A distribution system for the distribution of digital telephony data streams for use in a building or facility which uses, as a communication link, AC power lines (105) is described. This distribution system communicates signals and data without the need for continuous telephone lines. This system provides a base unit (104) connected to a subscriber interface unit (102), which in turn is connected to a public communication network. The base unit (104) further provides an AC power line interface (105) over which communication signals are communicated to extension units (106a, 106b, ..., 106e). The extension units (106a, 106b, ..., 106e) support standard user telecommunication devices, such as telephones, switchboards, facsimile machines, and modems. The preferred embodiment of this invention uses a FSK encoding/decoding scheme to support the communication of the digital signals and to improve system quality, reducing errors and having higher noise immunity.
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DIGITAL TELEPHONY CARRIER CURRENT SYSTEM

SPECIFICATION

To all whom it may concern:

Be it known that John M. Knab, Scott R. Bullock, Scott D. Smith and David B. Bartholomew citizens of the United States of America, have invented a new and useful invention entitled DIGITAL TELEPHONY CARRIER CURRENT SYSTEM of which the following comprises a complete specification.
Background of the Invention

Field of the Invention. This invention relates to methods and systems for the distribution of digital telephony data streams. More specifically, the invention relates to the distribution of digital telephony signals over AC power lines within a building or facility.

Description of Related Art. A variety of telephone distribution, digital telephony and power line carrier communication systems are well known in the art. Generally, these prior systems address some of the engineering requirements of a power line digital telephony distribution system but do not address the issues and problems of integrating all such a system together to provide a low-cost telephone signal connection that is inherently digital in nature and to distribute the signals within a building or facility while providing the means of interfacing such signals to both standard digital and analog communication equipment.

The reader is referred to the following U.S. patent documents for general background material. Each of these patents is hereby incorporated by reference in its entirety for the material contained therein.

U.S. Patent No. 4,430,731 describes a subscriber data distribution system having a means for translating data received from a transmission line and transmitting the data to a subscriber terminal via a subscriber drop, as well as a means for translating data received.
U.S. Patent No. 4,451,703 describes a line circuit for connecting a subscriber line to a telephony system that avoids the use of electro-mechanical elements such as relays.

U.S. Patent No. 4,550,425 describes a speech sampling and companding device wherein analog speech signals are sampled at a nominal rate of 6 kilohertz and digitized in a Mu-Law encoder.

U.S. Patent Nos. 4,864,598 and 4,937,851 describe a system for verifying the integrity of each one of a number of communication paths, illustratively telephone subscriber loops that run between a near end location and a corresponding remote far end location.

U.S. Patent No. 5,052,039 describes a line interface circuit for coupling telecommunications lines and AC current lines.

U.S. Patent No. 5,333,192 describes a line interface circuit for coupling signals between a telephone line and a hybrid circuit that includes a loop driver circuit for supplying energizing current to the telephone line and for driving the telephone line with alternating current signals.

U.S. Patent No. 5,465,256 describes a signally pre-processor for receiving signally from a line card of a telephone line.

U.S. Patent No. 5,528,675 describes a network interface unit for serving a central office line and one or more local stations by interfacing remotely monitored devices, such as utility controllers and meter readers, to an existing customer telephone line that serves the customer site.
U.S. Patent No. 5,627,898 describes a signal distribution system that includes a module-receiving means whereby a user may select isolation circuitry to eliminate ground-loop-induced interference.

U.S. Patent No. 5,694,335 describes an extensible, programmable digital electronic network that originates from a network node and includes a base node microcomputer and a network interface and is operatively connected to a power supply.

U.S. Patent No. 5,706,157 describes a communication power distribution system that includes a single power distribution system that includes a single power regulator which feeds a plurality of transmission lines current limited by a corresponding active current limiter.

U.S. Patent Nos. 5,710,798, 5,717,725, and 5,745,532 describe a system and method for wireless transmission of information which is subject to fading by using a RF carrier modulated with a subcarrier modulated with the information.

U.S. Patent Nos. 5,740,241 and 5,768,368 describe a technique for powering telephone lines using an unbalanced current source and current sink and a technique for improving attenuation/frequency distribution and return loss of transformer coupled wire-line communications circuits.

U.S. Patent No. 5,778,116 describes an apparatus for distributing and controlling distribution of externally and locally generated communications signals to and between a plurality of subscribers.
U.S. Patent No. 5,799,067 and 5,799,068 describe a business telephone system that employs digital signal processing in a digital telephone having a serial link for connection to a general-purpose computer.


**Summary of the Invention**

It is desirable to provide a system for distributing digital telephony data streams in a building or facility by using AC power line techniques. It is particularly desirable to provide such a system which is adapted to communicate telephony information between a base unit, connected to a subscriber interface that itself receives and sends telephony data to and from a public network, and any number of extension units, where the communication between the base unit and the extension units is over an AC power line.

Accordingly, it is the primary object of this invention to provide a system for the distribution of digital telephony data streams using the AC power lines within a building or facility.

Another object of this invention is to provide a system for the distribution of digital telephony data streams that includes a base unit adapted to be connected to a subscriber interface.

Another object of this invention is to provide a system for the distribution of digital telephony data streams that includes one or more extension units adapted to provide user access to a public network over AC power lines.
A further object of this invention is to provide a system for the distribution of
digital telephony data streams that provides low cost communication connections to
digital telephone signals within a building or facility.

A still further object of this invention is to provide a system for the
distribution of digital telephony data streams that provides a means for interfacing
digital telephony signals to standard digital and analog equipment.

Another object of this invention is to provide a system for the distribution of
digital telephone data streams that provides much improved signal quality.

Additional objects, advantages, and other novel features of this invention will
be set forth in part in the description that follows and in part will become apparent to
those skilled in the art upon examination of the following or may be learned with the
practice of the invention. The objects and advantages of this invention may be
realized and attained by means of the instrumentalities and combinations particularly
pointed out in the appended claims. Still other objects of the present invention will
become readily apparent to those skilled in the art from the following description
wherein there is shown and described the preferred embodiment of this invention,
simply by way of illustration of one of the modes best suited to carry out this
invention. As it will be realized, this invention is capable of other different
embodiments, and its several details, and specific electronic circuits, are capable of
modification in various aspects without departing from the invention. Accordingly,
the drawings and descriptions should be regarded as illustrative in nature and not as
restrictive.
To achieve the foregoing and other objectives, and in accordance with the purposes of the present invention, a subscriber interface unit is connected to a public network, a base unit is electrically connected to the subscriber interface unit, and one or more extension units, which communicate with the base unit across the AC power lines of a building or facility are employed. This invention makes use of the improved signal quality of digital signal communication. In particular, this invention uses a frequency shift key (FSK) encoding scheme.

**Brief Description of the Drawings**

The accompanying drawings incorporated in and forming a part of the specification, illustrate a preferred embodiment of the present invention. Some, although not all, alternative embodiments are described in the following description. In the drawings:

Figure 1 is a top level system block diagram showing the major sections of the invention.

Figure 2 is a block diagram providing additional detail of the subscriber interface unit of the preferred embodiment of the invention.

Figure 3 is a block diagram providing additional detail of the base unit of the preferred embodiment of the invention.

Figure 4 is a block diagram providing additional detail of the extension unit of the preferred embodiment of the invention.

Reference will now be made in detail to the present preferred embodiment of the invention, an example of which is illustrated in the accompanying drawings.
Detailed Description of the Invention

Figure 1 shows the top-level system block diagram of the preferred embodiment of the invention. Digital telephony signals 101 are received by a subscriber line interface unit 102. These digital telephony signals 101 may be provided by wired, fiber optical, RF or other similar network technologies. The subscriber line interface unit 102 receives and converts these signals 101 to make them compatible for the use of the base unit 104 of this invention. The subscriber line interface unit 102 is typically connected to the base unit 104 via an electronic signal connection 103. The base unit 104 employs an encoding scheme, typically and preferably FSK, and converts and imposes the signal on to the power line 105. Also, connected to the power line are one or more extension units 106a-e. These extension units 106a-e receive the encoded signal from the base unit 104, decode the signal and forward the signal to the user’s telecommunication equipment 107a-e. The user’s telecommunications equipment 107a-e may includes such devices as telephones, facsimile machines, modems and the like and are used to perform bi-directional digital and analog communications.

Figure 2 shows a block diagram of the subscriber interface unit (SIU) 102 of the preferred embodiment of the invention. The preferred SIU is typically mounted on the outside of the building and connects to both the cable television connection and the inside telephone connection box. The SIU may be powered 207 either by the cable television network or by a power adapter connected to inside AC power. Preferably the SIU is compatible with the Universal Serial Bus (PC USB) connection system. Essentially the preferred SIU is a cable modem dedicated to sending and
receiving telephony data over cable. As shown in figure 2, a typical and preferred
SIU is connected 205 electrically with the cable television system, via cable interface
circuitry 201. The preferred cable interface circuitry 201 includes both a modulator
and a demodulator. The cable interface circuitry 201 communicates electronically
with a processor 202, which may perform the modulation/demodulation functions as
well as frequency allocation, data encryption and decryption, as well as other well
understood control and decoding functions. The processor 202 transfers information
in two ways. First, standard telephone communication signals are communicated to
and from a telephone 206 via a standard subscriber line interface circuit (SLIC) 203.
Second, digital communication data is communicated via an I/O port 204 to a data
link 103 to the base unit 104. The I/O port 204 provides signal isolation as well as
level translation. This description of the preferred SIU is one possible embodiment.
Alternative commercially available SIU’s can be substituted without departing from
the concept of this invention.

Figure 3 shows a block diagram of the base unit 104 of the preferred
embodiment of the invention. The preferred base unit 104 has a plastic enclosure
with two electrical connections: a power line connection 307 providing a connection
to the AC power line communication channel 105 to the extension units 106; and a
data line connection 103 for communicating with the SIU 102. A processor 302 is
provided, in communication with the data line 103 via an I/O port 301, which matches
the network type on the SIU I/O port 204. The processor 302 formats the Power Line
Communication data and the USB data for communication. A modulator 303
receives the signals from the processor 302 transfer to the power line channel 105. A
buffer 304 receives the signals from the modulator 303. A filter 305 receives the
buffered signals from the buffer 304 and outputs the data to the power line interface
306 for transfer to the power line interface 307. Receiving data from the power line
interface 307, via the power line interface circuitry 306, is a filter 310. A buffer 309
receives the signal from the filter 310 and outputs the signal to a demodulator 308,
which in turn communicates the signal to the processor 302. Power 311 is preferably
provided to the base unit via the AC power outlet. The preferred modulator 303 and
demodulator 308 uses a frequency shift key modulation scheme, although alternative
modulation schemes can be substituted without departing from the concept of this
invention.

Figure 4 shows a block diagram of the extension unit 106 of the preferred
embodiment of the invention. The preferred extension unit 106 is contained in a
plastic enclosure and has two or three electrical connections. Typically, one
connection is provided to the power line 307 for communication with the base unit
104, via a power line interface circuit 401. The second connection is for connection
to a standard telephone 407, via a subscriber line interface circuit (SLIC) 405. A third
connection provides a data port 406 such as USB or RS-232. The data port 406 and
the SLIC 405 communicate with an extension unit processor 404, which in turn is
electrically connected to a modulator 408, for transfer data, and a demodulator 411.
The modulator 408 outputs its signal to a buffer 409, which passes the data to a filter
410 prior to transfer to the power line I/F circuit 401. The demodulator 411 receives
its signal from a buffer 403. The buffer 403 receives the signal from the power line
I/F 401 via a filter 402. The preferred modulation scheme used in the extension unit

106 is FSK, although alternative analog transmission techniques could be used without departing from the concept of this invention.

The foregoing description is of a preferred embodiment of the invention and has been presented for the purposes of illustration and as a description of the best mode of the invention currently known to the inventors. It is not intended to be exhaustive or to limit the invention to the precise form, connections, or choice of components disclosed. Obvious modifications or variations are possible and foreseeable in light of the above teachings. This embodiment of the invention was chosen and described to provide the best illustration of the principles of the invention and its practical application to thereby enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims when they are interpreted in accordance with the breadth to which they are fairly, legally and equitably entitled.
Claims

We claim:

1. A distribution system for communication of signals and data, comprising:
   
   (A) a digital telephony signal source;
   
   (B) a subscriber line interface unit;
   
   (C) a base unit;
   
   (D) an extension unit; and
   
   (E) a communication link connecting said base unit to said extension unit.

2. A distribution system for communication of signals and data as recited in claim 1, wherein said base unit further comprises a line interface adapted to send and receive signals from a variety of telephone service connections.

3. A distribution system for communication of signals and data as recited in claim 1 wherein said digital telephony signal source is selected from the group consisting of wired, optical fiber, and RF signal sources.

4. A distribution system for communication of signals and data as recited in claim 1, wherein said base unit further comprises an FSK encoder.

5. A distribution system for communication of signals and data as recited in claim 1, wherein said extension unit further comprises an FSK decoder.

6. A distribution system for communication of signals and data as recited in claim 1, wherein said communication link is an AC power line communication link.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER
IPC(7): H04M 11/00, 3/42; H04Q 7/32, 7/20; H04J 13/00, 3/16
US CL: 455/402, 425, 415, 462, 561; 379/165, 167; 370/18
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED
Minimum documentation searched (classification system followed by classification symbols)
U.S. : 455/402, 425, 415, 462, 561; 379/165, 167; 370/18

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

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
EAST/WEST
SEARCH TERMS: BASE UNIT, EXTENSION UNIT, SUBSCRIBER LINE, AC POWER

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of Box C. See patent family annex.

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*X* document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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*A* document member of the same patent family

Date of the actual completion of the international search: 20 MAY 2000
Date of mailing of the international search report: 07 JUL 2000

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Facsimile No. (703) 305-3230
Authorized officer: PABLO TRAN
Telephone No. (703) 305-3900

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