sums the squares together a according to Equation 11 above to produce an estimate of the received signal power attenuation P_a according to Equation 11 above. The estimated value of P_a is then provided to length mapping device **88**, which maps P_a into a corresponding channel length estimate according to a look-up table or an analytical expression, such as Equation 8, for example.

Several alternative methods and apparatuses can be used to estimate the channel length based on any unique representation or estimate of the channel's impulse response. Only two examples are shown in FIG. **4**. The channel length estimator can use an estimate of the total ISI energy or an estimate of only a portion of the ISI energy.

The channel length estimator of the present invention provides a means of accurately and effectively estimating the length of channels having low-pass filter characteristics, such as a twisted wire pair channels. The channel length estimator can be used in conjunction with any form of equalization that is used for such channels in a receiver. The method is very flexible and offers a designer many equivalent alternatives for estimating the cable length, depending on the specific requirements of the system and its application. The simplicity of the channel length estimator allows the estimator to be implemented with little computational complexity and additional hardware. This in turn allows significant hardware savings for implementations in application specific integrated circuits (ASICs) and a reduction in instructions and operations in processor-based systems.

Although the present invention has been described with reference to preferred embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and scope of the invention. For example, For example, the term "coupled" used in the specification and the claims can include a variety of connections, such as a direct connection or a connection through one or more intermediate elements. Also, the term "circuit" can refer to a hardware-implemented circuit or a software-implemented circuit or a combination of both.

What is claimed is:

1. A method of estimating the length of a communications channel transmission line that extends between a transmitter and a receiver and has a low-pass filter characteristic and an impulse response, the method comprising:

(a) receiving a data signal by the receiver from said transmission line;

(b) estimating the length of said transmission line as a function of the data signal received by the receiver and the impulse response; and

(c) providing an estimate of the impulse response at the receiver, wherein the estimating step (b) comprises estimating the length of said transmission line at the receiver as a function of the estimate of the impulse response.

2. The method of claim **1** wherein:

the providing step (c) further comprises estimating a representation of post-cursor intersymbol interference power within the data signal; and

the estimating step (b) comprises estimating the length of the transmission line as a function of the representation of the post-cursor intersymbol interference power estimated in step (c).

3. The method of claim **2** wherein:

the providing step (c) further comprises providing a predetermined estimate of the impulse response to the receiver and estimating the representation of the post-cursor intersymbol interference power of the transmission line from the predetermined estimate of the impulse response.

4. The method of claim **2** wherein the providing step (c) further comprises:

generating a local estimate of the impulse response based on the data signal received by the receiver.

5. The method of claim **4** wherein the generating step comprises:

estimating the post-cursor intersymbol interference power based on the relation,

$$P_a = \sum_{i=1}^{N} h^2(i)$$

where P_a represents the post-cursor intersymbol interference power, h(i) represents the estimate of the impulse response, i is an integer variable index that ranges from 1 to N, and N is an integer variable that is greater than or equal to 1.

6. The method of claim **5** wherein the step of estimating the post-cursor intersymbol interference power comprises:

applying a representation of the data signal received at the receiver to a decision feedback equalizer having N steady-state feedback tap coefficients denoted b(i), wherein each b(i) represents a corresponding h(i), for i=1 to N;

squaring each of the coefficients b(i) to generate N squared coefficients; and

adding the N squared coefficients together to generate an estimate of the post-cursor interference power.

7. The method of claim **4** wherein the step of generating comprises:

receiver comprises applying a representation of the data signal received at the receiver to a decision feedback equalizer, which has an equalizer output;

integrating the equalizer output over time to generate a measurement of the power content at the equalizer output, which is a function of the post-cursor intersymbol interference power and the impulse response; and

estimating the length of the transmission line as a function of the measurement of the power content at the equalizer output.

8. The method of claim **2** wherein the estimating step (b) comprises:

providing a look-up table, which associates each of a plurality of different intersymbol interference powers with a corresponding estimate of the length of the transmission channel;

applying the representation of the intersymbol interference power to the look-up table; and

outputting the estimate of the length of the transmission line that corresponds to the representation of the intersymbol interference power.

9. The method of claim **2** wherein the estimating step (b) comprises:

implementing a polynomial equation within the receiver, which provides the estimate of the transmission line length as a function of the representation of the interference power;

applying the representation of the interference power to the polynomial equation and solving the polynomial equation for the estimate of the transmission line length; and

outputting the estimate of the transmission line length.

10. A channel length estimator comprising:

a channel input for coupling to a transmission line having a length;

a decision feedback equalizer coupled to the channel input and comprising a plurality of steady-state feedback tap coefficients and an equalizer output;

a power estimator coupled either to the steady-state feedback tap coefficients or to the equalizer output and has an estimated power output; and

a channel length mapping circuit, which is coupled to the estimated power output and is adapted to map the estimated power output to an estimate of the transmission line length.

11. The channel length estimator of claim **10** wherein:

the power estimator is coupled to the steady-state feedback tap coefficients and is adapted to generate a sum of the squares of the steady-state feedback tap coefficients, which forms the estimated power output.

12. The channel length estimator of claim **10** wherein:

the power estimator is coupled to the equalizer output and comprises an integrator.

13. The channel length estimator of claim **10** wherein:

the power estimator is coupled to the equalizer output and comprises a low-pass filter.

14. The channel length estimator of claim **10** wherein the channel length mapping circuit comprises a look-up table.

15. The channel length estimator of claim **10** wherein the channel length mapping circuit implements a polynomial equation, which relates the estimated power output to an estimate of the transmission line length.

16. A data communications receiver for coupling to a transmission line that has a low-pass filter characteristic and an impulse response, the receiver comprising:

a receiver input adapted to receive a data signal from said transmission line;

a receiver output;

a detected symbol flow path from the receiver input to the receiver output; and

means coupled to the detected symbol flow path for providing an estimate of said impulse response at the receiver and for estimating the length of said transmission line as a function of the data signal received from said transmission line and the estimate of the impulse response.

* * * * *

Exhibit 1009

U.S. Patent 5,909,466 to Labat et al.

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US005909466A

United States Patent [19]

Labat et al.

[11] **Patent Number: 5,909,466**

[45] **Date of Patent: Jun. 1, 1999**

[54] **ADAPTIVE EQUALIZER FOR DIGITAL COMMUNICATIONS SYSTEMS**

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[21] Appl. No.: **08/793,539**

[22] PCT Filed: **Sep. 13, 1996**

[86] PCT No.: **PCT/FR96/01417**

§ 371 Date: **Feb. 7, 1997**

§ 102(e) Date: **Feb. 7, 1997**

[87] PCT Pub. No.: **WO97/10664**

PCT Pub. Date: **Mar. 20, 1997**

[30] **Foreign Application Priority Data**

Sep. 15, 1995 [FR] France 95/10832

[51] **Int. Cl.**[6] **H03H 7/30**

[52] **U.S. Cl.** **375/233**; 375/234; 375/348; 375/349; 364/724.2

[58] **Field of Search** 375/229, 230, 375/232, 234, 346, 348, 350; 364/724.011, 724.16, 724.17, 724.19, 724.2

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Primary Examiner—Amanda Le

Attorney, Agent, or Firm—Blakely Sokoloff Taylor & Zafman

[57] **ABSTRACT**

The equalizer circuit for the receiver of a digital communications system is characterized in that its predictor **(11)** is purely recursive, its phase equalizer **(12)** is purely transversal, and the relative positions of those two elements are interchangeable, means for evaluating performance in terms of decision error and for causing the two elements to be interchanged in application of a criterion for evaluating the difficulty of reception, the predictor being upstream and optimized in adaptive and self-learning manner to whiten its own output while the phase equalizer **(12)** is downstream and optimized in adaptive manner during periods of difficult reception, whereas the predictor **(11)** is downstream and the phase equalizer **(12)** is upstream, both being optimized jointly in adaptive manner to minimize decision error between the output ($\hat{d}(n)$) of the decision circuit **(2)** and its input (w(n) or y(n)) during periods of easy reception. The predictor **(11)** is then preferably fed with estimated data, so that the circuit thus becomes recursive and non-linear (DFE).

42 Claims, 6 Drawing Sheets

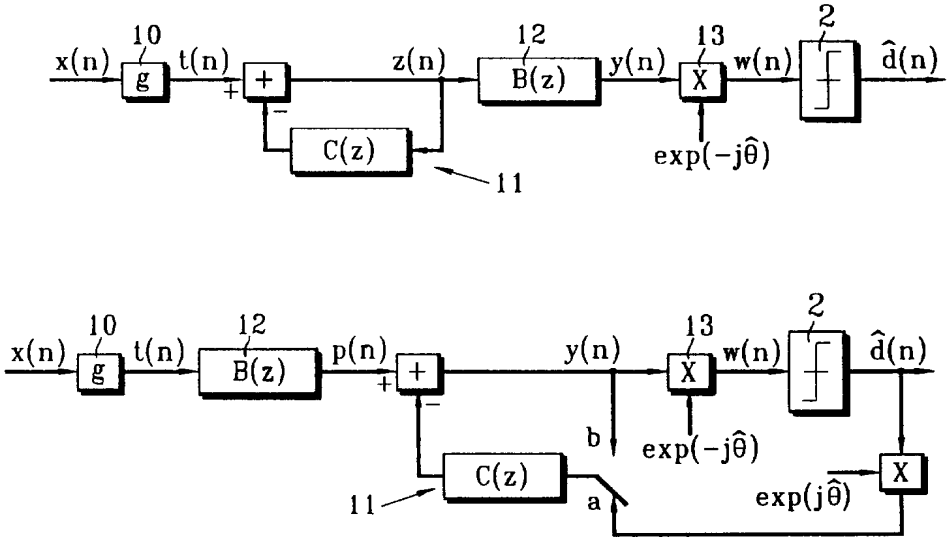
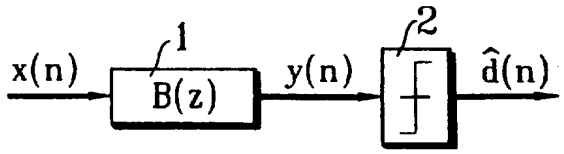


FIG. 1
PRIOR ART



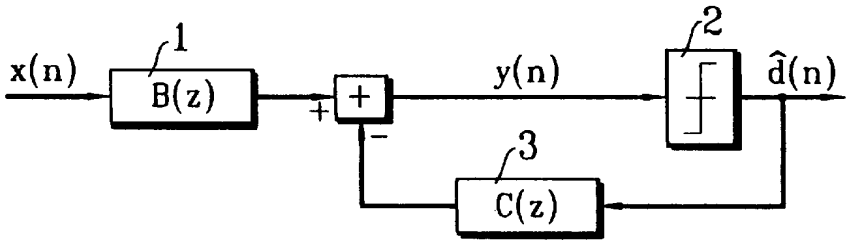


FIG. 2
PRIOR ART

FIG. 3

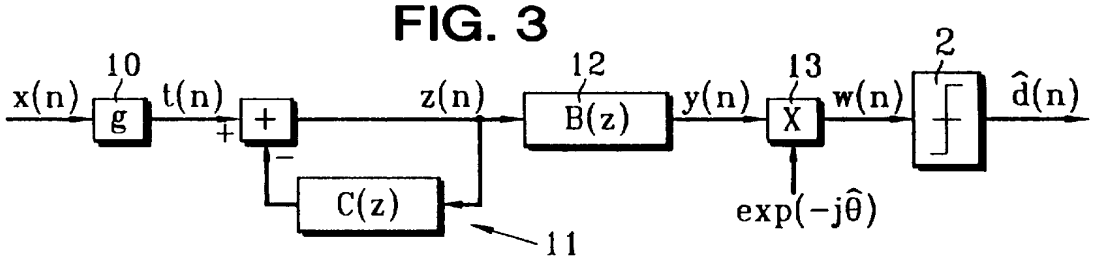


FIG. 4

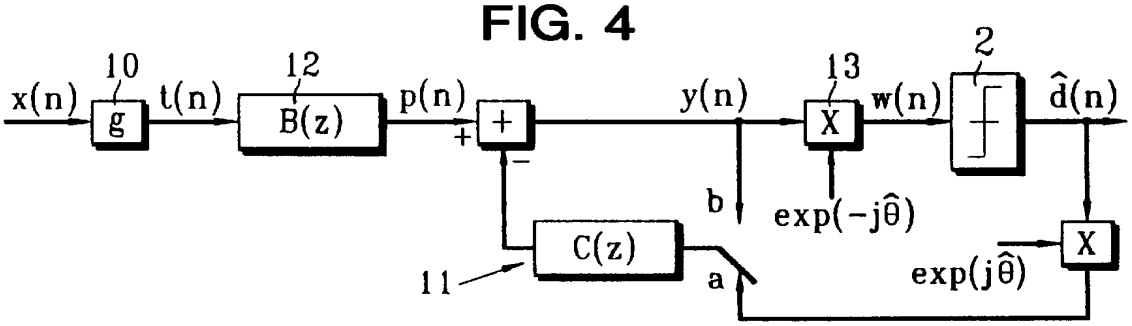


FIG. 5

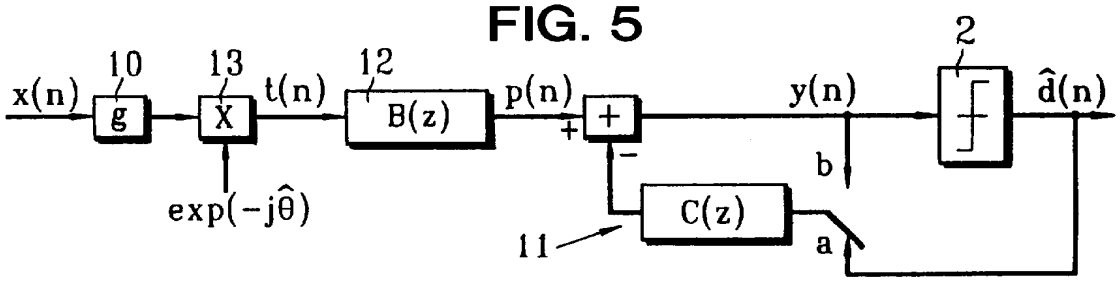


FIG. 6a

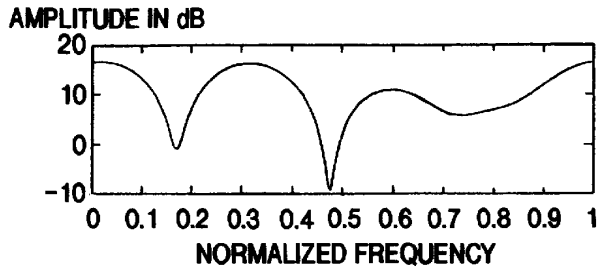
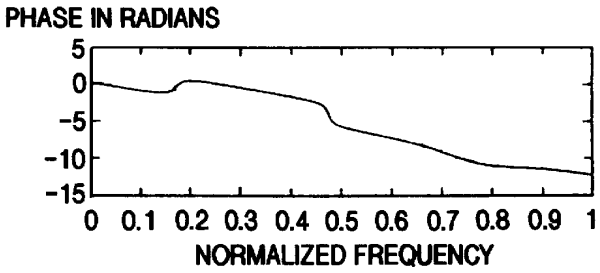


FIG. 6b



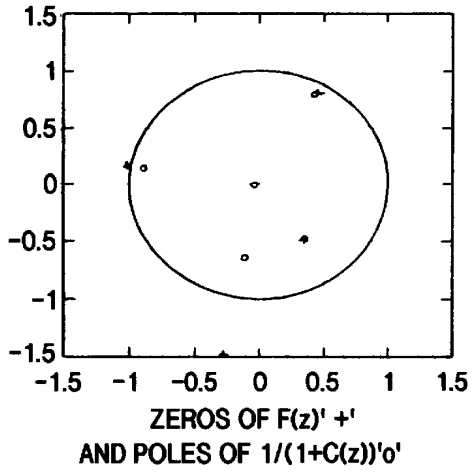


FIG. 7

FIG. 8a

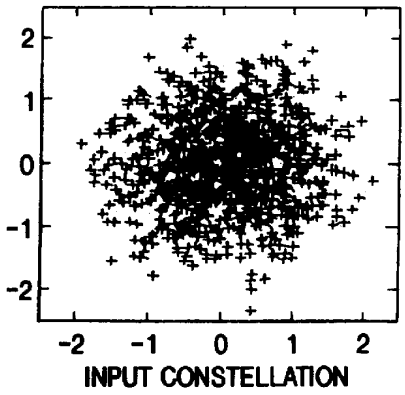


FIG. 8b

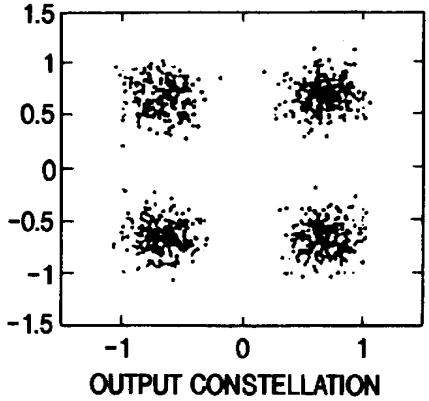


FIG. 9a

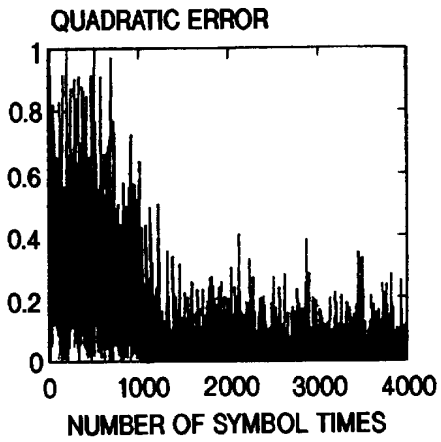
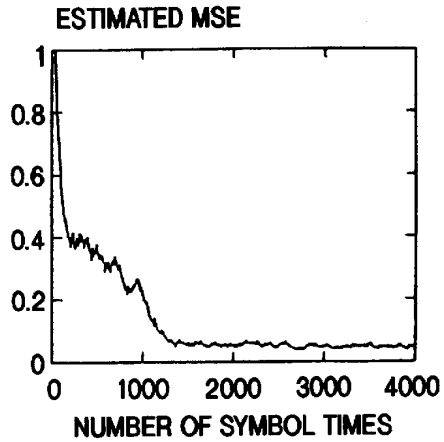


FIG. 9b



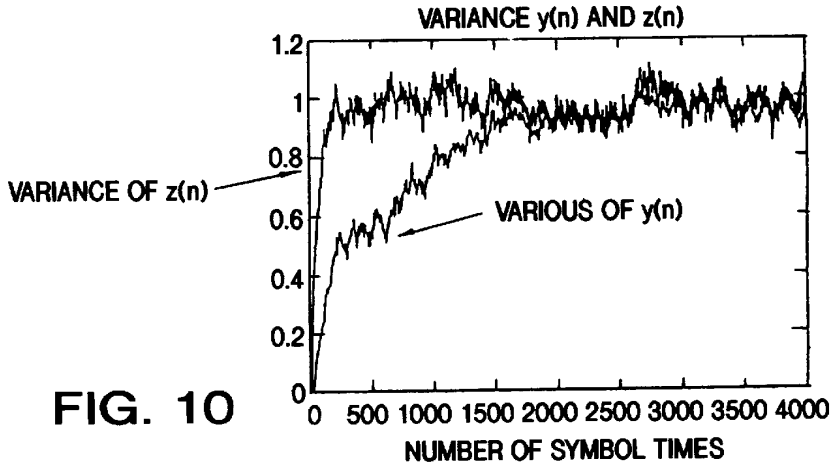


FIG. 10

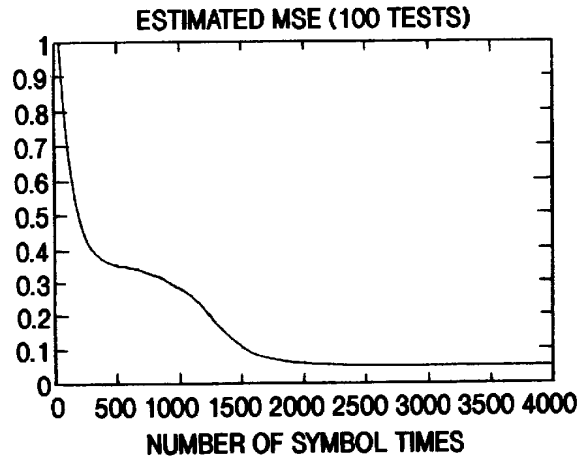


FIG. 11

FIG. 12a

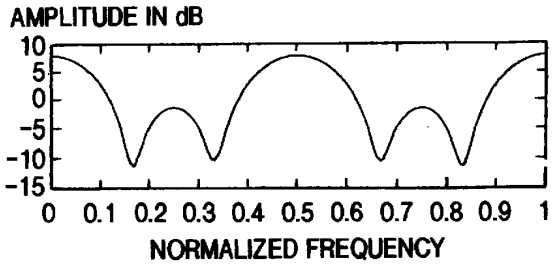
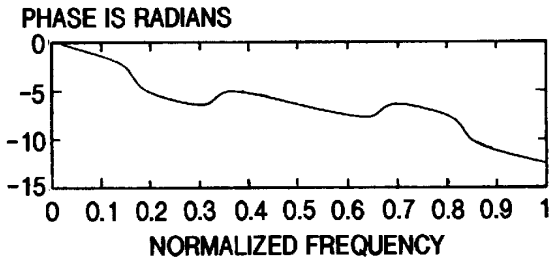


FIG. 12b



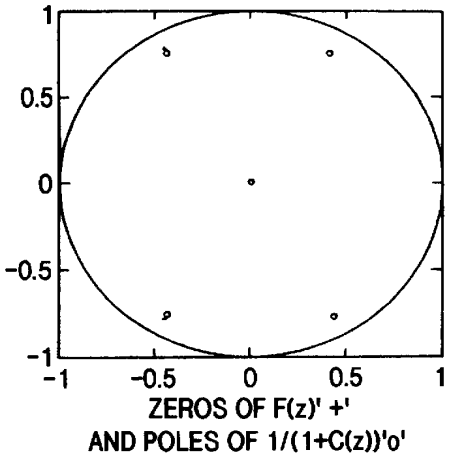


FIG. 13

FIG. 14a

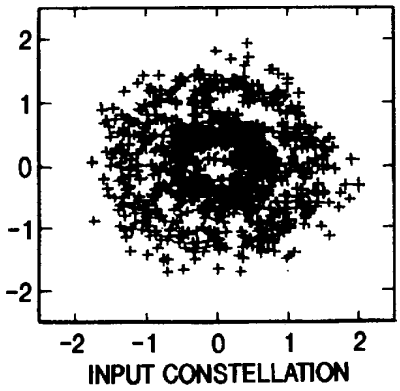


FIG. 14b

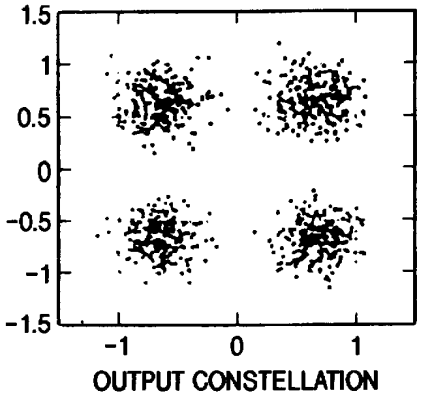


FIG. 15a

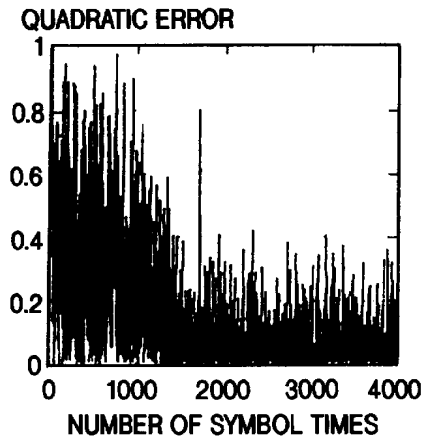


FIG. 15b

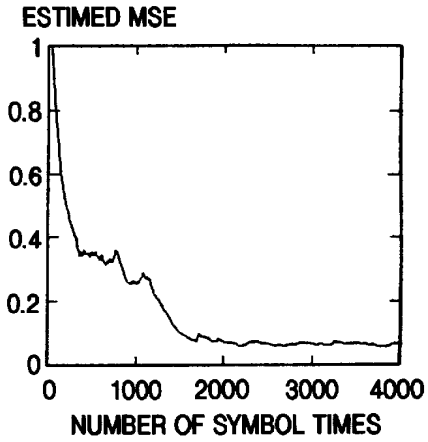


FIG. 16

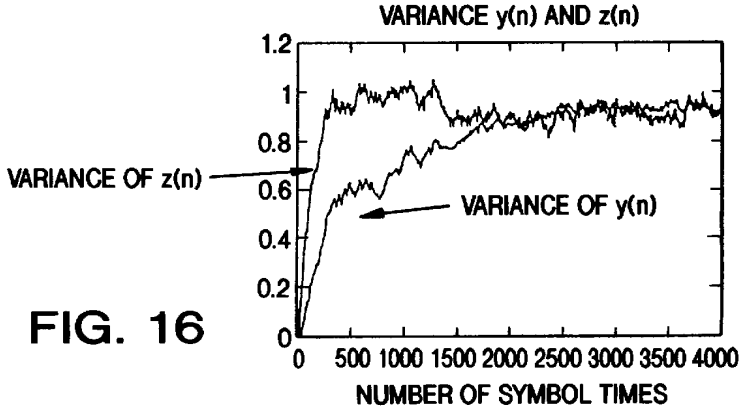


FIG. 17

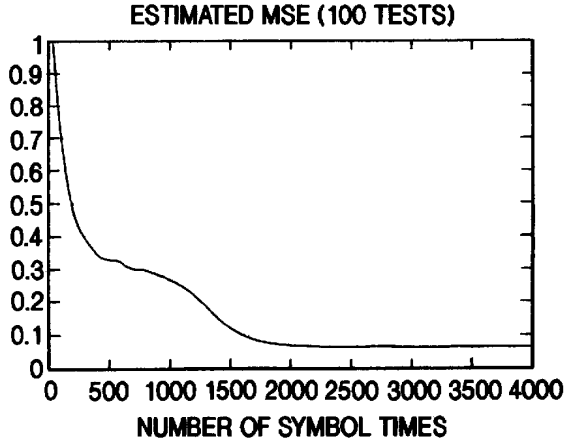


FIG. 18

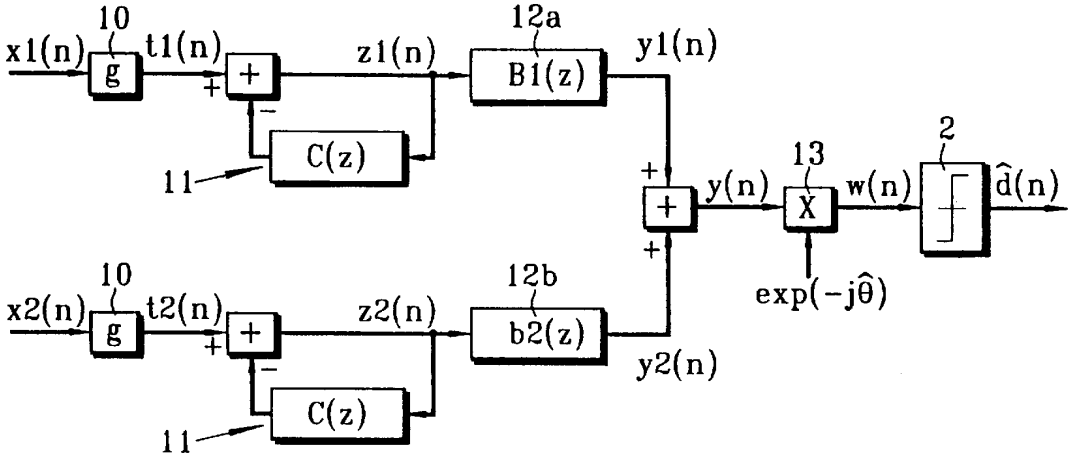
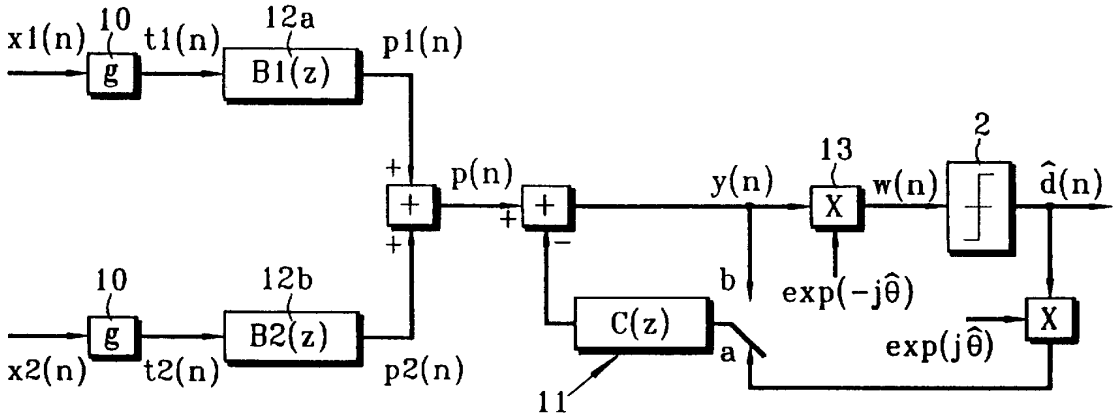

x1(n)
10
g
t1(n)
+
−
z1(n)
12a
B1(z)
y1(n)
C(z)
11
+
+
y(n)
13
X
w(n)
2
d̂(n)
exp(−jθ̂)
x2(n)
10
g
t2(n)
+
−
z2(n)
12b
b2(z)
y2(n)
C(z)
11

FIG. 19


x1(n)
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g
t1(n)
12a
B1(z)
p1(n)
+
+
p(n)
+
−
y(n)
13
X
w(n)
2
d̂(n)
b
exp(−jθ̂)
10
g
12b
B2(z)
x2(n)
t2(n)
p2(n)
C(z)
a
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X
11

ADAPTIVE EQUALIZER FOR DIGITAL COMMUNICATIONS SYSTEMS

The present invention relates to an equalizer circuit (or "equalizer") for receivers in digital communications systems.

In present digital communications systems, receivers include a certain number of functions including demodulation, i.e. transposing the received signal to baseband, equalization, synchronization (bit rate and carrier), decision-making, and channel decoding.

Equalization consists essentially in removing as much intersymbol interference (ISI) as possible, which interference is associated with the fact that the overall transmission system does not satisfy the so-called "Nyquist criterion". This can result from poor strategy in transmission and reception filtering, from poor setting of sampling instants, which is merely a special case, or from a phenomenon of multi-path propagation.

It is recalled that a digital communications system can be considered as comprising a source that transmits, at a rate 1/T and via a channel having a given discrete impulse response, symbols having values taken from a generally complex alphabet of finite size. This transmission rate constitutes the modulation speed and is generally expressed in Baud, T representing the time interval defined by transmitting two successive symbols (symbol time).

Historically, the first circuits used for countering the phenomenon of intersymbol interference were described by Lucky in the following publication:

[1] R. W. Lucky, "Automatic equalization for digital communications", BSTJ 44, pp. 547–588, April 1965.

Essentially he described adaptive linear transversal filters that are "synchronous" (i.e. using only one sample per symbol time), with adaptation being made necessary by the varying nature of the transmission channel. The coefficients of the transversal filter were updated using an ISI zero-forcing criterion, with that procedure leading to the folded spectrum being equalized, hence the term "equalizer".

That kind of transversal equalizer is shown in FIG. **1** in which there can be seen a front filter **1** of transfer function B(z) together with a decision circuit **2** situated downstream from the front filter.

It was only later that adaptive equalizers appeared that use, as their optimization criterion, minimizing mean square error (MSE). It turned out that with noisy channels, ISI zero forcing could give rise to a significant increase in noise at the output from the equalizer, thus contributing to a large decrease in performance, whereas, in contrast, the criterion of minimizing MSE turned out to be a good compromise enabling a substantial reduction in ISI to be obtained without significant increase in noise.

Equalization was conventionally done in two modes. During the first mode, the circuit was directed by a learning sequence of sufficient length to guarantee convergence, and then in the second mode it became self-adaptive, i.e. it was directed by its own decisions.

Later still, proposals were made, in particular in the following publication:

[2] C. A. Belfiore, J. H. Park, "Decision feedback equalization", Proceedings of the IEEE 67 (8), August 1979, for non-linear recursive equalizers with decision feedback (decision feedback equalizers or DFEs) in which detected data was fed back into a feedback filter **3** constituting the recursive portion of the equalizer, as shown in FIG. **2**.

Under the best circumstances, that approach made it possible to eliminate or at least considerably reduce ISI of

causal origin, providing of course there was no decision error. That new structure was expected to give advantageous performance with particularly difficult channels. Unfortunately, those circuits could simultaneously be extremely sensitive to decision errors, such that under severe conditions an error propagation phenomenon could be observed that sometimes went so far as to cause the circuit to diverge. In such situations, it was almost inevitable that the circuit needed to be reinitialized, which meant that a new learning sequence was required and it became essential for the learning sequence to be sent periodically. For any given application, this required, at best, a non-negligible increase in line transmission rate.

From another point of view, although it is true that a decision feedback equalizer (DFE) is not optimum with respect to minimizing error probability (equivalent to the criterion of maximizing likelihood a posteriori), it is nevertheless true that the optimum receiver initially described in:

[3] G. D. Forney, Jr., "Maximum likelihood sequence estimation of digital sequences in the presence of intersymbol interference", IEEE Trans. Inform. Theory, Vol. IT-18, pp. 363–378, May 1972, rapidly becomes impossible to implement when the length of the impulse response turns out to be long. Such a receiver begins by estimating the discrete impulse response of the transmission channel and then performs a search among all possible sequences for the sequence which is closest to the "vector" observation available at the output from the demodulator. At present, implementation of such receivers requires the use of the Viterbi algorithm, as described in:

[4] G. D. Forney, Jr., "The Viterbi algorithm", Proc. IEEE, Vol. 61, pp. 268–278, March 1973, which has the major advantage of making it possible to perform decision-making "on-line" while remaining optimum. In other words it is not necessary to have received all of the message before beginning to take decisions on the most likely sequence of transmitted symbols. Nevertheless, and by way of example, for 2-state phase shift keying (2-PSK) and for the case of a discrete impulse response of length **10**, the trellis associated with such a system has 1,024 states, whereas with 4-PSK it has 1,048,576, which, ipso facto, causes that type of receiver to be completely impracticable, at least for "real time" applications. The difficulty increases even more with an increase in the size of the alphabet of transmitted signals. Consequently, that technique can be envisaged in practice only for short ISI lengths, unless the discrete impulse response length of the transmission channel is arbitrarily truncated, which in any case would give rise to a loss of optimality.

Such an ISI length (ten symbol times) is quite conventional in various applications, and in particular for channels used with mobile radios, tropospheric radio, ionospheric radio, or indeed submarine acoustic channels and even on telephone lines. Other things being equal, it is always desirable to convey the highest possible data rates over channels of those types, and that inevitably leads to an increase in the size of the discrete impulse response. Thus, to illustrate the concept, a submarine acoustic channel may have a discrete impulse response of several tens of symbol times T. Consequently, non-linear decision feedback equalizers (DFE), even though suboptimal, nevertheless present a clear major advantage even though they are often difficult to use because of the error propagation phenomenon.

From the description above, it can be seen that there are essentially two equalizing structures, one is linear and transversal while the other is non-linear, recursive, and has decision feedback (DFE), the second structure providing a

non-negligible improvement on certain types of channel and also imparting a substantial reduction in noise at the output from the equalizer. Nevertheless, the necessary presence of a learning sequence gives rise to a non-negligible increase in the data rate required and thus in the associated spectrum occupancy. That is the reason behind present work seeking to perform self-learning (blind) equalization. The objective is to enable the channel to be equalized without the help of a learning sequence, i.e. solely on the basis of knowledge about the statistical distribution of input data, which knowledge is, in fact, quite legitimate.

In this respect, several authors have provided non-negligible contributions, including the following:

[5] Y. Sato, "A method of self-recovering equalization for multilevel amplitude modulation", IEEE Trans. Com., COM-23, pp. 679–682, June 1975;

[6] D. N. Godard, "Self-recovering equalization and carrier tracking in two-dimensional data communication systems", IEEE Trans. Com., COM-28, pp. 1867–1875, November 1980;

[7] A. Benveniste, M. Goursat, "Blind equalizers", IEEE Trans. on Com., Vol. 32, 1984, pp. 871–883;

[8] G. Picchi, G. Pratti, "Blind equalization and carrier recovery using a 'stop-and-go' decision-directed algorithm", IEEE Trans. Com., COM-35, pp. 877–887, November 1987;

[9] O. Macchi, Yi Gu, "Self-adaptive equalization with a mixed backward and forward predictor", ISELDECS, Kharagpur, India, pp. 437–440, December 1987;

[10] O. Shalvi, E. Weinstein, "New criteria for blind deconvolution of non-minimum phase systems channels", IEEE Trans. Inform. Theory, Vol. IT-36, No. 2, pp. 312–321, March 1990;

[11] B. Porat, B. Friedlander, "Blind equalization of digital communication channels using high-order moments", IEEE Trans. on Signal Processing, Vol. 39, pp. 522–526, February 1991;

[12] K. Hilal, P. Duhamel, "A blind equalizer allowing soft transition between the constant modulus algorithm and the decision directed algorithm for PSK modulated signals", Internat. Conf. on Comm., Geneva, Switzerland, pp. 1144–1148, May 1993.

All of the above algorithms make implicit reference to statistics of order greater than two since a non-minimum phase channel requires the use of such moments for inversion (deconvolution).

The first equalizers of that type generally made use of linear transversal structures. Nevertheless, other authors investigated linear recursive structures, in particular O. Macchi et al. in the following publications:

[13] C. A. Faria Da Rocha, O. Macchi, "A novel self-learning adaptive recursive equalizer with unique optimum for QAM", ICASSP, Adelaide 94;

[14] C. A. Faria Da Rocha, O. Macchi, J. M. T. Romano, "An adaptive non-linear IIR filter for self-learning equalization", ITS 94, Rio de Janeiro,

The equalizer was then essentially constituted by a transversal linear front filter (backward predictor), a purely recursive feedback filter (forward predictor), and automatic gain control (AGC). There remained the need to determine optimality criteria which, when minimized, would lead to a solution as close as possible to the solution that is optimum in the Wiener sense.

The same authors proposed an original cost function [13], comprising a linear combination of a whitening criterion (completely blind) and of a square error minimizing criterion (estimated relative to the decision taken). The main idea was to start with a blind criterion and to move progressively towards a square error minimizing criterion, with the equalizer thus becoming decision-directed. It then remained only to replace the data present at the input to the feedback filter with detected data and thus pass from a recursive linear structure to a recursive non-linear structure (DFE). That idea has turned out to be most advantageous in the sense that it makes it possible to equalize channels where other self-learning algorithms fail Nevertheless, in spite of the original nature of the idea and its undoubted contribution to the field of self-learning equalization, that structure possesses various points that would appear to be capable of being improved.

In the same year, O. Macchi et al. [14] proposed a structure essentially constituted by a predictor, automatic gain control (AGC), and an all-pass filter including a recursive portion, the predictor serving to provide amplitude equalization for the channel, the all-pass filter providing phase equalization, and the AGC restoring the proper level and dealing with the problem of carrier recovery. An increase in convergence speed was undoubtedly obtained, however the system was unsuitable for optimum structural reversibility without degrading performance, and that ran the risk of constituting a major handicap with time-varying channels.

The essential difference compared with the present invention lies in the fact that the phase equalizer (all-pass filter) described in [14] also includes a recursive portion. Consequently, on passing to tracking mode to take full advantage of a non-linear structure with decision feedback, it was necessary, on pain of considerable performance degradation, to replace the two feedback filters by a single (recursive) equivalent filter. It then became impossible to go back to the earlier configuration in the event of the channel worsening. In contrast, the circuit of the invention includes only one purely recursive predictor which distinguishes it significantly from the circuit described in [14].

The invention provides an equalizer circuit for a digital communications system, the circuit including automatic gain control means, carrier recovery means, data phase equalization means, and a predictor for data amplitude equalization, together with a decision circuit, and being characterized in that the predictor is purely recursive, the phase equalizer is purely transversal, and the relative positions of those two elements are interchangeable, means for evaluating performance in terms of decision error and for causing the two elements to be interchanged in application of a criterion for evaluating the difficulty of reception, the predictor being upstream and optimized in adaptive and self-learning manner to whiten its own output while the phase equalizer is downstream and optimized in adaptive manner during periods of difficult reception, whereas the predictor is downstream and the phase equalizer is upstream, both being optimized jointly in adaptive manner to minimize decision error between the output of the decision circuit and its input during periods of easy reception.

The proposed structure is adaptive, which constitutes a worthwhile original feature.

During convergence, it amounts to concatenating: real gain; a purely recursive predictor; a transversal linear filter; and a phase corrector. The presence of the whitening filter upstream from the linear transversal filter enables the transversal filter to converge more quickly.

In tracking mode, the structure used is identical to the above with the exception that the predictor and transversal filters are interchanged.

Thus, this recursive circuit possesses the two advantages of being entirely self-learning (blind) in its initial mode and of tending gradually towards a DFE type circuit that is

decision controlled using a criterion of minimizing MSE, and it remains naturally in that state so long as the channel does not degrade excessively. However, when propagation conditions make the channel too difficult and as a result the MSE exceeds a certain threshold, the circuit then switches over to its blind configuration, corresponding to convergence mode.

As a result, because of the adaptivity of its structure, the circuit of the invention makes it possible to achieve performance that is most advantageous both with respect to convergence and with respect to tracking. This essential property makes it capable of adapting to channel fluctuations in severe situations, unlike conventional equalizers of the prior art.

In addition, the circuit provided by the invention is particularly well adapted to time-varying channels, and in particular mobile radio channels, ionospheric channels, tropospheric channels, and acoustic submarine channels.

The invention also provides an equalizing method for the receiver of a digital communications system.

Other characteristics and advantages of the invention appear further from the following description.

BRIEF DESCRIPTION OF THE DRAWINGS

The description is purely illustrative and non-limiting It should be read with reference to the accompanying drawings, in which:

FIG. **1** is a block diagram of a transversal linear equalizer;

FIG. **2** is a block diagram of an equalizer with decision feedback;

FIG. **3** is a diagram showing the structure of a circuit constituting one possible embodiment of the invention during convergence;

FIG. **4** is a diagram showing the structure of a circuit constituting one possible embodiment of the invention during tracking;

FIG. **5** is a diagram showing a possible variant of the structure for tracking mode;

FIGS. **6***a* and **6***b* are graphs giving amplitude and phase response as a function of frequency for a Porat and Friedlander type channel;

FIG. **7** is a diagram in the complex plane showing the positions of the zeros of the transfer function of the transmission channel corresponding to FIGS. **6***a* and **6***b* (zeros symbolized by +), and also the poles of the transfer function 1/(1+C(z)) of the predictor (poles symbolized by o) relative to the unit circle;

FIGS. **8***a* and **8***b* show the constellations in 4-PSK that correspond respectively to the input signal and to the output signal from the circuit of the invention;

FIGS. **9***a* and **9***b* are graphs respectively showing instantaneous square error and square error estimated in the least squares sense, both plotted as a function of the number of symbols received;

FIG. **10** is a graph on which there are plotted curves of variance in the signals y(n) and z(n), as estimated in the least squares sense, and as a function of the number of symbols received;

FIG. **11** is a graph on which MSE is plotted as a function of number of symbols (averaged over 100 trials);

FIGS. **12***a* and **12***b* are graphs showing the amplitude and phase response as a function of frequency for a mixed-phase Macchi type channel;

FIG. **13** is a diagram in the complex plane showing the positions of the zeros of the transmission channel transfer function corresponding to FIGS. **12***a* and **12***b* (zeros symbolized by +), together with the poles of the transfer function 1/(1+C(z)) of the predictor (poles symbolized by o), relative to the unit circle;

FIGS. **14***a* and **14***b* show the 4-PSK constellations corresponding respectively to the input signal and to the output signal of the circuit of the invention;

FIGS. **15***a* and **15***b* are graphs respectively showing instantaneous square error and square error estimated in the least squares sense as a function of the number of symbols received;

FIG. **16** is a graph on which there are plotted curves showing the variance in the signals y(n) and z(n), as estimated in the least squares sense;

FIG. **17** is a graph on which there is plotted MSE as a function of number iterations (averaged over 100 trials); and

FIGS. **18** and **19** are block diagrams similar to those of FIGS. **3** and **4** and showing a fractionally-spaced equalizer of the invention.

GENERAL DESCRIPTION

The equalizer circuit of the invention has two different structures depending on whether it is in convergence mode (mode 1) or in tracking mode (mode 2), i.e. under steady-state conditions. These are the two structures shown in FIGS. **3** and **4**.

In the structure used during convergence, a linear and purely recursive predictor (whitening filter) precedes a transversal filter which is itself self-learning (blind). In tracking mode, the transversal filter is disposed upstream of the recursive filter which is then supplied with detected data. The optimality criterion then become that of minimizing MSE both for the transversal linear portion and for the recursive portion. There is thus a structural modification accompanied by a simultaneous change of optimality criterion.

Thus, depending on the degree of severity of the channel and on the criterion for measuring output signal performance, e.g. MSE estimated in the least squares sense (RLS), the circuit switches from a self-learning linear recursive structure as shown in FIG. **3** to a non-linear recursive structure (DFE) shown in FIG. **4**, or conversely from a decision directed DFE type structure to a self-learning linear recursive structure.

The structures corresponding firstly to convergence mode and secondly to tracking mode are described below.

Mode 1: convergence, periods of difficult reception

The structure corresponding to the convergence configuration shown in FIG. **3** comprises automatic gain control **10** of real type g, a predictor **11** having a transfer function 1/(1+C(z)), a transversal filter **12** having a transfer function B(z), and a circuit **13** for compensating phase error. It is important to observe that the AGC, characterized by its gain g, can be situated at other points in the system, and in particular between the purely recursive predictor **11** and the transversal filter **12**, or either upstream or downstream from the phase error compensating circuit **13**.

Gain g is updated on a blind criterion, the predictor **11** on a whitening criterion (amplitude equalization), and the transversal filter **12** on a blind criterion implying the use of statistics of order greater than two (phase equalization). For updating the coefficients of the transversal portion, various algorithms can be used, and in particular those described in above-mentioned articles **1** to **14**.

Carrier recovery **13**, i.e. estimating residual phase error and compensating it by multiplying by $\exp(-j\hat{\theta})$ is

performed, for example, using a criterion of minimizing MSE. The error signal generated can then be filtered so as to reduce to a second-order phase lock loop (or to a loop of order greater than two, depending on the type of filter used). This circuit **13** can also be situated at various points in the system, and in particular between the predictor **11** and the transversal filter **12**.

During this convergence mode, carrier recovery **13** is the only function to be decision directed. The other functions are optimized on criteria that do not rely in any way on decisions taken by the appropriate circuit (threshold circuit).

Consequently, this first mode is entirely self-learning (blind).

Better, each of the individual circuit portions possesses its own appropriate optimality criterion, thereby making the overall structure very robust.

In addition, the predictor **11** whitens the data present at the input of the transversal filter **12** which provides a non-negligible advantage in terms of convergence time, specifically because the self-correlation matrix of the input signal is then better conditioned.

Also, the respective positions of the AGC **10** and of the carrier recovery circuit do not, a priori, have any significance in absolute terms, ignoring any considerations relating to possible structural constraints. Thus, the AGC **10** (characterized by g) can be situated equally well between the predictor **11** and the transversal filter **12**, or upstream or downstream of the phase error compensating circuit **13**. Nevertheless, from the point of view of structural constraints, a position that is advantageous, at least with respect to gain g, appears to be that shown in the figures. If the AGC were to be situated upstream or downstream of the phase error compensating circuit **13**, then it would be necessary to use division in tracking mode (which is always difficult to implement), whereas situating it between the predictor and the transversal filter requires output data from the predictor and input data to the transversal filter to be stored, but that is not much of a penalty.

Mode 2: tracking, periods of easy reception

Once the channel has been substantially equalized, which situation can be perceived, for example, by observing the estimated MSE in the (recursive) least squares sense, and more precisely by comparing said value with a threshold, the recursive predictor **11** having the transfer function 1/(1+C (z)) and the transversal linear filter having the transfer function B(z) are interchanged.

The new structure obtained in this way (switch in position b in FIG. **4**) is entirely equivalent to the preceding structure given that the circuit is linear. It then remains to replace the data y(n) at the input to the feedback filter with the phase-corrected detected data, i.e. $\hat{d}(n)\exp(j\hat{\theta}(n-1))$, thus returning to the conventional DFE structure (switch in position a), that is decision directed in application of the criterion of minimizing MSE.

Naturally, if multiplication by the term $\exp(-j\hat{\theta}(n-1))$ is performed upstream, i.e., for example, at the input of the circuit as shown in FIG. **5**, then the data y(n) is replaced by detected data $\hat{d}(n)$ purely and simply, but always in progressive manner.

Thus, on transition from mode 1 to mode 2, the observation vector at the input to the recursive portion is constituted by signals $\hat{d}(n-1)$, y(n−2), y(n−3), y(n−M). In contrast, when going from mode 2 to mode 1, the observation vector at the input of the recursive portion is constituted by the signals y(n−1), $\hat{d}(n-2)$, $\hat{d}(n-3)$, . . . , $\hat{d}(n-M)$.

Also, it remains possible to integrate the AGC **10** in the linear transversal filter **12** B(z) by locking g to its preceding value, with this action being optional only, since on very time-varying signals, it is desirable to keep open the option of adapting the AGC.

This change in structure is entirely reversible This property is most advantageous since under severe conditions it makes it possible to return gradually to convergence mode, i.e. to a completely self-learning mode, with the purely recursive predictor **11** again seeking to equalize the channel in amplitude and with the transversal filter **12** subsequently seeking to equalize it in phase.

In contrast, when the channel becomes less severe, that gives rise, amongst other things, to a reduction in the associated MSE (e.g. estimated in the least squares sense (RLS)), so the system switches again to a recursive structure with decision feedback, and so on. In this respect, the nature of the present system is clearly both original and particularly attractive.

So far as the inventors are aware, there exists at present no circuit of this type that performs structural permutation, in other words that interchanges the upstream and downstream portions of the equalizer.

In parallel with this structural permutation, the cost functions required for updating the coefficients in the transversal and recursive portions are changed. In mode 1, these cost functions rely exclusively on knowledge of the statistics of the input signal, whereas in mode 2, the optimality criterion used is minimizing MSE. These aspects are clearly described in the technical appendix.

Finally, and this constitutes another original feature of the circuit, it is possible during mode 2 and on the basis of an estimate of the likelihood of the detected data sample, to replace the phase-corrected data i.e. $\hat{d}(n).\exp(j\hat{\theta}(n-1))$ by data y(n), as shown in the diagram of FIG. **4**, when the likelihood of the estimated data is insufficient. This provides a corresponding reduction in the impact of isolated decision errors despite an increase in the associated MSE. This strategy provides additional robustness to the above-described circuit, providing an estimate of the likelihood is available. If there is no such estimate, the switch is in position a.

Thus, the predictor can be fed either with phase-corrected estimated data $\hat{d}(n)$ obtained at the output from the decision circuit **2**, or else with data output by the predictor **11**. To this end, the circuit may include means for switching between these two feeds (b and a in FIG. **4**) as a function of the above-mentioned criterion for evaluating the likelihood of the estimated data.

DETAILED DESCRIPTION OF AN EMBODIMENT

An embodiment of the equalizer circuit of the invention is described below in detail.

Convergence mode, periods of difficult reception

The equations governing the operation of the circuit are the following:

$$t(n)=x(n)g(n-1) \tag{I-1}$$

$$z(n)=t(n)-[z(n-1), \ldots, z(n-N)]C(n-1) \tag{I-2}$$

$$y(n)=B^T(n-1)Z(n) \tag{I-3}$$

with:

$$Z(n)=[z(n-1), \ldots, z(n-L)]^T$$

and:

$$B=[b_0, \ldots, b_{L-1}, b_L]^T$$

$$w(n)=y(n).\exp(-j\hat{\theta}(n-1)) \quad \text{(I-4)}$$

By way of example, the vector B may be initialized as follows: B=[0 0 0 0 1]^T, while C is the zero vector of dimension N. It is recalled that N must naturally be selected to greater than or equal to the number of zeros in the transfer function F(z) of the transmission channel. Similarly, the size (L+1) of the transversal equalizer must be selected to be large enough to be able to process appropriately any zeros lying outside the unit circle and in the immediate vicinity thereof.

The real gain g is updated in application of the criterion initially recommended in [1] and [2].

$$G(n)=G(n-1)+\mu_G[1-|z(n)|^2]$$

$$g(n)=\sqrt{|G(n)|} \quad \text{(I-5)}$$

or else:

$$g(n)=|G(n)| \quad \text{(I-5b)}$$

Phase error can be updated using a similar strategy of decision-directed minimization of (estimated) square error. The error signal is conventionally filtered by a digital filter (phase advance integrator), characterized by two coefficients G_1 and G_2:

$$e(n)=Im\{w(n)[d(n)-w(n)]^*\} \quad \text{(I-6)}$$

$$s(n)=(e \otimes f)(n) \text{ and } Z\{f(n)\}=G_1+\frac{G_2}{1-z^{-1}} \quad \text{(I-7)}$$

$$\hat{\theta}(n)=\hat{\theta}(n-1)+\mu_\theta s(n) \quad \text{(I-8)}$$

A priori, phase updating should start from the beginning, particularly on channels having a discrete impulse response of the complex type. In contrast, on channels having an impulse response that is real, it is possible to examine faster convergence when updating is inhibited during the first iterations. This is explained by the fact that under such circumstances it is advantageous to use decision-directed criteria only once a portion of the ISI has been eliminated, thereby making it possible to increase the reliability of the detected data.

The signal z(n) is whitened by minimizing its variance $E\{|z(n)|^2\}$ by a "stochastic gradient" technique (SGLMS algorithm). It is known that the solution which is optimal in the Wiener sense is that which makes the prediction error z(n) orthogonal to the various components of the vector Z(n). Under such conditions, the samples z(n) are non-correlated on a finite horizon of duration N.

The equation for updating the vector C is then as follows:

$$C(n)=C(n-1)+\mu_c z(n)[z(n-1), \ldots, z(n-N)]^H \quad \text{(I-9)}$$

where the exponent H designates the transposition and conjugation operation.

To update the vector B, a certain number of cost functions, and in particular Godard's function (constant modulus algorithm) have been tried. Also, the inventors have investigated combined strategies associating Godard's function with a strategy of the Benveniste-Goursat type. They have also examined these various criteria over a number of channels, including those of Porat and Friedlander [11] and of Macchi [13].

The iterative technique implemented is the "stochastic gradient" technique (it could equally well be the recursive least squares technique). The various error signals corresponding to the above-mentioned strategies are expressed as follows:

$$e_{God}(n)=y(n)[1-|y(n)|^2] \quad \text{(I-10)}$$

Godard [6]

$$e_{sw}(n)=-y(n)|y(n)|^2 \quad \text{(I-11)}$$

Shalvi-Wenstein [10]

$$e_{DD}(n)=[\hat{d}(n).\exp(j\hat{\theta}(n-1))-y(n)]LMS \quad \text{(I-12)}$$

(Decision directed)

$$e_{Benv}(n)=k_1{}^{SM}e_{DD}(n)+k_2 \cdot e_{God}(n)|e_{DD}(n) \quad \text{(I-13)}$$

Benveniste-Godard

Whatever the criterion retained, i.e. whatever the cost function $e_x(n)$, the equation for updating the vector B is written as follows:

$$B(n)=B(n-1)+\mu_B e_x(n)Z^*(n) \quad \text{I-14)}$$

It will be observed that whatever the criterion retained, the algorithm is indeed self-learning. The criteria which appear to be fastest over all simulations are those of Godard, optionally associated with Benveniste strategies that make it possible to switch smoothly from a self-learning criterion (Godard) to a final (tracking) criterion of the decision directed LMS type.

More precisely, updating of B is started on a Godard criterion, and the system is then switched to a Benveniste type strategy when the variance z(n), as estimated in the least squares sense, reaches a given threshold. A typical forgetting factor for this estimation has been fixed at λ=0.99.

Also, the initial vector B(**0**) has been arbitrarily set so that B(**0**)=[0 0 . . . 1]^T. The initial position and value of the reference coefficients can naturally be changed. In other words, the transversal linear filter need not be purely anti-causal.

In any event, the restoration delay δ is equal to the size of the anti-causal portion of the transversal filter **12**.

Tracking mode, periods of easy reception

This mode begins when the estimated MSE in the recursive least squares (RLS) sense drops below a given fixed threshold, e.g. 0.2 for 4-PSK. The equation for updating the estimated MSE is then as follows:

$$MSE(n)=\lambda MSE(n-1)+(1-\lambda)|\hat{d}(n)\exp(j\hat{\theta}(n-1))-y(n)|^2 \quad \text{(II-0)}$$

$$MSE(\mathbf{0})=1$$

In this case, the predictor **11** and the linear transversal filter **12** are interchanged and, in addition, DFE mode is used, i.e. y(n) is replaced by the previously phase-corrected detected data i.e. $\hat{d}(n).\exp(j\hat{\theta}(n-1))$ in the upstream portion.

The equalizer thus passes overall from a linear recursive structure to a non-linear recursive structure (DFE).

In addition, the cost functions are changed and B and C are updated using the criterion of minimizing MSE (decision directed SGLMS algorithm). This change is naturally reversible, both with respect to structure and with respect to cost functions.

In parallel with the above two actions, it is also possible to lock the real gain g(n) to its preceding value, in which case the transversal filter **12** is treated as a conventional linear transversal filter capable, in this respect, of taking care of adaptation for automatic gain control. In other words, the final structure is then entirely equivalent to that of a decision feedback equalizer (DFE), with the advantage of being capable of returning simply to a completely blind structure that is recursive and linear whenever the estimated MSE exceeds the critical threshold.

The equations for updating the algorithm are as follows:

$$t(n)=x(n)g(n-1) \quad \text{(II-1)}$$

$$p(n)=B^T(n-1)T(n) \text{ with } T(n)=[t(n), \ldots t(n-L)]^T \quad \text{(II-2)}$$

$$y(n)=p(n)-C^T(n-1)Y(n) \quad \text{(II-3)}$$

$$Y(n)=[\hat{d}(n-1).\exp(j\hat{\theta}(n-2)), \ldots, \hat{d}((n-N).\exp(j\hat{\theta}(n-N-1))]^T \quad \text{(II-4)}$$

In parallel, it is necessary to calculate the following expressions:

$$z(n)=t(n)-[z(n-1), \ldots, z(n-N)]C(n-1) \quad \text{(II-5)}$$

$$Z(n)=[z(n), z(n-1), \ldots, z(n-L)]^T \quad \text{(II-6)}$$

The real gain g can be updated using the criterion used in convergence mode, or else this gain can be integrated in updating the vector B. Phase error updating is performed using the same strategy as during the initial mode.

The equations for updating the vectors B and C are those of a conventional decision driven LMS algorithm, i.e.:

$$B(n)=B(n-1)+\mu_B[\hat{d}(n)\exp(j\hat{\theta}(n-1))-y(n)]T^*(n) \quad \text{(II-7-a)}$$

corresponding to the switch in position a (decision feedback equalizer).

$$B(n)=B(n-1)+\mu_B[\hat{d}(n)\exp(j\hat{\theta}(n-1))-y(n)]Z^*(n) \quad \text{(II-7-b)}$$

corresponding to the switch in position b.

$$C(n)=C(n-1)+\mu_C[\hat{d}(n)\exp(j\hat{\theta}(n-1))-y(n)]Y^*(n) \quad \text{(II-8)}$$

Finally, during tracking, the AGC **10** can be integrated in the linear transversal filter, in which case it suffices to lock the parameter g to its preceding value, with this being advantageous particularly for non-varying channels. Under such conditions, the system reduces clearly to a DFE type structure whose performance characteristics are known. However, when the number of decision errors reaches a critical threshold, a conventional DFE diverges because of the decision error propagation phenomenon. In contrast, with the novel strategy, when severe conditions make the estimated MSE exceed the critical threshold, this causes the circuit to change its structure, enabling it to return to self-learning mode. A priori there is thus no longer any major risk of divergence due to the error propagation phenomenon. This is a remarkable feature.

Finally, restoration delay is always equal to the length L of the anti-causal portion of the linear transversal equalizer, and it is thus fixed by the initial position of the reference coefficient. This has been verified over several severe mixed-phase channels.

PERFORMANCE

The above-described circuit of the invention and the associated algorithms have been successfully tested on real submarine acoustical communications signals in particularly reverberating contexts (test basin and horizontal transmission in shallow sea).

In parallel, the operation of the circuit and the associated algorithms has been simulated for 4-PSK (or Q-PSK) over Macchi and over Porat Friedlander channels. In each case, data variance was normalized to 1. The signal-to-noise ratio was fixed at 15 dB, the dimension N of the predictor **11** being selected to be equal to 5, L being fixed at 19, thus giving rise to a linear transversal size equal to 20.

For each test, a random frequency offset ΔF was simulated such that the product ΔF×T was uniformly distributed over the range [0 to 0.002], T conventionally representing one symbol time. In parallel, for each test, we also injected an initial phase error that was uniformly distributed over the range [0 to 2π].

Porat and Friedlander channel

This channel had zeros on either side of the unit circle, and its discrete impulse response was as follows:

$$f=[2-0.4*j,\ 1.5+1.8j,\ 1,\ 1.2-1.3*j,\ 0.8+1.6*j]$$

It will be observed that this impulse response is complex, unlike that used in the following example. FIGS. **6***a* and **6***b* show the frequency response of this channel in phase and in amplitude, and FIG. **7** shows the positions of the zeros of the transfer function relative to the unit circle.

Then, on a special selection, the final positions of the poles of the transfer function 1/(1+C(z)) of the predictor **11** were examined. In accordance with theory, it should be observed that there are two internal poles symmetrical with the two external zeros of the transfer function F(z) of the transmission channel (mixed-phase type channel).

FIGS. **8***a* and **8***b* show the starting constellation and also the constellation of the signal w(n) for the most recent 1,000 values.

Also, still in the context of a particular file, FIGS. **9***a* and **9***b* show how the instantaneous square error and the estimated MSE in the least squares sense (RLS) vary. It can be seen that convergence is situated at about 1,000 iterations, which feature is quite remarkable, and much faster than in prior art circuits.

Variation in RLS estimated variance of y(n) and z(n) are given in FIG. **10**. Here again, it can be seen that convergence takes place at about 1,000 iterations.

Finally, FIG. **11** shows how estimated MSE varies. This estimate was obtained by taking **100** random trials and taking the arithmetic mean of the RLS estimated MSEs. This result serves to verify the power of the new circuit and the associated algorithms.

It can be seen in particular that when using 4-PSK type modulation, the convergence time is about 1,000 symbol

times for algorithms of the "stochastic gradient" type. By way of comparison, a self-learning linear transversal equalizer of the kind described by Godard typically requires fifteen thousand symbol times and it gives rise to an increase of about 3.5 dB in MSE.

Macchi channel

This channel has zeros on either side of the unit circle, its discrete impulse response being the following:

f=[0.8264, 001653, 008512, 001636, 081]

FIG. **12** shows the frequency response of this channel in phase and in amplitude, together with the positions of the zeros of the transfer function relative to the unit circle.

On a particular trial, the final positions of the poles of the transfer function 1/(1+C(z)) of the predictor **11** were examined. In accordance with theory, it will be observed in particular that there are two internal poles symmetrical with two external zeros of the transfer function F(z) of the transmission channel.

FIG. **14** shows the starting constellation and also the constellation of the signal w(n) over the most recent 1,000 values. ISI was considerably reduced by our circuit.

Also, still in the context of a special file, FIG. **15** shows how instantaneous square error and RLS estimated MSE varied, showing again that convergence takes place at around 1,000 iterations.

Simultaneously, FIG. **16** shows how estimated variances for y(n) and z(n) vary. This estimation was performed in the recursive least squares sense (RLS) with a forgetting factor of 0.99.

Finally, FIG. **17** shows how MSE varies after 100 trials. This result serves to corroborate the power of the new algorithm on this new channel.

APPLICATIONS

The fields covered by this invention naturally include radiotelecommunications, mobile radio, and submarine telecommunications by sound, where it is convention at present to use decision feedback non-linear equalizers (DFE) in particular. These channels all suffer from the particular feature of being highly time-varying and in general they have long impulse responses. Communications by cable can also take advantage of this novel invention, given that they are generally characterized by impulse responses covering several symbol times and are thus poorly suited to using optimal receivers.

The types of modulation concerned by this invention are essentially linear modulation such as two or four phase state modulation (2-PSK, 4-PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM), all of which kinds of modulation are used widely in present-day applications.

The field over which the present invention is valid also extends to receivers using space or frequency diversity techniques for which the optimal structure in the sense of minimizing MSE is constituted, on each path, by a linear transversal filter **12** (step size T) and a recursive filter.

This structure can also be extended to equalizers of the fractionally-spaced type, i.e. to equalizers using more than one sample per symbol time, as compared with equalizers that are "synchronous" or "T-spaced". Such fractionally-spaced circuits generally provide an improvement in performance terms due essentially to the fact that they are relatively insensitive to how the sampling instant is chosen, unlike synchronous equalizers.

One example of a possible embodiment of a fractionally-spaced equalizer is shown in FIGS. **18** and **19**. During a convergence period or a period of difficult reception, the structure of the circuit is as shown in FIG. **18**. The interleaved signals written respectively x**1**(n) and x**2**(n) are given by the following expressions:

$x1(n)=x(nT+\tau)$

$x2(n)=x(nT+\tau-\Delta)$

with, for example and in entirely conventional manner, $\Delta=T/2$, and τ designating the sampling phase.

The purely recursive predictor **11** of transfer function 1/(1+C(z)) is common to both paths to which the signals x**1**(n) and x**2**(n) are applied and is optimized to whiten the output z**1**(n). The AGC **10** is updated to match the mean power of the signal z**1**(n) at the output from the predictor **11** to its nominal level. The transversal linear filters are referenced **12***a* and **12***b*. They are distinct for each of the two signals and they are characterized by their respective transfer functions B**1**(z) and B**2**(z). They constitute the phase equalizer and they may be adapted by any of the above-described algorithms. To understand this, it suffices to observe that the signal y(n) can also be written:

$y(n)=B^T(n-1)Z(n)$

$BT=[B1^T\ B2^T]$

$Z(n)^T=[Z1(n)^T Z2(n)^T]$

$Z1(n)=[z1(n), z1(n-1), \ldots, z1(n-L)]^T$

$Z2(n)=[z2(n), z2(n-1), \ldots, z2(n-L)]T$

$B1=[b_{0,1}, \ldots, b_{L-1,1}, b_{L,1}]$

$B2=[b_{0,2}, \ldots, b_{L-1,2}, b_{L,2}]$

As in the preceding circuit, once the MSE as estimated in the least squares sense drops below a certain threshold, the structure of the circuit is then changed to that shown in FIG. **19**. Simultaneously, the optimality criterion for adapting the various parameters then becomes minimizing the MSE. The corresponding equations are entirely similar to those described above.

Also, and as before, the locations of the gain g and of the carrier recovery circuit can be situated at various other points in the system.

Finally, and from a general point of view, the above-described algorithms associated with the circuit of the invention make use of an iterative technique of the "stochastic gradient" type. Naturally, a different approach and in particular the "recursive least squares" approach with a forgetting factor can be envisaged to accelerate the convergence process and to provide better tracking of rapid fluctuations in the transmission channel, but only at the cost of an increase in computational complexity.

Also, the means for evaluating performance may compute an MSE between the input and the output of the decision circuit **2** or they may compute, for example, the kurtosis of the input signal to the decision circuit **2**. This takes account effectively of the degree of deconvolution of the channel or, in equivalent manner, of the extent to which the equalization process has advanced.

Also, the location of the means **13** enabling phase error to be corrected may naturally be different from that in the above-described variants.

In particular, as a variant of the structure shown in FIG. **5**, the locations of the phase correction means **13** and of the filter **12** can be interchanged, with the equations that apply to such a structure being derived straightforwardly from those described above.

This change in structure also makes it possible to omit one complex multiplication since the feedback filter C(z) is then fed directly with detected data $\hat{d}(n)$ instead of with $\hat{d}(n).\exp(j\hat{\theta}(n-1))$.

Also, it is possible to imagine using a different strategy for triggering the change in structure and in algorithm. It is possible to use two thresholds $J_1 \leqq J_0$ and to switch from mode 1 (convergence) to mode 2 if and only if $MSE(n) \leqq J_1$, while switching from mode 2 to mode 1 takes place if and only if $MSE(n) \geqq J_0$. This serves in particular to avoid changing over repetitively under certain difficult circumstances.

Finally, a circuit could be imagined that is more complex and in which a circuit corresponding to the initial mode or "convergence" would be kept operating continuously and in parallel, in readiness to take over more quickly in the event of the circuit switching from tracking mode (mode 2) to convergence mode (mode 1) due to poor transmission conditions.

We claim:

1. An equalizer circuit for a digital communications system, the circuit including an automatic gain control circuit, carrier recovery circuit, data phase equalization circuit, and a predictor for data amplitude equalization, together with a decision circuit, wherein an automatic gain control circuit is operable associated with the carrier recovery circuit, the data phase equalization circuit, the predictor, and the decision circuit, and wherein the predictor is purely recursive, the phase equalizer is purely transversal, and the relative positions of those two elements are interchangeable, means for evaluating performance in terms of decision error and for causing the two elements to be interchanged in application of a criterion for evaluating the difficulty of reception, the predictor being upstream and optimized in adaptive and self-learning manner to whiten its own output while the phase equalizer is downstream and optimized in adaptive manner during periods of difficult reception, whereas the predictor is downstream and the phase equalizer is upstream, both being optimized jointly in adaptive manner to minimize decision error between the output (d(n)) of the decision circuit and its input w(n) or y(n) during periods of easy reception.

2. The circuit according to claim **1**, wherein the predictor performs iterative optimization by stochastic gradient or by the recursive least squares (RLS) technique.

3. The circuit according to claim **1**, wherein the predictor performs iterative optimization by stochastic gradient or by the recursive least squares (RLS) technique.

4. The circuit according to claim **1**, wherein during periods of easy reception, automatic gain control is kept at a constant level, with adaptation of gain being performed by the phase equalizer.

5. The circuit according to claim **4**, wherein the predictor performs iterative optimization by stochastic gradient or by the recursive least squares (RLS) technique.

6. The circuit according to claim **1**, wherein the predictor is fed either with estimated data (d(n)) obtained at the output from the decision circuit and phase corrected ($\exp(j\theta)$), or else by data (y(n)) from the output of the predictor, the circuit including means (a, b) for switching between said two feeds as a function of a criterion for evaluating the likelihood of the estimated data at the output from the decision circuit.

7. The circuit according to claim **6**, wherein during periods of easy reception, automatic gain circuit is kept at a constant level, with adaptation of gain being performed by the phase equalizer.

8. The circuit according to claim **6**, wherein the predictor performs iterative optimization by stochastic gradient or by the recursive least squares (RLS) technique.

9. The circuit according to claim **6**, wherein automatic gain control is situated upstream from the predictor and the phase equalizer.

10. The circuit according to claim **1** or **2**, wherein the means for evaluating performance in terms of decision error compute an MSE between the estimated data (d(n)) at the output of the decision circuit and the data (w(n)) at its input.

11. The circuit according to claim **10**, wherein during periods of easy reception, automatic gain control is kept at a constant level, with adaptation of gain being performed by the phase equalizer.

12. The circuit according to claim **10**, wherein during periods of easy reception, automatic gain control is kept at a constant level, with adaptation of gain being performed by the phase equalizer.

13. The circuit according to claim **10**, wherein the predictor performs iterative optimization by stochastic gradient or by the recursive least squares (RLS) technique.

14. The circuit according to claim **10**, wherein automatic gain control is situated upstream from the predictor and the phase equalizer.

15. The circuit according to claim **10** wherein the carrier recovery means are situated downstream from the transversal filter and from the purely recursive predictor.

16. The fractionally-spaced equalizer for processing more than one sample per symbol time, comprising, an equalizer circuit according to claim **10**, the circuit having a predictor common to the interleaved signals and distinct phase equalizers for each of said signals.

17. The use of a circuit according to claim **10**, in radiotelecommunications, in mobile radio, or in submarine acoustic telecommunications, or in cable telecommunications.

18. The use of a circuit according to claim **10**, for receiving digital communications signals using single or multicarrier modulation, including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

19. The circuit according to claim **1** or **2**, wherein the means for evaluating performance in terms of decision error compute the kurtosis of the input signal of the decision circuit.

20. The circuit according to claim **10**, wherein the predictor performs iterative optimization by stochastic gradient or by the recursive least squares (RLS) technique.

21. The circuit according to claim **19** wherein automatic gain control is situated upstream from the predictor and the phase equalizer.

22. The circuit according to claim **19** wherein the carrier recovery means are situated downstream from the transversal filter and from the purely recursive predictor.

23. The fractionally-spaced equalizer for processing more than one sample per symbol time, comprising, an equalizer circuit according to claim **19**, the circuit having a predictor common to the interleaved signals and distinct phase equalizers for each of said signals.

24. The use of a circuit according to claim **19**, in radiotelecommunications, in mobile radio, or in submarine acoustic telecommunications, or in cable telecommunications.

25. The use of a circuit according to claim **19** for receiving digital communications signals using single or multicarrier modulation, including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

26. The circuit according to claims **1**, **2**, **5**, or **6**, wherein automatic gain control is situated upstream from the predictor and the phase equalizer.

27. The circuit according to claim **26**, wherein the carrier recovery means are situated downstream from the transversal filter and from the purely recursive predictor.

28. The circuit according to claim 26 wherein the carrier recovery means are situated downstream from the transversal filter and from the purely recursive predictor.

29. The fractionally-spaced equalizer for processing more than one sample per symbol time, comprising, an equalizer circuit according to claim 26 the circuit having a predictor common to the interleaved signals and distinct phase equalizers for each of said signals.

30. The use of a circuit according to claim 26, in radiotelecommunications, in mobile radio, or in submarine acoustic telecommunications, or in cable telecommunications.

31. The use of a circuit according to claim 26, for receiving digital communications signals using single or multicarrier modulation including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

32. The circuit according to claims 1, 2, 5, or 6 wherein the carrier recovery means are situated downstream from the transversal filter and from the purely recursive predictor.

33. The fractionally-spaced equalizer for processing more than one sample per symbol time, comprising, an equalizer circuit according to claim 32, the circuit having a predictor common to the interleaved signals and distinct phase equalizers for each of said signals.

34. The use of a circuit according to claim 32, in radiotelecommunications, in mobile radio, or in submarine acoustic telecommunications, or in cable telecommunications.

35. The use of a circuit according to claim 32, for receiving digital communications signals using single or multicarrier modulation including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

36. The fractionally-spaced equalizer for processing more than one sample per symbol time, comprising an equalizer circuit according to according to claims 1, 2, 5, or 6, the circuit having a predictor common to the interleaved signals and distinct phase equalizers for each of said signals.

37. The use of a circuit according to claim 36, in radiotelecommunications, in mobile radio, or in submarine acoustic telecommunications, or in cable telecommunications.

38. The use of a circuit according to claim 36, for receiving digital communications signals using single or multicarrier modulation including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

39. The use of a circuit according to claims 1, 2, 5, or 6, in radiotelecommunications, in mobile radio, or in submarine acoustic telecommunications, or in cable telecommunications.

40. The use of a circuit according to claim 39, for receiving digital communications signals using single or multicarrier modulation including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

41. The use of a circuit according to claims 1, 2, 5, or 6 for receiving digital communications signals using single or multicarrier modulation, including in particular phase shift keying (PSK), amplitude modulation (AM), and amplitude modulation on two carriers in quadrature (QAM).

42. An equalizing method for a receiver of a digital communications system having automatic gain control means, carrier recovery means, means for data phase equalization, and a predictor for data amplitude equalization, the method further comprising the predictor is purely recursive, the phase equalizer is purely transversal, and the relative positions of those two elements are interchangeable, and in that performance is evaluated in terms of decision error and the two elements are interchanged in application of a criterion for evaluating the difficulty of reception, the predictor being upstream and optimized in adaptive and self-learning manner to whiten its own output while the phase equalizer is downstream and optimized in adaptive manner during periods of difficult reception, whereas the predictor is downstream and the phase equalizer is upstream, both being optimized jointly in adaptive manner to minimize decision error between the output (d(n)) of the decision circuit and its input (w(n) or y(n)) during periods of easy reception.

* * * * *

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,909,466
DATED : June 1, 1999
INVENTOR(S) : Labat et al.

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

Item [56], under the heading "Foreign Paten Documents," delete "A-0 512 712 4/1992 European Pat. Off. ..... H04L 3/25" and insert -- A-0 512 712 4/1992 European Pat. Off. ..... H04L 25/03 --.

Column 4,
Line 8, delete "algorithms fail Nevertheless, in spite of" and insert -- algorithms fail. Nevertheless, in spite of --.

Column 5,
Line 24, delete "non-limiting It should be" and insert -- non-limiting. It should be -- .

Column 7,
Line 62, delete "y(n-3), y(n-M)." and insert -- y(n-3),..., y(n-M). --.

Column 8,
Line 4, delete "reversible This property" and insert -- reversible. This property -- .
Line 59, delete "Z(n)=[z(n-l),..., z(n-L)]^{T}" and insert -- Z(n)=[z(n), z(n-l),..., z(n-L)]^{T} --.

Column 9,
Line 4, delete "B=[0 0 0 0 ^{l}]^{T}" and insert -- B=[0 0 0 0 1]^{T} --

Column 10,
Line 20, delete "$e_{Benv}(n)=k_1{}^{SM}e_{DD}(n)+k_2 \cdot e_{God}(n)|e_{DD}(n)$" and insert
-- $e_{Benv}(n)=k_1 e_{DD}(n)+k_2 \cdot e_{God}(n)|e_{DD}(n)|$ --.
Line 25, delete "I-14)" and insert -- (I-14) --.

Column 13,
Line 9, delete "f=[0.8264, 001653, 008512, 001636, 081]" and insert -- f=[0.8264, 0.1653, 0.8512, 0.1636, 0.81] -- .

Column 14,
Line 27, delete "Z2(n)=[z2(n), z2(n-1),..., z2(n-L)T" and insert
-- Z2(n)=[z2(n), z2(n-1),..., z2(n-L)]^{T} --.

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO. : 5,909,466
DATED : June 1, 1999
INVENTOR(S) : Labat et al.

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

Column 15,
Line 22, delete "circuit is operable" and insert -- circuit is operably -- .
Line 36, delete "output (d(n)) of the decision circuit and its input w(n) or y(n)" and insert -- output $(\hat{d}(n))$ of the decision circuit and its input w(n) or y(n)) --.
Line 53, delete "data (d(n))" and insert -- data $(\hat{d}(n))$ -- .
Line 54, delete "corrected (exp(jθ))" and insert $(\exp(j\hat{\theta}))$ -- .

Column 16,
Line 3, delete "data (d(n))" and insert -- data $(\hat{d}(n))$ -- .
Line 23, delete "comprising, an equalizer" and insert -- comprising an equalizer --.
Line 40, delete "claim **10**" and insert -- claim **19** --.
Line 50, delete "comprising, an equalizer" and insert -- comprising an equalizer --.

Column 17,
Line 5, delete "comprising, an equalizer" and insert -- comprising an equalizer --.

Column 18,
Line 36, delete "output (d(n))" and insert -- output $(\hat{d}(n))$ -- .

Signed and Sealed this

Fourth Day of September, 2001

Nicholas P. Godici

Attest:

Attesting Officer

NICHOLAS P. GODICI
Acting Director of the United States Patent and Trademark Office

Exhibit 1011

"Digital Transmission Over In-Home Coaxial Wiring," Kerpez et al., IEEE (1997)

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DIGITAL TRANSMISSION OVER IN-HOME COAXIAL WIRING

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Abstract - The wiring of a customer's premises network (CPN) may be the weakest link in the end-to-end transport of residential broadband digital services such as digital video. Detailed knowledge of how such premises wiring will affect digital service delivery is critical to the cost-effective deployment and robust operation of digital technologies. This paper reports selected results from a series of experimental and analytical studies of coaxial-cable premises-wiring impairments for digital broadband signals. The investigations included return loss, isolation and attenuation measurements of a wide variety of components, as well as measurements and simulations of bit-error-rate performance for several inside-wiring test-bed configurations. The components showed a broader range of performance, and in some cases considerably worse performance, than indicated in previous studies. The premises wiring generated signal reflections which can severely degrade digital transmission. Some reflections can cause destructive interference that effectively decreases the received signal power by 10 dB more than the nominal attenuation, and this decrease is not mitigated by set-top or cable-modem adaptive equalization.

I. INTRODUCTION

In-home, customer-premises wiring represents one of the weakest links in the end-to-end delivery of residential broadband services. The quality of digital video or data services can be seriously degraded by ingress, impulse noise, signal reflections, and limited bandwidth or excessive attenuation in premises wiring.[1-3] The resulting signal impairments can vary widely from one home to another as a result of differences in inside-wiring topology, component quality and installation practices. These characteristics are not under the control of the service provider, and are likely to change over time as customers modify their wiring configurations.

A central question is the degree to which transmission impairments in premises wiring are likely to degrade service quality, potentially requiring changes in wiring, installation and maintenance procedures, or network design. These issues are relevant to a wide range of broadband digital networks, including terrestrial digital broadcasting, satellite, multichannel multipoint distribution service (MMDS), local multipoint distribution service (LMDS), hybrid fiber/coax (HFC), and switched digital video (SDV).

This paper addresses impairments in coaxial-cable customer premises networks (CPNs), and includes selected results from a series of measurements and simulations covering both component performance and the overall system impact on digital transmission. The focus here is primarily on signal reflections, which are shown to be capable of producing severe degradations. We identify one important class of static reflections which is not mitigated by adaptive equalization. More generally, the data and the underlying models developed in the course of this work can be applied to a wide range of access network technologies and inside-wiring topologies. This should be helpful in developing guidelines for new CPN installations, for determining when to repair or replace existing wiring, and for establishing installation and maintenance procedures to ensure service quality.

Section II briefly reviews existing broadband inside-wiring networks and the impairments which they can generate for digital signals. Section III focuses on the origins of signal reflections, and provides illustrative results from component performance studies. Section IV presents experimental investigations of the impact on system-level performance for digital transmission. Section V presents computer simulations of digital transmission on coaxial inside-wiring. Section VI contains further discussion and conclusions.

II. CUSTOMER PREMISES NETWORKS (CPN)

It is often assumed that new broadband services, such as digital video broadcasting or high-speed data delivery, will re-use existing premises wiring to minimize installation cost and subscriber inconvenience. The coaxial video-distribution network found in most homes is a natural candidate, due to its high bandwidth and its existing routing to one or more TV-viewing locations. New or replacement wiring would be similar, except for the use of more modern cable and components. Alternative

This paper was presented in part at the *Twelfth Annual National Fiber Optic Engineers Conference, NFOEC '96,* Denver, September 8-12, 1996.

Publisher Item Identifier: S 0018-9316(97)05619-9

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approaches have been proposed to improve the transmission performance, but typically require additional gateway electronics at the entrance to the home [4] (e.g., to select the signals of interest and re-modulate them in a more robust format), or a combination of gateway electronics and new premises wiring. Therefore it is important to determine under what circumstances traditional premises wiring will be adequate for carrying digital signals.

A typical video CPN might connect incoming video through a 1:2 splitter to a cable-ready TV and to a second TV utilizing a digital set-top box (STB). The cable itself is usually RG-6 or RG-59 coax. Coaxial F-connectors are used at every interface, i.e., at the ground block, splitter ports, wall plate, TV and set-top, and wherever jumpers have been added. Additional equipment may also be connected, such as VCRs, cable/antenna switches, FM traps (which separate video and FM bands), or video-game equipment. Many installations today consist of a 1:2 splitter serving two outlets, or even a single cable directly connected to one TV. This may well be inadequate for future services, given the growing interest in additional connections for personal computers, and the fact that one-third of US households now have at least three TVs. [5]

The condition of the CPN depends strongly on its original installation and its subsequent history. A wide range of component quality and installation practices must be expected. [6,7] Cables and connectors can deteriorate with age, and older systems are also likely to have lower-bandwidth components. The wiring may well have been modified or reconfigured by the residents.

Good performance for analog video does not ensure adequate quality for digital signals.[8] Most broadband digital networks will operate at higher and/or lower frequencies than traditional one-way cable systems. The CPN is the major entry point for ingress and impulse noise, which is especially pronounced in the low-frequency bands (i.e., < 40 MHz) now being activated. At higher frequencies, limited bandwidth or excessive attenuation can severely limit signal quality, as the digital bit-error rate (BER) degrades more abruptly than the analog carrier-to-noise ratio (CNR) with reductions in the received signal power.

Digital transmission is also strongly affected by small signal reflections (commonly referred to as microreflections in the cable-industry literature), which would not be noticeable with analog video. Signal distortion due to static reflections can be reduced by adaptive equalization. Equalization adds cost and complexity to set-top converters and high-speed modems, and must be designed to accommodate realistic reflection amplitudes and time delays. Upstream transmission is generally less amenable to this approach, due to the complications introduced by multiple-access systems. Time-varying reflections (such as those which can be caused by channel surfing on a TV connected to a different output port of the splitter connected to the digital receiver) are difficult to compensate with equalization, and can cause signal loss and gaps in real-time transmissions.

The remainder of this report focuses on signal reflections, which represent one of the most common CPN impairments.

III. COMPONENTS CAUSE REFLECTIONS THAT CAUSE ECHOES

As signals propagate, they encounter an impedance mismatch at every cable connector and component interface. Each mismatch causes a portion of the signal to be reflected and travel in the opposite direction. Two successive changes in direction can produce an echo, i.e., an attenuated and delayed replica of the signal, transmitted in the same direction. Echoes interfere with detection of the main signal, which travels directly to the receiver.

Figure 1 illustrates the two most common mechanisms for generating echoes in the CPN. Echo path 1 corresponds to a signal which is reflected twice in succession, by two different devices (in this example, the set-top converter and the two-way splitter). At each interface, the power in the reflected signal is attenuated by an amount equal to the return loss of the interface. The return loss, measured in dB, is the ratio of the incident signal power to the signal power which is reflected. A perfect, non-reflecting interface would have an infinite return loss, while a total 100% reflection (e.g., from an open or shorted cable) would correspond to a return loss of 0 dB. The echo corresponding to path 1 is thus attenuated at both reflection points, and is further attenuated (relative to the direct signal) as a result of the longer distance which it travels through the cable.

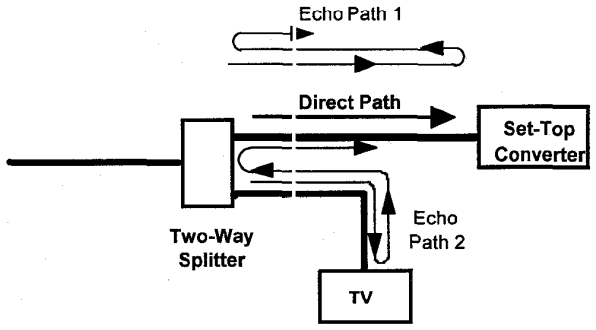


Fig. 1. Two types of echo paths which can interfere with the signals passing directly to the digital set-top converter.

Echo path 2 is an example of an echo generated by a single reflection point. In this case, inadequate isolation between the output ports of the splitter causes part of the signal reflected from the TV to be funneled into the other branch, leading to the set-top converter. The isolation, measured in dB, is the ratio of the signal power incident at an output port to the signal power which emerges from a different output port. A splitter with no cross-coupling between output ports would have an infinite isolation, while a splitter with complete coupling between output ports would have an isolation of 0 dB. The echo corresponding to path 2 is thus attenuated by the return loss at the TV, the isolation of the splitter, and the loss of the additional cable traversed.

Echo path 2 is often of particular concern, for two reasons. First, very large (0 dB) reflections can be generated on the lower branch in Fig. 1, if the cable is disconnected from the TV and left unterminated. In this case, the splitter isolation is the only reliable defense against large echoes on the other branch of the network. Secondly, with the TV connected, echo path 2 represents a major source of time-varying echoes. The input impedance of a TV is typically well-matched to 75 Ω only at the frequency to which the TV is tuned. At other frequencies the TV's return loss can be nearly 0 dB.[9] Furthermore, the return loss varies strongly with frequency. As a result, channel-surfing on the TV can generate strong, time-varying echoes at the (fixed) frequency being accessed by the set top on the other branch.

Since the size of the echoes depends so strongly on component properties, it is critical to know the full range of component performance which is likely to be encountered. Previously published studies [7] have provided valuable information on component performance, but have typically been limited to a very small sampling of devices (e.g., six 1:2 splitters, most with 600 MHz bandwidth). For this project, a wide variety of components was obtained, from equipment utilized by cable-television service providers, to components available at electronics stores and other retail outlets. This included roughly two dozen splitters, both 1:2 and 1:4 varieties, rated for operation at 600 MHz, 900 MHz and 1 GHz. Attenuation, return loss and isolation were measured over a range of 300 kHz to 1 GHz.

A sample of the results is presented here. Figure 2 presents the isolation performance (important for echo path 2) of several 1:4 splitters, all rated for operation to either 900 MHz or 1 GHz. Note that a splitter with 10 dB isolation will pass 10% of the signal power incident at one output port to the second output port. A splitter with 20 dB isolation (the worst-case value reported in [7]) passes only 1% of the signal power between output ports.

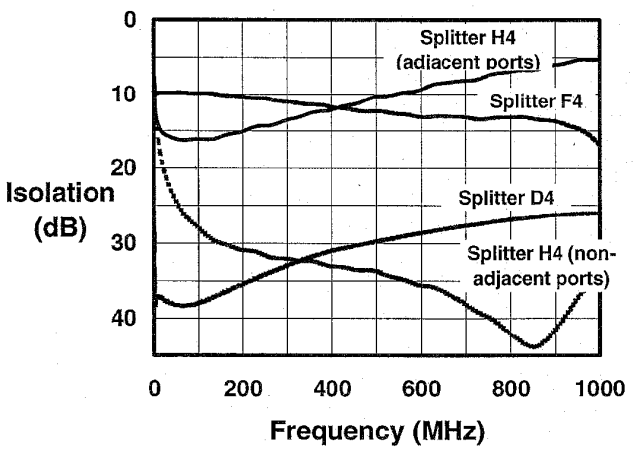


Fig. 2. Output-port isolation as a function of frequency for several 1:4 coax splitters, rated for 900 MHz or 1 GHz bandwidth.

The curves in Fig. 2 show a very wide range of performance. The two top curves show splitters which exhibit isolations well below 20 dB over their entire frequency range. The isolation of splitter F4 is no greater than 10 dB from 5 MHz to 140 MHz. The isolation of splitter H4 is less than 10 dB from 540 MHz up to the top rated frequency of 900 MHz, where it falls to only 6 dB. On the other hand, splitter D4 maintains a high isolation of at least 26 dB at all measured frequencies.

For comparison, 20-25 dB of isolation is typically provided between output ports of a coaxial multi-tap, which is used to supply signals to multiple subscriber drops. A previous study [7] of six 1:2 splitters had reported port-to-port isolations exceeding 20 dB over their full rated bandwidth (600 MHz or 1 GHz), and an earlier study [9] had reported a worst-case isolation of 15 dB for an unspecified number of splitters (apparently including 1:4s).

Splitter isolation can be measured between any pair of output ports. In some cases, significant differences were observed depending on the particular pairs of ports that were measured. With splitter H4 in place, Fig. 2 shows that the network performance could depend substantially on which specific splitter ports were connected to the equipment of interest. This is important to keep in mind when troubleshooting an existing premises network.

The return loss of the components was also measured, and a sample of these measurements is shown in Fig. 3. Return loss measurements were made with all unused ports terminated (in 75 Ω). Here again a wide range of performances was observed. The return loss of the worst component was as low as 3 dB, meaning that half the signal power was reflected.

Other components had return losses exceeding 20 dB at all measured frequencies.

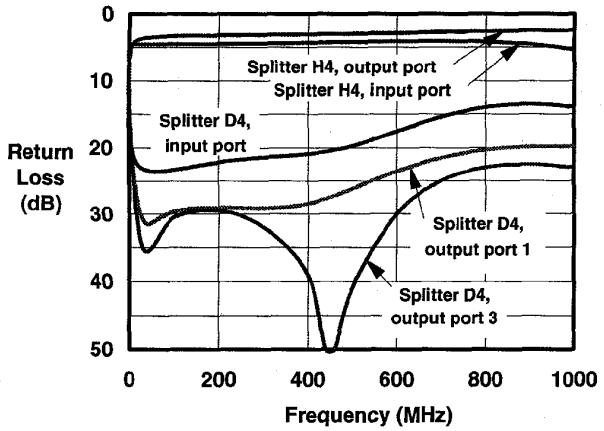


Fig. 3. Return loss as a function of frequency for several 1:4 coax splitters, rated for 900 MHz or 1 GHz bandwidth.

In general, our measurements of isolation, return loss and attenuation covered a wide variety of components, including many 1:2 and 1:4 splitters, and indicated that there is a broader range of performance, and in some cases considerably worse performance, than has been previously noted. [7,9] The worst overall performance of a 2-way splitter measured at a single frequency from 5-1000 MHz was 5 dB attenuation, 12 dB isolation, and 5 dB return loss. The worst overall performance of a 4-way splitter measured at a single frequency from 5-1000 MHz was 15 dB attenuation, 6 dB isolation, and 3 dB return loss. These numbers are exceptionally poor. On the other hand, quite a few components exhibited excellent performance and should not degrade digital signals. It is interesting to note that even simple components such as ground blocks and wall-plates can cause reflections; these components all had about 33 dB return loss at 50 MHz, 20 dB return loss at 300 MHz, and 12 dB return loss at 700 MHz.

Components tend to fall into groups on the basis of their *measured* performance. However, labels such as "CATV industry products" and "retail products" [7] are *not* always good predictors of performance. For example, one type of 1 GHz-rated cable-industry 1:2 splitter which was measured exhibited performance in critical tests which was comparable to the lowest-performance retail splitter.

IV. EXPERIMENTS OF DIGITAL TRANSMISSION ON COAX INSIDE-WIRING

Having examined the range of inside-wiring component characteristics that are encountered in residential CPNs, we next investigated the resulting impact on digital transmission performance. To quantify this impact, a number of CPN "test configurations" were developed, representing a range of component quality and likely wiring topologies. The configurations with good components had little impact on digital transmission, so the results for them are not displayed here. This paper instead concentrates on the configuration with the poorest characteristics.

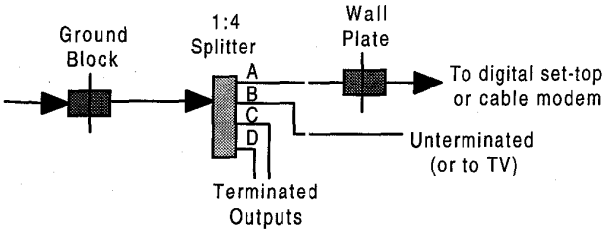


Fig. 4. One of several test configurations used to investigate premises-wiring impairments.

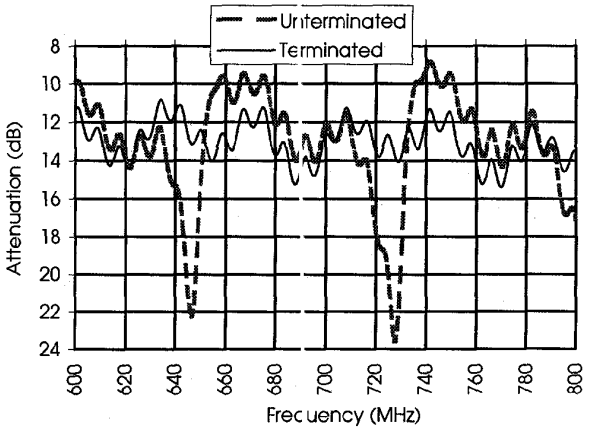


Fig. 5. The response of the test configuration in Fig. 4, with a 5-ft cable connected to output port B which is both with and without a 75 Ω termination.

Figure 4 shows this test configuration. From left to right, the set-up consists of a ground block, a four-way splitter and a wall plate, followed by a receiver (representing a digital set top or data modem). The splitter is a retail device (splitter H4 in Figs. 2 and 3) exhibiting high insertion loss (10 dB), low return loss (3 dB at the output port) and low isolation (8 dB), where the quoted performance was measured at 700 MHz. This splitter represents a worst case, but it is not at all unusual and was in fact one of the most

commonly available retail products in our area at the time this work was performed. Unused splitter ports C and D are terminated in 75 Ω. Port B is connected to either terminated or unterminated cables of varying lengths, to create reflections with different time delays and magnitudes (in addition to the many other reflections which take place between the ground block, splitter and wall plate). Figure 5 shows the measured magnitude response of this configuration at high frequencies with a 5-ft cable connected to port B. Notice the deep null at 728 MHz when the 5-ft cable is unterminated.

Bit-error-rate (BER) performance was measured as a function of the signal level at the entrance to the home (i.e., at the ground block) using a commercial 64-QAM modulator and demodulator operating at 30 Mbps. With 6 bits represented by each 64-QAM symbol, this corresponds to a rate of 5 Mbaud (5 million symbols per second). The demodulator contained a 16-tap adaptive equalizer, and the system had no error correction. The experimental configuration allows for BER testing over a wide span of carrier frequencies of interest in future digital networks, such as the 550 MHz to 750 MHz region frequently targeted for downstream digital transport over HFC networks. Quantifying BER performance as a function of the signal level at the CPN input, rather than at the input to the digital receiver, provides a more-direct measure of power penalties due to the inside wiring.

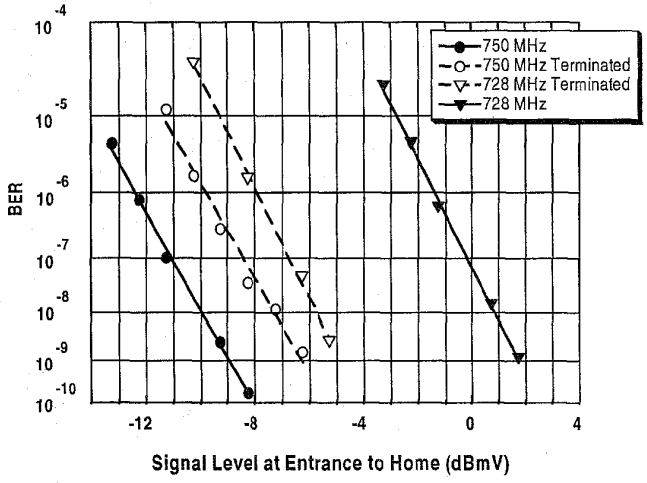


Fig. 6. BER measurements for 64-QAM transmission through the premises wiring test configuration in Fig. 4, at 728 MHz and 750 MHz, with and without termination at the end of a 5-ft cable connected to splitter port B.

Figure 6 shows BER curves for the configuration of Fig. 4 at two different carrier frequencies, with either terminated or unterminated 5-ft cables connected to splitter port B. One might expect relatively little variation in BER performance across the ~20 MHz range of frequencies shown in the figure, since the nominal cable and splitter attenuations are roughly constant across this region. However, when the 5-ft cable was left unterminated (a common occurrence in today's CPNs), changing the carrier frequency from 750 MHz to 728 MHz increased the CPN input signal-level requirement by nearly 11 dB. Terminating the 5-ft cable eliminated the strongest echoes in the transmission, reducing the BER variations with frequency, and improving the performance at 728 MHz by roughly 7 dB. Note, however, that terminating the 5-ft cable actually *degraded* the BER performance at 750 MHz.

This wide variation of BER with carrier frequency is the result of carrier interference effects that arise from strong short-time-delay echoes within the CPN. The relative phases of the carriers for the direct and reflected signals arriving at the digital receiver's input will depend on the carrier frequency and on reflection path lengths (i.e., on the lengths of CPN cables). For a prescribed set of cable lengths, a given echo will arrive in phase at certain frequencies, producing constructive interference, but will arrive 180 degrees out of phase at certain other frequencies, causing destructive interference. In our test configuration, the strong reflection from the 5-ft cable produces destructive interference which leads to deep nulls in the frequency response, including a null at 728 MHz. On the other hand, constructive interference from the various reflections in the system occurs at 750 MHz, which explains the improved performance when the cable is left unterminated. The exact positions of peaks and nulls in the CPN frequency response depend on the cable lengths, which of course will vary from one home to another. Since the echo from the 5-ft cable has a short delay (~ 3% of the 64-QAM baud period), it was not eliminated by the adaptive equalizer .

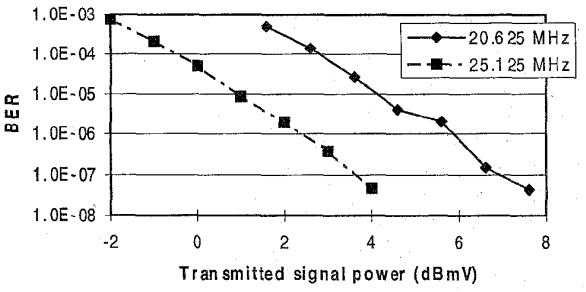


Fig. 7. BER measurements for 16-QAM transmission through the premises-wiring test configuration in Fig. 4, at 20.625 MHz and 25.125 MHz, with a 40 ft unterminated cable connected to splitter port B.

Transmission was also tested with frequencies and modulations typical for upstream transmission on cable TV networks such as HFC. A 16-QAM modulator and demodulator operating at the DS1 rate of 1.544 Mbps was used to send signals over the configuration in Fig. 4. Here the modulated signal has 100% excess bandwidth, and occupies 772 kHz of bandwidth. 16-QAM signals from the transmitter were injected into the inside-wiring test configuration. After passing through the inside wiring, the signals were sent to the 16-QAM receiver. A constant noise level was injected at the input to the receiver, which represents upstream reception of ingress and other noises from multiple sources. The receiver contained no adaptive equalizer, and no forward error correction.

The configuration in Fig. 4 was used with a 40-ft unterminated cable connected to the splitter output port B. A 40-ft cable was used here since the 5-ft cable did not create a notch in the configuration's magnitude response below 40 MHz. Carrier frequencies were chosen near a peak (25.125 MHz) and near a valley (20.625 MHz) of the configuration's magnitude response. The results of the 16-QAM experiments, shown in Fig. 7, indicate about a 3 dB difference between the two frequencies in the required transmit signal power for a fixed BER and a fixed received noise power. This difference, while significant, is much less than that observed at the higher-frequencies used with 64-QAM shown in Fig. 6.

V. COMPUTER SIMULATIONS OF DIGITAL TRANSMISSION ON COAX INSIDE-WIRING

Detailed computer simulations of digital signal delivery over coaxial CPNs have been developed and successfully tested against experimental measurements. The simulations build on previously reported work.[10] These simulations can determine the impacts of changes in spectrum allocation, modulation technique, component properties, cable lengths, or adaptive equalization. The computer models allow a more expeditious investigation of a broader range of important parameters than could be easily measured in the laboratory.

The simulations can be used to isolate the effects of different types of echoes on digital transmission. Reflections cause echoes that have either of two effects on transmission performance, depending on whether their time delay is long or short. Short-delay echoes are delayed by less than about one symbol period (one baud). Short-delay echoes effectively rotate, and either dilate or compress the received signal constellation. They will decrease the signal strength if they differ in carrier phase from the direct signal by a multiple of 180^0. This phase difference is sensitive to changes of just a few feet in propagation distance. Carrier recovery loops eliminate the phase rotation. However, any signal attenuation caused by the echo will irrecoverably decrease the received signal-to-noise ratio (SNR). In the worst case, the echo is 180^0 out of carrier phase and it coherently subtracts itself from the received signal voltage. Adaptive equalizers cannot recover the portion of the signal that is canceled by an out-of-phase short-delay echo.

Long- delay echoes are delayed by more than approximately one symbol period. Long-delay echoes can be effectively mitigated by an adaptive equalizer if the delay of the echo is within the span of the equalizer, and if the echo source does not vary rapidly with time. If there is no equalizer, then the distortion engendered by a long-delay echo will become additive noise that increases the BER.

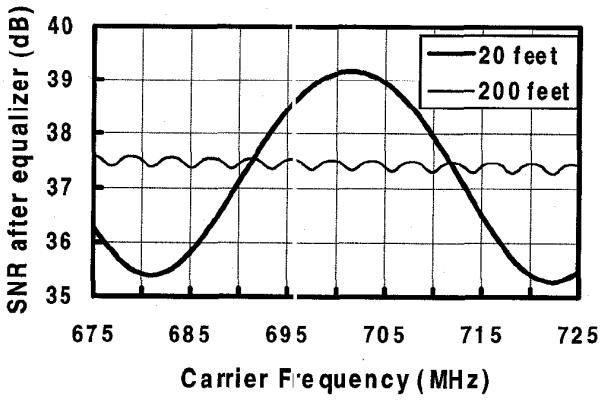


Fig. 8. Signal-to-Noise Ratio (SNR) at the output of the adaptive equalizer, with a single echo, 12 dB down from the direct signal, delayed by traveling an additional 20-ft or 200-ft round-trip path in the coax.

The difference in the effects of short- and long-delay echoes is illustrated in Fig. 8. This figure shows computer simulation results of a 64-QAM receiver for the idealized case of a single echo, with either a 20-ft or a 200-ft round-trip reflection path length. These lengths correspond to 0.1 and 1.1 baud periods, respectively, of the 64-QAM waveform carrying 30 Mbps. Both curves assume adaptive equalization, and both assume an echo amplitude 12 dB down from the direct signal. The short echo produces a 4 dB SNR variation across the range of carrier frequencies considered, while the longer echo causes negligible variation in SNR. In practice, the effects of long-delay echoes are often further reduced by the additional attenuation that usually accompanies the longer propagation lengths.

The simulation result shown in Fig. 8 illuminates the difference between short- and long-delayed echoes, but it is idealized. To mirror real-world conditions, simulations were written that read-in and use the measured response of a wiring configuration.

Simulations of 64-QAM were performed with and without adaptive equalization. The simulated 64-QAM sends 30 Mbps with a baud rate of 5 Mbaud using a raised-cosine pulse with 20% excess bandwidth, and occupies the same 6 MHz bandwidth as a TV channel. The equalizers are 16-tap, complex, baud-spaced, and adapted to minimum mean squared error. The noise power is constant, so it is the same at the transmitter and receiver; but the signal is attenuated and distorted by the inside-wiring, so it has lower power at the receiver than at the transmitter. The SNR is the ratio of the average signal power to the average noise power, where the noise is the sum of Gaussian noise and inter-symbol interference. The BER is calculated by taking the Q-function of the received SNR. The SNR at the transmitter is chosen so that the receiver operates near the limit of acceptable BER. 64-QAM requires 28 dB received SNR for a 10^{-7} BER with no error correction.

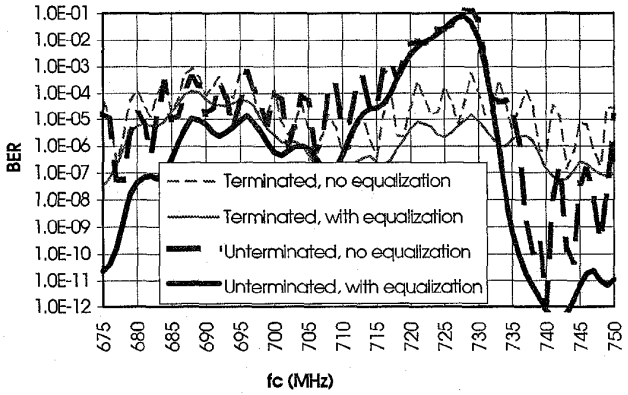


Fig. 9. Simulations of 64-QAM with a 5-ft cable connected to splitter port B which is terminated and unterminated. The SNR at the transmitter is 40 dB.

64-QAM simulation results are shown in Fig. 9. With an unterminated cable and equalization in the receiver, the BER difference as the carrier frequency changes from 750 MHz to 728 MHz corresponds to about an 11-dB difference in input SNR, the same as the experimental findings in Fig. 6. Fig. 9 shows that while equalization improves the performance somewhat, it does not remove the severe degradation at 728 MHz caused by the short-delayed echo.

Simulations were also run with typical modulations for upstream transmission on cable: QPSK and 16-QAM. Notice that QPSK is the same as 4-QAM. The bit rate of simulated QPSK and 16-QAM is 1.544 Mbps and the transmitter sends raised-cosine pulses modulated to the carrier frequency for both. 16-QAM transmits at 386 kbaud with 100% excess bandwidth and occupies 772 kHz RF bandwidth. QPSK transmits at 772 kbaud with 40% excess bandwidth and occupies 1.1 MHz RF bandwidth. The 16-QAM and QPSK receivers have no adaptive equalizer. A fixed level of noise is injected into the receiver, then the received signal and noise are demodulated to baseband and sampled at the baud rate, and the SNR and BER are calculated the same way as described for 64-QAM. The 16-QAM and QPSK simulations use no equalization.

16-QAM requires 21 dB received SNR for a 10^{-7} BER on a flat channel with no reflections. QPSK requires 14 dB received SNR for a 10^{-7} BER on a flat channel, 7 dB less than 16-QAM. Figure 10 presents a test case comparing these two modulations, where a 40-ft cable was attached to splitter port B since a 5-ft cable did not create a notch in the configuration's response below 40 MHz. Otherwise, the inside-wiring configuration is the same as previously. Figure 10 shows that 16-QAM and QPSK have essentially identical performance except for their constant difference in required SNR. The approximately periodic change in BER shown in Fig. 10 corresponds to the 3 dB transmit power difference shown in the experimental results in Fig. 7.

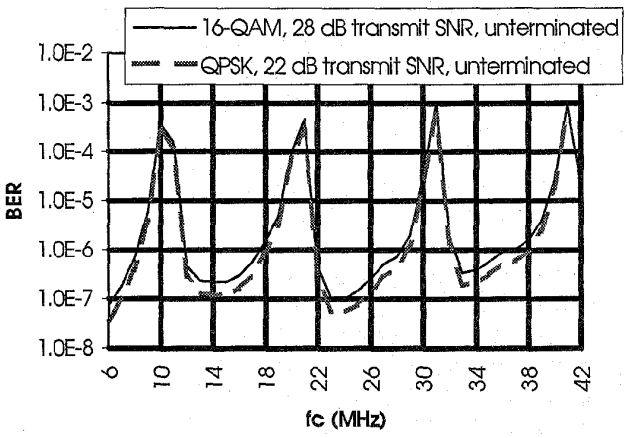


Fig. 10. A comparison of 16-QAM and QPSK transmitted on the configuration of Fig. 4 with a 40-ft unterminated cable connected to splitter port B. No equalization.

Another, more aggressive, technique for upstream transmission on cable is to send 16-QAM signals in high-frequency bands. This was simulated using the configuration of Fig. 4 with a 5 ft cable connected to splitter port B, the same as used with 64-QAM. The results are shown in Fig. 11, which indicates wide swings in performance, including frequency-dependent received SNR variations up to 10 dB.

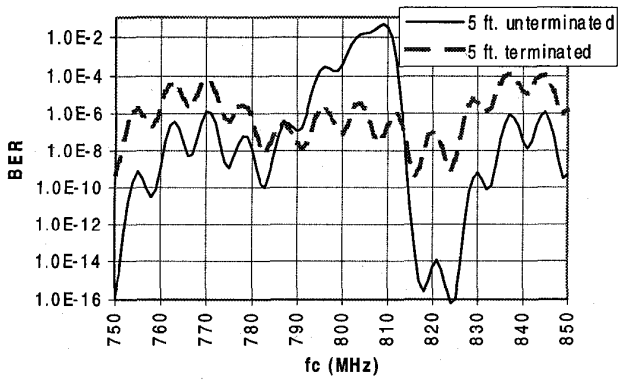


Fig. 11. High-frequency bands for upstream 16-QAM transmission on the configuration of Fig. 4 with a 5-t unterminated and unterminated cable connected to splitter port B. The SNR at the transmitter is 55 dB. No equalization.

VI. DISCUSSION AND CONCLUSIONS

The ability to deliver robust, high-quality broadband digital signals to the home will depend strongly on the quality of the customer-premises network, which is not directly under the control of the service provider or broadcaster. In order to manage this situation, it is critical to have a realistic picture of the range of impairments likely to be encountered, and to establish procedures for overcoming these effects in a cost-effective manner.

The major impairments for digital signals in the CPN are due to ingress, excessive attenuation, and signal reflections. This paper has reported selected results, focusing on reflections, from an extensive series of experimental and analytical studies of component and system-level performance.

The components showed a broader range of performance, and in some cases considerably worse performance, than indicated in previous studies. [7,9] For example, 900-MHz 1:4 splitters can have output port isolation as low as 6 dB at high frequencies, compared with the 20 dB isolation reported in earlier studies using a much smaller sample of splitters. The splitter isolation is directly related to the size of the static and time-varying echoes which will be observed at a digital set top or high-speed modem. Components tend to fall into several categories, based on their overall insertion loss, return loss and isolation performance. However, splitter origin (e.g., cable-industry supplier vs. retail supplier) is *not* always a good predictor of performance.

Using the component performance results, and a set of reasonable wiring topologies, a number of CPN "test configurations" were developed to represent a range of likely premises-network performance. These configurations were used for experimental performance measurements and computer simulations of the system-level impact of impairments on digital transmissions. It was found that coaxial inside-wiring causes a steady nominal attenuation that varies slowly with frequency, and a rapidly fluctuating attenuation caused by reflective echoes that add in and out of carrier phase with the signal. Results are presented here for the worst test configuration, but it should be noted that the other test configurations did not generate degradations as large as those presented here.

BER measurements were obtained for 64-QAM transmission of 30 Mbps data, as might be used for downstream transmission in an HFC system. Using a test configuration with a poor-quality 1:4 splitter and an unterminated 5-ft cable, destructive-interference effects produced frequency-dependent variations in the received SNR that were greater than 10 dB. This difference was observed at two frequencies separated by only about 20 MHz. The effective attenuation was as high as 23 dB, even though there was only a 1:4 split. These effects can be reduced or eliminated in principle through the use of better splitters, although the total eradication of poor-quality wiring components from residential CPNs is probably impractical in the near term.

Computer simulations were developed that can easily examine a wide range of transmission systems and parameters. The simulation results were shown to agree very well with the laboratory experiments. The same frequency-dependent SNR variations of over 10 dB were observed with the simulated 64-QAM.

Typical upstream modulations, QPSK and 16-QAM, were also tested. Experimental results showed only about a 3-dB frequency-dependent SNR variation from 5-40 MHz, much less than that observed at higher frequencies. 16-QAM consistently requires 6 to 7 dB more received signal power than QPSK to operate at the same BER. The potential use of high-frequency bands (750-850 MHz) for carrying upstream signals was also examined. The high-frequency transmissions experience more performance variations than low-frequency transmissions, with up to a 10-dB frequency-dependent SNR variation. Attenuation is also much worse at high frequencies.

Our results have the following implications:

The potential for high signal attenuation within the CPN requires that adequate signal strength be delivered to the input of the CPN. This requirement will clearly affect the design of the service provider's network.

Adaptive equalization within the set-top converter cannot be relied on to mitigate all inside-wiring problems. Equalization does not overcome

excessive CPN signal attenuation caused by excessive splitting or by interference effects from short-time-delay echoes.

Since interference effects vary strongly with frequency, they could easily be overlooked if an installer were to test the performance of only one or a few HFC, MMDS or LMDS channels. Even if testing were performed over a wide frequency range to detect existing problems, CPN characteristics will change as the customer installs new equipment and alters connections or cable lengths.

Consumers need to be educated to appreciate the value of good-quality inside wiring. Retail coaxial splitters should be rated, perhaps with a simple pass/fail based on just a small number of characteristics. Consumers should then be told of the rating, and they should also be encouraged to add terminators on unused cables and splitter ports.

There are a number of potential approaches for minimizing CPN-related service outages and craft dispatches. These include repairing or replacing premises wiring to minimize instances of poor-quality materials and craftsmanship, trading capacity for robustness by using less-aggressive digital modulation formats (e.g., 64-QAM rather than 256-QAM), increasing the transmitted power to deliver stronger signals to the home, or regenerating and re-modulating digital signals in a residential gateway at the side of the house. All of these options will effectively raise the cost of broadband digital service delivery. However, with careful planning, an appropriate set of installation, test and maintenance procedures can be developed which will guard against large, unanticipated deployment and life cycle costs.

The optimal approach to premises-wiring problems may vary from one service provider to another, or even from one geographic area to another, depending on the choice of network technology (e.g., VHF/UHF broadcast, satellite, MMDS, LMDS, HFC, or SDV), the nature of the projected service demands, and the resulting tradeoffs between installed first cost and life cycle costs. In any event, the implications of CPN impairments on digital network design, service installation and maintenance practices must be carefully considered to ensure successful deployment of broadband digital services.

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Exhibit 1006

U.S. Patent No. 7,127,734 to Mati Amit

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US007127734B1

(12) **United States Patent**
Amit

(10) **Patent No.: US 7,127,734 B1**
(45) **Date of Patent: Oct. 24, 2006**

(54) **SYSTEM AND METHODS FOR HOME NETWORK COMMUNICATIONS**

(75) Inventor: **Mati Amit**, Zur-Yigal (IL)

(73) Assignee: **Texas Instruments Incorporated**, Dallas, TX (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **09/548,048**

(22) Filed: **Apr. 12, 2000**

Related U.S. Application Data

(60) Provisional application No. 60/128,810, filed on Apr. 12, 1999.

(51) **Int. Cl.**
H04N 7/18 (2006.01)

(52) **U.S. Cl.** **725/80**; 725/82

(58) **Field of Classification Search** 725/74, 725/78, 80, 81, 82, 85, 111, 110, 131, 133, 725/139, 141, 151, 153; *H04N 7/18, 7/16*
See application file for complete search history.

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6,637,030	B1	*	10/2003	Klein 725/78

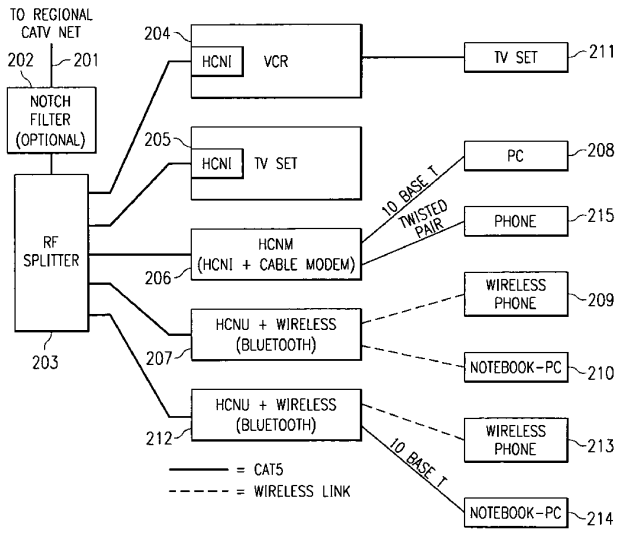
* cited by examiner

Primary Examiner—Vivek Srivastava
(74) *Attorney, Agent, or Firm*—Abdul Zindani; W. James Brady, III; Frederick J. Telecky, Jr.

(57) **ABSTRACT**

The present invention provides the ability to use existing cable TV wires for home networking.

18 Claims, 8 Drawing Sheets



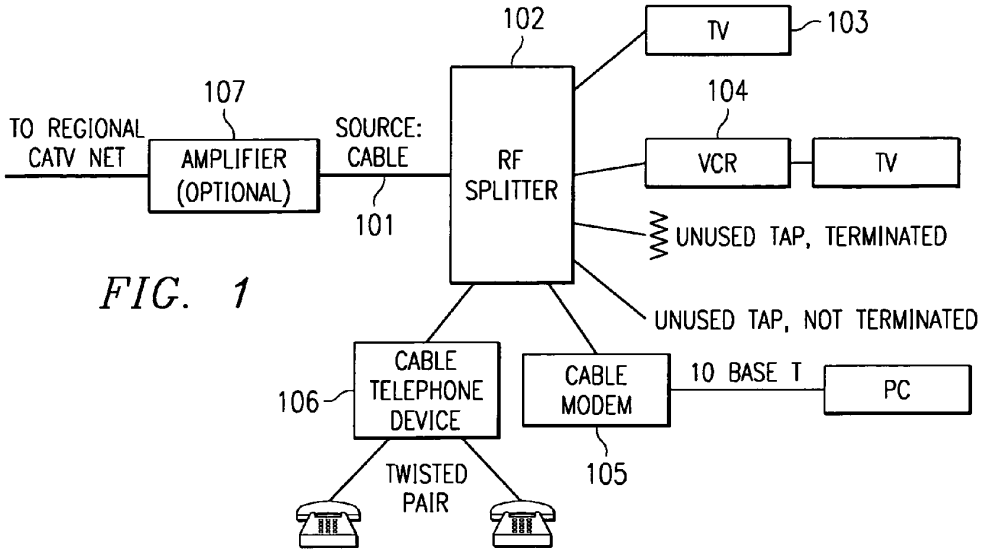

102
TV
103
107
104
TO REGIONAL CATV NET
AMPLIFIER (OPTIONAL)
SOURCE: CABLE
RF SPLITTER
VCR
TV
101
UNUSED TAP, TERMINATED
UNUSED TAP, NOT TERMINATED
CABLE TELEPHONE DEVICE
CABLE MODEM
10 BASE T
PC
106
105
TWISTED PAIR

FIG. 1

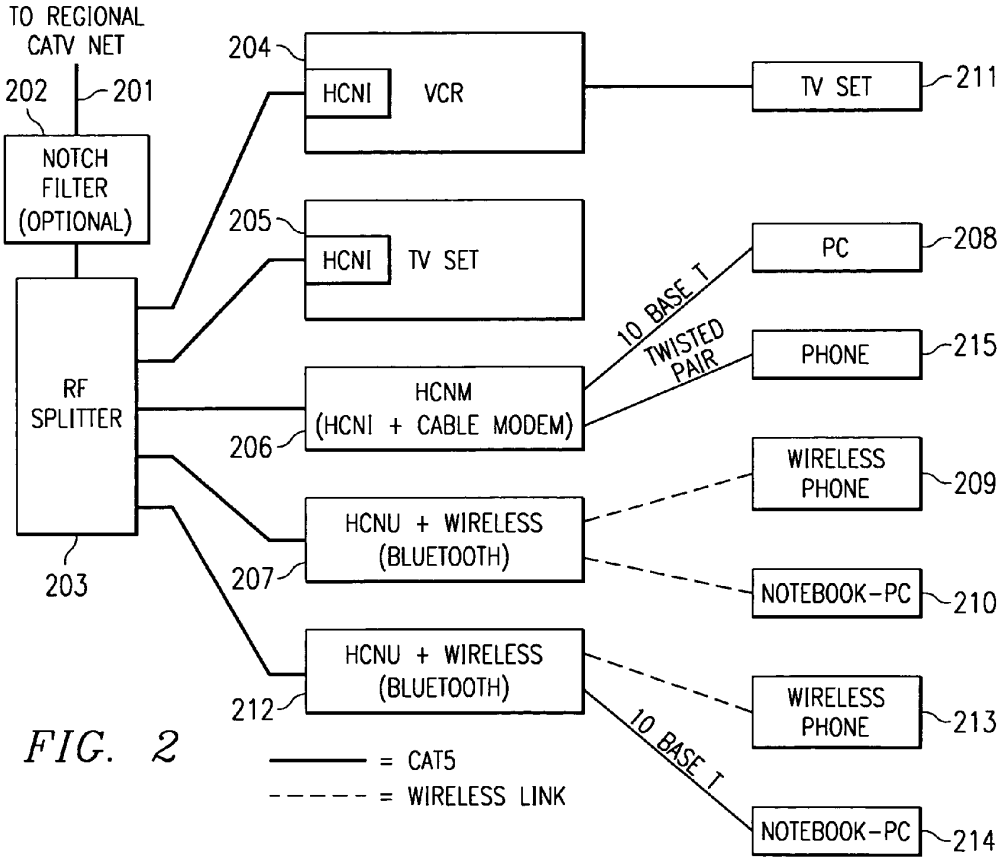

TO REGIONAL CATV NET
202
201
NOTCH FILTER (OPTIONAL)
RF SPLITTER
203
204
HCNI
VCR
TV SET
211
205
HCNI
TV SET
PC
208
10 BASE T
TWISTED PAIR
PHONE
215
HCNM (HCNI + CABLE MODEM)
206
WIRELESS PHONE
209
HCNU + WIRELESS (BLUETOOTH)
207
NOTEBOOK-PC
210
HCNU + WIRELESS (BLUETOOTH)
212
WIRELESS PHONE
213
10 BASE T
NOTEBOOK-PC
214
= CAT5
= WIRELESS LINK

FIG. 2

FIG. 3

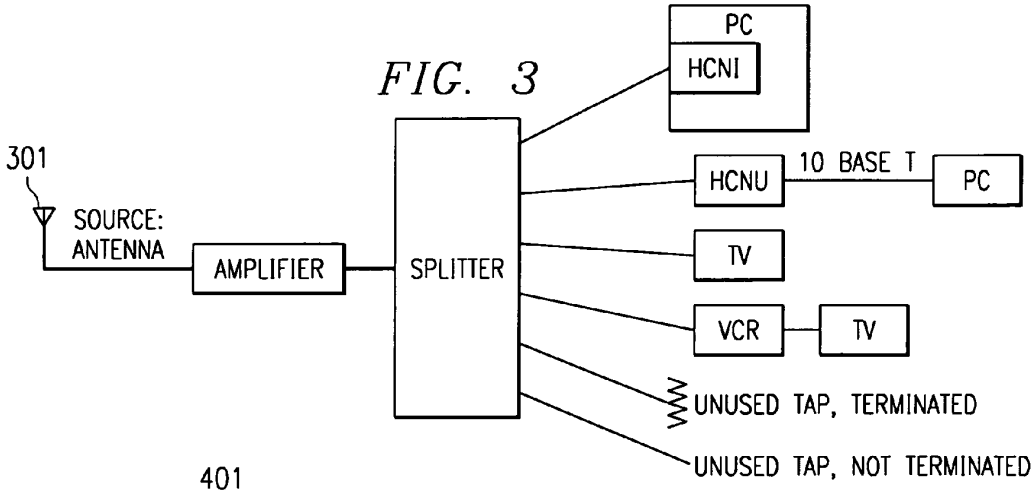


FIG. 4

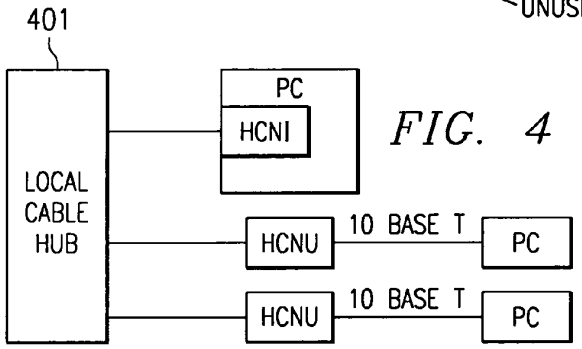


FIG. 5

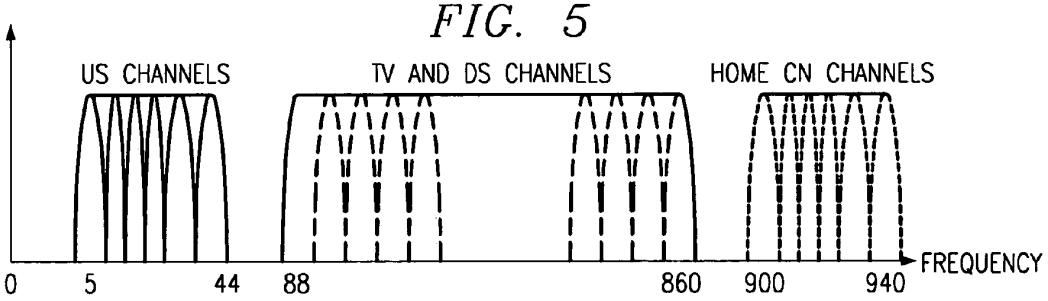


FIG. 7

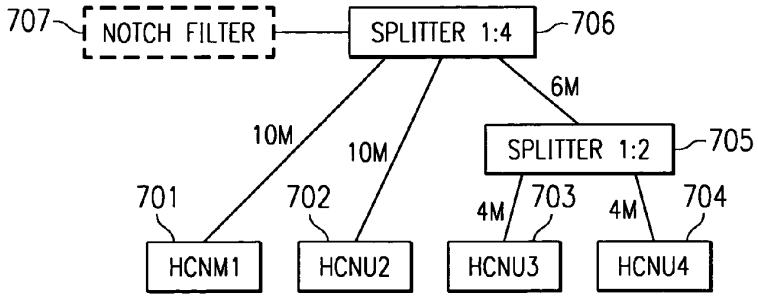


FIG. 6

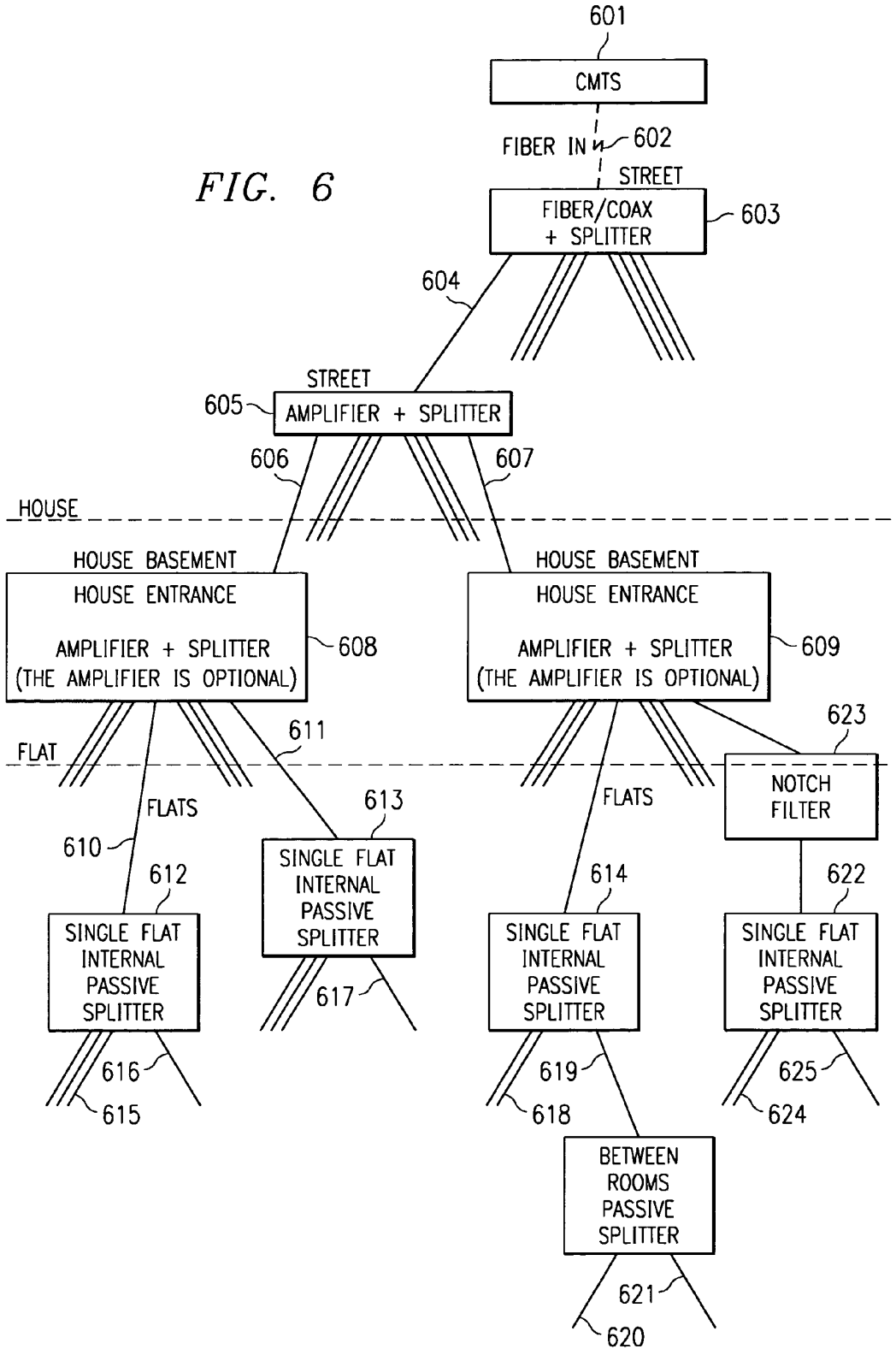

601
CMTS
FIBER IN
602
STREET
FIBER/COAX
+ SPLITTER
603
604
STREET
605
AMPLIFIER + SPLITTER
606
607
HOUSE
HOUSE BASEMENT
HOUSE ENTRANCE
AMPLIFIER + SPLITTER
(THE AMPLIFIER IS OPTIONAL)
608
HOUSE BASEMENT
HOUSE ENTRANCE
AMPLIFIER + SPLITTER
(THE AMPLIFIER IS OPTIONAL)
609
623
FLAT
611
FLATS
610
612
SINGLE FLAT
INTERNAL
PASSIVE
SPLITTER
613
SINGLE FLAT
INTERNAL
PASSIVE
SPLITTER
617
FLATS
614
SINGLE FLAT
INTERNAL
PASSIVE
SPLITTER
NOTCH
FILTER
622
SINGLE FLAT
INTERNAL
PASSIVE
SPLITTER
616
615
619
618
BETWEEN
ROOMS
PASSIVE
SPLITTER
625
624
621
620

FIG. 8

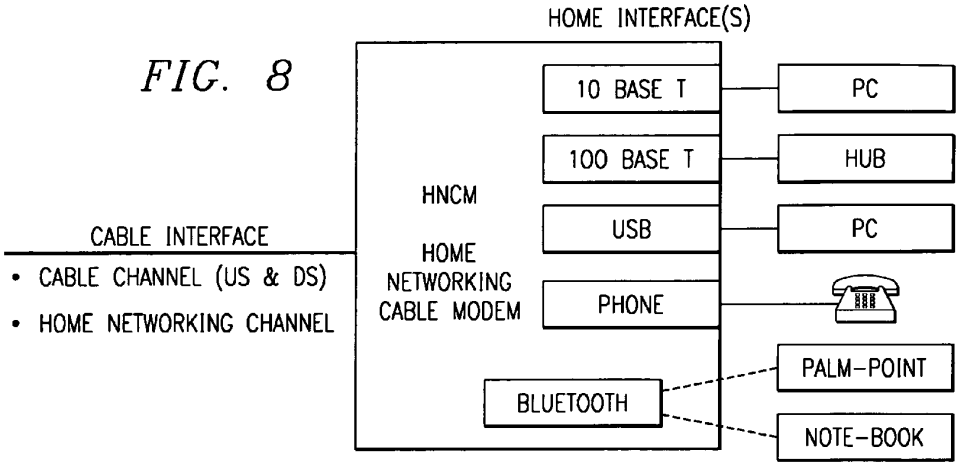

HOME INTERFACE(S)
10 BASE T
PC
100 BASE T
HUB
HNCM
USB
PC
CABLE INTERFACE
HOME
NETWORKING
CABLE MODEM
PHONE
• CABLE CHANNEL (US & DS)
• HOME NETWORKING CHANNEL
PALM-POINT
BLUETOOTH
NOTE-BOOK

FIG. 9

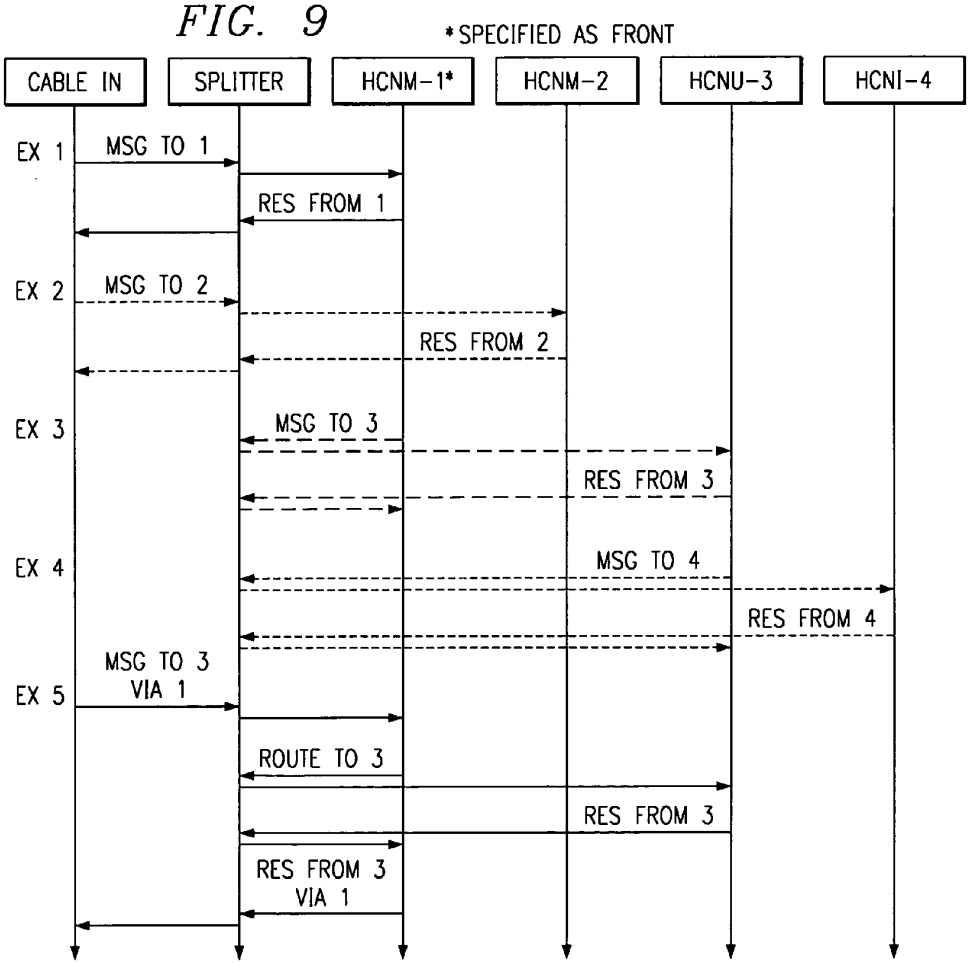

*SPECIFIED AS FRONT
CABLE IN
SPLITTER
HCNM-1*
HCNM-2
HCNU-3
HCNI-4
EX 1
MSG TO 1
RES FROM 1
EX 2
MSG TO 2
RES FROM 2
EX 3
MSG TO 3
RES FROM 3
EX 4
MSG TO 4
RES FROM 4
EX 5
MSG TO 3
VIA 1
ROUTE TO 3
RES FROM 3
RES FROM 3
VIA 1

FIG. 10

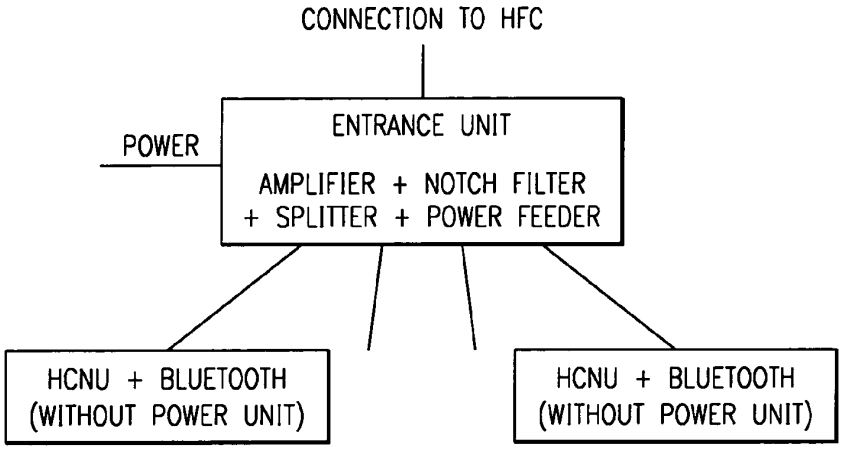

CONNECTION TO HFC
POWER
ENTRANCE UNIT
AMPLIFIER + NOTCH FILTER
+ SPLITTER + POWER FEEDER
HCNU + BLUETOOTH
(WITHOUT POWER UNIT)
HCNU + BLUETOOTH
(WITHOUT POWER UNIT)

FIG. 11

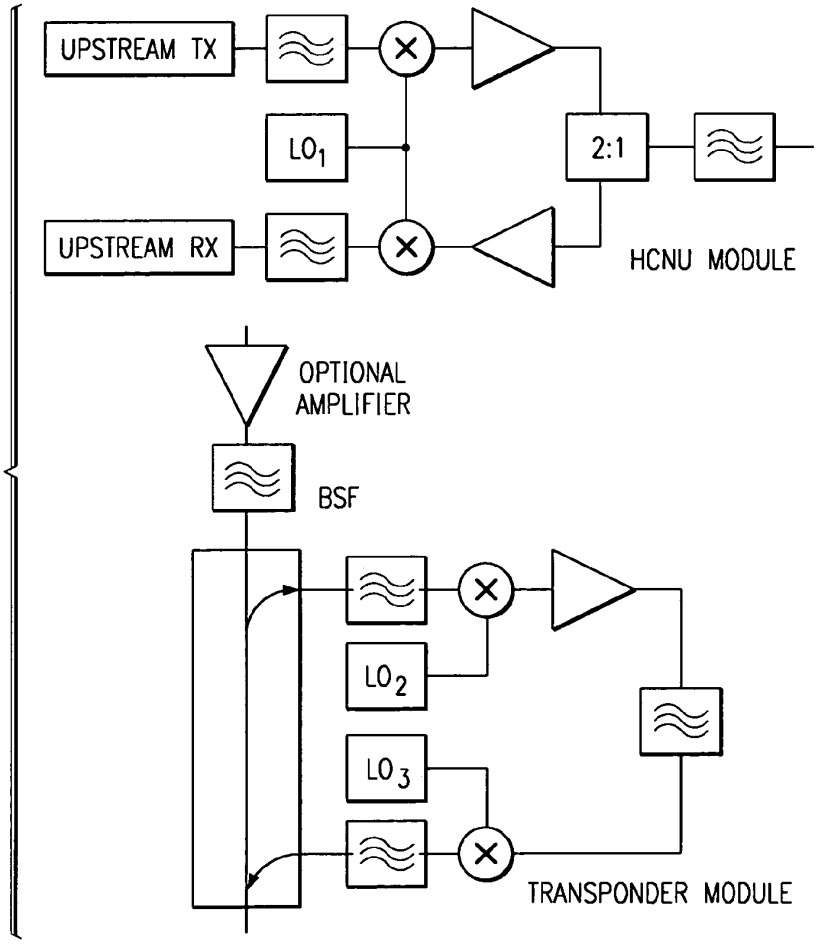

UPSTREAM TX
LO1
UPSTREAM RX
2:1
HCNU MODULE
OPTIONAL
AMPLIFIER
BSF
LO2
LO3
TRANSPONDER MODULE

FIG. 12

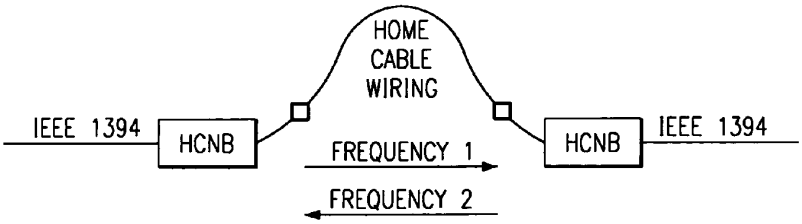


FIG. 13

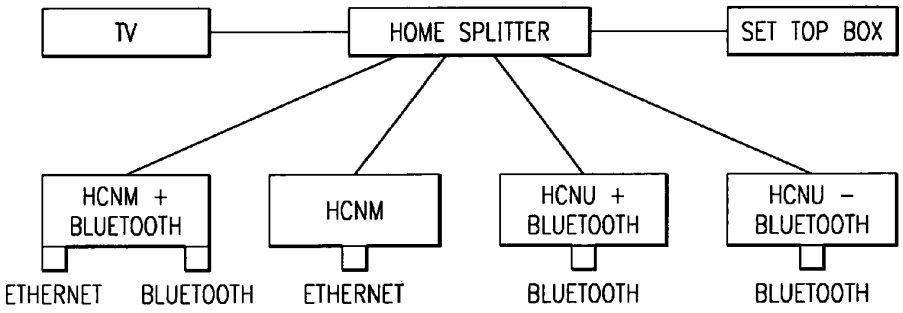


FIG. 14

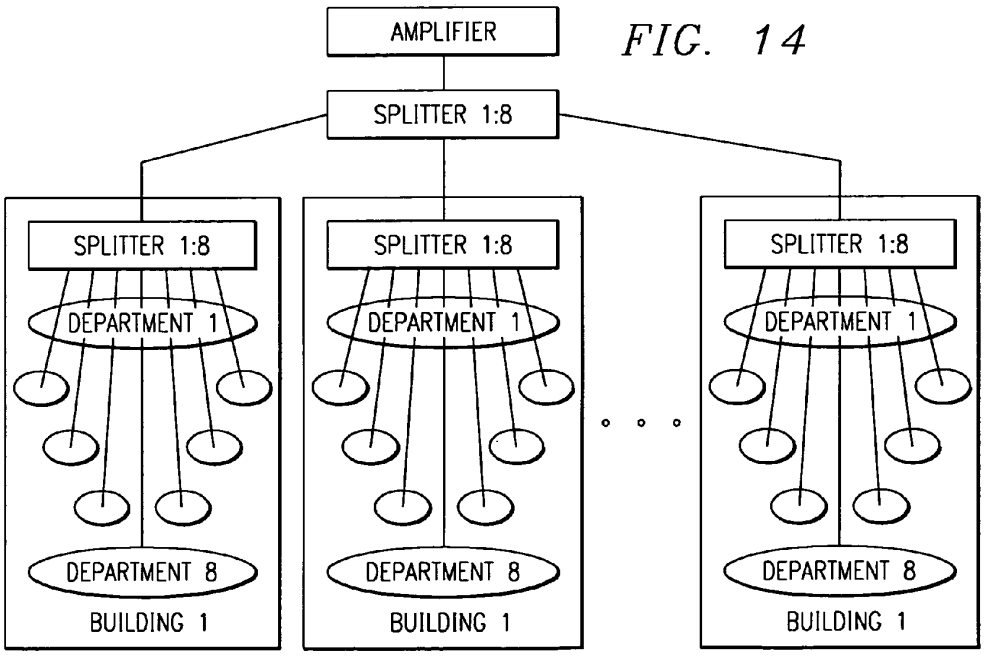


FIG. 15

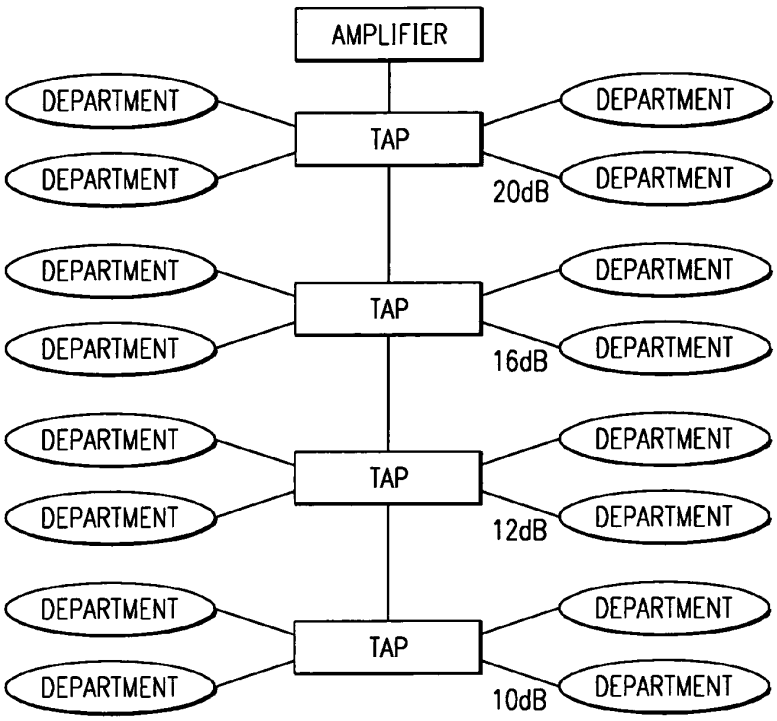


FIG. 16

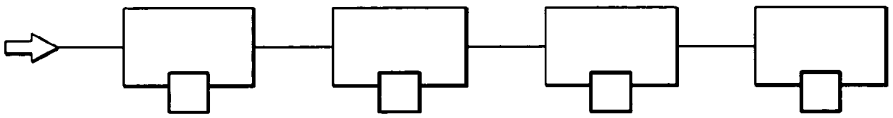


FIG. 17

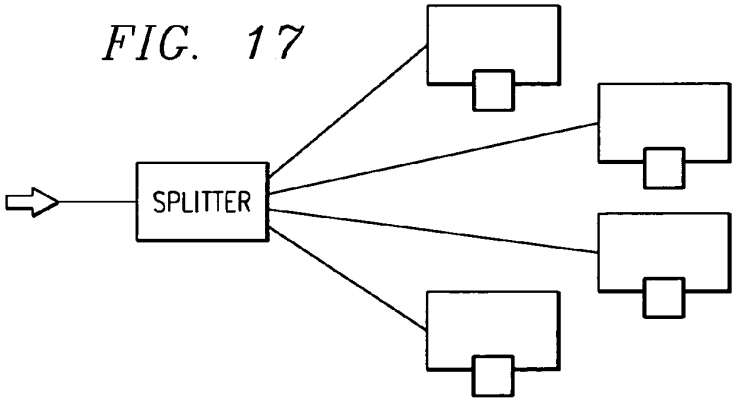


FIG. 18

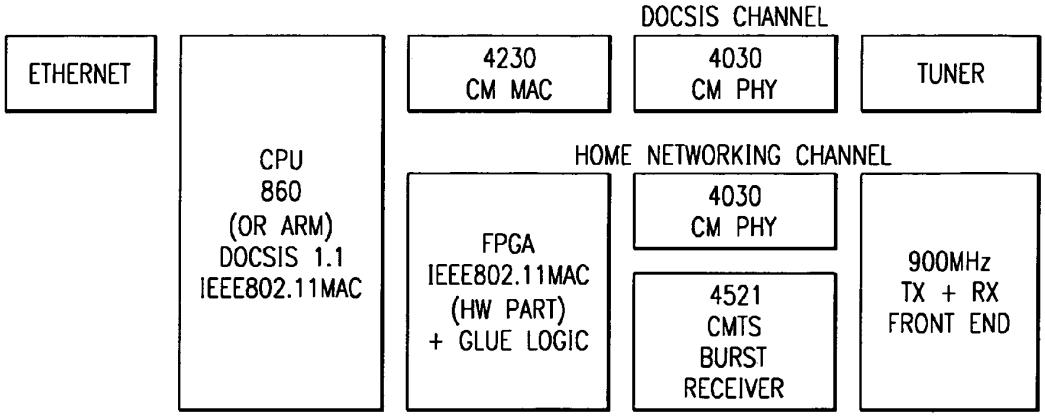
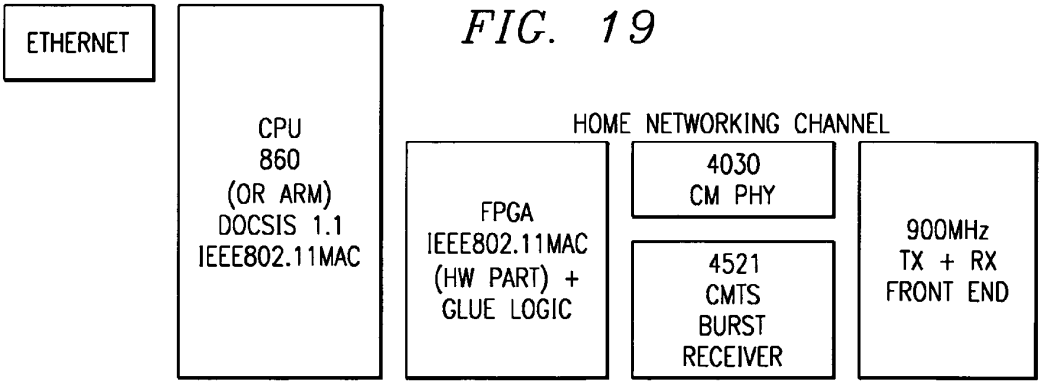


FIG. 19



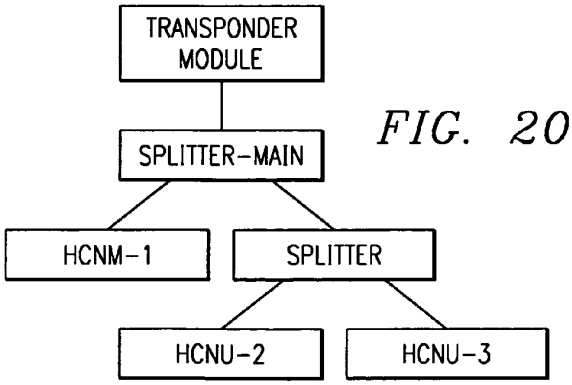


FIG. 20

SYSTEM AND METHODS FOR HOME NETWORK COMMUNICATIONS

This application claims priority under 35 USC §119(e)(1) of Provisional Application No. 60/128,810, filed Apr. 12, 1999.

TECHNICAL FIELD OF INVENTION

The present invention relates to communications systems, and more particularly, to systems and methods for home network communications.

BACKGROUND OF INVENTION

Home networking is a key technology for the evolving home infotainment market, and it is expected to become a very large market by itself within the next decade. Home networks will connect between computing devices (personal computers, palm computers, network computers, etc.), entertainment devices (TV, VCR, DVD player, video camera, audio systems, etc.), I/O devices (printer, scanner, headsets, keyboards, remote controls, mouse, loud-speakers, etc.), home appliances, and modems (such as cable modems, DSL modems, and PSTN modems) that connect the home outside. The home network will enable a wide range of application such as internet sharing, peripheral sharing, file and application sharing, and home automation. The home network will distribute the computation power of the computer from the study room to the living rooms.

There are several home networking solutions that have already been proposed, including networking over the existing telephone wiring (e.g. HomePNA), networking over the existing power lines, short range wireless networks (Bluetooth), medium range wireless networks (e.g. HomeRF, IEEE802.11), and solutions that require new wiring, such as IEEE1394 (I.LINK) or CAT 5 Ethernet wiring.

Existing Telephone wiring (HomePNA) generally allows ordinary voice telephone calls to be carried over the wire, while at the same time providing up to several megabits of data throughput.

It is also possible to use the normal AC electrical wiring in the home for data transmission. Electrical wiring has been used in the past for low bit-rate data applications (e.g. home automation). Technologies for achieving multi megabit throughput on existing residential electrical wiring are under investigation in the industry.

Wireless technologies (Short-range wireless; Bluetooth; HomeRF; IEEE 802.11) provide several megabits of throughput; however, their effectiveness can vary, depending on the size of the house, the proximity of other wireless networks, and other sources of noise.

The IEEE 1394 (i.LINK) standard defines a serial interface between digital devices. This inexpensive, easy-to-use and high-speed bus handles multimedia bandwidth requirements and provides a universal interface for a variety of devices. By allowing seamless data exchange between devices such as workstations, personal computers and digital televisions, VCRs, camcorders and set-top boxes, it enables a. new generation of computers and consumer electronic devices to operate in a common environment.

Originally developed as an interface to replace SCSI, IEEE 1394 offers bi-directionality, high data transfer rates and isochronous data transfers. This fire-wire technology required special wires.

For new homes, it is anticipated that standard Category 5 wiring can supplement twisted-pair telephone wiring. The added cost of including this extra wiring is low and the benefits reaped can be great, because 100BaseT and other high-speed network types work well over this cable.

TV wiring that consist of coaxial cables are used to connect the antenna/cable TV output, typically via passive splitters, to the cable outlets at specific points in the home. Typical home TV wiring scenarios are depicted in FIG. **1**.

The signals transmitted over the in-home coaxial TV wiring may include regular video channels, data channels for fast Internet access (using e.g., DOCSIS cable modem), voice channels for telephony over cable, pay-per-view, control signals and more.

Technically, to use the in-home TV wiring for home networking applications, one may connect standard cable modems through the cable TV (CATV) system. Data from one cable modem can be transmitted to the other cable modem via the CATV head-end.

Such a configuration has several drawbacks: (1) it loads the system, possibly above the typical headend system capacity; and (2) it introduces large delays that cannot be tolerated by at least some of the applications. Therefore, it is unlikely that cable operators will adopt such configuration.

It should be noted that a cable modem could be used to connect any type of home networking system to external (out of the home) networks, such as the Internet.

A home networking solution may also be built at a home that does not connect to the cable infrastructure (i.e. a home that is connected to a standard home antenna, a satellite dish, another access network (xDSL), or a wireless local loop).

SUMMARY OF INVENTION

The present invention provides a system and methods for communication between subscribers' devices over cable infrastructure designed to carry video signals, using passband frequency bands, without transmission through a CATV headend device. A particular application of this system and method is home networking over coaxial TV cables. The disclosed system will allow very high-speed digital and analog communications within the home and from the home to external devices or networks using low cost devices.

The present invention provides home networking solutions that utilize in-home TV wiring for supplying high rate connectivity between any two home networking nodes. The present invention does not load the city cable TV (CATV) network.

In many, if not most, of US residential homes, there are several TV inlets, connected by coaxial (coax) cables to either a municipal CATV network or a TV antenna. This coax cable is an excellent communication medium, as it has a high bandwidth and it is shielded to avoid noise. The present invention provides a method and system which allows home networking over these coax cables, allowing for very high data rates and a low cost implementation. The term Home Cable Network (HomeCN) is used herein for the system of the present invention.

In the prior art (e.g. the DOCSIS 1.0 spec), a CATV infrastructure is utilized for communication between a subscribers' devices (e.g. cable modem) and a headend, thus, two subscribers' devices can communicate via the headend. The system and method of the present invention is based on direct communications between two subscribers' devices, without transferring the data via a headend, thus allowing for high data rates between units in a home without reducing the capacity of the regional CATV network.

In the prior art, coaxial cables have been used for local area networks (LAN) and for analog communications. The system and method of the present invention is designed for cable networks that carry video or other information from a headend or an antenna, and thus it is different from prior art LAN over coaxial cables. Furthermore, the method employs a new digital modulation scheme based on pass-band RF signaling, which is fundamentally different than prior art LAN and analog modulation over coaxial cables.

The present invention enables installation of modems, connected to different types of nodes of the CATV, to enable communication between these nodes. The present invention provides a way to transfer data between these nodes, when the data is not required to be transferred to the headend.

The present invention provides a low cost solution, which is very important to enable a solution for the mass market.

A summary of some of the key principles of the disclosed system and methods are noted below.

1. Subscribers' devices may communicate directly (not via the headend) using RF signaling over the coax cable. These signals will typically propagate between the devices via reflections from other devices in the line, e.g. splitters or amplifiers in the line.
2. When the home coaxial cables are connected to a local or regional CATV network, the HomeCN is done in an out-of-band frequency (i.e. band that is not in use, e.g. above 860 MHz), or in part of the downstream band (e.g., within the range of 100–860 MHz) which is allocated (e.g. by the cable operator) for home networking applications.
3. When the home coaxial cables are connected to a local or regional CATV network, there is frequency re-use between portions of the CATV plants (i.e. same frequency range is allocated to different users in a CATV plant), taking into account the isolation between those users due to the attenuation of the cable plant.
4. The frequency re-use can be improved by adding filters within the signal path in the local or regional CATV network. The quality of the signal transmitted by one subscriber device to another subscriber device can be further improved by deliberately using splitters with high reflections.
5. The home devices may also be capable of connecting to the headend, e.g. operate as a DOCSIS or DVB cable modem or set-top box, either simultaneously with connecting to other devices in the home, or in an alternative mode in which a device switches between cable modem functionality and connecting to the other in-home devices. Parts of the device that are capable of connecting to a headend can be used for both home networking and for cable modem functionality, thus reducing the implementation cost of the home networking functionality. An architecture is proposed in which the home network includes only one device, which can operate both as a cable modem and as a home-networking device. In this architecture, all the other devices can communicate only over the home network, and if one of these devices need to communicate outside the home, it communicates via the device with the cable modem functionality. Other devices that have home networking and cable modem functionality may also handle a direct connection. The home networking functionality will be implemented in cable modems, and particularly in host-based cable modems, which are installed in personal computers and use the processor of the personal computer to perform some of the functionality of the cable modem and the home cable networking. More generally, the home networking devices will be installed in various kinds of devices that employ general purpose computers (such as a laptop computer, a network computer, a TV, a DVD device, or even certain cellular phones), and use their general purpose processors to perform home networking functionality, thus reducing the implementation cost of the home networking functionality.
6. In a particular implementation of the method, when the home coaxial cables are connected to a local or regional CATV network, each home device addresses the headend, and the headend assigns the carrier frequency and bandwidth to each home network, and maximum power levels to each device on the home network. The specific power level is assigned by the home networking devices that exist in each specific sub-network. In another implementation of the method, the devices search for a non-occupied frequency sub-band within a band that is pre-assigned for home networking, and once such a sub-band is found they use it for their needs. When a home CN device is initialized it is trying to "join its home network", that is trying to communicate with other devices in the same home and adopt their frequency band and protocol.
7. In a particular implementation of the method, the devices that share a home network are based on the IEEE 802.11 MAC layer. This protocol is in common use and is a collision avoidance multiple access protocol that supports priorities.
8. In a particular embodiment of the present invention, the splitter at the input to the user premises is replaced by a special splitter device that supplies higher quality home networking capabilities, or a filter is connected to the splitter. A passive filter connected to the splitter insures that the home networking signals in a specific home will not interfere with or be interfered by other home networks. This passive filter provides a "single home" operational mode that allows for low cost equipment and frequency re-use. A home network splitter that supplies less isolation between the home drops and includes the filter inside is also provided. This home network splitter provides better performance for the home network. An active device receives signals from a TV antenna or a regional CATV network and receives signals from subscribers' devices via the home coax lines, and functions as a repeater for communications signals between subscribers' devices as well as between subscribers' devices to a headend (in case the home is connected to a regional CATV network), while still allowing transparent transition of video signals from the TV antenna or the regional CATV network into the home.
9. In a particular embodiment of the present invention, the home coax network connects portions of the home (e.g. rooms or floors), and its terminals have inputs and outputs for wireless connections within these portions.
10. In a particular embodiment of the present invention, home CN devices have an interface to another communication link, such as IEEE1394 link (I.LINK), thus the home coax network is used to extend the range of the other link.
11. In a particular embodiment of the present invention, home CN devices have an interface to another communication link, such as Bluetooth, thus the home coax network is used to extend the range of Bluetooth coverage by supplying pico-cells that are connected between themselves and cover the required home area.

12. In cases where direct communications between home devices is not feasible (e.g. due to a highly balanced splitter that has very low reflections), the home devices may have a fallback option of communicating via a regional CATV headend.
13. The data transmitted in the coax home network may be secured (i.e. encrypted).

As used herein, the term a "home network" means a local network; it does not necessarily have to be in a home. For example, it may be in an office, or in a complex that contains several homes (e.g. an apartment building).

DESCRIPTION OF DRAWINGS

The preferred embodiments of the invention as well as other features and advantages thereof will be best understood by reference to the detailed description which follows, read in conjunction with the accompanying drawings, wherein:

FIG. **1** shows a home that has four nodes inside the home and is connected to a regional CATV plant;

FIG. **2** shows an example of a preferred embodiment of the home network method and system connected to a regional CATV plant;

FIG. **3** shows an example of the present invention, not connected to a CATV;

FIG. **4** shows an example of HomeCN with a hub;

FIG. **5** presents a frequency allocation that may be employed by the present invention;

FIG. **6** shows an HFC infrastructure;

FIG. **7** shows a network with a notch filter;

FIG. **8** shows HCNM interfaces;

FIG. **9** shows representative HCN data flows;

FIG. **10** shows a power supply;

FIG. **11** shows a dual frequency architecture;

FIG. **12** shows dual frequency components;

FIG. **13** shows layer **2** transport;

FIG. **14** shows a Bluetooth home network;

FIG. **15** shows neighborhood wiring;

FIG. **16** shows building wiring;

FIG. **17** and FIG. **18** show home wirings;

FIG. **19** depicts examples of an HCNM and HCNU, and

FIG. **20** shows a home networking two-frequency mode architecture.

DETAILED DESCRIPTION

FIG. **1** presents the structure of the existing regional CATV network.

The typical home coaxial cable infrastructure consists of a Cable Source [**101**] which is connected to the home Splitter [**102**] (the home splitter might be Customer Premises Equipment—CPE). Some wires connect the interfaces at home to the splitter. The components that can connect to the network are TV [**103**], VCR [**104**] that is connected to TV.

Cable Modems (CM) [**105**] (e.g. DOCSIS CM), and Cable Telephone Device [**106**] that connects some phones via the cable infrastructure (e.g. using VoIP protocol over DOCSIS channel).

An amplifier [**107**] can be added in the entrance of the home/house to increase the signal power. (If CM equipment exists at home, this amplifier should be bi-directional amplifier that amplifies the signal to home side (DS) in the 100 MHz–860 MHz frequency range, and amplifies the signal to the headend side (US) in the 5 MHz–44 MHz frequency range).

There are some major types of HomeCN components (see FIG. **2**):

HCNI: Home Cable Networking Interface.

A sub-component that supply Home Cable Networking interface. This sub-component is a part of specific equipment (e.g. PC, TV, DVD) [**204**,**205**].

HCNU: Home Cable Networking Unit

A component that supply connection to the Home Cable Networking. This component is a separate unit that contains one or more interfaces to the home equipment (e.g. 10BaseT, USB, wireless). This component does bridging or routing between the HCN to the other interfaces (networks) [**207**,**212**].

HCNM: Home Cable Networking Modem

A component that include HCN-U and cable modem (e.g. DOCSIS cable modem).

This component supplies a connection to the Home Cable Networking, and a connection to the cable headend. This component is usually a separate unit that also contains one or more other interfaces (e.g. 10BaseT, USB, wireless). This component does routing between the HCN network, the cable network and the other interfaces networks [**206**].

FIG. **2** shows an example of a preferred embodiment of the disclosed method and system.

FIG. **2** shows a Home Cable networking (HomeCN/HCN) that has 5 nodes [**204**–**207**, **212**] of the CATV network, and it is connected to the regional CATV plants via cable [**201**]. Notch filter [**202**], is a band reject filter that does not pass a certain RF range that is used by the home networking devices [**204**–**207**, **212**]. This filter improves the isolation between the home network and other homes as well as the regional network. However, the use of such a filter is optional, as we believe that the disclosed system and method is functional with the isolation levels of the CATV network without the additional notch filtering [**202**]. RF splitter [**203**] splits the signal coming from and to the regional CATV plant [**201**], to the signals coming to and from units [**204**–**207**, **212**] respectively. The signals arriving to RF splitter [**203**] from the home units [**204**–**207**, **212**] are partially reflected back to these home units [**204**–**207**]. It may be recommended to use splitters that deliberately have high reflection levels (although we believe that the method and system can operate with typical commercial splitters). The Video Cassette Recorder (VCR) [**204**] and TV set [**205**] include Home Cable Networking Interface (HCNI) devices. The Personal Computer (PC) [**208**] is connected to a Home Networking Cable Modem (HNCM) device [**206**] (that supplies the Home Networking functionality and the Cable Modem functionality). The HCNM is also connected to a phone [**215**] and supplies the VoIP functionality. A PC that includes HCNI can be connected directly to the HCN. The HCNU+ wireless units [**207**, **212**] are connected to the CATV and has a wireless output (e.g. Bluetooth, HomeRF or infra-red) which connects to devices within the vicinity of the device [**207**], such as wireless telephone unit [**209**, **213**], and a notebook computer [**210**]). The HCNU devices are capable of transmitting and receiving digital communications signals between them. These signals propagate in the CATV wires and are reflected by the RF splitter [**203**]. The HCNM device is further capable of operating as a DOCSIS cable modem and communicating with a headend of a regional CATV plant [**201**]. The HNCI's, the HCNU's and the HNCM use Home Cable Network Protocol HCNP.

The HomeCN can also be used to supply full home coverage by the Bluetooth network. To enable this coverage some HCNU+Bluetooth components that are connected to

HomeCN should be exist in the home [207, 212]. The person that is traveling between the rooms with his wireless phone [209, 213] or with his notebook computer [210] can be connected to the appropriate Bluetooth station in the home.

We note that the method and system will still be capable to perform home networking if the home coaxial wiring is not connected to a regional CAT plant [201], but connected to TV antenna, or even disconnected. However, in such cases the home network will not allow the capability of connecting the home outside through the CATV, as done by the HCNM unit [206].

The HomeCN operation modes are determined according to the existence/not existence of notch filter at the home entrance (see FIG. 2 [202]).

The notch filter in the entrance of the home is a one of the basic elements in the home network design. If this notch filter exists in the HomeCN is disconnected from the regional cable network, therefore its' design is more simple (single home network). When this filter does not exist the home network is part of the regional network, therefore its' design is more complicated, and some additional functionality is required.

The HomeCN Supports Two Operation Modes:

- Single Home operation mode—This mode required a Notch filter, or an amplifier that usually supplies similar functionality, or it can be operated in a system that is not connected to the CATV plant.
- Connected Home operation mode—This mode does not require a Notch Filter. This mode is more complex and requires additional functionality. Following are some functionalities that are required in the Connected Home operation mode: Wider frequency operation, frequency selection (FDM), multiple bandwidth, privacy, capability to be managed by the headend.

Notes:

- The notch filter can be passive component or an active component. An active component that also has management can supply some additional functionality. An example of an important functionality is to answer to the query "Is notch filter exist". This query can be used by the HCNP to verify the type of operating mode that should be handled if the components supply the two modes.
- Notch filter added to the home network design usually reduces the price and increase the performance of the home networking.
- The default operation mode is Single Home. The management system configures the components to the appropriate mode after initialization.
- The Connected Home operational mode is recommended only if it is managed by the CMTS.

FIG. 3 presents a Home Networking network that exist at a house that is not connected to the Regional Cable infrastructure. Instead, it is connected to a local antenna [301]. This system is operates in Single Home operational mode.

FIG. 4 presents HomeCN with a local cable hub. A Local Cable HUB [401] connects the HCNUs and the HCNIs. This system is operates in Single Home operational mode.

FIG. 5 presents a typical channel allocation. This figure is suitable for example to a system that supplies TV channels, DOCSIS CM (US and DS), and HomeCN channels.

In the present figure, some of the HomeCN channels have a different width.

HomeCN components that are working in the single home operation mode (reduced mode) always use the 900–906.25 MHz channel. These components do not support the frequency selection capability, and different channel bandwidth capability.

There is an additional mode 'Dual Frequencies Mode'. In this mode there is a different frequency- range to the transmitted information and a different frequency-range to the received information. In this mode a transponder at the entrance of the home transfers all the signals that are sent in the transmitted frequency-range to the received frequency-range. The major benefit of this method is decreasing the influence of the in-home echo (For more details see Dual Frequencies Mode appendix).

Note:

The HomeCN-P is defined by specifying the two lower communication layers: the physical layer and the data link layer.

The preferred frequency and the preferred frequency range (bandwidth) are selected according to the operational mode.

	Connected Home operation mode	Single Home operation mode
Frequency range	higher than 860 MHz; usually 900–960 MHz	900–906 MHz
RF channel spacing (bandwidth)	8 MHz or lower, according to the required rate	6.25 MHz

The modulation method is QPSK, QAM 16, QAM 64 or QAM 256 according to the channel conditions, and according to the equipment capabilities.

The modulator of the home networking device MUST provide QPSK and QAM 16.

The modulator of the home networking device MAY provide QAM 64 and QAM 256.

The modulator MUST provide 2,560 ksym/sec.

The modulator MAY provide 160, 320, 640, 1,280, and 5,120 ksym/sec.

FEC (Forward Error Correction) MUST support R-S (Reed Salomon) T=0,10.

FEC (Forward Error Correction) MAY support R-S (Reed Salomon) T=0, . . . ,10.

The Channel Allocation method is FDM—a specific frequency for each home network.

The frequency plan is done only in connected home operational mode. In this case it done by the management system.

The structure of the HFC is important for understanding the home networking when the system is in Connected Home operation mode. This structure is used for enabling frequency reuse.

The HFC system usually contains the following components (see FIG. 6):

- Headend (CMTS) [601] usually with fiber output.
- Fibers [602] that exist only in HFC (Hybrid Fiber Coax) environment and connect the Headend to the cabinets (Fiber Nodes) [603]. The cabinets include fiber to coax converters (O–E).
- Coax wires that connect the different components [604, 606, 607, 610, 611 . . .].
- Amplifiers that increase the signal power, and also filter the frequencies that are not amplified [605, 608, 609]. (These amplifiers might include splitters)
- Splitters that get a single wire as input, and some wires as output. [605, 608, 609, 612, 613, 614, 619, 622].

The splitters are divided into two types: Active splitters that usually include the amplifier inside, and passive splitters, that usually only divide the power between the different ports.

The active splitters are usually used close to the CMTS (headend) side. The passive splitters are usually used in the house entrance and in the flats (near to the home end equipment).

The Attenuation and Isolation are Used for Two Major Subjects:

Branches calculation—Dividing the HFC Network to Branches. The branches are the key for frequency reuse. Branch calculation should be done before frequency allocation for each HomeCN in the global HFC infrastructure.

HomeCN home network—Understanding of the home network conditions.

These aspects are required for the HomeCN component and protocol design.

The HFC infrastructure is similar to a tree. This tree build with connection points that supplies isolation between the sub-trees. The components that exists in the network (e.g. Amplifiers, splitters, and filters) supplies attenuation of the signal, except the amplifier that supply amplifying (only if it was designed to amplify the required frequency in this direction). This attenuation is also can be used for isolation between the sub-trees.

The key element for efficient frequency allocation to the HomeCN is frequency reuse.

To enable calculation of the frequency reuse in a different sub-trees, the term branch will be used. Branches are defined as sub-networks that can use any home networking frequency without interference another sub-network that exist in another 'branch' and reuse the same home networking frequency.

The cable network can be divided to 'branches' because the tree structure supplies attenuation between its branches. The attenuation is granted by the coaxial cables and by components that include filters. Some of the splitters also provide good isolation between the sub networks that are connected to these components.

The HomeCN is based on FDM (see HomeCN protocol), therefore each home gets its own frequency range. The ability to supply reasonable frequency range for each home is based on the network infrastructure and on the ability to reuse the after dividing the network to branches.

The size of the 'branches' can be reduced by adding filters. These filters enable increasing of the frequency reuse. These filters are usually passive filters that are relatively small and can be added easily by the cable operator, or by the user at the home entrance. This mechanism of adding low cost filters at the entrance of a home/flat enables a single home/flat branch, and enables the Single Home operation mode.

The frequency resources are limited. To increase the frequency resources one (or more) of the following methods can be used:

Frequency Reuse: Enabling simultaneous usage of the same frequency by some customers.

The 'branches' method is a method to support the isolation of customers group. This method enables reusing of the same frequency in separate groups. This method uses the attenuation characteristic of the existing components. The disadvantage of this method is the management complexity. The operator should be aware of its physical infrastructure attenuation characteristic.

Supports wider frequency range.

This option can be handled by building equipment that supports a wider range. The disadvantage of this method is higher price of the components that are required to support wider range, because wider range support increases the complexity of each component.

The 'branches' method is very cost effective, and it increase the robustness of the home networking solution. Therefore, this document includes a detailed definition of this method.

The 'branches' approach enables reuse of the same RF frequencies, which allows the following benefits:

It enable the manufactures to reduce the price of the home networking equipment, because home networking equipment can support a smaller range of frequencies.

It enables allocating a larger frequency range for each home/flat. This wider range can supply higher network capacity.

The Attenuation/Isolation calculations can be done by adding the attenuation of each component and the attenuation of the wire in the required pass and in the required direction.

The following table (table 1) presents the typical attenuation of the basic components.

TABLE 1

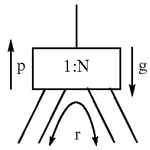
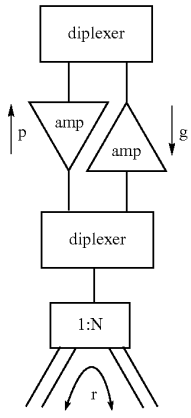
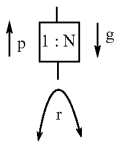
Attenuation/Isolation Calculation	
Component Type	Signal Attenuation [dB] For frequency range of 900–960 Mhz
Coaxial Wiring	_0.21 dB for meter (RJ 59 type). Notes: The isolation is depended in the wiring quality. Cable attenuation. Depends on cable length and signal frequency.
Passive splitter 	g - Insertion loss: $10\log_{10}(N)$: Theoretical $3_{(N=2)}$, $6_{(N=4)}$, $9_{(N=8)}$ Example of real values $4.2_{(N=2)}$, $8.2_{(N=4)}$, $12.5_{(N=8)}$ p - backward attenuation of downstream amplifier: $10\log_{10}(N)$: $3_{(N=2)}$, $6_{(N=4)}$, $9_{(N=8)}$ r - Isolation: 20–30 corresponding to the quality
Active splitter 	g - downstream amplifier gain: $10\log_{10}(N)$: $3_{(N=2)}$, $6_{(N=4)}$, $9_{(N=8)}$ (The amplifying functionality should be added). p - backward attenuation of downstream amplifier: ~55 dB. (The attenuation is lower when the power supply is disconnected). r - :20–30 corresponding to the quality (higher in better quality)
Notch Filter	g - 40–60 dB

TABLE 1-continued

Attenuation/Isolation Calculation

Component Type	Signal Attenuation [dB] For frequency range of 900–960 Mhz
	p - 40–60 dB r - 0.5 dB or 19 dB according to the design.

Data Form 1: Components Parameters

Components' Parameters

Component	Parameter	Value[dB]				Comments
Wires	dB/meter	RG-59 0.21	RG-6	RG-7	RG-11	
		N = 2	N = 4	N = 8		
Passive splitter	Insertion	4.2	8.2	12.5		
	Loss	22	25	30		20–30
	Isolation	11	11	12		
	Return Loss					
Amplifiers	Amplifing					
	Isolation					
	Return Loss					
Transmitter Isolator Notch Filter	Return Loss	10				

Following some typical calculations based on FIG. **6** and table 1. These calculations are based on a system that does not include notch filter.

Data Form 2: Typical Loss Between Two Apartments

Loss between two apartments

1 Loss between two modems in the same flat sharing the same splitter [from 615 to 616]:			
Wires [meters]	20	4.2	
Splitter Isolation (n = 4)[612]		25	
Total [dB]		29.2	
2 Loss between two modems in neighbor homes [from 615 to 617]:			
Wires [meters]	44	9.24	10 m[home 612] + 2*12 m [flat to basment] + 10 m [home 613]
Insertion Lost (n = 4)[612]		8.2	
Splitter Isolation (n = 8)[608]		30	Passive splitter
Insertion Lost (n = 4)[613]		8.2	
Total [dB]		55.64	

Note:

The loss between two moderns that required to pass amplifier is more then 60 dB, because the amplifier contains filter for these frequencies for the up stream direction.

The capability to calculate the attenuation between two different flats is important for enabling efficient frequency reuse. The cable operator should do the calculation of the "branches". The calculation of the 'branches' can be done by the following methods:

- Numerical Calculations—Calculations that are based on preceding knowledge of the cable operator. The cable operator can do calculations that are based on its network structure and its network components.
- Defining Basic Rules—The operator can define some base rules that usually works, and divide the network to branches according to these rules. E.g. (of rules) a. each port that connects directly to a filter/amplifier unit specify a "branch"; b. Homes/flats that are connected using passive filters will be on the same "branch".
- Measurements using special equipment—The cable operator can use spectrum measurement equipment. This equipment will usually be used to enable the cable operator to define the rules according to its own infrastructure.
- Measurements using HCNM Branch Calculation Mode—The cable operator can use a specific mode of the home networking equipment that enables 'branch' calculation.

Each HCNM should have a specific mode that enables the management system to calculate each 'branch' member.

This mode contains the following base features:

- Lock on a specific frequency, and on a specific frequency range.
- Transmit a signal in a specific power for a specific period (The pattern of this signal is known).
- Measure the power of the input signal (The pattern and the measurement period are known).

The algorithm is based on the structure of the cable infrastructure. A tree data structure is built in the computer memory. This data structure represents the existing infrastructure.

The tree is built according to the following rules:

- Tree nodes are the splitters (the splitters can be active or passive).
- The splitter capability to isolate between two sub-trees is saved as data in these nodes.
- The leaves are the CM, HCNM or HNO.
- The identification of these nodes is saved in these leaves.

The main process is to build the topology database. This process can be done by the following methods:

- Load the tree structure from the cable operator database. This process is simple but it required an updated database.
- Automatic generation of the tree structure based on measurements of the isolations between two components using the HCNM—Branch Calculation Mode. These calculations are very complex and are based on prior assumptions.

Note:

The base idea in automatic tree building is to calculate the isolation between two leaves. If the some leaves have similar isolation between themselves they can be connected to the same nodes. If there are two leaves with the same isolation, and an additional leave that has a higher isolation this leave connect to the previous two leaves using additional higher level node.

After building the topology database, it is required to verify that the nodes contain the isolation values. These values are usually loaded in the previous stage, but if this information was not entered, the system can use the Branch Calculation Mode to find the isolation of the nodes.

Note:

It is very hard to calculate these numbers when the tree is calculated automatically, and the splitter supplies different isolations between the wires that are connected to the same node.

This 'branch' specification is based on the data structure that was built.

'Branch' is specified by the isolation between this 'branch' to the other "branch". This isolation enable the systems in two different 'branch' to use the same frequency without (or with negligible) interference.

A 'branch' is defined by specifying a threshold of the minimal isolation between this 'branch' to the other 'branches'. When the isolation value in the tree nodes (or in summary of some layers that does not include leaves) is greater than the specified threshold all the nodes that are member in the specified sub-tree will be defined as nodes in a specific 'branch'.

Notes:

- When the system is not occupied as a balanced tree, the 'branch' calculation might be less effective. In this case, it might be required to divide the frequency range to some sub-ranges, and define a 'branch' for each one of them. The algorithm for these calculations will not be specified in this document, because we do not think that the common network includes such complex structure.
- The operator can add filters or special splitters to reduce the branches' size.

To use the Single Home operation mode that simplifies the equipment, a notch filter should be added. This filter can be added in the following points:

- Adding a filter at the flat/single user home entrance.
- The advantage of this method is the ability of the end user to add the filter by himself.
- Replace the house basement splitter that split the signals between the flats to a special splitter.
- The advantage of this method is the ability of the MSO to change a single splitter to a special splitter that includes internal filter. This splitter enables more effective usage of the home networking for some flats (homes).
- The disadvantage of this method exists only if the HomeCN uses the notch filter reflection. In this case the attenuation and the delay of the coaxial wire between the flat to the central splitter. This influence is usually negligible.

The attenuation between two points at home (and the range of these values when there are more than two points) dedicates the quality of the equipment that should be use for HomeCN.

There are some RF challenges in designing the HomeCN components:

- The "hidden nodes" problem:
- This "hidden nodes" might exist when the isolation difference between two different nodes is different than the isolation between other two nodes. This problem usually exist in a home that contains some splitters no notch filter.
- i.e. if there are some HCNU the attenuation between two of them might be low, and between each one of them to the 3rd might be high.
- e.g. FIG. **7**: the communication between **703** and **704** might be 'hidden' from **701** in particular when the notch filter **[707]** does not exist.

High reflection

- The reflection from the notch filter is in the power of the signal or it might be higher. When this reflection is higher than the signal we can use this reflection as our main signal.

The following calculations are based on table 1 and FIG. **7**. These calculations are only valid for homes that have notch filter.

Data Form 3: Home Networking Typical Calculations

Loss Between Two Modems in the Same Flat

1 Connected to the same main filter HCNM1 [701] HCNU2 [702]:

Without Notch Filter			Echo from the notch filter		
Wires [meters]	20	4.2	Wires [meters]	20	4.2
Splitter Isolation [706]		25	Insertion Lost (n = 4)[706]		8.2
			Return Loss [707]		10
Total [dB]		29.2	Insertion Lost (n = 4)[706]		8.2
			Total [dB]		30.6

2 Connected to the same minor filter HCNU3 [703] HCNU4 [704]:

Through the nearest splitter		
Wires [meters]	8	1.68
Splitter Isolation[705]		22
Total [dB]		23.68
Echo from Main Splitter		
Wires [meters]	20	4.2
Insertion Lost (n =[0 2)[705]		4.2
Return Loss [706]		11
Insertion Lost (n =[0 2)[705]		4.2
Total [dB]		23.6
Echo from the notch filter		
Wires[meters]	20	4.2
Insertion Lost (n = 2)[705]		4.2
Insertion Lost (n = 4)[706]		8.2
Return Loss [707]		10
Insertion Lost (n = 4)[706]		8.2
Insertion Lost (n = 2)[705]		4.2
Total [dB]		39

3 Connected to different filters HCNM1 [701] HCNU2 [704]:

Without Notch Filter			Echo from the notch filter		
Wires [meters]	20	4.2	Wires [meters]	20	4.2
Splitter Isolation [706]		25	Insertion Lost (n = 4)[706]		8.2
Insertion Lost		4.2	Return Loss [707]		10
(n = 2)[705]		33.4	Insertion Lost (n = 4)[706]		8.2
Total [dB]			Insertion Lost (n = 2)[705]		4.2
			Total [dB]		34.8

Note:

The CSMA/CA can be used with or without ACK protocol. The need for immediate ACK should be verified according to the quality of the infrastructure.

The security is only required in Connected Home operational mode.

The security that is required in this protocol is the base on IEEE 802.11 or on line privacy plus. The specification for line privacy plus protocol is presented in DOCSIS 1.1.

The management of the security keys can be done by the CMTS.

Note:

Home networks that works in connected home operational mode and are not connected to the CMTS will use a single key.

The priority is integrated in Layer two MAC.

A HCNM has at least two physical interfaces.

HCNM interface to the cable side.

This single physical interface contain two data channels (that use different frequencies):

1. Cable Modem Channel.

The cable modem channel (e.g. DOCSIS), containing two sub-channels: up stream channel (US) and down stream (DS) channel.

2. Home Networking Channel.

The Home Networking channel (a single channel that is used for sending and receiving information).

HCNM interface to the home side—Home Interface.

The home interface might be a single interface or it might contain some interfaces. This/these interface(s) are connected to the equipment at home. This/these interface(s) can be Ethernet (10/100/1G BaseT) (or some Ethernet ports), USB, Phone connection, Bluetooth, wireless, or other.

Notes:

The HCNU and the HCNI components do not contain the Cable Modem Channel. Except HCNI that designed as host-based, i.e. a card that inserted into the PC and connected to the PCI bus, in this special case it might implement the HCNM functionality.

The HCNM gets the information from these channels/interfaces simultaneously.

The HCNM bridges messages between the home interface to these cable channels and vice versa. In addition it might support the capability to bridge information between cable modem channel to the home-networking channel and vice versa (This capability is only required when HNO components exists).

The following table describes the bridging requirements for HCNM:

Bridging Type	Description
Cable Modem Channel-Home Interface	According to cable modem standard's specifications.
Home Networking Channel-Home Interface	Bridge the messages between the stations at the home networking and the stations that are connected to the HCNM home interface(s).
Cable Modem Channel-Home Networking Channel	Bridge the messages between the Cable Modem Channel and Home Networking Channel in the following conditions: This component was configured to do Cable Modem channel-Home Networking channel bridging; and

-continued

Bridging Type	Description
	The message should be transferred between Cable Modem Headend system and HNO component.

FIG. **9** presents some examples of data flow.

Ex.1 and Ex.2: Message from the Cable headend to component no. 1 or component no. 2; and the returned response. These examples present a standard cable modem protocol.

Ex.3 and Ex.4: Message from the one component in the home network to another component in the home- network (1 to 3; 3 to 4) and response. The messages from the home equipment is transferred to the splitter, the splitter distributes the energy to the Cable In connector, and to the other output connectors that are connected to the splitter. The destination-component gets the message and returns the response.

Ex.5: Message from the Cable headend to component **3** through component **1** (that was specified as the front router of the components that exist only in the home networking). The message is arrived to HNCM no. **1**, it identifies the destination and its duty as router, and it routes the message to HCNU no. **3**. The response is transferred in the opposite way. (Note: if HNCM no. **1** fails, HNCM no.**2** can be configured to take its duty automatically).

The purpose of the home networking system is to transport Internet Protocol (IP) traffic through the HomeCN system.

The Network Layer protocol is the IP [RFC-**791**].

The home networking management can be done by two methods:

Local management that is done at home.

This method is always used in the Single Home operation mode.

This option can be done when the house is not connected to the cable infrastructure, or when the house has isolation (for the home networking frequency) from the cable network and the headend does not support the home networking management capability.

Local management might not include all the capabilities that the central management supports.

Central Management

Management from the headend that is done by the cable operator.

This option is the preferred method for connected home operational mode. This method used the standard cable modem interface (e.g. DOCSIS interface). The configurations of the HCNU and HCNI can be done by the headend via HCNM routing capabilities.

There are some options for power supply to the HomeCN units. Most of the HomeCN components will use local power supply. The special unit is a HomeCN component that its only interface is wireless (i.e. Bluetooth). For this type of unit, that requires very low power consumption, a central home power supply can be added. The central power supply is a special HomeCN splitter that contains inside the following sub units: Notch filter, a passive splitter, and a power supply that enable units to gets its power from the home cable infrastructure (see FIG. **10**).

The present invention provides home networking solutions that utilize the in-home TV wiring, supplying high rate

connectivity between any two home networking nodes. The present solution does not load the city cable TV (CATV) network.

The present invention enables installation of modems, connected to different types of nodes of the CATV to enable communication between these nodes.

The present invention presents a solution of transferring the data between these nodes, when the data is not required to be transferred to the headend.

The present invention presents a low cost solution, which is very important to enable a solution to the mass market.

While Local Area Networks (LANs) constitute a well-accepted part of the communications environment for businesses, LANs infrastructure is not commonly deployed in the home. This is due to several technical and logistical reasons.

The major driving force behind creating new home connectivity products is the growing number of homes with two or more PCs.

In the prior art, home networking systems are designed using the existing copper-based (twisted pair) wiring or using wireless solutions. The present invention seeks to provide system and apparatus for designing home networking over the in-home TV wiring, used to connect the antenna or the cable TV to the TV sets in the home.

The following key applications drive the demand for home networking:

Internet Sharing

Sharing simultaneous access to the Internet is a major driving factor for home networking. Today, when multiple home users want to enjoy Internet access without constraint, separate telephone lines and Internet accounts are required. Since this is costly, multiple users are typically restricted to using the Internet one individual at a time. Home networks can deliver significant savings and greater utility by enabling shared access to a single Internet connection. The need for this shared access will grow as today's 28.8K, 33.6K, and 56K analog connections are replaced by higher-speed "always-on" connections such as cable modem, Universal ADSL, ADSL, or satellite. Standardizing on a high-speed local-area home network interface insulates installed home networked devices from changes in Internet access technologies.

Peripheral Sharing

Today, in a home with multiple PCs, each computer needs a duplicate set of peripherals, such as printers or scanners. With a home network, the limited budget can optimize for one higher-end shared peripheral rather than many low performance units. With a network standard for the home, future peripherals can be designed to connect directly to the network, simplifying installation.

File and Application Sharing

Multiple users can easily share applications, move files, or back up data, saving time and money. Automatic software updates are enabled by a network connection.

Other Applications Enabled by Home Networking:

Entertainment

Easy-to-use home networks will also enable popular multi-player network games, either within the home or over the Internet.

Home Automation

A ubiquitous, easy-to-install home network will also foster home automation applications, such as environmental control and security systems.

Voice and Video over IP

New digital voice and video services are being introduced into the home. All these digital services—whether data, voice, or video—need to be accessible anywhere in the home by any device. All digital devices, including PCs, digital televisions, and digital telephones, will require a high-speed connection to the home network.

Today, it is estimated that over 15 million of the 100 million homes in the United States have two or more PCs, and 60% of new consumer PC purchases are by families that already have at least one computer. This number is expected to double by the year 2000.

Chief among these is the fact that the widely adopted and supported enterprise networking technologies require a technically skilled individual capable of designing and maintaining complex network architecture. Enterprise networks also require the use of high-grade wiring typically not found in most homes.

Also, few home users are willing to master the art of installing and maintaining an Ethernet repeater, learn even the basics about network protocols, or drill holes through their walls to run new network-capable wiring throughout their home.

Success in the consumer market requires that a home networking technology be inexpensive, easy to install, and easy to use. To be truly effective and embraced by consumers, a home networking solution must meet these criteria:

1. No new wiring.
   Most existing homes are not wired for traditional networking equipment. Rewiring the home is too expensive and a hassle for most consumers.
2. Simple to install and use.
3. Must be low cost to allow the mass market to enjoy the benefits of home networking.
4. The range must be adequate to operate within a typical home.
5. Support high data rate.
6. The networking capability must grow with user applications without obsoleting existing devices.
7. The network must be secure.
   The network data must remain private; it must not be accessible to neighbors or anyone outside the home.
8. The solution must not interfere with other systems, appliances and services.

Requirements:

1. The home networking equipment coexists with the other services on the cable network. In particular,
   It is spectrally aligned with any combination of television and other signals in the cables; and
   It does not cause harmful interference to any other services that are assigned to the cable network in spectrum outside of that allocated to the home networking. Therefore,
      The solution should not interfere with the TV/video channels.
      The solution should not interfere with any cable modem channels.
2. Comply with the general home networking requirements.
3. Verify that the technology does not limit the number of cable modems or the number of home networking modems. Due to using HCNM technology, each home will include more than a single CM. It is required that the cable headend will support the increased amount of CM's. For example DOCSIS protocol can support high quantity of CM's (up to 8,000 CM's for a MAC chip) in particular DOCSIS 1.1.

4. The Home Networking (HN) is required to supply a scaleable bandwidth range (100 Kb–10 Mb and more).
5. The number of nodes that are connected to the home network should not be limited by the presented solution. The only limitation should be the identification method in layer two (e.g. the limitation of using MAC address).
6. The connection method and the connection rate from home to the Internet using any technology (e.g. xDSL, cable modem) should not be influenced by the home networking technology.
   The only difference may be the ability to use this Internet connection for central management. For example, the Ethernet protocol, as a home networking protocol, complies with this requirement. It does not create any limitations to the protocol that is used for connecting the home to the Internet. The HomePNA is a home networking protocol that adds limitations and does not comply with this requirement. HomePNA enables the G.Lite protocol to be used for connecting the home to the Internet, but it does not enable the use of ADSL (10 Mbps) or VDSL protocols because it uses the same medium (phone line) and the same frequencies.
7. The ability to create a component that supplies the functionality of home networking and the functionality of connection to the Internet.

Nice to have:

1. The ability to create a component that supplies the functionality of home networking and does not supply the functionality of connection to the Internet.
2. Home Networking might be able to operate without connection to the headend.
3. An important point is to define this protocol to use limited "cable" resources.
   It should not use the limited US (up stream) frequencies. It can use some of the DS (down stream) frequencies or higher frequencies (even if their distance is limited).

There are some advantages in using this solution:

No new wiring is required. Usually there are some ports of the TV cable in each home.

The capacity of data that can be transferred using this infrastructure is very high.

There is no radiation. Wire radiation is very low, in particular Coax wires radiation is negligible. (Compared to wireless solutions this point is very important).

Simple to install and to use.

It can be low cost to allow the mass market to enjoy the benefits of home networking.

Supply high data rate.

It enables a secured network. The network data can remain private; the information can not be accessible to neighbors or anyone outside the home.

The range limitation is negligible compared to the typical home.

The networking capability grows with user applications without making the existing devices obsolete.

Total isolation from the home network to the cable infrastructure (filters) can be added, although it is not required.

It uses the same infrastructure that is used today by the current entertainment equipment (e.g. TV, Video). Therefore, the cabling probably exists. Supporting this protocol only requires minor changes in the equipment.

The advantages of using the cable infrastructure:

No new wiring is required. Usually there are some ports of the TV cable in each home. These ports are usually located in the appropriate location, because one of the major aspects of home networking is to connect your TV environment (that already has some interfaces to the cable infrastructure) to the computer environment (that already has an interface for the current cable modem).

The capacity of data that can be transferred using this infrastructure is very high (Order of Gbps).

There is no radiation. Wire radiation is very low, in particular Coax wire radiation is negligible. Compared to wireless solutions this point is of great importance. The coax cables are also not sensitive to external radiation.

The two-frequency mode exists to eliminate the echo problem that exists in some of the homes in the single frequency mode. The method is transmitting the information is a specific frequency range (e.g. 900–906 MHz) and receiving the information in a different frequency range (e.g. 910–916 MHz). The architecture of this solution appears in the following figure.

In the single frequency mode the information that is transferred from HCNU-**2** to HCNU-**3** is transferred through Splitter-I and in addition and echo from Splitter-main also received.

In the Dual Frequencies Mode the Transponder module is required to be added in the entrance to the home. The signal from HCNU-**2** is transferred to the transponder module. The transponder module changes the signal frequency from the US frequency to the DS frequency and transmits it to the home. The HCNU-**3** received this signal with no echo.

The transponder is a simple one that translates the input frequency to another, whether if it is with an up and down conversion or other technique such as conversion to base-band and back.

The HCNU can support the two modes, and according to the configuration the operation mode will be specified. The configuration can be done manually or automatically by verifying if the transponder exists (by sending a signal in the US channel and verifying if the signal arrived in the DS channel).

Therefore this module can be inserted in houses where there is a problem with reflection.

There are some additional benefits in the two-frequency mode:

The transmission path has low insertion loss and negligible reflections.

The transponder module can be inserted with the notch filter and with an amplifier.

Note:

The transponder can be powered down (even remote) and the system returns to the initial model, this ability maybe very important to the cable operator.

This section describes other applications that can be operated using the same physical layer.

These applications are a group of applications that can be built on the same infrastructure, transporting of variety classes of layer two protocols through the home cable infrastructure. These applications are based on home networking layer one that is described in this document, and used the specific application layer two.

The HomeCN-P is a protocol that includes layer one and two. There are two options to transfer different layer two over this infrastructure:

To transfer different layers two using the same layer one. This method is used in the presented application.

To transfer different layers two over the layer two of the HomeCN-P.

This method is not used in this presented solution because the capacity and the delay are not good enough for the presented applications.

Following some examples of layer two protocol that can be used:

USB

IEEE 1394 (fire-wire)

Ethernet (10BaseT, 100BaseT)

Wireless

This system enables high rate connection between two points at home.

The system contains two Home Networking Bridges (HNB) that are connected through the home cable wiring, each one of them has the same layer two interface e.g. IEEE 1394.

The system structure is presented in the following:

This structure enables information sending in very high rates (e.g. 40 Mbps) for each direction.

Note:

This system does not required burst modulator/demodulator. It can use a "standard" one.

The Bluetooth technology is design to supply connectivity of components that are located in the same area. The distance between the components should be less than meters (This range probably does not include wall interference). When you build your home network, and your home is larger then a small flat. You need to connect component when the distance between them is larger then 10 meters.

The idea is to build a network at home that connects the Bluetooth sub-networks.

Advantages

The benefits of the Bluetooth connectivity can be used.

You can cover much larger range.

The location of the cable infrastructure port in the room is going to be less important because all the room is "covered" (connected) by the network using Bluetooth connectivity.

The Bluetooth CM can be very simple, and cost effective.

Disadvantages

Adding Home Networking protocol that connects all the sub-networks of Bluetooth is required.

You have two types of networks at your home.

The rate of Bluetooth is less than 1Mbps. If a higher capacity is required, an additional connector type should be added (HomeCN-P capacity is 10–50 Mbps). This additional type might make your network more complex, and will required an appropriate network management.

Notes:

FIG. **13** present an example of a network.

The HNO-Bluetooth can be a very simple component if the network is required to have at least one component of HCNM+Bluetooth that has the capability to manage the simple HNO-Bluetooth components.

The management of the Bluetooth sub-networks and the ability to transfer the connection of a network element from one Bluetooth sub-network to another required a specific layer two Bluetooth rooming-in protocol.

Adding Power-supply capabilities to the home amplifier enable very simple Bluetooth-CM component. Bluetooth-CM component is required to include the following: Tuner, CM-chip, Bluetooth-chip, and very small CPU (only is the CM-chip and the Bluetooth-chip does not contain CPU). The installation procedure is going to be very simple, Just plug it to the cable interface, no other wire are required. The BOM of this component is going to be very low.

When the system is working in a single home operational mode and a notch filter exist, all the management is done local and the requirements from this management system are reduced.

When the system is working in a Connected Home operation mode, and the system contain a CM channel, the management is done from the headend. This management is much more complex.

The following table presents the management functionality:

TABLE NNN

Management Functionality

Functionality	Description	Operation Mode (ALL or Only-Connected Home)
HCN units identification	Identify all the units that are sharing the same HCN	All
Ranging	Ranging between each two modems	All
Headend management	Enabling management from the headend.	Only-Connected Home
Frequency Selection And frequency plan	Select the required frequency for HCN and the required frequency range	Only-Connected Home
Security	Management of the BLP (Base Line Privacy) keys	Only-Connected Home
Support branch Calculation Mode	Support the ability to measure the signal amplitude according to the command of the headend	Only-Connected Home

The following section describes the frequency planning mechanism.

The configuration for the specific frequency will be done by the management system. The calculation is based on the 'branch' calculation, because the process of frequency allocation is done separately in each "branch".

The following are base rules that are used in the calculation of each home-network frequency- range.

The home-network frequency-range is specified by the required home-networking bandwidth. The required bandwidth is specified for each home-network separately.

E.g. the required home-network frequency-range to transfer 40 Mbps is 6 MHz.

The total frequency-range is specified by the capability of the home networking equipment.

E.g. the total frequency-range can be 40 MHz.

The total frequency-range should be larger than the summaries of the home-networks frequency-range of all the home-networks that exist in each "branch".

If this condition is not met, the cable operator can decrease the bandwidth of its customers, or divide the network into smaller "branches".

E.g. If a 'branch' contains 16 flats and each one of them asks for the higher bandwidth and the total frequency-range is 40 MHz, each one of the flats can get 40 MHz/16=2.5 MHz home-networks frequency-range. The operator can also divide the total frequency-range in other method, 4 flats will get 5 MHz each, and the other 12 flats will get 1.6 MHz each.

There are some frequency-ranges that might be used.

The preferred frequency range is higher than 860 MHz.

Note:

There are some existing chips (low price) that supply two-direction filtering and tuner functionality for the specific 900–1000 MHz frequency-range (Note: These chips were designed for the cellular market).

The following table presents the comparison between these frequency-ranges.

Frequencies Range	Pros	Cons
<5 MHz	Not used by DOCSIS and by the TV. Tuners are not required. Low attenuation of the Coax Cable enables low power.	The capacity is very low. The quality of this frequency-range is low. The cable network contains amplifiers for part of this frequency-range. These amplifiers are designed to amplify in the US direction; therefore the segmentations to 'brunch' are limited. Low attenuation of the Coax Cable increases the 'branch' size.
5–42 MHz	Tuners are not required. Low attenuation of the Coax Cable enables low power.	The DOCSIS channels use this frequency-range. The frequency-range resource is very limited. The cable network contains amplifiers for this frequency-range. These amplifiers are designed to amplify in the US direction; therefore the amplifier may be saturated. Low attenuation of the Coax Cable increases the 'branch' size.
42–88 MHz	Not used by DOCSIS and by the TV, these rates are the gap between DOCSIS US channels to TV channels and DOCSIS DS channels.	This range is not free all over the world. For example, in the DEVIC standard this range is reduced. The cable network contains amplifiers for part of this frequency-range. These amplifiers are designed to amplify in the US direction; therefore the amplifier may be saturated.
88–860 MHz	The standard tuner can be used. The capacity is not limited. There is good isolation between different home segments; therefore, 'branch' separation can be used.	The TV channels and the DOCSIS channels use this frequency-range; therefore the cable companies probably prefer to use this resource for the TV channels and DOCSIS channels.
>860 MHz	Not used by DOCSIS channels and by the TV channels. There is a good isolation between different home segments, due to the non-matched impedance (Z_0). There are some existing chips (low price) that supply two-direction filtering and tuner functionality.	The attenuation is high; therefore there are some distances limitations in very high frequencies. (Note: The distance limitation is not relevant to home networking). There are some FCC limitations. These limitation probably not relevant for coaxial wires

Various types of modulation can be used.

The modulation method should comply with the following requirements:

Can be used in the required frequency range.
Should support high bandwidth rate (more then 10 Mbps).
Should support bursts with short learning time.
The selected modulations that comply with these requirements are QPSK and QAM.

The Channel Allocation method should be FDM—a specific frequency for each home network. This chapter describes the Design Considerations.

There are some alternatives for channel allocation. The mechanism of channel allocation should answer the problem that a sub-network("branch") usually contains some home networks. The number of home networks that should use the same frequency range can be changed according to the physical layer condition i.e. according to the 'branch' size.

There are some known methods to allocate channels for each home-network. The following table compares between them. This table does not present methods that are a combination of two base methods, because these combinations are not required (e.g. combination of FDM and TDM) in our simple problem:

Method	Pros	Cons
FDM-Frequency Domain Multiplexing	Simple The frequency range can be updated according to the number of home-networks that share the same frequency, and according to the required bandwidth. Can use wide spectrum for the whole solution, when each home is required to use narrow range (less then 6 MHz). Very efficient, in particular when the number of home-networks in a specific 'branch' is low. Does not require synchronization and does not require CMTS for synchronization.	Not efficient in case of many home-networks on the same "branch" According to our estimations, this case is probably rare. CBR based; therefore it is not affective when the traffic is not CBR type.
FDM with frequency hopping	Does not require any configuration. I.e. not required configuration of the frequency that each home should use. Very efficient when the traffic is ABR type.	More complex then FDM. Hard to be managed by the Cable Operator. It is not efficient when the traffic is CBR type (e.g. digital movie playing on the DVD in the living room, when the TV is in the bad room). It has only disadvantage when the home is the only home on the branch.
TDM-Time Domain Multiplexing	The bandwidth allocation can be dynamic-according to the needs.	Requires synchronization, therefore, it require CMTS for synchronization. Can not use the wide spectrum (more then 10 MHz) in each channel group. Making Home Cable Networking Unit (HCNU) equipment is very complex, because this equipment is required to get the sync from the cable modem network. It is similar to FDM, but more complex, when the home is the only home on the branch.
CDM-Code Domain Multiplexing	The supplied bandwidth (data rate) can be dynamic-according to the needs.	Very complex Requires synchronization, therefore, it requires CMTS for synchronization. Making Home Cable Networking Unit (HCNU) equipment is very complex, because this equipment is required to get the sync from the cable modem network. Can not use wide spectrum (more than 10 MHz) in each channels group. The performances are low unless you are using complex equipment that supports wide spectrum sampling. It is similar to FDM, but more complex, when the home is the only home on the branch.

The data link protocol should be the IEEE 802.11 MAC layer CSMA/CA.

Note:

The CSMA/CA can be used with or without ACK protocol. The need for immediate ACK should be verified according to the quality of the infrastructure.

Following the design considerations:

There are some options to define the layer two (data link) protocol.

The major aspects that should be considered are:

- The number of stations that use the home networking is variable (usually 2–15).
- Station can be added to the network or removed from the network during the home network operation.
- Collision prevention is required, because collision detection in the QAM technology is complex.
- It is preferable that all the components will be similar, so that the home network will not require a special head component.
- This method usually increases the robustness of the network, and does not require special addition of equipment.
- A standard protocol or protocol that is close to a standard protocol is preferred.

There are some protocols that comply with these requirements, following two examples:

- The 802.11 MAC layer CSMA/CA.
- This protocol is used today by many vendors, usually, in the wireless LAN equipment. Consider the fact that Bluetooth interface might be required to exist on the HCNM/HCNU/HCNI components, it would be much simpler to support a single MAC protocol. This protocol also supports priority.
- The Token Bus 802.4.
- This protocol is not common, and it is very complex. Building a reduced version of this protocol can simplify the protocol, but it will not be a standard protocol.

The system security is done in layer two. This security can be based on to the following standards:

- The DOCSIS standard.
- IEEE 802.11 standard.

The preferred option is according to DOCSIS standard because:

- The CMTS headend already manages this security.
- The standard CM already contains these cores.

Priority should be defined for the two channels separately.

The priority for the cable modem channel:

The need for priority for this channel was investigated. Cable modem protocols such as DOCSIS include this capability for services that require this capability e.g. VoIP.

EXAMPLE

- The priority mechanism for the DOCSIS standard is well defined in DOCSIS 1.1.

The priority for the Home Networking channel:

The priority for this channel is divided into two aspects:

- Priority is required in the home-networking channel for applications that are required to be connected to the standard cable modem channel; but they are using the home networking as transport media. The solution for these applications is to use HCNM and not HCNU/HCNI, and to use the cable modem channel directly.
- Priority is required in the home-networking channel for applications at home. E.g. CBR priority for transferring a video from the DVD reader to the digital TV on another floor, high priority for games, low priority for backup.
- The priority requirements for these applications probably will be added soon. But the basic requirements of the home networking does not require priority capabilities, and the data rate of the home networking is high therefore "best effort" is good enough.

According to the presented analyses, specifying the priority for the home networking can be handled in the 2^{nd} phase.

The following table compares between the different home networking solutions.

Subject	HomePNA	HomeCN
No new wiring	Use the existing phone interfaces small advantage for the number of phone jacks	Use the existing TV cable interfaces Advantage in the location for usage of home networking to entertainment (e.g. TV, VCR, DVD)
Installation	Simple to install and use. Does not required any change in the home wiring.	Simple to be install and use. Usually, does not required any change in the home wiring. In some of the cases it required adding a component in the entrance of the home.
Notch filter adding	Might be required-depends on the VDSL/HomePNA coexistence.	May be require for low cost equipment, or to enable higher bandwidth.
Low cost	The host-based product price is $79 for 1 Mbps (Intel).	The solution can be in similar prices.
Range	Adequate to a typical home.	
User privacy	Does not require The neighbor can use the cross talk for eavesdropping (intelligence).	Required, only, when the notch filter (or flat amplifier) not exist, and you are afraid from eavesdropping (intelligence) from neighbors that are connected to the same building splitter.
Interferes	Interferes with VDSL	No interferes

-continued

Subject	HomePNA	HomeCN
Available capacity	HomePNA 1-1 Mbps HomePNA 2-10 Mbps (This capacity is very difficult to achieve because the home phone wiring is in very low quality.	Single Home low cost version-20 Mbps Higher version can support very high capacity because the coaxial network has very high quality.
Integrated into	DSL (G.Lite), Cable Modems?	Uaually-Cable Modems, Bluetooth

Following some typical Street/Building wiring

The following describes HCNM.

The 1st chip is designed to be designed in "system on a chip" architecture. The base chip should support the Single Home operation mode to reduce the price. In addition it requires supplying a Bluetooth interface.

Following the components should exist on the chip: Burst receiver, Burst Transmitter, 900 MHz front end (bi-directional), MAC (based on 802.11) that supports the HomeCN and the Bluetooth, The Bluetooth interface, and CPU core (ARM).

The chip should support only specific the frequencies of 900–906 MHz and transmission rate of up to 30 Mbps.

Note:

This chip might also include Bluetooth core.

CATV	Cable Television
CM	Cable Modem
DOCSIS	Data Over Cable Service Interface Specifications
HCNP	Home Cable Networking Protocol
HCNM	Home Cable Networking Modem
HCNI	Home Cable Networking Interface
HCNU	Home Cable Networking Unit
HomeCN, HCN	Home Cable Networking

What is claimed is:

1. A method of networking a plurality of devices residing within a home, creating a home network, with a home cable network modern, wherein the devices include TV's, VCR's, PC's, DVD's, DOCSIS cable modems, set-top boxes, wireless devices, Bluetooth stations, cellular phones, and computer games, each device each including a home network interface coupled to an RF element over a coaxial cable, wherein the home cable network modem is also coupled to the RF element over a coaxial cable, and wherein the RF element is also coupled to a cable source, the method comprising the steps of:

receiving a television signal from the cable source at frequencies below a source frequency limit;

operating one of the home network interfaces to transmit a home network signal, in a home network frequency band above the source frequency limit, over coaxial cable to the RF element; and

receiving the transmitted home network signal over coaxial cable at the home cable network modem.

2. A method of networking a plurality of devices residing within a home, creating a home network, with a home cable network modem, each device each including a home network interface coupled to an RF element over a coaxial cable, wherein the home cable network modem is also coupled to the RF element over a coaxial cable, and wherein the RF element is also coupled to a cable source, the method comprising the steps of:

receiving a television signal from the cable source at frequencies below a source frequency limit;

operating a cable modem termination system (CMTS) to assign the home network frequency band;

operating one of the home network interfaces to transmit a home network signal, in a home network frequency band above the source frequency limit, over coaxial cable to the RF element; and

receiving the transmitted home network signal over coaxial cable at the home cable network modem.

3. The method according to claim **2** wherein the home cable network modem comprises a CATV set top box;

and further comprising:

forwarding the received television signal to a television set coupled to the set-top box.

4. The method according to claim **3** wherein the upstream and downstream home network frequency bands are between 900 and 960 MHz.

5. A communications network comprising:

a cable source adapted to transmit television signals within a frequency range below a source frequency limit;

an RF element, coupled to the cable source, and having a plurality of terminals, and comprising a transponder adapted to calculate branches;

a plurality of devices, each device including a cable networking interface that is coupled to a terminal of the RF element by way of coaxial cable, and that is for transmitting and receiving signals in a home network frequency band above the source frequency limit; and

a home cable networking modem, coupled to a terminal of the RF element, for receiving signals transmitted by, and for transmitting signals to, a cable networking interface of one of the plurality of devices in the home network frequency band.

6. The network according to claim **5** wherein the transponder calculates branches by calculating the isolation among the plurality of devices.

7. The network according to claim **5**, wherein the transponder is for translating signals received from a cable networking interface of one of the plurality of devices from an upstream frequency range within the home network frequency band into a downstream frequency range within the home network frequency band, and for transmitting the translated signals to the cable networking interface of the others of the plurality of devices and to the home cable network modem.

8. A communications network comprising:

a cable source, coupled to a cable modem termination system (CMTS), and adapted to transmit television signals within a frequency range below a source frequency limit of about 860 MHz;

an RF element, coupled to the cable source, having a plurality of terminals, and comprising a transponder;

a plurality of devices, each device including a cable networking interface that is coupled to a terminal of the RF element by way of coaxial cable, and that is for transmitting and receiving signals in a home network frequency band above the source frequency limit, the home network frequency band allocated by the CMTS; and

a home cable networking modem, coupled to a terminal of the RF element, for receiving signals transmitted by, and for transmitting signals to, a cable networking interface of one of the plurality of devices in the home network frequency band.

9. The network according to claim **8** wherein the CMTS is adapted to allocate the home network frequency band to prevent interference with other home networks.

10. The network according to claim **8** wherein the CMTS allocates the same home network frequency band to at least one other home network.

11. The network according to claim **10** wherein the RF element further comprises at least one filter for blocking signals in the home network frequency band from being applied to the cable source.

12. The network according to claim **10** wherein the RF element further comprises a splitter with high reflections in the home network frequency band.

13. A home cable networking (HCN) device, comprising:

a coaxial cable interface, coupled to a coaxial cable television (CATV) cable, for communicating signals within a frequency range below a source frequency limit;

a home network interface for receiving and transmitting communication signals, over a coaxial cable, and within a home network frequency band above the source frequency limit, among a plurality of devices in a home;

a computer interface, for communicating with a computer; and

circuitry for modulating signals received from the computer over the computer interface, and for converting signals received from the plurality of devices over the home network interface, into Internet Protocol (IP) signals for transmission over the coaxial cable interface, and for demodulating IP signals received over the coaxial cable interface and transmitting the demodulated IP signals over the computer interface and the home network interface.

14. The HCN device according to claim **13** wherein the device comprises a set-top box.

15. The HCN device according to claim **13** wherein the home frequency band is between 900–960 MHz.

16. A home cable networking (HCN) device, comprising:

a coaxial cable interface, coupled to a coaxial cable television (CATV) cable and to a cable modem termination station (CMTS), for communicating signals within a frequency range below a source frequency limit; and

a home network interface for receiving and transmitting communication signals among a plurality of devices in a home over a coaxial cable, and within a home network frequency band selected by the CMTS and above the source frequency limit.

17. The HCN device according to claim **16** wherein the communication signals received and transmitted over the home network interface are based on the IEEE 802.11 standard.

18. The HCN device according to claim **17** further comprising an encryption function for encrypting data transmitted and received over the home network interface.

* * * * *

Exhibit 1002

File History of U.S. Patent No. 7,594,249

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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/910,412	07/21/2001	Itzhak Gurantz	

CONFIRMATION NO. 2398

POA ACCEPTANCE LETTER

23446
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OC000000126244515

Date Mailed: 06/11/2021

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 06/08/2021.

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.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/tmwilliams/

PTO/AIA/80 (07-17)
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POWER OF ATTORNEY TO PROSECUTE APPLICATIONS BEFORE THE USPTO

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

I hereby appoint:

[X] Practitioners associated with Customer Number: 23,446

OR

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

Name	Registration Number	Name	Registration Number

As attorney(s) or agent(s) to represent the undersigned before the United States Patent and Trademark Office (USPTO) in connection with any and all patent applications assigned only to the undersigned according to the USPTO assignment records or assignment 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:

[X] The address associated with Customer Number: 23,446

OR

[ ]

Firm or individual name		
Address		
City	State	Zip
Country		
Telephone	Email	

Assignee name and address: ENTROPIC COMMUNICATIONS, LLC
1345 AVENUE OF THE AMERICAS, 46TH FLOOR
NEW YORK, NY 10105

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 /Andrea L. Gothing/	Date 2021-05-04
Name Andrea L. Gothing	Telephone 415-830-0613
Title Licensing Officer and Authorized Signatory, Entropic Communications, LLC	

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 update (and by the USPTO to process) the file of a patent or reexamination proceeding. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 18 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Privacy Act Statement

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

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

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

Electronic Acknowledgement Receipt

EFS ID:	42931574
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	23446
Filer:	Ronald H. Spuhler/Deborah Wilson
Filer Authorized By:	Ronald H. Spuhler
Attorney Docket Number:	
Receipt Date:	08-JUN-2021
Filing Date:	21-JUL-2001
Time Stamp:	16:38:54
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	Assignee showing of ownership per 37 CFR 3.73	29236US01_373c_Statement_AIA-96.pdf	124095 a876f9e57afb5da136896f2544e36cdb6b31e717	no	3

Warnings:

Information:					
2	Power of Attorney	Entropic-POA_General_Assignee_EntropicCommunications_ALG.pdf	487892 51444e06ae84b241bfc127dc47c5d6c6469 44dd7	no	2
Warnings:					
Information:					
			Total Files Size (in bytes):	611987	

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

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

PTO/AIA/96 (08-12)
Approved for use through 01/31/2013. 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.

STATEMENT UNDER 37 CFR 3.73(c)

Applicant/Patent Owner: ENTROPIC COMMUNICATIONS, LLC

Application No./Patent No.: 09/910,412 Filed/Issue Date: 2021-07-21

Titled: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

ENTROPIC COMMUNICATIONS, LLC, a limited liability company

(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: Itzhak Gurantz, Ladd Eiwardani, Anton Monk, Brett Bernath, Magnus Berggren To: ENTROPIC COMMUNICATIONS INC.

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

   Reel 012499, Frame 0136, or for which a copy thereof is attached.

2. From: EXCALIBUR ACQUISITION CORPORATION, ENTROPIC COMMUNICATIONS, INC. To: ENTROPIC COMMUNICATIONS, INC.

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

   Reel 035706, Frame 0267, or for which a copy thereof is attached.

This collection of information is required by 37 CFR 3.73(b). 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 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

PTO/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
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.

STATEMENT UNDER 37 CFR 3.73(c)

3. From: ROPIC COMMUNICATIONS, INC., EXCALIBUR SUBSIDIARY, LLC To: ENTROPIC COMMUNICATIONS, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 035717, Frame 0628, or for which a copy thereof is attached.

4. From: ENTROPIC COMMUNICATIONS, LLC To: MAXLINEAR COMMUNICATIONS LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 055776, Frame 0482, or for which a copy thereof is attached.

5. From: MAXLINEAR COMMUNICATIONS LLC To: ENTROPIC COMMUNICATIONS, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 055899, Frame 0291, 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.

/Ronald H. Spuhler/	2021-06-08
Signature	Date
Ronald H. Spuhler	52245
Printed or Typed Name	Title or Registration Number

[Page 2 of 2]

Privacy Act Statement

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

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

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

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
09/910,412	07/21/2001	Itzhak Gurantz	E010001USU1

CONFIRMATION NO. 2398

77330
ENTROPIC COMMUNICATIONS, INC.
6350 SEQUENCE DRIVE
SAN DIEGO, CA 92121

POWER OF ATTORNEY NOTICE

OC000000076127219

Date Mailed: 07/07/2015

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/02/2015.

- 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).

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/dtvernon/

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
09/910,412	07/21/2001	Itzhak Gurantz	

CONFIRMATION NO. 2398

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

POA ACCEPTANCE LETTER

OC000000076127256

Date Mailed: 07/07/2015

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 07/02/2015.

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.

Questions about the contents of this notice and the requirements it sets forth should be directed to the Office of Data Management, Application Assistance Unit, at **(571) 272-4000** or **(571) 272-4200** or **1-888-786-0101**.

/dtvernon/

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
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.

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(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 23446

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 assignment documents attached to this form in accordance with 37 CFR 3.73(b).

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

☑ The address associated with Customer Number: 23446

OR

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

Assignee Name and Address:

Entropic Communications, LLC.
2051 Palomar Airport Road, Suite 100
Carlsbad, CA 92011

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

SIGNATURE of Assignee of Record

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

Signature		Date	6/15/15
Name	Adam Spice	Telephone	
Title	Chief Finanical Officer		

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

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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).
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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.
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PTO/SB/96 (07-09)
Approved for use through 07/31/2012. 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.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Itzhak Gurantz, Ladd Eiwardani, Anton Monk, Brett Bernath, Magnus Berggren

Application No./Patent No.: 7,594,249 Filed/Issue Date: 09/22/2009

Titled: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

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

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;

2. ☐ an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

OR

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

1. From: Itzhak Gurantz, Ladd Eiwardani, Anton Monk, E To: ENTROPIC COMMUNICATIONS INC.
The document was recorded in the United States Patent and Trademark Office at
Reel 012499 , Frame 0136 , or for which a copy thereof is attached.

2. From: ENTROPIC COMMUNICATIONS INC. and EX To: ENTROPIC COMMUNICATIONS INC.
The document was recorded in the United States Patent and Trademark Office at
Reel 035706 , Frame 0267 , or for which a copy thereof is attached.

3. From: ENTROPIC COMMUNICATIONS INC. and EX To: ENTROPIC COMMUNICATIONS, LLC
The document was recorded in the United States Patent and Trademark Office at
Reel 02084535 , Frame 0628 , 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(b)(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.

/Christopher C. Winslade/ 07/02/2015
Signature Date

Christopher C. Winslade, Reg. No. 36308 Attorney for Applicant
Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). 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 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Privacy Act Statement

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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.
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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.
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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:	22819648
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77330
Filer:	Christopher C. Winslade/Deb Wilson
Filer Authorized By:	Christopher C. Winslade
Attorney Docket Number:	E010001USU1
Receipt Date:	02-JUL-2015
Filing Date:	21-JUL-2001
Time Stamp:	17:36:25
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	Power of Attorney	Entropic_POA_PreAIA.pdf	340881 8107f4c6d5473b527f97e45769199b81a37aad1b	no	2
Warnings:					
Information:					

2	Assignee showing of ownership per 37 CFR 3.73	29236US01_373b_Statement_sb96.pdf	431539 fc95478775c6dc768bc4b5e86fa748077a79f0a3	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	772420

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

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

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

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

PTO/SB/80 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
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.

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(b).

I hereby appoint:

☑ Practitioners associated with the Customer Number: 23446

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 assignment documents attached to this form in accordance with 37 CFR 3.73(b).

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

☑ The address associated with Customer Number: 23446

OR

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

Assignee Name and Address:

Entropic Communications, LLC.
2051 Palomar Airport Road, Suite 100
Carlsbad, CA 92011

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

SIGNATURE of Assignee of Record

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

Signature		Date	6/15/15
Name	Adam Spice	Telephone	
Title	Chief Finanical Officer		

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

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Privacy Act Statement

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Electronic Acknowledgement Receipt

EFS ID:	22819854
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77330
Filer:	Christopher C. Winslade/Deb Wilson
Filer Authorized By:	Christopher C. Winslade
Attorney Docket Number:	E010001USU1
Receipt Date:	02-JUL-2015
Filing Date:	21-JUL-2001
Time Stamp:	17:49:15
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	Assignee showing of ownership per 37 CFR 3.73	29236US01_373b_Statement_sb96.pdf	431532 00e3e5f36bbc881ae9a52ddcaae3df398ef5b384	no	2
Warnings:					
Information:					

2	Power of Attorney	Entropic_POA_PreAIA.pdf	340881 8107f4c6d5473b527f97e45769199b81a37aad1b	no	2

Warnings:	
Information:	
Total Files Size (in bytes):	772413

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PTO/SB/96 (07-09)
Approved for use through 07/31/2012. 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.

STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Itzhak Gurantz, Ladd Eiwardani, Anton Monk, Brett Bernath, Magnus Berggren

Application No./Patent No.: 7,594,249 Filed/Issue Date: 09/22/2009

Titled: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

Entropic Communications, LLC , a corporation

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

states that it is:

1. ☒ the assignee of the entire right, title, and interest in;

2. ☐ an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. ☐ the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

OR

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

1. From: Itzhak Gurantz, Ladd Eiwardani, Anton Monk, E To: ENTROPIC COMMUNICATIONS INC.

The document was recorded in the United States Patent and Trademark Office at
Reel 012499 , Frame 0136 , or for which a copy thereof is attached.

2. From: ENTROPIC COMMUNICATIONS INC. and EX To: ENTROPIC COMMUNICATIONS INC.

The document was recorded in the United States Patent and Trademark Office at
Reel 035706 , Frame 0267 , or for which a copy thereof is attached.

3. From: ENTROPIC COMMUNICATIONS INC. and EX To: ENTROPIC COMMUNICATIONS, LLC

The document was recorded in the United States Patent and Trademark Office at
Reel 035717 , Frame 0628 , 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(b)(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.

/Christopher C. Winslade/ 07/02/2015

Signature Date

Christopher C. Winslade, Reg. No. 36308 Attorney for Applicant

Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). 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 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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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.	ISSUE DATE	PATENT NO.	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	09/22/2009	7594249	E010001USU1	2398

77330 7590 09/02/2009

ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121

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 816 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):

Itzhak Gurantz, San Diego, CA;
Ladd Eiwardani, La Jolla, CA;
Anton Monk, San Diego, CA;
Brett Bernath, San Diego, CA;
Magnus Berggren, San Diego, CA;

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)

77330 7590 05/18/2009

ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121

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 VIA EFS-WEB

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.

Tim Ellis	(Depositor's name)
/Tim Ellis/	(Signature)
August 13, 2009	(Date)

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	07/21/2001	Itzhak Gurantz	E010001USU1	2398

TITLE OF INVENTION: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

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	08/18/2009

EXAMINER	ART UNIT	CLASS-SUBCLASS
CHOWDHURY, SUMAIYA A	2421	725-078000

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 Michael W. Landry
2 Bruce W. Greenhaus
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: Entropic Communications, Inc.

(B) RESIDENCE: (CITY and STATE OR COUNTRY): San Diego, CA

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 USPTO Deposit Account
☒ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number 504613 (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 /Bruce W. Greenhaus/ Date August 13, 2009

Typed or printed name Bruce W. Greenhaus Registration No. 37339

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:	09910412
Filing Date:	21-Jul-2001
Title of Invention:	NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE
First Named Inventor/Applicant Name:	Itzhak Gurantz
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Attorney Docket Number:	E010001USU1

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Pages:				
Claims:				
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Utility Appl issue fee	1501	1	1510	1510
Publ. Fee- early, voluntary, or normal	1504	1	300	300

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

Electronic Acknowledgement Receipt	
EFS ID:	5881966
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77330
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Filer Authorized By:	Bruce Wayne Greenhaus
Attorney Docket Number:	E010001USU1
Receipt Date:	13-AUG-2009
Filing Date:	21-JUL-2001
Time Stamp:	13:17:05
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	10076
Deposit Account	504613
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 1.17 (Patent application and reexamination processing fees)	

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)	E010001USU1_Issue-Fee-Payment_8-13-09.pdf	106206 a7c806161004ba47b554fb695aa90e3561fd236f	no	1
Warnings:					
Information:					
2	Fee Worksheet (PTO-875)	fee-info.pdf	32094 14ae7fb263d873db75f7b65bc5ff5ae1f2f1df9c	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	138300		

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
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

NOTICE OF ALLOWANCE AND FEE(S) DUE

77330 7590 05/18/2009

ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121

EXAMINER	
CHOWDHURY, SUMAIYA A	
ART UNIT	PAPER NUMBER
2421	

DATE MAILED: 05/18/2009

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	07/21/2001	Itzhak Gurantz	E010001USU1	2398

TITLE OF INVENTION: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

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	08/18/2009

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

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

HOW TO REPLY TO THIS NOTICE:

I. Review the SMALL ENTITY status shown above.

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

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

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

If the SMALL ENTITY is shown as NO:

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

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

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

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

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

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

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)

77330 7590 05/18/2009

ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121

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.
09/910,412	07/21/2001	Itzhak Gurantz	E010001USU1	2398

TITLE OF INVENTION: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

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	08/18/2009

EXAMINER	ART UNIT	CLASS-SUBCLASS
CHOWDHURY, SUMAIYA A	2421	725-078000

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 _____

2 _____

3 _____

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

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

(A) NAME OF ASSIGNEE (B) RESIDENCE: (CITY and STATE OR COUNTRY)

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

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

❑ Issue Fee

❑ Publication Fee (No small entity discount permitted)

❑ Advance Order - # of Copies _____

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

❑ A check is enclosed.

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

❑ The Director is hereby authorized to charge the required fee(s), any deficiency, or credit any overpayment, to Deposit Account Number _____ (enclose an extra copy of this form).

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

❑ a. Applicant claims SMALL ENTITY status. See 37 CFR 1.27.

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

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

Authorized Signature _____ Date _____

Typed or printed name _____ Registration No. _____

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

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

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	07/21/2001	Itzhak Gurantz	E010001USU1	2398

77330 7590 05/18/2009

ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121

EXAMINER	
CHOWDHURY, SUMAIYA A	
ART UNIT	PAPER NUMBER
2421	

DATE MAILED: 05/18/2009

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 816 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 816 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.	Applicant(s)	
	09/910,412	GURANTZ ET AL.	
	Examiner	Art Unit	
	SUMAIYA A. CHOWDHURY	2421	

-- 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 *1/19/09*.

2. ☒ The allowed claim(s) is/are *5, 18, 23-37*.

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. ☐ 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 _____.

/John W. Miller/
Supervisory Patent Examiner, Art Unit 2421

DETAILED ACTION

Allowable Subject Matter

1. Claims 5, 18, and 23-37 are allowed.

Reasons for Allowance

2. The following is an examiner's statement of reasons for allowance:

Regarding claims 5, 25, and 29, the prior art of record to Kliger (US 2002/0069417) teaches a home network system in which a module in one room can communicate with modules in other rooms through a signal reflector unit. The prior art of record fails to reasonably show or suggest a filter located at the point of entry of a building tuned to reject network signals originating in the building such that the network signals originating in the building do not pass through the filter, but rather are reflected back into the building.

3. 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."

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SUMAIYA A. CHOWDHURY whose telephone number is (571)272-8567. The examiner can normally be reached on Mon-Fri, 9-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Miller can be reached on (571) 272-7353. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/John W. Miller/
Supervisory Patent Examiner, Art Unit 2421

/Sumaiya A Chowdhury/
Examiner, Art Unit 2421

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	09910412	GURANTZ ET AL.
	Examiner	Art Unit
	SUMAIYA A CHOWDHURY	2421

✓	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	03/25/2008	10/12/2008	05/06/2009						
1	5	✓	✓	=						
2	18	✓	✓	=						
4	23	✓	✓	=						
3	24	✓	✓	=						
5	25	✓	✓	=						
6	26	✓	✓	=						
7	27	✓	✓	=						
8	28	✓	✓	=						
10	29	✓	✓	=						
11	30	✓	✓	=						
12	31	✓	✓	=						
13	32	✓	✓	=						
16	33	✓	✓	=						
14	34	✓	✓	=						
15	35	✓	✓	=						
9	36	✓	✓	=						
17	37	✓	✓	=						

Issue Classification	Application/Control No.	Applicant(s)/Patent Under Reexamination
	09910412	GURANTZ ET AL.
	Examiner	Art Unit
	SUMAIYA A CHOWDHURY	2421

ORIGINAL		INTERNATIONAL CLASSIFICATION	
CLASS	SUBCLASS	CLAIMED	NON-CLAIMED
725	78	H 0 4 N 7 / 18 (2006.01.01)	

CROSS REFERENCE(S)

CLASS	SUBCLASS (ONE SUBCLASS PER BLOCK)				
725	51	54	74	78	80
725	85	125	119	127	

☐ 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	5	17	37												
2	18														
4	23														
3	24														
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10	29														
11	30														
12	31														
13	32														
16	33														
14	34														
15	35														
9	36														

/SUMAIYA A CHOWDHURY/ Examiner.Art Unit 2421	5/6/09	**Total Claims Allowed:**	
(Assistant Examiner)	(Date)	17	
/John W Miller/ Supervisory Patent Examiner.Art Unit 2421	05/08/2009	O.G. Print Claim(s)	O.G. Print Figure
(Primary Examiner)	(Date)	5	2

U.S. Patent and Trademark Office — Part of Paper No. 20090506

Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	09910412	GURANTZ ET AL.
	Examiner	Art Unit
	SUMAIYA A CHOWDHURY	2421

SEARCHED

Class	Subclass	Date	Examiner
725	51	3/25/2008	SAC
725	51, 54	4/17/2009	SAC
725	74, 78, 80	4/20/2009	SAC
725	85, 125, 119	4/21/2009	SAC
725	127	5/6/2009	SAC

SEARCH NOTES

Search Notes	Date	Examiner
Double Patenting Search	4/20/2009	SAC
Inventorship Search	4/20/2009	SAC
Consulted Chris Grant	1/4/06	SAC
Consulted Hai Tran	5/2/06	SAC
Consulted Jason Salce	5/2/06	SAC
Consulted Vivek Srivastava	5/2/06	SAC
Consulted Drew Koenig	5/22/06	SAC
Consulted Dominic Saltarelli	5/23/06	SAC
Consulted Ngoc Vu	5/23/06	SAC

INTERFERENCE SEARCH

Class	Subclass	Date	Examiner
725	78, 80, 85	5/6/2009	SAC

/S. A. C./ Examiner.Art Unit 2421	

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. 2398

SERIAL NUMBER	FILING or 371(c) DATE RULE	CLASS	GROUP ART UNIT	ATTORNEY DOCKET NO.
09/910,412	07/21/2001	725	2421	E010001USU1

APPLICANTS

Itzhak Gurantz, San Diego, CA;
Ladd Eiwardani, La Jolla, CA;
Anton Monk, San Diego, CA;
Brett Bernath, San Diego, CA;
Magnus Berggren, San Diego, CA;

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

This appln claims benefit of 60/288,967 05/04/2001

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

**** IF REQUIRED, FOREIGN FILING LICENSE GRANTED ****

09/06/2001

Foreign Priority claimed	☐ Yes ☑ No	☐ Met after Allowance	STATE OR COUNTRY	SHEETS DRAWINGS	TOTAL CLAIMS	INDEPENDENT CLAIMS
35 USC 119(a-d) conditions met	☐ Yes ☑ No					
Verified and Acknowledged	/SUMAIYA A CHOWDHURY/ Examiner's Signature	Initials	CA	5	18	3

ADDRESS

ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121
UNITED STATES

TITLE

Network interface device and broadband local area network using coaxial cable

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

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L3	0	2002/0069417.did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 19:43
L4	2	"20020069417".did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 19:43
L5	85	725/78.CCLS. AND 725/80.CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 19:53
L6	27	725/78.CCLS. AND 725/85.CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 19:53
L7	377	725/127.CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 19:55
L8	9116	(NETWORK ADJ INTERFACE ADJ DEVICE)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 20:11
L9	202	(NETWORK ADJ INTERFACE ADJ DEVICE) same filter	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 20:11

L10	9	(NETWORK ADJ INTERFACE ADJ DEVICE) same filter same building	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 20:11
L11	1	(NETWORK ADJ INTERFACE ADJ DEVICE) same filter same building same reflect$4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/05/06 20:11
S1	2	"20020069417".did.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:25
S2	12026	filter with reject$3 with signal$1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:53
S3	138	(filter with reject$3 with signal$1) and ("725"). clas.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:53
S4	176	(filter with reject$3 with signal$1) same (building house housing)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:55
S5	23	(filter with reject$3 with signal$1) same (building house housing) same reflect$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:56
S6	814	(filter with reject$3 with signal$1) same communicat$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:57

S7	211	(filter with reject$3 with signal$1) same communicat$3 same (device$1 appliance$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:58
S8	421	(filter with (reflect$3 reject$3) with signal$1) same communicat$3 same (device$1 appliance$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:59
S9	12	(filter with (reflect$3 reject$3) with signal$1) same communicat$3 same (device$1 appliance$1) and "725"/$.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 18:59
S10	270	("20010005906" | "20010017920" | "20010030664" | "20010039660" | "20020002707" | "20020007485" | "20020010936" | "20020019984" | "20020035726" | "20020035729" | "20020040475" | "20020044762" | "20020051200" | "20020051581" | "20020056112" | "20020059615" | "20020059617" | "20020059637" | "20020066101" | "20020067437" | "20020069417" | "20020083438" | "20020087996" | "20020090198" | "20020095673" | "20020095689" | "20020100041" | "20020104001" | "20020108121" | "20020116626" | "20020133558" | "20020137517" | "20020141582" | "20020144262" | "20020146237" | "20020154892" | "20020157112" |	US-PGPUB; USPAT; USOCR	OR	ON	2009/04/20 19:04

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		"20020174444" |					
		"20020178445" |					
		"20020187779" |					
		"20020194596" |					
		"20030005300" |					
		"20030009763" |					
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		"20030063003" |					
		"20030063814" |					
		"20030097563" |					
		"20030108199" |					
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		"20030142664" |					
		"20030145336" |					
		"20030149986" |					
		"20030149991" |					
		"20030159140" |					
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		"20040034874" |					
		"20040040035" |					
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		"20040054771" |					
		"20040064714" |					
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		"20050050557" |					
		"20050063422" |					
		"20050155052").PN. OR					

		("20050235323" "20050251827" "20050262542" "20060069645" "20060218591" "20060259584" "4215366" "4290081" "4439784" "4535355" "4540958" "4578533" "4644526" "4686564" "4706121" "4751578" "4885803" "4908713" "4916532" "4963994" "4963995" "5010299" "5010399" "5038211" "5048054" "5251074" "5253066" "5293357" "5406626" "5412416" "5479268" "5481542" "5508815" "5515377" "5524051" "5568272" "5574964" "5579308" "5590195" "5600364" "5600573" "5600707" "5621793" "5638423" "5666151" "5682206" "5699105" "5701383" "5708961" "5714945" "5715020" "5715277" "5751806" "5758257" "5774527" "5787472" "5793413" "5793414" "5796442" "5808659" "5809204" "5828403" "5835128" "5851149" "5867485" "5872644" "5886732" "5886753" "5915068" "5920801" "5930247" "5936660" "5940073" "5940387" "5970386" "5983068" "5990927" "5995258" "6005861" "6014546" "6026150"						

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		"7140033" | "7146628" | "7155012" | "7184550" | "7190901" | "7209667" | "7222358" | "7233669" | "7260829" | "7310355" | "7360233" | "7360235").PN.				
S11	10	(reflector with signal$1 with (device$1 appliance $1)) and "725"/$.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 19:07
S12	143	(reflector with signal$1 with (device$1 appliance $1) with communicat $3)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 19:10
S13	87279	filter$1 with reflect$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 19:20
S14	111854	filter$1 with (reject$3 reflect$3)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 19:21
S15	400	725/51,54.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 20:20
S16	416	725/80.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 21:33
S17	321	725/74.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 21:40

S18	395	725/78.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/20 23:45
S19	416	725/80.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 10:39
S20	106	725/85.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 11:34
S21	6	"910412".ap.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:03
S22	2	"910412".ap. and filter $3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:13
S23	413	(block$3 reject$3 reflect $3) with filter$3 with mismatch$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:26
S24	150	(block$3 reject$3 reflect $3) with filter$3 with mismatch$3 with signal $3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:27
S26	150	(block$3 reject$3 reflect $3) with filter$3 with mismatch$3 with signal $4	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:27

S27	13	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3 with signal$4) same (device $1 appliance$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:28
S28	3	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3 with signal$4) same (building house housing)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:30
S29	3	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3 with signal$4) same (building house hous$3 room$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:30
S30	5	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3) same (building house hous$3 room$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:31
S31	15	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3) same (building home hospital hotel school office multiunit multiroom hous $3 room$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:35
S32	10	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3) same (building home hospital hotel school office multiunit multiroom hous $3 room$1) not S30	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:35
S33	28	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3) same communicat$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:36
S34	0	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3) same premis$2	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:39

S35	0	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3) same premise$1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:39
S36	150	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3 with signal$4)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:39
S37	14	((block$3 reject$3 reflect$3) with filter$3 with mismatch$3 with signal$4) same (television$1 device$1 appliance$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 12:41
S38	105	725/125.ccls.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 13:40
S40	337	725/119.CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2009/04/21 13:51

5/6/2009 8:12:15 PM
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/910,412	07/21/2001	Itzhak Gurantz	9202

CONFIRMATION NO. 2398

77676
Michael W. Landry
5098 Seachase Street
San Diego, CA 92130

POWER OF ATTORNEY NOTICE

OC000000034576137

Date Mailed: 02/18/2009

NOTICE REGARDING CHANGE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/19/2009.

- 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).

/gbien-aime/

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

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Alexandria, Virginia 22313-1450
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APPLICATION NUMBER	FILING OR 371(C) DATE	FIRST NAMED APPLICANT	ATTY. DOCKET NO./TITLE
09/910,412	07/21/2001	Itzhak Gurantz	9202

CONFIRMATION NO. 2398

77330
ENTROPIC COMMUNICATIONS, INC.
6290 SEQUENCE DRIVE
SAN DIEGO, CA 92121

POA ACCEPTANCE LETTER

OC000000034576173

Date Mailed: 02/18/2009

NOTICE OF ACCEPTANCE OF POWER OF ATTORNEY

This is in response to the Power of Attorney filed 01/19/2009.

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.

/gbien-aime/

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

PTO/SB/81 (01-09)
Approved for use through 11/30/2011. OMB 0651-0035
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POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	09/910,412
Filing Date	21-Jul-2001
First Named Inventor	Itzhak Gurantz
Title	Network interface device...
Art Unit	2421
Examiner Name	CHOWDHURY, SUMAIYA A
Attorney Docket Number	9202

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: 77330

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified application to:

☒ The address associated with the above-mentioned Customer Number.

OR

☐ The address associated with Customer Number:

OR

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

I am the:

☐ Applicant/Inventor.

OR

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on February 11, 2009

SIGNATURE of Applicant or Assignee of Record

Signature		Date	February 11, 2009
Name	Bruce W. Greenhaus	Telephone	858-768-3679
Title and Company	V.P. Chief Patent Counsel, Entropic Communications Inc.		

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 2 forms are submitted.

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.**

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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Entropic Communications Inc.

Application No./Patent No.: 09/910,412 Filed/Issue Date: 21-Jul-2001

Titled:
Network interface device and broadband local area network using coaxial cable

Entropic Communications Inc. , a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

OR

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

1. From: Itzhak Gurantz et. al. To: Entropic Communications Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 012499, Frame 0136, or for which a copy thereof is attached.

2. From: Entropic Communications Inc. To: Silicon Valley Bank
The document was recorded in the United States Patent and Trademark Office at
Reel 013016, Frame 0075, or for which a copy thereof is attached.

3. From: Silicon Valley Bank To: Entropic Communications Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 014072, Frame 0754, 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(b)(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	February 11, 2009 Date
Bruce W. Greenhaus Printed or Typed Name	V.P. Chief Patent Counsel Title

This collection of information is required by 37 CFR 3.73(b). 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 12 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Electronic Acknowledgement Receipt	
EFS ID:	4773209
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77676
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Filer Authorized By:	Bruce Wayne Greenhaus
Attorney Docket Number:	9202
Receipt Date:	11-FEB-2009
Filing Date:	21-JUL-2001
Time Stamp:	12:54:50
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		E010001USU1_POA-3_73b_2-11-09.pdf	1266026 e0af0ad7caa007e75cdb3449ae035addf0916e9d	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
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	Assignee showing of ownership per 37 CFR 3.73(b).	2	2
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This Acknowledgement Receipt evidences receipt on the noted date by the USPTO of the indicated documents, characterized by the applicant, and including page counts, where applicable. It serves as evidence of receipt similar to a Post Card, as described in MPEP 503.

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

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

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

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:
Gurantz, et al.

Serial No.: 09/910,412

Filed: June 21, 2001

For: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

Group Art Unit: 2421

Confirmation No. 2398

AMENDMENT

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

Attention: Sumaiya A. Chowdhury
Examiner

Dear Sir:

In response to the Office Action of October 20th, 2008, please note the following remarks and comments:

Amendments to the Claims begin on page 2 of this paper.

Remarks/Comments begin on page 6 of this paper.

I hereby certify that this correspondence is being electronically deposited with the Commissioner for Patents through the USPTO electronic filing system, on:

September 24, 2008
(Date of Deposit)
Tim L. Ellis
(Name of Person Making Deposit)
/Tim L. Ellis/
(Signature)

AMENDMENTS TO THE CLAIMS:

1-4. (Cancelled)

5. (Currently Amended) A signal distribution network comprising:

a filter located at the point of entry of a building tuned to reject ~~reflect~~ network signals originating in the building ~~back into the building~~, such that the network signals originating in the building do not pass through the filter, but rather are reflected back into the building;

at least one signal splitter, the signal splitter having a common port and a plurality of tap ports, the common port of the signal splitter being coupled to the filter; and

a plurality of terminal devices, each terminal device being coupled to a tap port of at least one signal splitter, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

wherein the reflections from the filter provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals to other terminal devices thus allowing terminal devices to communicate directly with each other to form the signal distribution network.

6-17 (Cancelled)

18. (Previously Amended) The signal distribution network of claim 5, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

19-22. (Cancelled)

23. (Previously Amended) The signal distribution network of claim 5, wherein the signal modulation used by the terminal devices is orthogonal frequency division multiplexing (OFDM) and the modulation order of each OFDM carrier is adjusted according to the signal

to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter.

24. (Previously Amended) The signal distribution network of claim 18, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter.

25. (Currently Amended) A broadband local area network using coaxial cable building wiring as a communication channel, the network comprising:

a plurality of terminal devices, each terminal device communicating with other terminal devices using orthogonal frequency division multiplexing (OFDM) modulation, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

a network of building cables coupled to the plurality of terminal devices; and

a filter having a first and second port, the first port connected to a building point of entry and the second port connected to the plurality of terminal devices via the network of building cables, wherein signals transmitted by any of the terminal devices and received at the second port of the filter are rejected by the filter such that such signals do not pass through the filter, but rather are reflected back into the network of building cables in order to create a communication path between the transmitting terminal device and at least one other terminal device coupled to the network of building cables.

26. (Previously Amended) The broadband local area network of claim 25 wherein the modulation order of each OFDM carrier is adjusted according to the signal to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the filter.

27. (Previously Amended) The broadband local area network of claim 25, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM

carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the filter.

28. (Previously Amended) The broadband local area network of claim 25 wherein the frequency used for communicating is above the cable television band.

29. (Currently Amended) A broadband local area network for transmitting modulated signals using coaxial cable building wiring containing a plurality of branches comprising:

a filter located at the point of entry of the building wiring that rejects ~~reflects~~ network signals originating in the building wiring such that the rejected network signals do not pass through the filter, but rather are reflected by the filter back into all branches of the building wiring;

at least one signal splitter;

a plurality of terminal devices connected to the wiring branches, each terminal device capable of communicating with other terminal devices the reflected signal path created by the filter, wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome communication channel impairments caused by the reflected signals.

30. (Previously Amended) The network of claim 29 wherein the equalization is frequency domain equalization.

31. (Previously Amended) The network of claim 29 wherein the equalization is time domain equalization.

32. (Previously Amended) The network of claim 29 wherein the equalization is adaptive.

33. (Previously Amended) The network of claim 29 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

34. (Previously Amended) The network of claim 32 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

35. (Previously Presented) The network of claim 34 wherein the terminal devices use forward error correction to recover the transmitted signals without errors.

36. (Previously Amended) The broadband local area network of claim 25, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

37. (Previously Amended) The broadband local area network of claim 29, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

REMARKS/ARGUMENTS

Claims 5, 18, and 23-37 are pending in the application. Claims 5, 18, and 23-37 were rejected. Applicants have amended Claims 5, 25, and 29. Applicants respectfully request reconsideration and allowance of all pending claims.

Discussion of Rejections Under 35 U.S.C. §102

Claims 5, 23, 25-30 were rejected under 35 U.S.C. §102(e) as being Anticipated by Kliger. The Examiner indicated that Applicants' arguments are not persuasive. The Examiner once again disputes Applicants' contention that Kliger does not teach or suggest using a filter to reflect the signals back through the splitter for transmission to other devices in the network. In order to further clarify the issues, Applicants have amended the claims to recite that the filter is "tuned to **reject** network signals originating in the building, such that the network signals originating in the building **do not pass through the filter**, but rather are reflected back into the building.

Applicants respectfully point out to the Examiner that a rejection based upon 102(e) requires that the Examiner identify within the cited reference relied upon, each and every element recited in the claims being rejected. In particular, Applicants contend that the Examiner has failed to show that the references cited disclose a filter as recited in independent claims 5, 25, and 29.

Examiner has stated that:

> Kliger teaches a signal distribution network comprising: a filter (44 - fig. 2) located at the point of entry of a building tuned to reflect network signals originating in the building back into the building - (HRU 44 is located within demarcation point unit 14 which is located at the point of entry of the building. [0055], [0056]).

The Examiner provides support for this contention in paragraph 2 of the Office Action dated 10/20/08, which has the heading "Response to Arguments". The Examiner contends that "Fig.2 in Kliger illustrates the demarcation point unit 14 which reflects incoming signals from various devices in a home network." However, as noted by Applicant in earlier

responses (and as is made more clear by the currently presented amendments that do not alter the scope of Claim 5 or the other amended claims), the HRU 44, while located within demarcation point unit 14 is located at the point of entry of the building, is not **tuned to reject** signals that originate in the building. Rather, the HRU 44 of Kliger takes those signals in and loops them back out after processing those signals. The amount of hardware necessary to perform that looping function (as opposed to rejecting the signal, as recited in the currently amended claims) is significantly more than just the filter that is recited in currently presented claims, such as Claim 5. Kliger at paragraph [55] states:

> FIG. 2A shows another embodiment of the HRU 44 including a diplexer 42, band pass (BP) filters 46, 48, amplifiers 50, 52, an **RF down-converter 54, an RF up-converter 56** and an intermediate frequency filter and amplifier unit 58. (emphasis added).

It should be clear that there is a significant difference between the Kliger **looping** HRU 44 which requires that the signal be filtered, up and down converted, amplified, filtered again, etc. and the simple structure of the **filter tuned to reject signals** originating from inside the building. More specifically, **Kliger does not teach or suggest a filter tuned to reject signals** in order to reflect those signals back to their source. The ultimate end result is the same, that is, to return signals back to the building. However, the structure that is claimed for achieving this end result is completely different from that disclosed by Kliger.

Applicants believe that by rephrasing the language of the claims to recite that the filter is **tuned to reject the signals and not to allow the signals to pass** that Applicants will more clearly distinguish the claimed invention from Kliger's disclosed HRU 44 which performs the looping function noted above and which the Examiner so eloquently described in the most recent office action. Applicants believe that it should be quite clear in light of the current amendments that it is the particular claimed structure that distinguishes the present claims from Kliger and not the fact that both Kliger and the claimed invention return signals to the building to allow devices within the building to communicate with one another through circuitry provided at the point of demarcation.

Accordingly, Applicants respectfully request that the Examiner reconsider the applicant's contention that the references, neither alone nor in combination, teach nor suggest

all claimed features. Even more particularly, Applicants respectfully still contend that none of the references teach, suggest or motivate one of ordinary skill in the art to make the claimed invention, since none of the cited references teach **a filter that rejects network signals and thus reflects those rejected signals** back into the building in order to allow terminals coupled to the tap ports (those ports other than the common port) within a network to communicate directly with one another. Nor would it otherwise be obvious to combine elements provided in the prior art in light of the failure of the prior art to provide the missing element of a filter tuned to reject the signals, rather than passing them and looping them back into a splitter.

Note that nothing in Kliger (and more particularly in the discussion of the HRU 44) teaches or suggests that the HRU 44 is (or uses) a filter to reject the signals that are returned to the building. **Applicants contend that the failure of the prior art to teach or disclose the use of a filter is due to the effects that were discussed in the previous response, namely the distortion that the use of a filter that reflects the signals would create. It is only by the additional improvements to the signal processing that use of such a filter becomes a consideration, and through the use of these improvements, such as the circuits for doing bitloading and power control, as those terms were discussed and described in Applicants' previous response.**

Applicant's once again point out that while the embodiment disclosed in figure 2A teaches the inclusion of two bandpass filters (BPFs) in the HRU 44, those filters are **only used for the purpose of separating the high frequencies from the low frequencies**. The two BPFs shown in figure 2A clearly **do not reject and reflect the signal** that is applied to them.

Likewise, independent Claims 25 and 29 have been amended to recite the limitations similar to those limitations discussed above with respect to Claim 5. Thus, Applicants contend that Claims 5, 25 and 29 and those claims that depend therefrom are in condition for allowance.

Discussion of Rejections Under 35 U.S.C. §103

Claims 18, 24, and 36 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger as applied to claim 5 above, and further in view of Manssen (5809421).

Claims 29, 30, and 33 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger in view of Mukherjee (6226322).

Claim 31 was rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, and Mukherjee as applied to claim 29 above, and further in view of Kapoor (6,396,886).

Claim 35 was rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Mukherjee, and Ise in view of Wu.

Claims 32, 34, and 35, were rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Ise (6,778,601).

Claim 37 was rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Manssen.

It should be noted that while the Examiner has cited several additional references (including: Manssen, Zhang, Ling, Mukherjee, Kapoor, Ise and Wu) in rejecting some of the dependent claims, none of these references teach or suggest the missing element of a filter tuned to reject and reflect signals back into the network from which they were transmitted as described above and recited in the claims as now presented.

Accordingly, Applicants respectfully request reconsideration and allowance of claims 5, 25, 29 and those claims that depend therefrom.

CONCLUSION

Applicants believe that all claims pending in the application are allowable. Applicants therefore respectfully request that a timely Notice of Allowance be issued in this case.

This is a response to the Office Action mailed on 10/20/08, and as such, is submitted timely and no fee is required.

If there are any other fees due in connection with the filing of the response, please charge the fees to our Deposit Account No. 50-4613. If a fee is required for an extension of time under 37 CFR 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned.

Respectfully submitted,

Dated: January 19, 2009

By: /Bruce W. Greenhaus/
Bruce W. Greenhaus
Attorney for Applicants
Registration No. 37,339

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6290 Sequence Drive
San Diego, California 92121
Telephone: (619) 980-2612
e-mail address: bruceg@entropic.com

Print Form

PTO/SB/81 (11-08)
Approved for use through 11/30/2011. OMB 0651-0035
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POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	09/910,412
Filing Date	21-Jul-2001
First Named Inventor	Gurantz, Itzhak
Title	Network interface device and broadband local area netw
Art Unit	2421
Examiner Name	Sumaiya A. Chowdhury
Attorney Docket Number	9202

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: 77330

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified application to:

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Address					
City		State		Zip	
Country					
Telephone		Email			

I am the:

☐ Applicant/Inventor.

OR

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on May 19, 2003

SIGNATURE of Applicant or Assignee of Record

Signature		Date	1-19-09
Name	Bruce W. Greenhaus	Telephone	+1 (858) 768-3679
Title and Company	V.P., Chief Patent Counsel		

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 2 forms are submitted.

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:	4637319
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77676
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Filer Authorized By:	Bruce Wayne Greenhaus
Attorney Docket Number:	9202
Receipt Date:	19-JAN-2009
Filing Date:	21-JUL-2001
Time Stamp:	18:36:25
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		E010001USU1_OA_Response_1-19-09.pdf	123063 059b90637caf5ad6ce5290df38e80d70bf16aaa2	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	9
	Amendment/Req. Reconsideration-After Non-Final Reject	10	10

Warnings:					
Information:					
2		E010001USU1_POA_3-73b_Statement_1-19-09.pdf	1250198 c3833412d18c4a1666f0427a0e8798cd5382fce4	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	1	1
	Assignee showing of ownership per 37 CFR 3.73(b).	2	2

Warnings:	
Information:	
Total Files Size (in bytes):	1373261

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responses (and as is made more clear by the currently presented amendments that do not alter the scope of Claim 5 or the other amended claims), the HRU 44, while located within demarcation point unit 14 is located at the point of entry of the building, is not **tuned to reject** signals that originate in the building. Rather, the HRU 44 of Kliger takes those signals in and loops them back out after processing those signals. The amount of hardware necessary to perform that looping function (as opposed to rejecting the signal, as recited in the currently amended claims) is significantly more than just the filter that is recited in currently presented claims, such as Claim 5. Kliger at paragraph [55] states:

> FIG. 2A shows another embodiment of the HRU 44 including a diplexer 42, band pass (BP) filters 46, 48, amplifiers 50, 52, an **RF down-converter 54, an RF up-converter 56** and an intermediate frequency filter and amplifier unit 58. (emphasis added).

It should be clear that there is a significant difference between the Kliger **looping** HRU 44 which requires that the signal be filtered, up and down converted, amplified, filtered again, etc. and the simple structure of the **filter tuned to reject signals** originating from inside the building. More specifically, **Kliger does not teach or suggest a filter tuned to reject signals** in order to reflect those signals back to their source. The ultimate end result is the same, that is, to return signals back to the building. However, the structure that is claimed for achieving this end result is completely different from that disclosed by Kliger.

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Likewise, independent Claims 25 and 29 have been amended to recite the limitations similar to those limitations discussed above with respect to Claim 5. Thus, Applicants contend that Claims 5, 25 and 29 and those claims that depend therefrom are in condition for allowance.

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CONCLUSION

Applicants believe that all claims pending in the application are allowable. Applicants therefore respectfully request that a timely Notice of Allowance be issued in this case.

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If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned.

Respectfully submitted,

Dated: January 19, 2009

By: /Bruce W. Greenhaus/
Bruce W. Greenhaus
Attorney for Applicants
Registration No. 37,339

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:
Gurantz, et al.

Serial No.: 09/910,412

Filed: June 21, 2001

For: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

Group Art Unit: 2421

Confirmation No. 2398

AMENDMENT

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

Attention: Sumaiya A. Chowdhury
Examiner

Dear Sir:

In response to the Office Action of October 20th, 2008, please note the following remarks and comments:

Amendments to the Claims begin on page 2 of this paper.

Remarks/Comments begin on page 6 of this paper.

I hereby certify that this correspondence is being electronically deposited with the Commissioner for Patents through the USPTO electronic filing system, on:

January 19, 2009
(Date of Deposit)
Tim L. Ellis
(Name of Person Making Deposit)
/Tim L. Ellis/
(Signature)

AMENDMENTS TO THE CLAIMS:

1-4. (Cancelled)

5. (Currently Amended) A signal distribution network comprising:

a filter located at the point of entry of a building tuned to reject ~~reflect~~ network signals originating in the building ~~back into the building~~, such that the network signals originating in the building do not pass through the filter, but rather are reflected back into the building;

at least one signal splitter, the signal splitter having a common port and a plurality of tap ports, the common port of the signal splitter being coupled to the filter; and

a plurality of terminal devices, each terminal device being coupled to a tap port of at least one signal splitter, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

wherein the reflections from the filter provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals to other terminal devices thus allowing terminal devices to communicate directly with each other to form the signal distribution network.

6-17 (Cancelled)

18. (Previously Amended) The signal distribution network of claim 5, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

19-22. (Cancelled)

23. (Previously Amended) The signal distribution network of claim 5, wherein the signal modulation used by the terminal devices is orthogonal frequency division multiplexing (OFDM) and the modulation order of each OFDM carrier is adjusted according to the signal

to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter.

24. (Previously Amended) The signal distribution network of claim 18, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter.

25. (Currently Amended) A broadband local area network using coaxial cable building wiring as a communication channel, the network comprising:

a plurality of terminal devices, each terminal device communicating with other terminal devices using orthogonal frequency division multiplexing (OFDM) modulation, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

a network of building cables coupled to the plurality of terminal devices; and

a filter having a first and second port, the first port connected to a building point of entry and the second port connected to the plurality of terminal devices via the network of building cables, wherein signals transmitted by any of the terminal devices and received at the second port of the filter are rejected by the filter such that such signals do not pass through the filter, but rather are reflected back into the network of building cables in order to create a communication path between the transmitting terminal device and at least one other terminal device coupled to the network of building cables.

26. (Previously Amended) The broadband local area network of claim 25 wherein the modulation order of each OFDM carrier is adjusted according to the signal to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the filter.

27. (Previously Amended) The broadband local area network of claim 25, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM

carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the filter.

28. (Previously Amended) The broadband local area network of claim 25 wherein the frequency used for communicating is above the cable television band.

29. (Currently Amended) A broadband local area network for transmitting modulated signals using coaxial cable building wiring containing a plurality of branches comprising:

a filter located at the point of entry of the building wiring that rejects ~~reflects~~ network signals originating in the building wiring such that the rejected network signals do not pass through the filter, but rather are reflected by the filter back into all branches of the building wiring;

at least one signal splitter;

a plurality of terminal devices connected to the wiring branches, each terminal device capable of communicating with other terminal devices the reflected signal path created by the filter, wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome communication channel impairments caused by the reflected signals.

30. (Previously Amended) The network of claim 29 wherein the equalization is frequency domain equalization.

31. (Previously Amended) The network of claim 29 wherein the equalization is time domain equalization.

32. (Previously Amended) The network of claim 29 wherein the equalization is adaptive.

33. (Previously Amended) The network of claim 29 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

34. (Previously Amended) The network of claim 32 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

35. (Previously Presented) The network of claim 34 wherein the terminal devices use forward error correction to recover the transmitted signals without errors.

36. (Previously Amended) The broadband local area network of claim 25, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

37. (Previously Amended) The broadband local area network of claim 29, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

REMARKS/ARGUMENTS

Claims 5, 18, and 23-37 are pending in the application. Claims 5, 18, and 23-37 were rejected. Applicants have amended Claims 5, 25, and 29. Applicants respectfully request reconsideration and allowance of all pending claims.

Discussion of Rejections Under 35 U.S.C. §102

Claims 5, 23, 25-30 were rejected under 35 U.S.C. §102(e) as being Anticipated by Kliger. The Examiner indicated that Applicants' arguments are not persuasive. The Examiner once again disputes Applicants' contention that Kliger does not teach or suggest using a filter to reflect the signals back through the splitter for transmission to other devices in the network. In order to further clarify the issues, Applicants have amended the claims to recite that the filter is "tuned to **reject** network signals originating in the building, such that the network signals originating in the building **do not pass through the filter**, but rather are reflected back into the building.

Applicants respectfully point out to the Examiner that a rejection based upon 102(e) requires that the Examiner identify within the cited reference relied upon, each and every element recited in the claims being rejected. In particular, Applicants contend that the Examiner has failed to show that the references cited disclose a filter as recited in independent claims 5, 25, and 29.

Examiner has stated that:

> Kliger teaches a signal distribution network comprising: a filter (44 - fig. 2) located at the point of entry of a building tuned to reflect network signals originating in the building back into the building - (HRU 44 is located within demarcation point unit 14 which is located at the point of entry of the building. [0055], [0056]).

The Examiner provides support for this contention in paragraph 2 of the Office Action dated 10/20/08, which has the heading "Response to Arguments". The Examiner contends that "Fig.2 in Kliger illustrates the demarcation point unit 14 which reflects incoming signals from various devices in a home network." However, as noted by Applicant in earlier

responses (and as is made more clear by the currently presented amendments that do not alter the scope of Claim 5 or the other amended claims), the HRU 44, while located within demarcation point unit 14 is located at the point of entry of the building, is not **tuned to reject** signals that originate in the building. Rather, the HRU 44 of Kliger takes those signals in and loops them back out after processing those signals. The amount of hardware necessary to perform that looping function (as opposed to rejecting the signal, as recited in the currently amended claims) is significantly more than just the filter that is recited in currently presented claims, such as Claim 5. Kliger at paragraph [55] states:

> FIG. 2A shows another embodiment of the HRU 44 including a diplexer 42, band pass (BP) filters 46, 48, amplifiers 50, 52, an **RF down-converter 54, an RF up-converter 56** and an intermediate frequency filter and amplifier unit 58. (emphasis added).

It should be clear that there is a significant difference between the Kliger **looping** HRU 44 which requires that the signal be filtered, up and down converted, amplified, filtered again, etc. and the simple structure of the **filter tuned to reject signals** originating from inside the building. More specifically, **Kliger does not teach or suggest a filter tuned to reject signals** in order to reflect those signals back to their source. The ultimate end result is the same, that is, to return signals back to the building. However, the structure that is claimed for achieving this end result is completely different from that disclosed by Kliger.

Applicants believe that by rephrasing the language of the claims to recite that the filter is **tuned to reject the signals and not to allow the signals to pass** that Applicants will more clearly distinguish the claimed invention from Kliger's disclosed HRU 44 which performs the looping function noted above and which the Examiner so eloquently described in the most recent office action. Applicants believe that it should be quite clear in light of the current amendments that it is the particular claimed structure that distinguishes the present claims from Kliger and not the fact that both Kliger and the claimed invention return signals to the building to allow devices within the building to communicate with one another through circuitry provided at the point of demarcation.

Accordingly, Applicants respectfully request that the Examiner reconsider the applicant's contention that the references, neither alone nor in combination, teach nor suggest

all claimed features. Even more particularly, Applicants respectfully still contend that none of the references teach, suggest or motivate one of ordinary skill in the art to make the claimed invention, since none of the cited references teach **a filter that rejects network signals and thus reflects those rejected signals** back into the building in order to allow terminals coupled to the tap ports (those ports other than the common port) within a network to communicate directly with one another. Nor would it otherwise be obvious to combine elements provided in the prior art in light of the failure of the prior art to provide the missing element of a filter tuned to reject the signals, rather than passing them and looping them back into a splitter.

Note that nothing in Kliger (and more particularly in the discussion of the HRU 44) teaches or suggests that the HRU 44 is (or uses) a filter to reject the signals that are returned to the building. **Applicants contend that the failure of the prior art to teach or disclose the use of a filter is due to the effects that were discussed in the previous response, namely the distortion that the use of a filter that reflects the signals would create. It is only by the additional improvements to the signal processing that use of such a filter becomes a consideration, and through the use of these improvements, such as the circuits for doing bitloading and power control, as those terms were discussed and described in Applicants' previous response.**

Applicant's once again point out that while the embodiment disclosed in figure 2A teaches the inclusion of two bandpass filters (BPFs) in the HRU 44, those filters are **only used for the purpose of separating the high frequencies from the low frequencies**. The two BPFs shown in figure 2A clearly **do not reject and reflect the signal** that is applied to them.

Likewise, independent Claims 25 and 29 have been amended to recite the limitations similar to those limitations discussed above with respect to Claim 5. Thus, Applicants contend that Claims 5, 25 and 29 and those claims that depend therefrom are in condition for allowance.

Discussion of Rejections Under 35 U.S.C. §103

Claims 18, 24, and 36 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger as applied to claim 5 above, and further in view of Manssen (5809421).

Claims 29, 30, and 33 were rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger in view of Mukherjee (6226322).

Claim 31 was rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, and Mukherjee as applied to claim 29 above, and further in view of Kapoor (6,396,886).

Claim 35 was rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Mukherjee, and Ise in view of Wu.

Claims 32, 34, and 35, were rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Ise (6,778,601).

Claim 37 was rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Manssen.

It should be noted that while the Examiner has cited several additional references (including: Manssen, Zhang, Ling, Mukherjee, Kapoor, Ise and Wu) in rejecting some of the dependent claims, none of these references teach or suggest the missing element of a filter tuned to reject and reflect signals back into the network from which they were transmitted as described above and recited in the claims as now presented.

Accordingly, Applicants respectfully request reconsideration and allowance of claims 5, 25, 29 and those claims that depend therefrom.

CONCLUSION

Applicants believe that all claims pending in the application are allowable. Applicants therefore respectfully request that a timely Notice of Allowance be issued in this case.

This is a response to the Office Action mailed on 10/20/08, and as such, is submitted timely and no fee is required.

If there are any other fees due in connection with the filing of the response, please charge the fees to our Deposit Account No. 50-4613. If a fee is required for an extension of time under 37 CFR 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned.

Respectfully submitted,

Dated: January 19, 2009

By: /Bruce W. Greenhaus/
Bruce W. Greenhaus
Attorney for Applicants
Registration No. 37,339

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San Diego, California 92121
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Print Form

PTO/SB/81 (11-08)
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POWER OF ATTORNEY OR REVOCATION OF POWER OF ATTORNEY WITH A NEW POWER OF ATTORNEY AND CHANGE OF CORRESPONDENCE ADDRESS

Application Number	09/910,412
Filing Date	21-Jul-2001
First Named Inventor	Gurantz, Itzhak
Title	Network interface device and broadband local area netw
Art Unit	2421
Examiner Name	Sumaiya A. Chowdhury
Attorney Docket Number	9202

I hereby revoke all previous powers of attorney given in the above-identified application.

☐ A Power of Attorney is submitted herewith.

OR

☒ I hereby appoint Practitioner(s) associated with the following Customer Number as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith: 77330

OR

☐ I hereby appoint Practitioner(s) named below as my/our attorney(s) or agent(s) to prosecute the application identified above, and to transact all business in the United States Patent and Trademark Office connected therewith:

Practitioner(s) Name	Registration Number

Please recognize or change the correspondence address for the above-identified application to:

☒ The address associated with the above-mentioned Customer Number.

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☐ The address associated with Customer Number:

OR

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

I am the:

☐ Applicant/Inventor.

OR

☒ Assignee of record of the entire interest. See 37 CFR 3.71.
Statement under 37 CFR 3.73(b) (Form PTO/SB/96) submitted herewith or filed on May 19, 2003

SIGNATURE of Applicant or Assignee of Record

Signature		Date	1-19-09
Name	Bruce W. Greenhaus	Telephone	+1 (858) 768-3679
Title and Company	V.P., Chief Patent Counsel		

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 2 forms are submitted.

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.**

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Electronic Acknowledgement Receipt	
EFS ID:	4637365
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77676
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Filer Authorized By:	Bruce Wayne Greenhaus
Attorney Docket Number:	9202
Receipt Date:	19-JAN-2009
Filing Date:	21-JUL-2001
Time Stamp:	18:52:01
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		E010001USU1_2ND_OA_Response_1-19-09.pdf	123078 3f7485589e16a99a0753921f9d1584dcdc5be101	yes	10

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Amendment/Req. Reconsideration-After Non-Final Reject	1	1
	Claims	2	5
	Applicant Arguments/Remarks Made in an Amendment	6	9
	Amendment/Req. Reconsideration-After Non-Final Reject	10	10

Warnings:					
Information:					
2		E010001USU1_POA_3-73b_Statement_1-19-09.pdf	1250198 c3833412d18c4a1666f0427a0e8798cd5382fce4	yes	2

	Multipart Description/PDF files in .zip description		
	Document Description	**Start**	**End**
	Power of Attorney	1	1
	Assignee showing of ownership per 37 CFR 3.73(b).	2	2

Warnings:	
Information:	
Total Files Size (in bytes):	1373276

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

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

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

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

PTO/SB/96 (01-09)
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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Entropic Communications Inc.

Application No./Patent No.: 09/910,412 Filed/Issue Date: 21-Jul-2001

Titled:
Network interface device and broadband local area network using coaxial cable

Entropic Communications Inc. , a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

OR

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

1. From: Gurantz et al. To: Entropic Communications Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 012499, Frame 0136, or for which a copy thereof is attached.

2. From: Entropic Communications Inc. To: Silicon Valley Banks
The document was recorded in the United States Patent and Trademark Office at
Reel 013016, Frame 0075, or for which a copy thereof is attached.

3. From: Silicon Valley Bank To: Entropic Communications Inc.
The document was recorded in the United States Patent and Trademark Office at
Reel 014072, Frame 0754, 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(b)(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 1-19-09 Date

Bruce W. Greenhaus V.P. Chief Patent Counsel
Printed or Typed Name Title

This collection of information is required by 37 CFR 3.73(b). 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 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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STATEMENT UNDER 37 CFR 3.73(b)

Applicant/Patent Owner: Entropic Communications Inc.

Application No./Patent No.: 09/910,412 Filed/Issue Date: 21-Jul-2001

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Network interface device and broadband local area network using coaxial cable

Entropic Communications Inc. , a Corporation
(Name of Assignee) (Type of Assignee, e.g., corporation, partnership, university, government agency, etc.

states that it is:

1. [X] the assignee of the entire right, title, and interest in;

2. [ ] an assignee of less than the entire right, title, and interest in
(The extent (by percentage) of its ownership interest is _____ %); or

3. [ ] the assignee of an undivided interest in the entirety of (a complete assignment from one of the joint inventors was made)

the patent application/patent identified above, by virtue of either:

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 therefore is attached.

OR

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

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The document was recorded in the United States Patent and Trademark Office at
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2. From: Entropic Communications Inc. To: Silicon Valley Banks
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[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 1-19-09 Date

Bruce W. Greenhaus V.P. Chief Patent Counsel
Printed or Typed Name Title

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PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
09/910,412	07/21/2001	

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	
	01/19/2009	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
AMENDMENT	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0	X $ =		OR	X $52=	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $ =		OR	X $220=	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

		(Column 1)		(Column 2)	(Column 3)					
		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	

* 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:
/BRUCE D. HARRISON/

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

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	07/21/2001	Itzhak Gurantz	9202	2398

77676 7590 10/20/2008

Michael W. Landry
5098 Seachase Street
San Diego, CA 92130

EXAMINER	
CHOWDHURY, SUMAIYA A	
ART UNIT	PAPER NUMBER
2421	
MAIL DATE	DELIVERY MODE
10/20/2008	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)	
	09/910,412	GURANTZ ET AL.	
	Examiner	Art Unit	
	SUMAIYA A. CHOWDHURY	2421	

-- 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 July 2008*.

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) *5,18 and 23-37* 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) *5, 18, 23-37* 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 _____ 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

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 7/28/08 has been entered.

Response to Arguments

2. Applicant's arguments filed 7/28/08 have been fully considered but they are not persuasive.

(a) Applicant argues "…none of the cited references teach a filter that reflects signals back into a splitter in order to allow terminals coupled to the tap ports…within a network to communicate directly with one another." on page 6, 4th paragraph of the remarks filed 7/28/08.

The Examiner disagrees. Fig.2 in Kliger illustrates the demarcation point unit 14 which reflects incoming signals from various devices in a home network. The demarcation point unit 14 consists of three main components; namely, splitter 24', DIP 40, and HRU 44. Kliger provides a block diagram of the HRU 44 in Fig. 2A. When a first device 33 in one room needs to communicate with a second device 33 in a second room, the first device 33 sends an upstream signal to the demarcation point unit 14. Once the upstream signal enters the demarcation point unit 14, it passes through

diplexer 42, and is then band pass filtered by BP filter 46, amplified by amplifier 50, and RF down-converted by down-converter 54 to an intermediate frequency (paragraph [0055]). The IF filter and amplifier unit 58 then amplifies and band pass filters the IF signal. The RF up-converter 56 shifts the frequency of the IF signal up to the downstream frequency band. The amplifier 52 and BP filter 48 then amplify and filter the downstream signal. This downstream signal then passes back to the backbone 20 of the home network 10. This allows the devices 30 to communicate with each other by issuing messages to the backbone 20. The HRU 44 receives the upstream signal, amplifies and shifts the RF frequency to the backbone 20 as the downstream signal. The HNMs 28 then receive the messages in the downstream signal from the backbone 20 – (paragraph [0056]). In other words, HRU 44 in the demarcation unit 14 performs the function of the filter as recited in claim 1 which reflects incoming upstream signals from devices 33 to other devices over a home network.

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 5, 23, 25-27, and 28-30 are rejected under 35 U.S.C. 102(e) as being anticipated by Kliger (US 2002/0069417)

Note: Information relied on from Kliger can be found in provisional applications 60/229263 and 60/275060

As for claim 5, Kliger teaches a signal distribution network comprising:

a filter (44 – fig. 2) located at the point of entry of a building tuned to reflect network signals originating in the building back into the building – (HRU 44 is located within demarcation point unit 14 which is located at the point of entry of the building. [0055], [0056]).

at least one signal splitter (24'), the signal splitter having a common port (fig. 2; port between splitter 24' and DIP 40) and a plurality of tap ports (fig. 2; ports between splitter 24' and coax wires 22), the common port of the signal splitter being coupled to the filter – (Referring to fig. 2, splitter 24' is connected to filter 44 via DIP 40. [0051], [0056]); and

a plurality of terminal devices (33), each terminal device being coupled to a tap port of at least one signal splitter (Referring to fig. 1, terminal devices 33 are connected to splitter 24' via a tap port), at least one of the terminal devices (modem 114) providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high – (Higher data rates are achieved for a specific

frequency band which produces less cross talk (high SNR) between potentially interfering signals [0073]);

wherein the reflections from the filter provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals to other terminal devices thus allowing terminal devices to communicate directly with each other to form the signal distribution network – [0048], [0047], [0050], [0055], [0056];

As for claims 23 and 26, Kliger teaches wherein the signal modulation used by the terminal devices is OFDM and the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter – [0073].

As for claim 27, Kliger teaches wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter [0057]-[0059].

Claim 25 contains the limitations of claims 5 and 24 and are analyzed as previously discussed with respect to those claims.

As for claim 28, Kliger teach the claimed limitations. In particular, Kliger teaches the frequency used for communicating is above the cable television band – ([0052]; provisional application 60/275,060).

5. Claims 18, 24, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger as applied to claim 5 above, and further in view of Manssen (5809421).

As for claims 18 and 36, Kliger fails to teach wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network– col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

As for claim 24, Kliger teaches wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome

frequency selective channel impairments caused by the reflections from the filter [0057]-[0059].

6. Claims 29, 30, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger in view of Mukherjee (6226322).

Claim 29 contains the limitations of claims 5 and 25 and is analyzed as previously discussed with respect to those claims. Claim 29 additionally calls for the following:

wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome the communication channel impairments caused by the multipath signals.

In an analogous art, Mukherjee teaches the terminal devices perform equalization on the received signal signal that restores a flat frequency response to overcome the communication channel impairments caused by the multipath signals – col. 8, lines 40-52.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger's invention to include the above mentioned limitation, as taught by Mukherjee, for the advantage of flattening the signal spectrum and compensating for phase distortion.

As for claim 30, Kliger and Mukherjee disclose the claimed limitations. In particular, Mukherjee teaches equalization is frequency domain equalization.

As for claims 33 Kliger teaches wherein the signal modulation used by the terminal devices is OFDM and the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter – [0073].

7. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, and Mukherjee as applied to claim 29 above, and further in view of Kapoor (6,396,886).

As for claim 31, Kliger, and Mukherjee fail to teach wherein equalization is time domain equalization.

In an analogous art, Kapoor teaches wherein equalization is time domain equalization that restores a flat frequency response to overcome multipath effects – col. 6, lines 47-63.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Mukherjee's invention to include the above mentioned limitation, as taught by Kapoor, for the advantage of restoring the frequency envelope.

8. Claims 32, 34, and 35, are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Ise (6778601).

As for claim 32, Kliger and Mukherjee fail to teach wherein equalization is adaptive .

In an analogous art, Ise teaches wherein equalization is adaptive (see abstract, col. 4, lines 33-47, col. 5, lines 17-27, lines 40-50).

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Mukherjee's invention to include the above mentioned limitation, as taught by Ise, in order to inhibit an excessive peak in the filter characteristic.

As for claim 34, Kliger, Mukherjee, and Ise disclose the claimed limitations. In particular, Kliger teaches wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals – [0073].

9. Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Mukherjee, and Ise in view of Wu.

As for claim 35, Kliger, Mukherjee, and Ise fail to disclose wherein the terminal devices use forward error correction to recover the transmitted signal without errors.

In an analogous art, Wu teaches wherein the terminal devices use forward error correction to recover the transmitted signal without errors – [0062].

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Mukherjee, and Ise's invention to include the above mentioned limitation, as taught by Wu, for the advantage of recovering the signal without errors.

10. Claim 37 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Manssen.

As for claim 37, Kliger and Mukherjee fail to teach wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches sharing the communication channel between locations using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network – col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Mukherjee's invention to include the above

mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SUMAIYA A. CHOWDHURY whose telephone number is (571)272-8567. The examiner can normally be reached on Mon-Fri, 9-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Miller can be reached on (571) 272-7353. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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

/John W. Miller/
Supervisory Patent Examiner, Art Unit 2421

/Sumaiya A Chowdhury/
Examiner, Art Unit 2421

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	09910412	GURANTZ ET AL.
	Examiner	Art Unit
	SUMAIYA A CHOWDHURY	2623

✓	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	03/25/2008	10/12/2008							
	5	✓	✓							
	18	✓	✓							
	23	✓	✓							
	24	✓	✓							
	25	✓	✓							
	26	✓	✓							
	27	✓	✓							
	28	✓	✓							
	29	✓	✓							
	30	✓	✓							
	31	✓	✓							
	32	✓	✓							
	33	✓	✓							
	34	✓	✓							
	35	✓	✓							
	36	✓	✓							
	37	✓	✓							

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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PATENT APPLICATION FEE DETERMINATION RECORD Substitute for Form PTO-875	Application or Docket Number 09/910,412	Filing Date 07/21/2001	☐ 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	
AMENDMENT	07/28/2008	CLAIMS REMAINING AFTER AMENDMENT		HIGHEST NUMBER PREVIOUSLY PAID FOR	PRESENT EXTRA	RATE ($)	ADDITIONAL FEE ($)		RATE ($)	ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0	X $ =		OR	X $50=	0
	Independent (37 CFR 1.16(h))	* 3	Minus	***3	= 0	X $ =		OR	X $210=	0
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Legal Instrument Examiner:
/CHANTAE DESSAU/

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APPLICATION AS AMENDED – PART II

AMENDMENT 07/28/2008

	(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 ($)	ADDITIONAL FEE ($)
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					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	0

AMENDMENT

	(Column 1)		(Column 2)	(Column 3)					
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Independent (37 CFR 1.16(h))	*	Minus	***	=	X $ =		OR	X $ =	
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					TOTAL ADD'L FEE		OR	TOTAL ADD'L FEE	

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Legal Instrument Examiner:
/CHANTAE DESSAU/

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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Electronic Patent Application Fee Transmittal

Application Number:	09910412
Filing Date:	21-Jul-2001
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Attorney Docket Number:	9202
Filed as Small 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:				
Extension-of-Time:				
Extension - 1 month with $0 paid	2251	1	60	60

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
Request for continued examination	2801	1	405	405
		Total in USD ($)		**465**

Electronic Acknowledgement Receipt	
EFS ID:	3687695
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	77676
Filer:	Bruce Wayne Greenhaus/Tim Ellis
Filer Authorized By:	Bruce Wayne Greenhaus
Attorney Docket Number:	9202
Receipt Date:	28-JUL-2008
Filing Date:	21-JUL-2001
Time Stamp:	16:26:12
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Deposit Account
Payment was successfully received in RAM	$465
RAM confirmation Number	1762
Deposit Account	504613
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 1.21 (Miscellaneous fees and charges)	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)
1		E010001USU1_RCE_AsFiled_7-28-08.pdf	4097411 d971398ceac2552363a79379fab5f1ba80815432	yes	13

Multipart Description/PDF files in .zip description

Document Description	Start	End
Request for Continued Examination (RCE)	1	1
Extension of Time	2	2
Amendment After Final	3	3
Claims	4	7
Applicant Arguments/Remarks Made in an Amendment	8	13

Warnings:

Information:

2	Fee Worksheet (PTO-06)	fee-info.pdf	8339 10b45c44ee95b93dad1ad9464f27b1c82c5b86fc	no	2

Warnings:

Information:

Total Files Size (in bytes):	4105750

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

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

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

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

PTO/SB/30 (01-08)
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Request for Continued Examination (RCE) Transmittal

Address to:
Mail Stop RCE
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Application Number	09/910,412
Filing Date	21-Jul-2001
First Named Inventor	Itzhak Gurantz
Art Unit	2623
Examiner Name	Chowdhury, Sumaiya A.
Attorney Docket Number	9202

This is a Request for Continued Examination (RCE) under 37 CFR 1.114 of the above-identified application.
Request for Continued Examination (RCE) practice under 37 CFR 1.114 does not apply to any utility or plant application filed prior to June 8, 1995, or to any design application. See Instruction Sheet for RCEs (not to be submitted to the USPTO) on page 2.

1. Submission required under 37 CFR 1.114 Note: If the RCE is proper, any previously filed unentered amendments and amendments enclosed with the RCE will be entered in the order in which they were filed unless applicant instructs otherwise. If applicant does not wish to have any previously filed unentered amendment(s) entered, applicant must request non-entry of such amendment(s).

   a. ☐ Previously submitted. If a final Office action is outstanding, any amendments filed after the final Office action may be considered as a submission even if this box is not checked.

      i. ☐ Consider the arguments in the Appeal Brief or Reply Brief previously filed on _____

      ii. ☐ Other _____

   b. ☑ Enclosed

      i. ☑ Amendment/Reply
      ii. ☐ Affidavit(s)/ Declaration(s)
      iii. ☐ Information Disclosure Statement (IDS)
      iv. ☐ Other _____

2. Miscellaneous

   a. ☐ Suspension of action on the above-identified application is requested under 37 CFR 1.103(c) for a period of _____ months. (Period of suspension shall not exceed 3 months; Fee under 37 CFR 1.17(i) required)

   b. ☐ Other _____

3. Fees The RCE fee under 37 CFR 1.17(e) is required by 37 CFR 1.114 when the RCE is filed.

   a. ☑ The Director is hereby authorized to charge the following fees, any underpayment of fees, or credit any overpayments, to Deposit Account No. 504613. I have enclosed a duplicate copy of this sheet.

      i. ☑ RCE fee required under 37 CFR 1.17(e)
      ii. ☑ Extension of time fee (37 CFR 1.136 and 1.17)
      iii. ☐ Other _____

   b. ☐ Check in the amount of $ _____ enclosed

   c. ☐ Payment by credit card (Form PTO-2038 enclosed)

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.

SIGNATURE OF APPLICANT, ATTORNEY, OR AGENT REQUIRED

Signature	/Bruce W. Greenhaus/	Date	28-July-2008
Name (Print/Type)	Bruce W. Greenhaus	Registration No.	37339

CERTIFICATE OF MAILING OR TRANSMISSION

I hereby certify that this correspondence is being deposited with the United States Postal Service with sufficient postage as first class mail in an envelope addressed to: Mail Stop RCE, Commissioner for Patents, P. O. Box 1450, Alexandria, VA 22313-1450 or facsimile transmitted to the U.S. Patent and Trademark Office on the date shown below.

Signature			
Name (Print/Type)		Date	

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PTO/SB/22 (01-08)
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PETITION FOR EXTENSION OF TIME UNDER 37 CFR 1.136(a) **FY 2008** *(Fees pursuant to the Consolidated Appropriations Act, 2005 (H.R. 4818).)*	Docket Number (Optional) 9202
Application Number 09/910,412	Filed 21-Jul-2001
For Network interface device and broadband local area network using coaxial cable.	
Art Unit 2623	Examiner Chowdhury, Sumaiya A.

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):

		Fee	Small Entity Fee	
☑	One month (37 CFR 1.17(a)(1))	$120	$60	$ 60.00
☐	Two months (37 CFR 1.17(a)(2))	$460	$230	$
☐	Three months (37 CFR 1.17(a)(3))	$1050	$525	$
☐	Four months (37 CFR 1.17(a)(4))	$1640	$820	$
☐	Five months (37 CFR 1.17(a)(5))	$2230	$1115	$

☑ 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 a Deposit Account.

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 504613. 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 37339

☐ attorney or agent under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34 _____

/Bruce W. Greenhaus/	28-July-2008
Signature	Date
Bruce W. Greenhaus	(858) 768-3835
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 One forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:
Gurantz, et al.

Serial No.: 09/910,412

Filed: July 21, 2001

For: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

Group Art Unit: 2623

AMENDMENT

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

Attention: Sumaiya A. Chowdhury
Examiner

Dear Sir:

In response to the Final Office Action of April 4, 2008, please note the following remarks and comments:

Amendments to the Claims: claims begin on page 2 of this paper; however, there are no amendments to the claims.

Remarks/Arguments: remarks/arguments begin on page 6 of this paper.

AMENDMENTS TO THE CLAIMS:

1-4. (Cancelled)

5. (Previously Amended) A signal distribution network comprising:

a filter located at the point of entry of a building tuned to reflect network signals originating in the building back into the building;

at least one signal splitter, the signal splitter having a common port and a plurality of tap ports, the common port of the signal splitter being coupled to the filter; and

a plurality of terminal devices, each terminal device being coupled to a tap port of at least one signal splitter, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

wherein the reflections from the filter provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals to other terminal devices thus allowing terminal devices to communicate directly with each other to form the signal distribution network.

6-17 (Cancelled)

18. (Previously Amended) The signal distribution network of claim 5, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

19-22. (Cancelled)

23. (Previously Amended) The signal distribution network of claim 5, wherein the signal modulation used by the terminal devices is orthogonal frequency division multiplexing (OFDM) and the modulation order of each OFDM carrier is adjusted according to the signal to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter.

24. (Previously Amended) The signal distribution network of claim 18, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter.

25. (Previously Amended) A broadband local area network using coaxial cable building wiring as a communication channel, the network comprising:

a plurality of terminal devices, each terminal device communicating with other terminal devices using orthogonal frequency division multiplexing (OFDM) modulation, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

a network of building cables coupled to the plurality of terminal devices; and

a filter having a first and second port, the first port connected to a building point of entry and the second port connected to the plurality of terminal devices via the network of building cables, wherein signals transmitted by any of the terminal devices and received at the second port of the filter are reflected back into the network of building cables in order to create a communication path between the transmitting terminal device and at least one other terminal device coupled to the network of building cables.

26. (Previously Amended) The broadband local area network of claim 25 wherein the modulation order of each OFDM carrier is adjusted according to the signal to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the filter.

27. (Previously Amended) The broadband local area network of claim 25, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the filter.

28. (Previously Amended) The broadband local area network of claim 25 wherein the frequency used for communicating is above the cable television band.

29. (Previously Amended) A broadband local area network for transmitting modulated signals using coaxial cable building wiring containing a plurality of branches comprising:

a filter located at the point of entry of the building wiring that reflects network signals originating in the building wiring back into all branches of the building wiring;

at least one signal splitter;

a plurality of terminal devices connected to the wiring branches, each terminal device capable of communicating with other terminal devices the reflected signal path created by the filter, wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome communication channel impairments caused by the reflected signals.

30. (Previously Amended) The network of claim 29 wherein the equalization is frequency domain equalization.

31. (Previously Amended) The network of claim 29 wherein the equalization is time domain equalization.

32. (Previously Amended) The network of claim 29 wherein the equalization is adaptive.

33. (Previously Amended) The network of claim 29 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

34. (Previously Amended) The network of claim 32 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

35. (Previously Presented) The network of claim 34 wherein the terminal devices use forward error correction to recover the transmitted signals without errors.

36. (Previously Amended) The broadband local area network of claim 25, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

37. (Previously Amended) The broadband local area network of claim 29, wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

REMARKS/ARGUMENTS

Claims 5, 18, and 23-37 are pending in the application. Claims 5, 18, and 23-37 were rejected. Applicants have not herein amended any of the claims currently pending. Applicants respectfully request reconsideration and allowance of all pending claims.

Discussion of Rejections Under 35 U.S.C. §103

Claims 5, 25 and 28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kliger in view of Wu. The Examiner has indicated that Applicants' arguments are not persuasive. The Examiner disputed Applicants' contention that Kliger does not teach or suggest using a filter to reflect the signals back through the splitter for transmission to other devices in the network.

Applicants reiterate the requirement to establish a *prima facie* case of obviousness. That is, the prior art reference, or references when combined, must provide all of the claim limitations and must establish that it would be obvious for one of ordinary skill in the art to combine the references in a way that would successfully result in the claimed invention.

Applicants contend that, in light of the amendments previously made to the claims as once again presented, a *prima facie* case of obviousness cannot be established and Applicants respectfully traverse the rejections. In particular, Applicants respectfully request that the Examiner reconsider the applicants contention that the references, neither alone nor in combination, teach nor suggest all claimed features. Even more particularly, Applicants respectfully still contend that none of the references teach, suggest or motivate one of ordinary skill in the art to make the claimed invention, since none of the cited references teach **a filter that reflects signals back into a splitter** in order to allow terminals coupled to the tap ports (those ports other than the common port) within a network to communicate directly with one another. Nor would it otherwise be obvious to combine elements provided in the prior art in light of the failure of the prior art to provide the missing element of a filter tuned to reflect signals back into a splitter.

The Examiner disagreed with Applicants' statement that Kliger doesn't teach or suggest the use of a filter. The Examiner supported that position by pointing to the Home-

network Reflection Unit (HRU) 44 disclosed by Kliger. On page 3 of the Final Office Action mailed on 4/4/08, the Examiner stated that Kliger teaches a filter 44 (Fig. 2) tuned to reflect signals back into the building. However, Applicants respectfully contend that upon inspection of Kliger, it is clear that the device that Kliger discloses in figure 2 as HRU 44 is not a filter that reflects signals back into the building at all. Rather, at paragraph 51, Kliger states that:

> FIG. 2 shows an embodiment of the DPU 14 including a **diplexer 40**, a **home-network reflector unit (HRU) 44** and a splitter 24". In general, **the diplexer 40 separates** a cable TV (CaTV) signal (or satellite signal) received from the external network 18 from a home network signal received from the HNMs 28 connected to the backbone 20. One input/output (I/O) port (the "L" port) **of the diplexer 40** transmits and receives the CaTV signal (or satellite signal) to and from the external network 18. Another I/O port (the "H" port) **of the diplexer 40** transmits and receives the home network signal to and from HRU 44.

It should be noted that the diplexer 40 and the HRU 44 are two distinct and separate devices with quite distinct and different functions. Kliger goes on in paragraph 52 to say:

> The "L" port uses a low-pass filter at a certain predetermined frequency, fc, and the "H" port uses a high-pass filter at the same frequency, fc. By setting the frequency, fc, to about 900 MHz, for example, the low-pass "L" port transfers TV signals (5-860 Mhz), and the high-pass "H" port transfers the home network signal above 860 MHz. More specifically, one embodiment sets the cutoff frequency to 950 MHz to separate frequencies above 950 MHz for use by the home network signal from the CaTV signals, which are in the 5-860 MHz range.

Accordingly, it is the function of the diplexer 40, and more particularly the filters with in the diplexer, to separate the high frequency signals that carry the home network signals from the low frequency signals that carry the TV signals. The high frequency home network signals are then coupled to the HRU 44. No signals are reflected by the diplexer 40, since they are either routed to the L port or the H port. It is then the HRU 44 which the Examiner

correctly noted reflects the home network signals back into the diplexer, and thus through to the splitter 24'. However, in describing at paragraph 54 the HRU 44 shown in figure 2, Kliger states:

> In some embodiments, the HRU 44 is **either an unterminated or a shorted** coaxial cable, which reflects the home network signal received from the diplexer 40 back to the diplexer 40. Some embodiments of a passive HRU connect one port of a passive delay line to the H port of the diplexer 40 to improve the performance of the network 10 by avoiding signal fading. In such embodiments, the other port of the passive delay line **is unterminated or shorted**. In still other embodiments, **leaving an output of the diplexer 40 unterminated or by shorting that output to ground attains reflection** of the home network signal. These embodiments of the HRU 44 are referred to as passive HRUs.

Note that nothing in the description of the HRU 44 teaches or suggests that the HRU 44 is (or uses) a filter of any kind. Applicants contend that the failure of Kliger to teach or disclose the use of a filter in the HRU 44 is due to the effects that were discussed in the previous response, namely the distortion that the use of a filter to reflect the signals would create, and which is improved by the use of the circuits for doing bitloading and power control, as those terms were discussed and described in Applicants' previous response.

Kliger goes on in paragraphs 55 and 56 to disclose another embodiment of the HRU 44 (shown in figure 2A). However, while the embodiment disclosed in figure 2A teaches the inclusion of two bandpass filters (BPFs) in the HRU 44, those filters are only used for the purpose of separating the high frequencies from the low frequencies. The two BPFs shown in figure 2A clearly **do not reflect the signal** that is applied to them. Therefore, that embodiment does no more then did the embodiment of figure 2 to teach or suggest the use of a filter to **reflect** signals back into the splitter. Accordingly, Kliger fails to teach the claimed elements of:

> a **filter** located at the point of entry of a building **tuned to reflect network signals** originating in the building back into the building

and

wherein the **reflections from the filter** provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals to other terminal devices thus allowing terminal devices to communicate directly with each other to form the signal distribution network.

As previously noted, it would **not** be reasonable for one of ordinary skill in the art to modify the teaching of Kliger to substitute a filter for the HRU disclosed by Kliger, since the resulting distortions would cause serious problems which are only corrected in the presently claimed invention by the use of one of the two techniques recited in the claims (i.e., either bitloading or power control). Accordingly, Applicants respectfully contend that the presently claimed invention would not be obvious to one of ordinary skill in the art.

Accordingly, Applicants respectfully contend that the claims as previously amended and once again presented place the application in condition for allowance. Accordingly, applicants believe that it would be appropriate to enter this response and allow all claims based upon the failure of the prior art to teach or suggest the use of a filter located at the point of entry of a building tuned to reflect network signals originating in the building back into the building.

It should be noted that Claim 18, 23 and 24 depend from Claim 5 and accordingly, for the reasons stated above, each of these claims should are considered to be in condition for allowance.

Claim 25 has been amended to recite the filter as described above and the bitloading technique discussed in connection with the use of the filter. Since, as noted above, none of the references teach or suggest the filter recited in Claim 25, Applicants respectfully contend that Claim 25 is also in condition for allowance. Claims 26-28 and 36 depend from Claim 25 and so for the same reasons as noted with regard to Claim 25, Applicants respectfully content that Claims 26-28 and 36 are in condition for allowance.

Likewise, Claim 29 has been amended to recite the filter discussed above with respect to Claim 5 and thus Applicants contend that Claim 29 and those claims that depend therefrom (Claims 30-35, and 37) are in condition for allowance.

It should be noted that while the Examiner has cited several additional references (including: Manssen, Zhang, Ling, Mukherjee and Kapoor) in rejecting some of the dependent claims, none of these references teach or suggest the missing element of a filter turned to reflect signals back into the network from which they were transmitted together with the use of bitloading and/or power control to make use of the filter viable as described above and recited in the claims as now presented.

Accordingly, Applicants respectfully request reconsideration and allowance of claims 5, 25, 29 and those claims that depend therefrom.

CONCLUSION

Applicants believe that all claims pending in the application are allowable. Applicants therefore respectfully request that a timely Notice of Allowance be issued in this case.

This is a response to the Office Action mailed on 4/4/08, and as such, is submitted together with a request for a one month extension of time and the fee required for such a one month extension of time.

If there are any other fees due in connection with the filing of the response, please charge the fees to our Deposit Account No. 50-4613. If a fee is required for an extension of time under 37 CFR 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned.

Respectfully submitted,

Dated: July 28, 2008

By: /Bruce W. Greenhaus/
Bruce W. Greenhaus
Attorney for Applicants
Registration No. 37,339

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San Diego, California 92121
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e-mail address: patentteam@entropic.com

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	07/21/2001	Itzhak Gurantz	9202	2398

77676 7590 04/04/2008

Michael W. Landry
5098 Seachase Street
San Diego, CA 92130

EXAMINER	
CHOWDHURY, SUMAIYA A	
ART UNIT	PAPER NUMBER
2623	

MAIL DATE	DELIVERY MODE
04/04/2008	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)	
	09/910,412	GURANTZ ET AL.	
	Examiner	Art Unit	
	SUMAIYA A. CHOWDHURY	2623	

-- 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 *22 January 2008*.

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) *5,18 and 23-37* 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) *5,18 and 23-37* 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 _____ 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

Response to Arguments

1. Applicant's arguments with respect to claims 5, 18, and 23-37 have been considered but are moot in view of the new ground(s) of rejection.
2. Applicant's arguments filed 1/22/08 have been fully considered but they are not persuasive.

(a) Applicant argues "…none of the cited references teach a filter that reflects signals back into a splitter in order to allow terminals coupled …" on page 7, 4th paragraph of the Remarks filed 1/22/08.

The Examiner disagrees. Kliger teaches a filter (44 – fig. 2) which reflects signals back into a splitter (24') so that devices can communicate with each other – [0055], [0056], [0051].

Claim Rejections - 35 USC § 102

3. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(e) the invention was described in (1) an application for patent, published under section 122(b), by another filed in the United States before the invention by the applicant for patent or (2) a patent granted on an application for patent by another filed in the United States before the invention by the applicant for patent, except that an international application filed under the treaty defined in section 351(a) shall have the effects for purposes of this subsection of an application filed in the United States only if the international application designated the United States and was published under Article 21(2) of such treaty in the English language.

4. Claims 5, 23, 25-27, and 28-30 are rejected under 35 U.S.C. 102(e) as being anticipated by Kliger (US 2002/0069417)

Note: Information relied on from Kliger can be found in provisional applications 60/229263 and 60/275060

As for claim 5, Kliger teaches a signal distribution network comprising:

a filter (44 – fig. 2) located at the point of entry of a building tuned to reflect network signals originating in the building back into the building – (Filter 44 is located within demarcation point unit 14 which is located at the point of entry of the building. [0055], [0056]).

at least one signal splitter (24'), the signal splitter having a common port (fig. 2; port between splitter 24' and DIP 40) and a plurality of tap ports (fig. 2; ports between splitter 24' and coax wires 22), the common port of the signal splitter being coupled to the filter – (Referring to fig. 2, splitter 24' is connected to filter 44 via DIP 40. [0051], [0056]); and

a plurality of terminal devices (33), each terminal device being coupled to a tap port of at least one signal splitter (Referring to fig. 1, terminal devices 33 are connected to splitter 24' via a tap port), at least one of the terminal devices (modem 114) providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high – (Higher data rates are achieved for a specific frequency band which produces less cross talk (high SNR) between potentially interfering signals [0073]);

wherein the reflections from the filter provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals

to other terminal devices thus allowing terminal devices to communicate directly with each other to form the signal distribution network – [0048], [0047], [0050], [0055], [0056];

As for claims 23 and 26, Kliger teaches wherein the signal modulation used by the terminal devices is OFDM and the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter – [0073].

As for claim 27, Kliger teaches wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter [0057]-[0059].

Claim 25 contains the limitations of claims 5 and 24 and are analyzed as previously discussed with respect to those claims.

As for claim 28, Kliger teach the claimed limitations. In particular, Kliger teaches the frequency used for communicating is above the cable television band – ([0052]; provisional application 60/275,060).

5. Claims 18, 24, and 36 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger as applied to claim 5 above, and further in view of Manssen (5809421).

As for claims 18 and 36, Kliger fails to teach wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network– col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

As for claim 24, Kliger teaches wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter [0057]-[0059].

6. Claims 29, 30, and 33 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger in view of Mukherjee (6226322).

Claim 29 contains the limitations of claims 5 and 25 and is analyzed as previously discussed with respect to those claims. Claim 29 additionally calls for the following:

wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome the communication channel impairments caused by the multipath signals.

In an analogous art, Mukherjee teaches the terminal devices perform equalization on the received signal signal that restores a flat frequency response to overcome the communication channel impairments caused by the multipath signals – col. 8, lines 40-52.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger's invention to include the above mentioned limitation, as taught by Mukherjee, for the advantage of flattening the signal spectrum and compensating for phase distortion.

As for claim 30, Kliger and Mukherjee disclose the claimed limitations. In particular, Mukherjee teaches equalization is frequency domain equalization.

As for claims 33 Kliger teaches wherein the signal modulation used by the terminal devices is OFDM and the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments caused by the reflections from the filter – [0073].

7. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, and Mukherjee as applied to claim 29 above, and further in view of Kapoor (6,396,886).

As for claim 31, Kliger, and Mukherjee fail to teach wherein equalization is time domain equalization.

In an analogous art, Kapoor teaches wherein equalization is time domain equalization that restores a flat frequency response to overcome multipath effects – col. 6, lines 47-63.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Mukherjee's invention to include the above mentioned limitation, as taught by Kapoor, for the advantage of restoring the frequency envelope.

8. Claims 32, 34, and 35, are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Ise (6778601).

As for claim 32, Kliger and Mukherjee fail to teach wherein equalization is adaptive .

In an analogous art, Ise teaches wherein equalization is adaptive (see abstract, col. 4, lines 33-47, col. 5, lines 17-27, lines 40-50).

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Mukherjee's invention to include the above mentioned limitation, as taught by Ise, in order to inhibit an excessive peak in the filter characteristic.

As for claim 34, Kliger, Mukherjee, and Ise disclose the claimed limitations. In particular, Kliger teaches wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals – [0073].

9. Claim 35 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Mukherjee, and Ise in view of Wu.

As for claim 35, Kliger, Mukherjee, and Ise fail to disclose wherein the terminal devices use forward error correction to recover the transmitted signal without errors.

In an analogous art, Wu teaches wherein the terminal devices use forward error correction to recover the transmitted signal without errors – [0062].

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Mukherjee, and Ise's invention to include the above mentioned limitation, as taught by Wu, for the advantage of recovering the signal without errors.

10. Claim 37 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Mukherjee as applied to claim 29 above, and further in view of Manssen.

As for claim 37, Kliger and Mukherjee fail to teach wherein at least one of the communication channels between terminal devices uses time division duplex protocol for communications and the communications are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches sharing the communication channel between locations using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network – col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Mukherjee's invention to include the above mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SUMAIYA A. CHOWDHURY whose telephone number is (571)272-8567. The examiner can normally be reached on Mon-Fri, 9-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Miller can be reached on (571) 272-7353. 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).

/John W. Miller/
Supervisory Patent Examiner, Art Unit 2623

SAC

Index of Claims	Application/Control No.	Applicant(s)/Patent Under Reexamination
	09910412	GURANTZ ET AL.
	Examiner	Art Unit
	SUMAIYA A CHOWDHURY	2623

✓	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	03/25/2008								
	5	✓								
	18	✓								
	23	✓								
	24	✓								
	25	✓								
	26	✓								
	27	✓								
	28	✓								
	29	✓								
	30	✓								
	31	✓								
	32	✓								
	33	✓								
	34	✓								
	35	✓								
	36	✓								
	37	✓								

EAST Search History

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	225	725/51.CCLS.	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/03/25 17:12
S10	3534	frequency adj bin $1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/03/20 19:20
S11	57	(frequency adj bin$1) same snr same channel	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/03/20 19:21
S12	28	(frequency adj bin$1) same (snr with (more high $2)) same channel	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT; IBM_TDB	OR	ON	2008/03/20 19:28
S17	35	("3668307" | "3673517" | "4367548" | "4394691" | "4420841" | "4509211" | "4606072" | "4677686" | "4710917" | "4907079" | "5027426" | "5216499" | "5227780" | "5255267" | "5343240" | "5384603" | "5410720" | "5440335" | "5467384" | "5485630" |	US-PGPUB; USPAT; USOCR	OR	ON	2008/03/24 17:14

		"5499047" | "5512963" | "5539880" | "5583931" | "5585837" | "5592482" | "5623542" | "5642155" | "5663682" | "5675390" | "5722041" | "5760822" | "5805806" | "5886732" | "6014386").PN.				

3/25/2008 5:13:22 PM
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Search Notes	Application/Control No.	Applicant(s)/Patent Under Reexamination
	09910412	GURANTZ ET AL.
	Examiner	Art Unit
	SUMAIYA A CHOWDHURY	2623

SEARCHED			
Class	Subclass	Date	Examiner
725	51	3/25/2008	SAC

SEARCH NOTES		
Search Notes	Date	Examiner

INTERFERENCE SEARCH			
Class	Subclass	Date	Examiner

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APPLICATION NUMBER	PATENT NUMBER	GROUP ART UNIT	FILE WRAPPER LOCATION
09/910,412		2623	26M1

Correspondence Address / Fee Address Change

The following fields have been set to Customer Number 77676 on 03/06/2008

- Correspondence Address
- Maintenance Fee Address

The address of record for Customer Number 77676 is:
Michael W. Landry
5098 Seachase Street
San Diego,CA 92130

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In Re Application of:
Gurantz, et al.

Serial No.: 09/910,412

Filed: June 21, 2001

For: NETWORK INTERFACE DEVICE AND BROADBAND LOCAL AREA NETWORK USING COAXIAL CABLE

Group Art Unit: 2623

AMENDMENT

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

Attention: Sumaiya A. Chowdhury
Examiner

Dear Sir:

In response to the Office Action of July 24, 2007, please amend the above-identified application as follows:

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

Remarks/Arguments begin on page 7 of this paper.

I hereby certify that this correspondence is being sent via first class mail addressed to the Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450, on:

_____
(Date of Deposit)

_____
(Name of Person Making Deposit)

_____
(Signature)

AMENDMENTS TO THE CLAIMS:

1-4. (Cancelled)

5. (Currently Amended) A signal distribution network ~~for transmitting modulated signals using coaxial cable building wiring containing a plurality of branches as a communication channel~~ comprising:

a ~~network interface device~~ filter located at the point of entry of ~~the~~ a building ~~wiring that reflects~~ tuned to reflect network signals originating in the building ~~wiring~~ back into ~~all branches of~~ the building ~~wiring wherein the reflection introduced by the network interface device produces a multipath signal in the wiring branches that creates impairments to the performance of the communication channel~~;

at least one signal splitter, the signal splitter having a common port and a plurality of tap ports, the common port of the signal splitter being coupled to the filter; and

a plurality of terminal devices, ~~wherein the signal modulation used by the terminal devices is orthogonal frequency division multiplexing to overcome the communication channel impairments caused by the network interface device~~ each terminal device being coupled to a tap port of at least one signal splitter, at least one of the terminal devices providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high;

wherein the ~~network interface device provides~~ reflections from the filter provide a path for terminal devices back through the tap port of the signal splitter and out each other tap port to transmit signals to ~~and receive from~~ other terminal devices ~~and wherein~~ thus allowing terminal devices to communicate directly with each other to form the signal distribution network.

6-17 (Cancelled)

18. (Currently Amended) The signal distribution network of claim 5, ~~further comprising a method of sharing~~ wherein at least one of the communication ~~channel~~ channels between terminal devices ~~using~~ uses time division duplex protocol for communications and the communications ~~that~~ are synchronized by broadcasting a beacon message on the network.

19-22. (Cancelled)

23. (Currently Amended) The signal distribution network of claim 5 ~~18,~~ wherein the signal modulation used by the terminal devices is orthogonal frequency division multiplexing (OFDM) and the modulation order of each OFDM carrier is adjusted according to the signal to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments ~~present in the coaxial building wiring~~ caused by the reflections from the ~~network interface device~~ filter.

24. (Currently Amended) The signal distribution network of claim 18, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments ~~present in the coaxial building wiring~~ caused by the reflections from the ~~network interface device~~ filter.

25. (Currently Amended) A broadband local area network ~~to enable terminal devices to transmit messages to and receive messages from other terminal devices~~ using coaxial cable building wiring as a communication channel ~~comprising a point of entry and a plurality of branches connected to terminal devices~~, the network comprising:

~~a network interface device connected to the point of entry of the building wiring comprising:~~

~~a first port connected to the point of entry side of a branch of the building wiring;~~

~~a second port connected to the terminal device side of a branch of the building wiring; and~~

~~a frequency selective signal at the second port is reflected out the port and back a reflected signal path is created that produces a multipath signal in the wiring branches that creates impairments to the performance of the communication channel;~~

a plurality of terminal devices ~~connected to the wiring branches~~, each terminal device ~~bidirectionally~~ communicating with other terminal devices ~~through the reflected signal path created by the network interface device~~ using orthogonal frequency division multiplexing (OFDM) modulation, at least one of the terminal devices

providing frequency bins with more transmit bits which occupy parts of the channel where the signal to noise ratio (SNR) is high ~~to overcome the communication channel impairments caused by the network interface device~~.;

a network of building cables coupled to the plurality of terminal devices; and

a filter having a first and second port, the first port connected to a building point of entry and the second port connected to the plurality of terminal devices via the network of building cables, wherein signals transmitted by any of the terminal devices and received at the second port of the filter are reflected back into the network of building cables in order to create a communication path between the transmitting terminal device and at least one other terminal device coupled to the network of building cables.

26. (Currently Amended) The broadband local area network of claim 25 wherein the modulation order of each OFDM carrier is adjusted according to the signal to noise ratio (SNR) at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the ~~network interface device~~ filter.

27. (Currently Amended) The broadband local area network of claim 25, wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the ~~network interface device~~ filter.

28. (Previously Amended) The broadband local area network of claim 25 wherein the frequency used for communicating is above the cable television band.

29. (Currently Amended) A broadband local area network for transmitting modulated signals using coaxial cable building wiring containing a plurality of branches comprising:

a ~~network interface device~~ filter located at the point of entry of the building wiring that reflects network signals originating in the building wiring back into all branches of the building wiring ~~wherein the network interface device is frequency dependent and reflects signals by reflecting a predetermined frequency band of~~

~~signals, wherein the reflected signals produce a multipath signal in the wiring branches that creates impairments to the performance of the communication channel~~;

at least one signal splitter;

a plurality of terminal devices connected to the wiring branches, each terminal device capable of ~~bidirectionally~~ communicating with other terminal devices ~~through~~ using the reflected signal path created by the ~~network interface device~~ filter, wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome ~~the~~ communication channel impairments caused by the reflected signals ~~multipath signals~~.

30. (Previously Amended) The network of claim 29 wherein the equalization is frequency domain equalization.

31. (Previously Amended) The network of claim 29 wherein the equalization is time domain equalization.

32. (Previously Amended) The network of claim 29 wherein the equalization is adaptive.

33. (Previously Amended) The network of claim 29 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

34. (Previously Amended) The network of claim 32 wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals.

35. (Previously Presented) The network of claim 34 wherein the terminal devices use forward error correction to recover the transmitted signals without errors.

36. (Currently Amended) The broadband local area network of claim 25, ~~further comprising a method of sharing~~ wherein at least one of the communication ~~channel~~ channels

between terminal devices ~~using~~ uses time division duplex protocol for communications and the communications ~~that~~ are synchronized by broadcasting a beacon message on the network.

37. (Currently Amended) The broadband local area network of claim 29, ~~further comprising a method of sharing~~ wherein at least one of the communication ~~channel~~ channels between terminal devices ~~using~~ uses time division duplex protocol for communications and the communications ~~that~~ are synchronized by broadcasting a beacon message on the network.

REMARKS/ARGUMENTS

Claims 5, 18, and 23-37 are pending in the application. Claims 5, 18, and 23-37 were rejected. Applicants, by this paper, amend claims 5, 18, 23-27, 29, 36 and 37. No new matter is added by amendment. Applicants respectfully request reconsideration and allowance of all pending claims.

Discussion of Rejections Under 35 U.S.C. §103

Claims 5, 25 and 28 were rejected under 35 U.S.C. §103(a) as being unpatentable over Kliger in view of Wu.

To establish a *prima facie* case of obviousness, the prior art reference, or references when combined, must provide all of the claim limitations and must establish that it would be obvious for one of ordinary skill in the art to combine the references in a way that would successfully result in the claimed invention.

Applicants contend that, in light of the amendments that have been made to the claims as now presented, a *prima facie* case of obviousness cannot be established and Applicants respectfully traverse the rejections. In particular, Applicants contend that the references, neither alone nor in combination, teach nor suggest all claimed features. Even more particularly, Applicants contend that none of the references teach, suggest or motivate one of ordinary skill in the art to make the claimed invention, since none of the cited references teach a filter that reflects signals back into a splitter in order to allow terminals coupled to the tap ports (those ports other than the common port) within a network to communicate directly with one another. Nor would it otherwise be obvious to combine elements provided in the prior art in light of the failure of the prior art to provide the missing element of a filter tuned to reflect signals back into a splitter.

While Applicants are well aware that the use of filters has a long a rich history, the use of a filter in the present context would not be obvious. That is because use of a filter recited in the present claims would typically result in a relatively weak reflection that would not provide sufficient energy reflecting back into the network. This is true even without a splitter to attenuate the reflection, but all the more so when the splitter is in the path of the

reflected signal. Filters that are sharp enough to reflect sufficient energy in the signal are difficult to make and expensive to purchase. It is for this reason that Kliger has not disclosed the use of filters to perform this function. The benefits to using such filters are typically not considered to be achievable in a practical solution. However, what makes it possible for the present invention to take advantage of the use of such a filter as a means for reflecting the signals back into the network is the use of two techniques (used either separately or together) for dealing with the variable nature of the interference that occurs to the transmission of the data over the network. The first of these techniques is known as "bitloading" and is disclosed on page 18, line 12, et al. of the present application. In accordance with the technique,

> Higher SNR channels can support higher data capacity. Frequency bins occupying parts of the channel where the SNR is high can be used to transmit more bits. Each carrier may be modulated with a different order constellation, where higher SNR frequencies can bear a higher order constellation, and the resulting closer spacing of the constellation points. Frequencies with the lower SNR use lower order constellation such as QPSK. (Original Specification page 18, line 12-19).

The second of these techniques is referred to as "power control". This term is used by those skilled in the art to describe several different techniques, however in this case the term is used to refer to the technique described on page 18 at lines 21-28, which states that:

> The power in individual frequency bins can be adjusted to compensate for insertion loss that varies as a function of frequency. The power level in regions of the channel can be altered by scaling the complex valued vector for the bins where power adjustment is needed before applying the inverse Fourier transform. **In order to avoid interference with certain bands in the RF spectrum, the power level of certain bins can be reduced to zero.**

Accordingly, Claim 5 has been amended to recite the use of the bitloading technique together with the filter and a Claim 24 recites the use of power control together with the filter.

It should be noted that Claim 18, 23 and 24 depend from Claim 5 and accordingly, for the reasons stated above, each of these claims should are considered to be in condition for allowance.

Claim 25 has been amended to recite the filter as described above and the bitloading technique discussed in connection with the use of the filter. Since, as noted above, none of the references teach or suggest the filter recited in Claim 25, Applicants respectfully contend that Claim 25 is also in condition for allowance. Claims 26-28 and 36 depend from Claim 25 and so for the same reasons as noted with regard to Claim 25, Applicants respectfully content that Claims 26-28 and 36 are in condition for allowance.

Likewise, Claim 29 has been amended to recite the filter discussed above with respect to Claim 5 and thus Applicants contend that Claim 29 and those claims that depend therefrom (Claims 30-35, and 37) are in condition for allowance.

It should be noted that while the Examiner has cited several additional references (including: Manssen, Zhang, Ling, Mukherjee and Kapoor) in rejecting some of the dependent claims, none of these references teach or suggest the missing element of a filter turned to reflect signals back into the network from which they were transmitted together with the use of bitloading and/or power control to make use of the filter viable as described above and recited in the claims as now presented.

Accordingly, Applicants respectfully request reconsideration and allowance of claims 5, 25, 29 and those claims that depend therefrom.

CONCLUSION

Applicants believe that all claims pending in the application are allowable. Applicants therefore respectfully request that a timely Notice of Allowance be issued in this case.

This is a response to the Office Action mailed on 7/24/07, and as such, is submitted together with a request for a three month extension of time and the fee required for such a three month extension of time.

If there are any other fees due in connection with the filing of the response, please charge the fees to Deposit Account No. 502165. If a fee is required for an extension of time under 37 CFR 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned.

Respectfully submitted,

Dated: January 22, 2008

By: /Michael W. Landry/
Michael W. Landry
Attorney for Applicants
Registration No. 38,216
858-229-6801

PTO/SB/22 (10-07)
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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) 9202
Application Number 09/910,412	Filed 7/21/2001
For Network Interface Device and Broadband Local Area Network Using Coaxial Cable	
Art Unit 2623	Examiner Chowdhury

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):

		Fee	Small Entity Fee	
☐	One month (37 CFR 1.17(a)(1))	$120	$60	$
☐	Two months (37 CFR 1.17(a)(2))	$460	$230	$
☑	Three months (37 CFR 1.17(a)(3))	$1050	$525	$ 1050
☐	Four months (37 CFR 1.17(a)(4))	$1640	$820	$
☐	Five months (37 CFR 1.17(a)(5))	$2230	$1115	$

☐ 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.~~ Filed online

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

☑ The Director is hereby authorized to charge any fees which may be required, or credit any overpayment, to Deposit Account Number 502165. 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 38,216

☐ attorney or agent under 37 CFR 1.34.
Registration number if acting under 37 CFR 1.34 _____

/Michael W. Landry/ — Signature
January 22, 2008 — Date

Michael W. Landry — Typed or printed name
858-229-6801 — 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 _____ forms are submitted.

This collection of information is required by 37 CFR 1.136(a). The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.11 and 1.14. This collection is estimated to take 6 minutes to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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

Electronic Patent Application Fee Transmittal

Application Number:	09910412
Filing Date:	21-Jul-2001
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Filer:	Michael William Landry/Michelle Landry
Attorney Docket Number:	9202
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:				
Extension-of-Time:				
Extension - 3 months with $0 paid	1253	1	1050	1050

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous:				
			Total in USD ($)	**1050**

Electronic Acknowledgement Receipt	
EFS ID:	2745193
Application Number:	09910412
International Application Number:	
Confirmation Number:	2398
Title of Invention:	Network interface device and broadband local area network using coaxial cable
First Named Inventor/Applicant Name:	Itzhak Gurantz
Customer Number:	24244
Filer:	Michael William Landry/Michelle Landry
Filer Authorized By:	Michael William Landry
Attorney Docket Number:	9202
Receipt Date:	22-JAN-2008
Filing Date:	21-JUL-2001
Time Stamp:	01:02:08
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1050
RAM confirmation Number	11234
Deposit Account	
Authorized User	

File Listing:

Document Number	Document Description	File Name	File Size(Bytes) /Message Digest	Multi Part /.zip	Pages (if appl.)

1	Amendment - After Non-Final Rejection	9202-OAresponse-831-f-2-ver2-EFS.pdf	124572 6db64144828c4b9d6011e862e35546850c6c0e8a	no	10
Warnings:					
Information:					
2	Extension of Time	9202-extension-of-time-EFS.pdf	54823 8c5c210240c69ac8d4cce4d32d22644764985470	no	1
Warnings:					
Information:					
3	Fee Worksheet (PTO-06)	fee-info.pdf	8173 076b416016b41a3f60ee06314b69b6f978d07a1e	no	2
Warnings:					
Information:					
		Total Files Size (in bytes):	187568		

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

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

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

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

PTO/SB/06 (07-06)
Approved for use through 1/31/2007. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it displays a valid OMB control number.

PATENT APPLICATION FEE DETERMINATION RECORD

Substitute for Form PTO-875

Application or Docket Number	Filing Date	☐ To be Mailed
09/910,412	07/21/2001	

APPLICATION AS FILED – PART I

FOR	(Column 1) NUMBER FILED	(Column 2) NUMBER EXTRA	SMALL ENTITY ☐ RATE ($)	SMALL ENTITY ☐ FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY FEE ($)
☐ BASIC FEE (37 CFR 1.16(a), (b), or (c))	N/A	N/A	N/A			N/A	
☐ 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

AMENDMENT	01/22/2008	(Column 1) CLAIMS REMAINING AFTER AMENDMENT		(Column 2) HIGHEST NUMBER PREVIOUSLY PAID FOR	(Column 3) PRESENT EXTRA	SMALL ENTITY RATE ($)	SMALL ENTITY ADDITIONAL FEE ($)	OR	OTHER THAN SMALL ENTITY RATE ($)	OTHER THAN SMALL ENTITY ADDITIONAL FEE ($)
	Total (37 CFR 1.16(i))	* 17	Minus	** 20	= 0	X $ =		OR	X $50=	0
	Independent (37 CFR 1.16(h))	* 3	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

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

* If the entry in column 1 is less than the entry in column 2, write "0" in column 3.

** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 20, enter "20".

*** If the "Highest Number Previously Paid For" IN THIS SPACE is less than 3, enter "3".

The "Highest Number Previously Paid For" (Total or Independent) is the highest number found in the appropriate box in column 1.

Legal Instrument Examiner:
/EUGENIA v. HARDY/

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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Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/910,412	07/21/2001	Itzhak Gurantz	9202	2398

24244 7590 07/24/2007

MICHAEL W LANDRY
5098 SEACHASE STREET
SAN DIEGO, CA 92130

EXAMINER	
CHOWDHURY, SUMAIYA A	
ART UNIT	PAPER NUMBER
2623	

MAIL DATE	DELIVERY MODE
07/24/2007	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)	
	09/910,412	GURANTZ ET AL.	
	Examiner	Art Unit	
	Sumaiya A. Chowdhury	2623	

-- 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 *25 May 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) *5,18 and 23-37* 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) *5,18 and 23-37* 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 _____ 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

Continued Examination Under 37 CFR 1.114

1. A request for continued examination under 37 CFR 1.114, including the fee set forth in 37 CFR 1.17(e), was filed in this application after final rejection. Since this application is eligible for continued examination under 37 CFR 1.114, and the fee set forth in 37 CFR 1.17(e) has been timely paid, the finality of the previous Office action has been withdrawn pursuant to 37 CFR 1.114. Applicant's submission filed on 5/25/07 has been entered.

Response to Arguments

2. Applicant's arguments with respect to claims 5, 18, and 23-37, have been considered but are moot in view of the new ground(s) of rejection.

Claim Rejections - 35 USC § 103

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

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

4. Claim ~~5~~ 5, 25, & 28 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger (US 2002/0069417) in view of Wu (US 2002/0088005).

Note: Information relied on from Kliger can be found in provisional applications 60/229263 and 60/275060

As for claim 5, Kliger teaches discloses a signal distribution network for transmitting modulated signals using building wiring containing a plurality of branches as a communication channel comprising:

a network interface device (14) located at the point of entry of the building wiring () that reflects network signals originating in the building wiring wherein the reflection introduced by the network interface device produces a multipath signal in the wiring branches that creates impairments to the performance of the communication channel – [0043].

at least one signal splitter (24') – [0043]; and

a plurality of terminal devices (33) – [0044];

wherein the network interface device provides a path for terminal devices to transmit to and receive from other terminal devices and wherein terminal devices communicate directly with each other to form the signal distribution network – [0048], [0047], [0050];

The signal distribution network uses coaxial cable wiring;

However, Kliger fails to teach:

The signal modulation used by the terminal devices is orthogonal frequency division multiplexing to overcome the communication channel impairments caused by the network interface device;

In an analogous art, Wu teaches:

The signal modulation used by the terminal devices is orthogonal frequency division multiplexing to overcome communication impairments (multipath distortion and interference) caused by the network interface device – [0048], [0058], [0060];

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger's invention to include the above mentioned limitation, as taught by Wu, in order to allow recovery of data.

As for claim 25, Kliger teaches:

a network interface device (14—fig. 2) connected to the point of entry of the building wiring comprising:

a first port (18-fig. 2) connected to the point of entry side of a branch of the building wiring – [0051];

a second port (24'-fig. 2) connected to the terminal device side of a branch of the building wiring – [0051];

a frequency selective signal reflecting circuit (40-fig. 2) connected between the first and second port – [0051]-[0053];

wherein a signal received at the second port is reflected out the second port and back into all the building wiring branches and a reflected signal path is created that produces a multipath signal in the wiring branches that creates impairments to the performance of the communication channel – [0043], [0051];

a plurality of terminal devices connected to the wiring branches, each terminal device bidirectionally communicating with other terminal devices through the reflected signal path created by the network interface device– [0047], [0048], [0050], [0043].

However, Kliger fails to teach:

The signal modulation used by the terminal devices is orthogonal frequency division multiplexing to overcome the communication channel impairments caused by the network interface device;

In an analogous art, Wu teaches:

The signal modulation used by the terminal devices is orthogonal frequency division multiplexing to overcome communication impairments (multipath distortion and interference) caused by the network interface device – [0048], [0058], [0060];

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger's invention to include the above mentioned limitation, as taught by Wu, in order to allow recovery of data.

As for claim 28, Kliger and Wu teach the claimed limitations. In particular, Kliger teaches the frequency used for communicating is above the cable television band – ([0052]; provisional application 60/275,060).

5. Claim 18 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Wu as applied to claim 5 above, and further in view of Manssen (5809421).

As for claim 18, Kliger and Wu fails to teach sharing the communication channel between terminal devices using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches sharing the communication channel between locations using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network – col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

6. Claim 23 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Wu, and Manssen as applied to claim 18 above, and further in view of Ling (6771706).

As for claim 23, Kliger, Wu, and Manssen fail to teach wherein the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring cause by the reflections from the network interface device.

In an analogous art, Ling teaches the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments present – col. 20, lines 45-60.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Wu, and Manssen's invention to include the above mentioned limitation, as taught by Ling, in order to achieve high throughput or bit rate for a particular level of performance.

7. Claim 24 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Wu, and Manssen as applied to claim 18 above, and further in view of Zhang (7151740).

As for claim 24, Kliger, Wu, and Manssen fail to teach wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the network interface device.

In an analogous art, Zhang teaches the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments present – col. 3, lines 29-52, Abstract.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Wu, and Manssen's invention to include the

above mentioned limitation, as taught by Zhang, in order to overcome transmission power loss.

8. Claim 26 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Wu as applied to claim 25 above, and further in view of Ling.

As for claim 26, Kliger and Wu fail to teach wherein the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring cause by the reflections from the network interface device.

In an analogous art, Ling teaches the modulation order of each OFDM carrier is adjusted according to the SNR at each OFDM carrier frequency to overcome frequency selective channel impairments present – col. 20, lines 45-60.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above mentioned limitation, as taught by Ling, in order to achieve high throughput or bit rate for a particular level of performance.

9. Claim 27 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Wu as applied to claim 25 above, and further in view of Zhang.

As for claim 27, Kliger and Wu fail to teach wherein the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments present in the coaxial building wiring caused by the reflections from the network interface device.

In an analogous art, Zhang teaches the power level of each OFDM carrier is adjusted according to the signal loss at each OFDM carrier frequency to overcome frequency selective channel impairments present – col. 3, lines 29-52, Abstract.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above mentioned limitation, as taught by Zhang, in order to overcome transmission power loss.

10. Claim 36 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger and Wu as applied to claim 25 above, and further in view of Manssen.

As for claim 36, Kliger and Wu fail to teach sharing the communication channel between terminal devices using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches sharing the communication channel between locations using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network – col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

11. Claims 29, 30, and 33, are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger in view of Wu and Mukherjee (6226322)

Claim 29 contains the limitations of claims 5 and 25 and is analyzed as previously discussed with respect to those claims. Claim 29 additionally calls for the following:

wherein the terminal devices perform equalization on the received signal that restores a flat frequency response to overcome the communication channel impairments caused by the multipath signals.

In an analogous art, Mukherjee teaches the terminal devices perform equalization on the received signal signal that restores a flat frequency response to overcome the communication channel impairments caused by the multipath signals – col. 8, lines 40-52.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger and Wu's invention to include the above

mentioned limitation, as taught by Mukherjee, for the advantage of flattening the signal spectrum and compensating for phase distortion.

As for claim 30, Kliger, Wu, and Mukherjee disclose the claimed limitations. In particular, Mukherjee teaches equalization is frequency domain equalization.

As for claim 33, Kliger, Wu, and Mukherjee disclose the claimed limitations. In particular, Wu teaches wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals–[0048], [0058], [0060];

12. Claim 31 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Wu, and Mukherjee as applied to claim 29 above, and further in view of Kapoor (6,396,886).

As for claim 31, Kliger, Wu, and Mukherjee fail to teach wherein equalization is time domain equalization.

In an analogous art, Kapoor teaches wherein equalization is time domain equalization that restores a flat frequency response to overcome multipath effects – col. 6, lines 47-63.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Wu, and Mukherjee's invention to include the

above mentioned limitation, as taught by Kapoor, for the advantage of restoring the frequency envelope.

13. Claims 32, 34, and 35, are rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Wu, and Mukherjee as applied to claim 29 above, and further in view of Ise (6778601).

As for claim 32, Kliger, Wu, and Mukherjee fail to teach wherein equalization is adaptive .

In an analogous art, Ise teaches wherein equalization is adaptive (see abstract, col. 4, lines 33-47, col. 5, lines 17-27, lines 40-50).

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Wu, and Mukherjee's invention to include the above mentioned limitation, as taught by Ise, in order to inhibit an excessive peak in the filter characteristic.

As for claim 34, Kliger, Wu, Mukherjee, and Ise disclose the claimed limitations. In particular, Wu teaches wherein the terminal devices use orthogonal frequency division multiplexing (OFDM) modulation to overcome the communication channel impairments caused by the reflected signals –[0048], [0058], [0060];

As for claim 35, Kliger, Wu, Mukherjee, and Ise disclose the claimed limitations. In particular, Wu teaches wherein the terminal devices use forward error correction to recover the transmitted signal without errors – [0062].

14. Claim 37 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kliger, Wu, and Mukherjee as applied to claim 29 above, and further in view of Manssen.

As for claim 37, Kliger, Wu, and Mukherjee fails to teach sharing the communication channel between terminal devices using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network.

In an analogous art, Manssen teaches sharing the communication channel between locations using time division duplex protocol for communications that are synchronized by broadcasting a beacon message on the network – col. 8, lines 30-48, col. 4, lines 9-25.

It would have been obvious to one of ordinary skill in the art at the time of applicant's invention to modify Kliger, Wu, and Mukherjee's invention to include the above mentioned limitation, as taught by Manssen, for the advantage of preventing co-channel interference.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Sumaiya A. Chowdhury whose telephone number is (571) 272-8567. The examiner can normally be reached on Mon-Fri, 9-5:00.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, John Miller can be reached on (571) 272-7353. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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SAC

ANDREW Y. KOENIG
PRIMARY PATENT EXAMINER

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