(51) International Patent Classification:
H04L 12/10 (2006.01)

(21) International Application Number:
PCT/IB2014/058805

(22) International Filing Date: 5 February 2014 (05.02.2014)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
61/761,787 7 February 2013 (07.02.2013) US

(71) Applicant (for all designated States except DE):
KONINKLIJKE PHILIPS N.V. [NL/NL]; High Tech Campus 5, NL-5656 AE Eindhoven (NL).

(71) Applicant (for DE only): PHILIPS DEUTSCHLAND GMBH [DE/DE]; Lubeckertordamm 5, 20099 Hamburg (DE).

(72) Inventors: WENDT, Matthias; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL). RADER-MACHER, Harald Josef Gunther; c/o High Tech Campus, Building 5, NL-5656 AE Eindhoven (NL).

(74) Agents: VAN EEUWIJK, Alexander Henricus Walterus et al; High Tech Campus Building 5, NL-5656 AE Eindhoven (NL).

(54) Title: POWER AND DATA DISTRIBUTION SYSTEM

(57) Abstract: The invention relates to a power and data distribution system comprising an electrical conductor (20), to which an electrical consumer (7, 8), a power source (6) and a data source are connectable for distributing power and data, wherein the electrical conductor comprises a data conductor (4) for distributing the data and at least two power subconductors (3, 5) for distributing the power, wherein the electrical conductor (20), the data source and the electrical consumer are impedance matched regarding the data distribution and wherein the electrical conductor is adapted such that the electrical consumer is connectable with the electrical conductor at several locations along the electrical conductor. This system allows several electrical consumers to be easily connected in a bus topology by connecting them at the several locations along the electrical conductor. In contrast, known Ethernet power and data distribution systems generally allow for a star connection topology only.
Power and data distribution system

FIELD OF THE INVENTION

The invention relates to a power and data distribution system for distributing power and data. The invention relates further to an electrical conductor, an electrical consumer and a data source of the power and data distribution system.

BACKGROUND OF THE INVENTION

The IEEE 802.3.af standard defines a power and data distribution system, which allows distributing power and data via a twisted-pair Ethernet cable. According to this standard, electrical consumers can be connected to a switch for receiving power from the switch and for exchanging data, wherein the switch comprises several ports and wherein to each port a single electrical consumer can be connected. The resulting connection topology is a star topology and does not easily allow for another topology like a bus topology or a daisy chaining topology. For instance, in the case of a daisy chaining topology an electrical consumer in the middle of the daisy chain would need to offer to a neighboring electrical consumer a power supply port that can provide power. Moreover, an electrical consumer of the daisy chain would need to indicate power requirements down the daisy chain to the switch providing the power, which inherently would require knowledge about the power requirements up the daisy chain.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide a power and data distribution system, which more easily allows for a topology not being a star topology. It is a further object of the present invention to provide an electrical conductor, an electrical consumer and a data source of the power and data distribution system.

In a first aspect of the present invention a power and data distribution system is presented, comprising:
- an electrical consumer for consuming power,
- a power source for providing power to be consumed by the electrical consumer,
a data source for providing data to be sent to the electrical consumer,
an electrical conductor, to which the electrical consumer, the power source and
the data source are connectable for distributing the power and the data, wherein the electrical
conductor comprises a data subconductor for distributing the data and at least two power
subconductors for distributing the power, wherein the electrical conductor, the data source
and the electrical consumer are impedance matched regarding the data distribution and
wherein the electrical conductor is adapted such that the electrical consumer is connectable
with the electrical conductor at several locations along the electrical conductor.

Since the electrical conductor comprises a data subconductor and at least two
power subconductors, wherein the electrical conductor, the data source and the electrical
consumer are impedance matched regarding the data distribution and wherein the electrical
conductor is adapted such that the electrical consumer is connectable with the electrical
conductor at several locations along the electrical conductor, data and power can be
effectively transmitted via the electrical conductor, wherein several electrical consumers can
be easily connected in a bus topology by connecting the same at the several locations along
the electrical conductor.

The electrical conductor preferentially has an impedance of 50 Ω regarding the
data transmission. Moreover, one of the power subconductors is preferentially adapted to
provide a positive voltage and another of the electrical subconductors is preferentially
adapted to provide a negative voltage.

The electrical consumer is preferentially a lighting device. However, it can
also be another device, for instance, a sensing device like an occupancy sensor or a flux
sensor, an air conditioning device, a user interface device like a light control unit et cetera.

Several electrical consumers can be attached to the electrical conductor.

Moreover, attaching or detaching one or several electrical consumers to or from, respectively,
the electrical conductor does preferentially not imply a loss of connectivity for other
electrical consumers of the power and data distribution system.

It is preferred that the electrical conductor comprises a carrier element
carrying the data subconductor and the power subconductors. The electrical conductor with
the carrying element and the subconductors can be regarded as being a power rail comprising
a data trace formed by the data subconductor and power traces formed by the power
subconductors. The carrier element is preferentially a longish element having a T-shaped or a
U-shaped cross section. However, the cross section may also have another shape.
An electrical insulator may be arranged between the data subconductor and at least one of the power subconductors. Moreover, the carrier element may comprise an insulating material such that the electrical insulator between the data subconductor and at least one of the power subconductors may be formed by the carrier element. The carrier element preferentially comprises a first side and an opposing second side, wherein the data subconductor is located on the first side and wherein an electrically conductive surface is provided on the second side for forming a microstrip data transmission. This configuration is especially useful for conveying the data in the form of microwave-frequency signals. Since the electrical conductor is impedance matched, the width of the data subconductor, the dielectric constant of the carrier element and the thickness of the insulating material of the carrier element are preferentially configured such that the impedance of the microstrip data transmission matches the impedance of the data source and the impedance of the electrical consumer.

In a preferred embodiment the electrically conductive surface is at least partly formed by at least one of the power subconductors. Thus, a same subconductor can be used for two purposes, transmitting power and transmitting data. This allows for a more compact structure of the electrical conductor, which may lead to reduced dimensions of the electrical conductor.

The electrically conductive surface may comprise separated electrically conductive surface elements, which are capacitively coupled. For instance, the electrically conductive surface elements can be coupled by capacitor components or capacitive coupling sheets. At least one of the separated electrically conductive surface elements can be formed by a power subconductor. The several capacitive elements may be placed between the separated electrically conductive surface elements in a certain distance of, for example, 10 cm.

The carrier element may comprise a first side and an opposing second side, wherein the data subconductor may be located on the first side and at least one of the power subconductors may be arranged on the second side. This configuration is particularly useful, if a microstrip data transmission is used for transmitting the data, because it allows for a simple utilization of the power subconductor on the second side as the electrically conductive surface on the back side of the carrier element, which in this example comprises insulating material.

Moreover, in an embodiment a power subconductor may be located on the first side and another power subconductor may be located on the second side. For instance, a
positive power subconductor, i.e. a power subconductor carrying a positive voltage, and the
data subconductor can be arranged on the first side, whereas a negative subconductor, i.e. a
subconductor carrying a negative voltage, can be arranged on the second side.

The electrical conductor may comprise at least three power subconductors,

wherein at least two power subconductors are arranged on the first side and at least one
power subconductor is arranged on the second side and wherein the carrying element
comprises an electrical via for electrically contacting the at least one power subconductor on
the second side with at least one power subconductor on the first side. This allows accessing
the at least one power subconductor arranged on the second side from the first side such that
all contacts between the electrical consumer and the electrical conductor can be located on
the first side, thereby allowing for a simplified electrical connection of the electrical
consumer to the electrical conductor. Moreover, the at least one power subconductor on the
second side can be used as an electrically conductive surface on the back side of the carrying
element, which in this example is insulating, for forming a microstrip data transmission. This
can lead to a more compact structure of the electrical conductor.

In an embodiment the data subconductor may be located on the first side and
all power subconductors may be located on the first side or on the second side. In particular,
all subconductors can be arranged on the same side of the carrier element, thereby allowing
for a single contact location for contacting, for example, the electrical consumer to the
electrical conductor.

The data source may be attached to the electrical conductor at an end of the
electrical conductor or at a location along the length of the electrical conductor.

It is preferred that the data subconductor and at least some of the power
subconductors are uncovered along a length covering the several locations, at which the
electrical consumer is connectable with the electrical conductor, in order to allow the
electrical consumer to be electrically connected with the electrical conductor at the several
locations. Since the data subconductor and at least some of the power subconductors, in
particular, all power subconductors, are uncovered along a length covering the several
locations, the electrical consumer can be freely attached to the electrical consumer as desired
by a user.

In a preferred embodiment, the electrical conductor comprises two opposing
sides, wherein the electrical consumer is contacted with the electrical conductor from one of
the two opposing sides or from the two opposing sides. In the first case the contacting
procedure may be easier, because only a single side of the electrical conductor needs to be accessed. In the latter case the contact may be more reliable.

The electrical consumer may be contacted with the electrical conductor using at least one contact element selected from the group consisting of a spring, a roll, a pin to be clamped and a screw. The contacts between the electrical consumer and the electrical conductor can be such that the subconductors are touched only by the contact elements or the contact elements cut into the subconductors, in order to make an especially reliable contact.

Preferentially, at at least one end of the electrical conductor a termination resistor is connected having the impedance of the data subconductor, which may be, for instance, 50 Ω. The termination resistor may be provided as an end cap of the electrical conductor.

In a further aspect of the present invention an electrical conductor for distributing power and data and for being used in a power and data distribution system as defined in claim 1 is presented, wherein the electrical conductor is adapted such that the electrical consumer, the power source and the data source are connectable to the electrical conductor for distributing the power and the data, wherein the electrical conductor comprises a data subconductor for distributing the data and at least two power subconductors for distributing the power, wherein the electrical conductor, the data source and the electrical consumer are impedance matched regarding the data distribution and wherein the electrical conductor is adapted such that the electrical consumer is connectable to the electrical conductor at several locations along the electrical conductor.

In a further aspect of the present invention an electrical consumer for consuming power and for being used in a power and data distribution system as defined in claim 1 is presented, wherein the electrical consumer, the electrical conductor and the data source are impedance matched regarding the data distribution and wherein the electrical consumer is adapted such that the electrical consumer is connectable to the electrical conductor at several locations along the electrical conductor.

In a further aspect of the present invention a data source for providing data to be sent to the electrical consumer and for being used in a power and data distribution system as defined in claim 1 is presented, wherein the data source, the electrical conductor and the electrical consumer are impedance matched regarding the data distribution. Moreover, also the data source can be adapted to be connectable to the electrical conductor at several locations along the electrical conductor.
It shall be understood that the power and data distribution system of claim 1, the electrical conductor of claim 13, the electrical consumer of claim 14, and the data source of claim 15 have similar and/or identical preferred embodiments, in particular, as defined in the dependent claims.

It shall be understood that a preferred embodiment of the invention can also be any combination of the dependent claims with the respective independent claim.

These and other aspects of the invention will be apparent from and elucidated with reference to the embodiments described hereinafter.

**BRIEF DESCRIPTION OF THE DRAWINGS**

In the drawings:

Fig. 1 shows schematically and exemplarily an embodiment of a power and data distribution system,

Fig. 2 shows schematically and exemplarily an embodiment of a lighting device of the power and data distribution system,

Fig. 3 shows schematically and exemplarily an embodiment of a user interface device of the power and data distribution system,

Fig. 4 shows schematically and exemplarily a part of an embodiment of an electrical conductor of the power and data distribution system in more detail, and

Figs. 5 to 8 show schematically and exemplarily further embodiments of an electrical conductor of the power and data distribution system.

**DETAILED DESCRIPTION OF EMBODIMENTS**

Fig. 1 shows schematically and exemplarily a power and data distribution system 1 comprising several electrical consumers 7, 8 for consuming power, a power source 6 for providing power to be consumed by the electrical consumers 7, 8 and an electrical conductor 20 for transmitting the power and data. The electrical conductor 20, to which the power source 6 and the electrical consumers 7, 8 are connected, comprises a data subconductor 4 for distributing the data and two power subconductors 3, 5 for distributing the power, wherein the electrical conductor is adapted such that the electrical consumers 7, 8 are connectable to the electrical conductor 20 at several locations along the electrical conductor 20. In particular, the data subconductor 4 and the power subconductors 3, 5 are uncovered, i.e. blank, along the length of the electrical conductor 20, in order to allow a user to connect the electrical consumers 7, 8 and in this embodiment also the power source 6 at desired
locations along the length of the electrical conductor 20. The electrical consumer 7, which is
schematically and exemplarily shown in more detail in Fig. 2, is a lighting device comprising
a lamp driver 9 and a lamp 10. The lamp driver 9 receives the power from the power
subconductors 3, 5 and converts the power to a power required by the lamp 10, if necessary.
Moreover, the lamp driver 9 receives data from the data subconductor 4, wherein the data are
preferentially control data for controlling the lamp driver 9 and, thus, the lamp 10. Fig. 3
shows schematically and exemplarily in more detail the electrical consumer 8 being a user
interface device. The user interface device 8 comprises a user interface controller 11 and a
user interface unit 12. The user interface unit 12 allows a user to input control data for
controlling the lighting devices 7. For instance, the user interface unit 12 can comprise a
rotatable and/or slidable knob or a keyboard or another means for allowing a user to input a
desired light characteristic like a desired dimming level or light color. The user interface
controller 11 generates control data for controlling the lighting devices 7 depending on the
input provided by the user via the user interface unit 12. The generated control data are
transmitted to the lighting devices 7 via the data subconductor 4. Since the user interface
controller 11 generates and provides control data, it can be regarded as being a data source.
The data source 11, the electrical conductor 2 and the lighting devices 7 are
impedance matched regarding the data distribution, i.e. regarding the data transmission.
Preferentially, the electrical conductor 20 has an impedance of 50 Ω regarding the data
transmission. Moreover, the power subconductor 3 is preferentially adapted to provide a
positive voltage and the power subconductor 5 is preferentially adapted to provide a negative
voltage.
The power source 6 is preferentially adapted to provide DC power. The power
source can be adapted to receive power from another power source and to adapt the received
power such that it can be consumed by the electrical consumers attached to the electrical
conductor. For instance, it can be a power converter for converting mains AC power to DC
power. However, the power source can also be adapted to provide AC power.
The power and data distribution system 1 is configured such that attaching or
detaching one of the several components, i.e. one of the power source 6 and the electrical
consumers 7, 8, to or from, respectively, the electrical conductor 20 does not imply a loss of
connectivity of the other components attached to the electrical conductor 20.
The electrical conductor 20 further comprises a carrier element 2 for carrying
the data subconductor 4 and the power subconductors 3, 5. The carrier element 2 is made of
an insulating material and a longish element with a T-shaped cross section. In another
embodiment the carrier element may also have another cross section, for instance, it may have a U-shaped cross section. The electrical conductor 20 is exemplarily and schematically shown in more detail in Fig. 4.

As can be seen in Fig. 4, the electrical conductor 20, which could also be regarded as being a conduction rail or main rail, comprises the data subconductor 4 at a first side of the electrical conductor 20 and the power subconductors 3, 5 at an opposing second side of the electrical conductor 20. Thus, between the data subconductor 4 and the power subconductors 3, 5 the insulating carrier element 2 is arranged.

The two power subconductors 3, 5 on the second side can be regarded as being separated electrically conductive surface elements forming an electrically conductive surface on the second side. This electrically conductive surface 3, 5 forms together with the data subconductor 4 and the insulating carrier element 2 a microstrip data transmission for conveying the data in the form of microwave frequency signals. The data trace width, i.e. the width of the data subconductor 4, the dielectric parameter of the insulating carrier material and the insulation thickness, i.e. the thickness of the insulating carrier material between the data subconductor 4 and the power subconductors 3, 5, are chosen in a way that the impedance of the data transmission is matching the impedance of the data source 11 and the impedance of the electrical consumers 7, in particular, of the lamp drivers 9. In this embodiment the impedance of the data transmission is chosen to be 50 \( \Omega \).

The lighting devices 7 are electrically connected to the electrical conductor 20 via a cable 15, a connector 13 and spring contacts 14. Since the data subconductor 4 is arranged on the first side of the carrying element 2 and the power subconductors 3, 5 are arranged on the opposing second side of the carrying element 2, the lighting devices 7 are contacted with the electrical conductor 20 via the cable 15, the connector 13 and the spring contacts 14 from the two opposing sides. In other embodiments, also other contact elements can be used like roll contact elements, pin contact elements, screw contact elements, et cetera. The contacts between the electrical consumers and the electrical conductors can be such that the subconductors are touched only by the contact elements, for instance, as shown in Fig. 3 or such that the contact elements cut into the subconductors, in order to make an especially reliable contact.

Further electrical consumers like the user interface device 8 or other electrical consumers and other components to be attached to the electrical conductor 20 can use the same connectors as used by the lighting devices 7 or other connectors, which are adapted to
electrically connect the respective component to the power subconductors 3, 5 and the data subconductor 4.

The separated electrically conductive surface elements 3, 5 formed, in this embodiment, by the power subconductors can be capacitively coupled as schematically and exemplarily illustrated in Fig. 5. In this example capacitor components 16 are mounted in a distance of, for instance, 10 cm between the power traces, i.e. between the power subconductors, 3, 5. The capacitor components 16 provide a good coupling between the elements of the split backplane, i.e. between the two separate electrically conductive surface elements 3, 5 for the preferred high frequencies contained in the data signal.

On both ends of the electrical conductor 30 a termination resistor of 50 Ω may be mounted (not shown in Fig. 4). The termination resistor may be placed as an end cap for the electrical conductor 20. Also the data source, which in this embodiment is a part of the user interface device 8, may, in another embodiment, be attached to an end of the electrical conductor 20, wherein the data source may also be an integrated element integrated in another component or a separate element.

Although Fig. 4 shows a certain arrangement of power and data subconductors on the carrying element, the electrical conductor can comprise another arrangement of power and data subconductors. For instance, one power subconductor, in particular, the negative power subconductor, can be arranged on the second side and another power subconductor, in particular, a positive power subconductor, and the data subconductor can be provided on the first side of the carrying element.

It is also possible that all subconductors are arranged on a single side of the carrying element, which allows contacting an electrical consumer with the electrical conductor from one side of the carrying element only, i.e. this configuration allows for a single side attachment of the contacts. Figs. 6 to 8 schematically and exemplarily illustrate possible configurations of the electrical conductor.

The configurations shown in Figs. 6 to 8 provide, as the configuration shown in Figs. 4 and 5, a stripline conductor with integrated power conduction. In Fig. 6 the data subconductor 204 forms together with the insulating carrying element 202 and the electrically conducted surface 218 a microstrip data transmission line. The data subconductor 204 is located on a first side of the carrying element 202, wherein on the same side also two power subconductors 203, 205 are arranged. The electrical conductor 220 shown in Fig. 6 further comprises electrical vias 217 through the intermediate insulating carrying element 202 for electrically connecting the electrically conductive surface 218 with one of the power
subconductors 203. The power subconductor 203 electrically connected with the backplane 218, i.e. electrically connected with the electrically conductive surface 218, is preferentially a negative power subconductor carrying the negative voltage. In the configuration shown in Fig. 6 the backplane is in one part, whereas the electrical conductor 320 exemplarily and schematically shown in Fig. 7 uses a split backplane 318, 319. Thus, in the embodiment shown in Fig. 7 the backplane is formed by two electrically conductive surface elements 318, 319. These electrically conductive surface elements 318, 319 are electrically connected with power subconductors 303, 305 on the opposite side of the carrying element 302 by using vias 317. The separated electrically conductive surface elements 318, 319 can therefore also be regarded as being power subconductors. In this embodiment the separate electrically conductive surface elements have different dimensions, whereas in the embodiment described above with reference to Figs. 4 and 5 the separate electrically conductive surface elements have the same dimensions. One electrically conductive surface element 318 is adapted such that it covers a region on the second side of the carrying element 302, which corresponds to a region on the first side of the carrying element 302 covering the first power subconductor 302 and the data subconductor 304, whereas the second electrically conductive surface element 319 covers a region on the second side of the carrying element 302, which corresponds to a region on the first side of the carrying element 302, which includes the second power subconductor 305. The first power subconductor 303 is preferentially a negative power subconductor and the second power subconductor 305 is preferentially a positive power subconductor. The configuration shown in Fig. 7 provides a well balanced current density and it allows for a relatively slim electrical conductor, because a part of the current flows on the back side, i.e. the second side, of the electrical conductor.

Fig. 8 shows schematically and exemplarily a further embodiment of an electrical conductor. The electrical conductor 420 shown in Fig. 8 comprises a longish carrying element 402, which has a substantially U-shaped cross section. The carrying element 402 can be regarded as having an inner region, which may be regarded as being a first side, and an outer region, which may be regarded as being a second side. In the inner region a data subconductor 403 and two power subconductors 404, 405 are provided. Moreover, on the second side, i.e. in the outer region, an electrically conductive surface 418 is provided such that the data subconductor 404, the electrically conductive surface 418 and the intermediate part of the carrying element 402, which is made of an insulating material, form a microstrip data transmission. Thus, in an embodiment the electrical conductor can have a hollow rail setup, wherein the subconductors are embedded in a U-shaped insulating carrier 402. Also in
this embodiment the backplane 418, i.e. the electrically conductive surface 418, can be connected to one of the power subconductors 403, 405 by using, for instance, electrical vias through the insulating carrying element 402, in order to also use the backplane 418 for power conduction and for minimizing losses. This U-configuration can lead to an easier mechanical fixation of electrical consumers to the electrical conductor.

The data source, the electrical conductor and the electrical consumers are preferentially adapted such that substantially an Ethernet communication is realized following the 10Base2 physical layer definition, wherein instead of a coaxial 50 Ω cable a microstrip data transmission is used as shared medium. The microstrip transmission has preferentially an impedance of 50 Ω, in order to keep pulse distortions low. For designing the microstrip data transmission such that it has an impedance, which matches the impedances of the data source and the electrical consumers, for instance, in order to provide an impedance of 50 Ω, known calculations and algorithms can be used like the QUCS transmission line calculations.

Since the data communication is preferentially realized following the 10Base2 physical layer definition, the electrical consumers, the data source and preferentially also the power source can be adapted to be in conformance with the 10Base2 definition. For instance, they can use interfaces in accordance with the DP8392C coaxial transceiver interface being a coaxial cable line driver/receiver for Ethernet/Thin Ethernet type local area networks.

The power and data distribution system described above with reference to Figs. 1 to 8 allows supplying a number of loads connected to a power rail, in order to form a bus topology. The power rail, i.e. the electrical conductor, comprises a data rail having preferentially a 50 Ω impedance, i.e. the data subconductor, and negative and positive power rails, i.e. the power subconductors.

Although in above described embodiments the data subconductor and the power subconductors are uncovered, i.e. blank, in another embodiment the data subconductor and/or the power subconductors can also be covered by an insulating layer, which is penetratable by scratching, cutting through or another technique. Thus, when connecting a component like an electrical consumer, a power source, a data source, et cetera to the electrical conductor, the cover layer can be penetrated, in order to electrically connect the respective unit to the electrical conductor. The cover layer may be a plastic coating or another electrically insulating layer, which is penetratable at the positions, at which the respective units should be electrically connected to the electrical conductor.
The electrical conductor, the data source and the electrical consumer are impedance matched regarding the data distribution, i.e. the electrical conductor, a data sending element of the data source and a data receiving element of the electrical consumer are impedance matched. For instance, the lamp driver of the electrical consumer described above with reference to Fig. 2 may be adapted to receive data from the data subconductor of the electrical conductor and may therefore form or comprise the data receiving element. However, the electrical consumer can also comprise a separate data receiving element. Regarding the data source described above with reference to Fig. 3, the data source is adapted to send data and therefore forms or comprises a data sending element, which in another embodiment may also be a separate element. The data sending element of the data source may also be adapted to receive data and the data receiving element of the electrical consumer may also be adapted to send data.

The electrical consumer may comprise several components like a data receiving element, an adapter, a component which actually consumes the power like the above described lamp 10, a connector for electrically connecting the electrical consumer to the electrical conductor, et cetera. These components may be included in a single casing or at least some of these components may be separated from each other, wherein the separated components are of course still electrically connected for transmitting power and/or signals being indicative of the data. For instance, in an embodiment the electrical consumer can comprise an adapter, which forwards the power from the electrical conductor to the component really consuming the power like the lamp 10.

The data source, the electrical conductor and the electrical consumer are preferentially configured such that no reflections are generated along the data transmission path, i.e. between a data sending element of the data source, the electrical conductor and a data receiving element of the electrical consumer. In order to have substantially no reflections, the electrical conductor, the data source and the electrical consumer are impedance matched regarding the data distribution, i.e. the difference between the largest impedance and the smallest impedance is preferentially smaller than 10 percent of the largest impedances, further preferred smaller than 5 percent and even further preferred the impedances are equal.

The data sending element of the data source is preferentially arranged as close as possible to the contact point, where the data source is connected to the electrical conductor, i.e. the corresponding conducting path is preferentially as short as possible. Moreover, also a conducting path between a data receiving element of the electrical
consumer and a contact point, where the electrical consumer is electrically connected to the electrical conductor, is preferentially as short as possible.

The data connection between the data source and the electrical consumer via the electrical conductor is preferentially a TCP/IP connection.

Although in the embodiment described above with reference to, for instance, Figs. 1 and 3 the electrical consumer 8 comprises a user interface controller 11 as the data source, also other components like other electrical consumers or the power source may be adapted to send data via the electrical conductor. Moreover, not only the electrical consumer 7 may be adapted to receive data, but also other components like the power source and other electrical consumers may be adapted to receive data via the electrical conductor.

Preferentially, the described bus structure allows every device to send messages to any other device. For instance, the power source may send control messages to the electrical consumers, for instance, in order to ask for a load reduction in case of power shortage situations. Furthermore, the power source may also be adapted to provide a bridging function, wherein it allows for a data exchange between the bus system and an external network. In this way also commands from, for instance, a building management system (BMS) may reach each device connected to the bus system, i.e. connected to the electrical conductor of the power and data distribution system.

Although in the embodiments described above with reference to, for instance, Figs. 5 to 8 the data subconductor is located on a first outer side of the insulating carrier element and an electrically conductive surface is located on an opposing second outer side of the carrier element for forming a microstrip data transmission, the first side and/or the outer side, on which the data subconductor and the electrically conductive surface, respectively, are located, can also be inner sides of the carrier element. Thus, the data subconductor can be covered by a portion of the carrier element and/or the electrically conductive surface can be covered by a portion of the carrier element, i.e., for instance, the electrically conductive surface can be an inner layer of the carrier element.

Although in above described embodiments the electrical consumer is, for instance, a lighting device, also other kinds of electrical consumers can be attached to the electrical conductor. For instance, a sensing device like an occupancy sensor or a flux sensor, an air conditioning device et cetera can be attached to the electrical conductor.

The control conductors, i.e. the data subconductors, are preferentially placed parallel to the power subconductors in a fixed relative location, wherein the subconductors are blank, in order to allow for a connection of loads, i.e. of electrical consumers, at
deliberate positions along the power data bundle, i.e. along the electrical conductor comprising the subconductors. The power data bundle is a flat construction, in particular, a substantially flat construction. Moreover, the data subconductor is preferentially impedance controlled by means of a micro stripline configuration. The data transfer provided by the electrical conductor is preferentially compliant to the 10Base2 Ethernet standard.

Other variations to the disclosed embodiments can be understood and effected by those skilled in the art in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims.

In the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

A single unit or device may fulfill the functions of several items recited in the claims. The mere fact that certain measures are recited in mutually different dependent claims does not indicate that a combination of these measures cannot be used to advantage.

Any reference signs in the claims should not be construed as limiting the scope.

The invention relates to a power and data distribution system comprising an electrical conductor, to which an electrical consumer, a power source and a data source are connectable for distributing power and data, wherein the electrical conductor comprises a data subconductor for distributing the data and at least two power subconductors for distributing the power, wherein the electrical conductor, the data source and the electrical consumer are impedance matched regarding the data distribution and wherein the electrical conductor is adapted such that the electrical consumer is connectable with the electrical conductor at several locations along the electrical conductor. This system allows several electrical consumers to be easily connected in a bus topology by connecting them at the several locations along the electrical conductor. In contrast, known Ethernet power and data distribution systems generally allow for a star connection topology only.
CLAiM5:

1. A power and data distribution system comprising:
   - an electrical consumer (7, 8) for consuming power,
   - a power source (6) for providing power to be consumed by the electrical consumer (7, 8),
   - a data source (11) for providing data to be sent to the electrical consumer (7, 8),
   - an electrical conductor (20; 220; 320; 420), to which the electrical consumer (7, 8), the power source (6) and the data source (11) are connectable for distributing the power and the data, wherein the electrical conductor (20; 220; 320; 420) comprises a data subconductor (4; 204; 304; 404) for distributing the data and at least two power subconductors (3, 5; 203, 205, 218; 303, 305, 318, 319; 403, 405) for distributing the power, wherein the electrical conductor (20; 220; 320; 420), the data source (11) and the electrical consumer (7, 8) are impedance matched regarding the data distribution and wherein the electrical conductor (20; 220; 320; 420) is adapted such that the electrical consumer (7, 8) is connectable with the electrical conductor (20; 220; 320; 420) at several locations along the electrical conductor (20; 220; 320; 420).

2. The power and data distribution system as defined in claim 1, wherein the electrical conductor (20; 220; 320; 420) comprises a carrier element (2; 202; 302; 402) carrying the data subconductor (4; 204; 304; 404) and the power subconductors (3, 5; 203, 205, 218; 303, 305, 318, 319; 403, 405).

3. The power and data distribution system as defined in claim 2, wherein the carrier element (2; 202; 302; 402) comprises an insulating material.

4. The power and data distribution system as defined in claim 3, wherein the carrier element (2; 202; 302; 402) comprises a first side and an opposing second side, wherein the data subconductor (4; 204; 304; 404) is located on the first side and wherein an
electrically conductive surface (3, 5; 218; 318; 418) is provided on the second side for forming a microstrip data transmission.

5. The power and data distribution system as defined in claim 4, wherein the electrically conductive surface (103, 105; 218; 318) is at least partly formed by at least one of the power subconductors.

6. The power and data distribution system as defined in claim 4, wherein the electrically conductive surface comprises separated electrically conductive surface elements (3, 5), which are capacitively coupled.

7. The power and data distribution system as defined in claim 2, wherein the carrier element (2; 102; 202; 302) comprises a first side and an opposing second side, wherein the data subconductor (4; 204; 304) is located on the first side and at least one of the power subconductors (3, 5; 203, 205, 218; 303, 305, 318, 319) is arranged on the second side.

8. The power and data distribution system as defined in claim 7, wherein a power subconductor (203, 205; 303, 305) is located on the first side and another power subconductor (218; 318, 319) is located on the second side.

9. The power and data distribution system as defined in claim 8, wherein the electrical conductor (220; 320) comprises at least three power subconductors (203, 205, 218; 303, 305, 318, 319), wherein at least two power subconductors (203, 205; 303, 305) are arranged on the first side and at least one power subconductor (218; 318, 319) is arranged on the second side and wherein the carrying element (202; 302) comprises an electrical via (217; 317) for electrically contacting the at least one power subconductor (218; 318, 319) on the second side with at least one power subconductor (203; 303, 305) on the first side.

10. The power and data distribution system as defined in claim 2, wherein the carrier element (2) comprises a first side and an opposing second side, wherein the data subconductor (4) is located on the first side and all power subconductors (3, 5) are located on the first side or on the second side.
11. The power and data distribution system as defined in claim 1, wherein the data subconductor (4; 204; 304; 404) and at least some of the power subconductors (3, 5; 203, 205, 218; 303, 305, 318, 319; 403, 405) are uncovered along a length covering the several locations, at which the electrical consumer (7, 8) is connectable with the electrical conductor (20; 220; 320; 420), in order to allow the electrical consumer (7, 8) to be electrically connected with the electrical conductor (20; 220; 320; 420) at the several locations.

12. The power and data distribution system as defined in claim 1, wherein the electrical conductor (20; 220; 320; 420) comprises two opposing sides, wherein the electrical consumer (7, 8) is contacted with the electrical conductor (20; 220; 320; 420) from one of the two opposing sides or from the two opposing sides.

13. An electrical conductor for distributing power and data and for being used in a power and data distribution system as defined in claim 1, wherein the electrical conductor (20; 220; 320; 420) is adapted such that the electrical consumer (7, 8), the power source (6) and the data source (11) are connectable to the electrical conductor (20; 220; 320; 420) for distributing the power and the data, wherein the electrical conductor (20; 220; 320; 420) comprises a data subconductor (4; 204; 304; 404) for distributing the data and at least two power subconductors (3, 5; 203, 205, 218; 303, 305, 318, 319; 403, 405) for distributing the power, wherein the electrical conductor (20; 220; 320; 420), the data source (11) and the electrical consumer (7, 8) are impedance matched regarding the data distribution and wherein the electrical conductor (20; 220; 320; 420) is adapted such that the electrical consumer (7, 8) is connectable to the electrical conductor (20; 220; 320; 420) at several locations along the electrical conductor (20; 220; 320; 420).

14. An electrical consumer (7, 8) for consuming power and for being used in a power and data distribution system as defined in claim 1, wherein the electrical consumer (7, 8), the electrical conductor (20; 220; 320; 420) and the data source (11) are impedance matched regarding the data distribution and wherein the electrical consumer (7, 8) is adapted such that the electrical consumer (7, 8) is connectable to the electrical conductor (20; 220; 320; 420) at several locations along the electrical conductor (20; 220; 320; 420).

15. A data source (11) for providing data to be sent to the electrical consumer (7, 8) and for being used in a power and data distribution system as defined in claim 1, wherein
the data source (11), the electrical conductor (20; 220; 320; 420) and the electrical consumer (7, 8) are impedance matched regarding the data distribution.
FIG. 2

FIG. 3