United States Patent Application Publication	20250267021
Kind Code	A1
Publication Date	August 21, 2025
Inventor(s)	Huang; Chung-Hsien et al.

POWERED DEVICE FOR POWER OVER ETHERNET, POWER OVER ETHERNET SYSTEM, AND OPERATING METHOD THEREOF

Abstract

A powered device (PD) for Power over Ethernet (POE), a PoE system, and an operating method for PoE are provided. The powered device includes a first Ethernet transmission port, a second Ethernet transmission port, a power meter, and a controller. The first Ethernet transmission port receives a first power and a first packet from a power sourcing equipment (PSE). The first packet includes a first output voltage value and a first maximum allowable power value. The second Ethernet transmission port provides a second power to a next-level powered device. The power meter measures an input voltage value and an input current value of the powered device. The controller sends a second packet to the next-level powered device via the second Ethernet transmission port. The second packet includes a second output voltage value and a second maximum allowable power value.

Inventors: **Huang; Chung-Hsien (Hsinchu City, TW), Tseng; Yueh-O (Hsinchu City, TW)**

Applicant: **Zyxel Networks Corporation** (New Taipei City, TW)

Family ID: **1000008151503**

Assignee: **Zyxel Networks Corporation (New Taipei City, TW)**

Appl. No.: **18/818645**

Filed: **August 29, 2024**

Foreign Application Priority Data

TW	113106063	Feb. 21, 2024

Publication Classification

Int. Cl.: **H04L12/10** (20060101); **G06F1/26** (20060101)

U.S. Cl.:

CPC **H04L12/10** (20130101); **G06F1/266** (20130101);

Background/Summary

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This application claims the priority benefit of Taiwan application serial no. 113106063, filed on Feb. 21, 2024. The entirety of the above-mentioned patent application is hereby incorporated by reference herein and made a part of this specification.

BACKGROUND

Technical Field

[0002] The disclosure relates to a powered device, a power supply network system, and an operating method for the power supply network, and in particular to a powered device for Power over Ethernet, a Power over Ethernet system, and an operating method for Power over Ethernet.

Description of Related Art

[0003] Generally speaking, in a Power over Ethernet (POE) system, a power sourcing equipment (PSE) may communicate with a powered device (PD) based on a protocol defined in Power over Ethernet standard (for example, IEEE standard 802.3af/at/bt) to determine a power consumption value provided to the powered device, and provide power to the powered device according to the power consumption value. However, in the case where the number of powered devices increases or the Power over Ethernet system has a larger power demand, the power consumption of a cable between the power sourcing equipment and the powered device is more significant. There will be a difference between the power consumption value determined by the above-mentioned protocol and the actual power consumption value. Therefore, the power consumption value determined by the protocol may not be accurate, causing that the power provided by the Power over Ethernet system is not fully utilized.

SUMMARY

[0004] The disclosure provides a powered device for Power over Ethernet, a Power over Ethernet system, and an operating method for Power over Ethernet. The powered device, the Power over Ethernet system, and the operating method can obtain accurate power consumption.

[0005] A powered device of the disclosure includes a first Ethernet transmission port, a second Ethernet transmission port, a power meter, and a controller. The first Ethernet transmission port is coupled to a power sourcing equipment. The first Ethernet transmission port receives a first power and a first packet from the power sourcing equipment. The first packet includes a first output voltage value and a first maximum allowable power value. The second Ethernet transmission port is coupled to a next-level powered device. The second Ethernet transmission port provides a second power to the next-level powered device. The power meter measures an input voltage value and an input current value of the powered device. The controller sends a second packet to the next-level powered device via the second Ethernet transmission port. The second packet includes a second output voltage value and a second maximum allowable power value.

[0006] A Power over Ethernet system of the disclosure includes a power sourcing equipment and a powered device. The power sourcing equipment includes a first Ethernet transmission port and a first controller. The first controller is coupled to the first Ethernet transmission port and provides a power and sends a first packet via the first Ethernet transmission port. The first packet includes an output voltage value and a maximum allowable power value. The powered device includes a second Ethernet transmission port, a power meter, and a second controller. The second Ethernet transmission port is coupled to the first Ethernet transmission port. The second Ethernet transmission port receives the power and the first packet. The power meter measures an input voltage value and an input current value of the powered device. The second controller is coupled to the second Ethernet transmission port and the power meter. The second controller obtains an allowable power value of the powered device according to the output voltage value, the input voltage value, and the maximum allowable power value.

[0007] An operating method of the disclosure is used for a Power over Ethernet system. The Power over Ethernet system includes a power sourcing equipment and a powered device. The operating method comprises the following steps: a first power and a first packet are sent to the powered device by the power sourcing equipment, wherein the first packet includes a first output voltage value and a first maximum allowable power value; an input voltage value and an input current value of the powered device are measured by the powered device and an allowable power value of the powered device is obtained by the powered device according to the output voltage value, the input voltage value, and the maximum allowable power value.

Description

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. **1** is a schematic diagram of a Power over Ethernet system according to an embodiment of the disclosure.

[0009] FIG. **2** is a schematic diagram of a Power over Ethernet system according to an embodiment of the disclosure.

[0010] FIG. **3** is a schematic diagram of a Power over Ethernet system according to an embodiment of the disclosure.

[0011] FIG. **4** is a flowchart of an operating method according to an embodiment of the disclosure.

[0012] FIG. **5**A and FIG. **5**B are flowcharts of an operating method according to an embodiment of the disclosure.

[0013] FIG. **6** is a schematic diagram of an operation according to an embodiment of the disclosure.

DESCRIPTION OF THE EMBODIMENTS

[0014] Some embodiments of the disclosure will be described in detail with reference to the drawings. Reference numerals cited in the following description will be regarded as referring to the same or similar elements when the same reference numerals appear in different drawings. The embodiments are only a part of the disclosure and do not disclose all possible implementations of the disclosure. Specifically, the embodiments are only examples within the protection scope of the disclosure.

[0015] FIG. **1** is a schematic diagram of a Power over Ethernet system according to an embodiment of the disclosure. In the embodiment, a Power over Ethernet system **100** includes a power sourcing equipment **110** and a powered device **120**. The power sourcing equipment **110** may communicate with the powered device **120** using an Ethernet Power over Ethernet standard (for example, IEEE standard 802.3af/at/bt). The power sourcing equipment **110** includes an Ethernet transmission port PT**1** and a controller **111**. The controller **111** is coupled to the Ethernet transmission port PT**1**. The power sourcing equipment **110** provides a power and sends a first packet to the powered device **120** via the Ethernet transmission port PT**1**. In the embodiment, the first packet includes an output voltage value of the Ethernet transmission port PT**1** and a maximum allowable power value that the powered device **120** is allowed to use.

[0016] In the embodiment, the powered device **120** includes an Ethernet transmission port PT**2**, a power meter **121**, and a controller **122**. The Ethernet transmission port PT**2** is coupled to the

Ethernet transmission port PT**1**. The Ethernet transmission port PT**2** is connected to the Ethernet transmission port PT**1** via an Ethernet connection cable. The Ethernet transmission port PT**2** receives the power and the first packet from the power sourcing equipment **110**. The power meter **121** measures an input voltage value and an input current value received by the powered device **120** via the Ethernet transmission port PT**2**.

[0017] In the embodiment, the controller **122** is coupled to the Ethernet transmission port PT**2** and the power meter **121**. The controller **122** receives the first packet, and obtains an allowable power value of the powered device **120** according to the output voltage value of the power sourcing equipment **110**, the input voltage value of the powered device **120**, and the maximum allowable power value of the powered device **120** (that is, the maximum allowable power value that the power sourcing equipment **110** can provide).

[0018] It is worth mentioning here that the controller **122** of the powered device **120** can accurately calculate the actually allowable power value of the powered device **120** according to the output voltage value provided by the power sourcing equipment **110**, the input voltage value of the powered device **120**, and the maximum allowable power value allowed for the powered device **120**.

[0019] In the embodiment, the controller **122** may calculate the allowable power value of the powered device **120** according to Equation (1) shown below.

[00001] $\mathrm{PWR2} = \mathrm{PWR1} - ((V_{\mathrm{out}} - V_{\mathrm{in}}) \times I_{\mathrm{in}})$ Equation(1)

[0020] “PWR2” is the allowable power value of the powered device **120**. “PWR1” is the maximum allowable power value that the power sourcing equipment **110** can provide. “V.sub.out” is the output voltage value of the power sourcing equipment **110**. “V.sub.in” is the input voltage value of the powered device **120**. “I.sub.in” is the input current value of the powered device **120**. “(V.sub.out−V.sub.in)×I.sub.in” is an actual power loss between the power sourcing equipment **110** and the powered device **120**, including, for example, a transmission power loss of a connection cable and a power loss consumed by the device itself.

[0021] It is worth mentioning here that the controller **122** can obtain the actual remaining power allowable for the powered device **120** after the power sourcing equipment **110** and the powered device **120** are connected via a cable because the allowable power value of the powered device **120** is a result obtained by considering the actual power loss.

[0022] For example, based on the first packet, the controller **122** may know that the maximum allowable power value that the power sourcing equipment **110** can provide is 90 watts, and know that the output voltage value of the power sourcing equipment **110** is 52 volts. The power meter **121** measures that the input voltage value received by the powered device **120** is 46.6 volts, and the input current value is 0.35 amps. Therefore, based on Equation (1), the controller **122** may determine that the actual power loss (including the transmission power loss and the power loss consumed by the powered device **120** itself) is equal to 1.89 watts, and the actually allowable power value of the powered device **120** is equal to 88.11 watts.

[0023] In addition, the controller **111** calculates the maximum allowable power value that the power sourcing equipment **110** can provide to the powered device **120** and obtains the output voltage value at the Ethernet transmission port PT**1**. The controller **111** compares the values of the maximum allowable power value provided to the powered device **120** and the output voltage value at the Ethernet transmission port PT**1** with corresponding thresholds. When the maximum allowable power value provided to the powered device **120** is determined to be higher than or equal to a first threshold and the output voltage value of the Ethernet transmission port PT**1** is determined to be higher than or equal to a second threshold, this indicates that the maximum allowable power value and the output voltage value are both sufficient. Therefore, the controller **111** sends the first packet to the powered device **120**. For example, the first threshold may be a pre-defined allowable power value of the powered device **120**, such as 4 watts. The second threshold may be a minimum input voltage value of the Ethernet transmission port of the powered device **120**, such as 37 volts.

[0024] On the other hand, when the maximum allowable power value provided to the powered device **120** is lower than the first threshold and/or the output voltage value is lower than the second threshold, this indicates that the maximum allowable power value provided to the powered device **120** and/or the output voltage value is insufficient. Therefore, the controller **111** stops sending the first packet.

[0025] FIG. **2** is a schematic diagram of a Power over Ethernet system according to an embodiment of the disclosure. In the embodiment, a Power over Ethernet system **200** includes a power sourcing equipment **210** and powered devices **220** and **230**. The power sourcing equipment **210** may communicate with the powered device **220** via a Power over Ethernet standard. The power sourcing equipment **210** includes an Ethernet transmission port PT**1** and a controller **211**. The controller **211** is coupled to the Ethernet transmission port PT**1**. The controller **211** provides a first power and sends a first packet to the powered device **220** via the Ethernet transmission port PT**1**. In the embodiment, the first packet includes a first output voltage value corresponding to the Ethernet transmission port PT**1** of the power sourcing equipment **210** and a first maximum allowable power value provided by the power sourcing equipment **210**.

[0026] In the embodiment, the powered device **220** includes Ethernet transmission ports PT**2** and PT**3**, a power meter **221**, and a controller **222**. The Ethernet transmission port PT**2** is coupled to the power sourcing equipment **210**. The Ethernet transmission port PT**2** receives the first power and the first packet from the power sourcing equipment **210**. The Ethernet transmission port PT**3** is coupled to the powered device **230** (that is, the next-level powered device). The controller **222** provides a second power and sends a second packet to the powered device **230** via the Ethernet transmission port PT**3**.

[0027] The power meter **221** measures an input voltage value and an input current value received by the powered device **220**. The controller **222** sends the second packet to the next-level powered device via the Ethernet transmission port PT**3**. The second packet includes a second output voltage value corresponding to the Ethernet transmission port PT**3** of the powered device **220** and a second maximum allowable power value provided by the powered device **220**.

[0028] The powered device **230** includes an Ethernet transmission port PT**4**, a power meter **231**, and a controller **232**. The Ethernet transmission port PT**4** is coupled to the powered device **220**. The Ethernet transmission port PT**4** receives the second power and the second packet from the powered device **220**. The power meter **231** measures an input voltage value and an input current value received by the powered device **230**.

[0029] The controller **232** receives the second packet, and obtains an allowable power value of the powered device **230** according to the second output voltage value of the powered device **220**, the input voltage value of the powered device **230**, and the second maximum allowable power value that the powered device **220** can provide.

[0030] In the embodiment, the controller **222** may calculate the allowable power value, that is, the remaining allowable power of the powered device **220** according to Equation (2) shown below.

[00002] $\text{PWR4} = \text{PWR3} - ((V_{\text{out1}} - V_{\text{in2}}) \times I_{\text{in2}})$ Formula(2)

[0031] “PWR4” is the allowable power value of the powered device **220**. “PWR3” is the maximum allowable power value that the power sourcing equipment **210** can provide. “V.sub.out1” is the output voltage value of the power sourcing equipment **210**. “V.sub.in2” is the input voltage value of the powered device **220**. “I.sub.in2” is the input current value of the powered device **220**. “(V.sub.out1−V.sub.in2)×I.sub.in2” is an actual power loss between the power sourcing equipment **210** and the powered device **220**, including, for example, a transmission power loss of a connection cable and a power loss consumed by the device itself. Here, the controller **222** can obtain the actually remaining power allowable for the powered device **220** after the power sourcing equipment **210** and the powered device **220** are connected via a cable because the allowable power value of the powered device **220** is a result obtained by considering the actual power loss of the connection cable.

[0032] In the embodiment, the controller **232** may calculate the allowable power value, that is, the remaining allowable power of the powered device **230** according to Equation (3) shown below.

[00003] $\mathrm{PWR6} = \mathrm{PWR5} - ((V_{out2} - V_{in3}) \times I_{in3})$ Formula(3)

[0033] "PWR6" is the allowable power value of the powered device **230**. "PWR5" is the maximum allowable power value that the powered device **220** can provide. "V.sub.out2" is the output voltage value of the powered device **220**. "V.sub.in3" is the input voltage value of the powered device **230**. "I.sub.in3" is the input current value of the powered device **230**. "(V.sub.out2−V.sub.in3)×I.sub.in3)" is an actual power loss between the powered device **220** and the powered device **230**, including, for example, a transmission power loss of a connection cable and a power loss consumed by the device itself. Here, the controller **232** can obtain the actually remaining power allowable for the powered device **230** after the powered device **220** and the powered device **230** are connected via a cable because the allowable power value of the powered device **230** is a result obtained by considering the actual power loss of the connection cable.

[0034] In an embodiment, when the total power of the power supply system of the power sourcing equipment **210** is insufficient, a power management mechanism may be activated. Specifically, when the abovementioned situation occurs, the power sourcing equipment **210** may send a packet to immediately notify the powered device **220** so that the powered device **220** may reduce the power loading in response to receiving the packet. The packet includes the output voltage value of the Ethernet transmission port PT**1** of the power sourcing equipment **210** and an adjusted maximum allowable power value of the powered device **220**. When the powered device **220** detects changes of the received maximum allowable power value, the powered device **220** can recalculate the allowable power for limiting its power loading and output. In addition, the powered device **220** may perform a same method as the power sourcing equipment **210** operates to notify the next-level powered device **230** for reducing the power loading.

[0035] FIG. **3** is a schematic diagram of a Power over Ethernet system according to an embodiment of the disclosure. In the embodiment, a Power over Ethernet system **300** includes a power sourcing equipment **310** and powered devices **320** to **350**. The power sourcing equipment **310** may operate as the power sourcing equipment **110** shown in FIG. **1** or the power sourcing equipment **210** shown in FIG. **2**. The powered devices **320** to **350** may individually operate as the powered device **220** shown in FIG. **2**. The power sourcing equipment **310** and the powered devices **320** to **350** are coupled to each other in series by Ethernet transmission lines.

[0036] Taking the embodiment as an example, the power sourcing equipment **310** is coupled to the powered device **320** and supplies power to the powered device **320**. The powered device **320** is coupled to the powered device **330** and an electronic device ED**1**. The powered device **320** may supply power to the powered device **330** and the electronic device ED**1**. The powered device **330** is coupled to the powered device **340** and electronic devices ED**2** and ED**3**. The powered device **330** may supply power to the powered device **340** and the electronic devices ED**2** and ED**3**. The powered device **340** is coupled to the powered device **350** and electronic devices ED**4** and ED**5**. The powered device **340** may supply power to the powered device **350** and the electronic devices ED**4** and ED**5**. The powered device **350** is coupled to electronic devices ED**6**, ED**7**, and ED**8**, and supplies power to the electronic devices ED**6**, ED**7**, and ED**8**.

[0037] The powered device **320** may calculate a power loss between the power sourcing equipment **310** and the powered device **320** and a power consumption value of the powered device **320**. The powered device **330** may calculate a power loss between the powered device **320** and the powered device **330** and a power consumption value of the powered device **330**, and so on. Therefore, the Power over Ethernet system **300** may determine or design an allowable cable length between the power sourcing equipment **310** and the powered devices **320** to **350** based on the power loss and the power consumption value of the powered devices. For example, the smaller the power loss or the power consumption value of the powered device is, the longer the allowable cable length between the power sourcing equipment **310** and the powered devices **320** to **350** may be. The greater the power loss or the power consumption value of the powered device is, the shorter the length of the allowable cable length between the power sourcing equipment **310** and the powered devices **320** to **350** may be.

[0038] In addition, the Power over Ethernet system **300** may determine or design the number of cascaded powered devices based on the power loss or the power consumption value of the powered device. For example, the smaller the power loss or the power consumption value of the powered device is, the greater the number of the cascaded powered devices may be. The greater the power loss or the power consumption value of the powered device is, the smaller the number of the cascaded powered devices may be.

[0039] In the embodiment, the electronic devices ED**1** to ED**8** are, for example, individually devices such as image capture devices (for example, IP cameras), notebook computers, smart phones, tablet computers, and chargers, etc., but the disclosure is not limited thereto. The number of electronic devices of the disclosure may be determined according to the maximum allowable power value of the power sourcing equipment **310**, and the number of electronic devices of the disclosure is not limited to the embodiment.

[0040] FIG. **4** is a flowchart of an operating method according to an embodiment of the disclosure. In the embodiment, an operating method S**100** is applicable to the Power over Ethernet system **100** in FIG. **1**. The operating method S**100** includes Steps S**110** to S**140**. In Step S**110**, the power sourcing equipment **110** provides a power to the powered device **120** via the Ethernet transmission port PT**1**. In Step S**110**, the power sourcing equipment **110** may first complete power activation for the powered device **120** based on the Power over Ethernet standard (for example, IEEE standard 802.3af/at/bt).

[0041] In Step S**120**, the power sourcing equipment **110** sends a first packet to the powered device **120**. The first packet includes the output voltage value of the Ethernet transmission port PT**1** of the power sourcing equipment **110**. In Step S**130**, the powered device **120** measures the input voltage value and the input current value of the powered device **120**. In Step S**140**, the powered device **120** calculates the power loss between the power sourcing equipment **110** and the powered device **120** according to a voltage difference value between the output voltage value of the power sourcing equipment **110** and the input voltage value of the powered device **120**, and the input current value of the powered device **120**.

[0042] The implementation details of Steps S**120** to S**140** have been clearly explained in the embodiment of FIG. **1** and will not be repeated here.

[0043] FIG. **5**A and FIG. **5**B are flowcharts of an operating method according to an embodiment of the disclosure. FIG. **6** is a schematic diagram of an operation according to an embodiment of the disclosure. In the embodiment, an operating method S**300** may be applicable to the Power over Ethernet systems **200** in FIGS. **2** and **300** in FIG. **3**. The Power over Ethernet system **200** will be taken as an example for explanation in the following description. The operating method S**300** includes Steps S**301** to S**312**. In Step S**301**, the power sourcing equipment **210** and the powered device **220** are connected. The power sourcing equipment **210** may first complete power activation for the powered device **220** based on the Power over Ethernet standard (for example, IEEE standard 802.3af/at/bt).

[0044] In Step S**302**, the power sourcing equipment **210** calculates the maximum allowable power value providable to the powered device **220**, and obtains the output voltage value of the Ethernet transmission port PT**1** of the power sourcing equipment **210** (that is, the output voltage value to be provided to the powered device **220**).

[0045] In Step S**303**, the power sourcing equipment **210** compares the values of the maximum allowable power value providable to the powered device **220** and the output voltage value of the Ethernet transmission port PT**1** with corresponding thresholds. When the maximum allowable

power value providable to the powered device **220** is determined to be lower than the first threshold and/or the output voltage value of the first Ethernet transmission port PT**1** is determined to be lower than the second threshold, the controller **211** stops sending the first packet, and ends the operating method S**300**.
[0046] On the other hand, in Step S**303**, when the maximum allowable power value providable to the powered device **220** is determined to be higher than or equal to the first threshold, and the output voltage value of the Ethernet transmission port PT**1** is determined to be higher than or equal to the second threshold, the power sourcing equipment **210** sends the first packet to the powered device **220** in Step S**304**. The first packet includes the output voltage value of the Ethernet transmission port PT**1** and the maximum allowable power value providable to the powered device **220**.
[0047] In Step S**305**, the powered device **220** measures the input voltage value and the input current value received by the powered device **220**. In Step S**306**, the powered device **220** calculates the power loss between the power sourcing equipment **210** and the powered device **220**.
[0048] Next, the powered device **220** determines whether the powered device **220** has PSE function which can provide a power to a next-level powered device in Step S**307**. When the powered device **220** does not have the PSE function, the operating method S**300** ends. On the other hand, when the powered device **220** has PSE function, the powered device **220** calculates the maximum allowable power value providable to the powered device **230** (that is, the next-level powered device) and the output voltage value of the Ethernet transmission port PT**3** of the powered device **220** (that is, the output voltage value to be provided to the powered device **230**) in Step S**308**.
[0049] In Step S**309**, the powered device **220** compares the maximum allowable power value providable to the powered device **230** and the output voltage value of the Ethernet transmission port PT**3** with corresponding thresholds. When the maximum allowable power value providable to the powered device **230** is determined to be lower than a third threshold and/or the output voltage value of the Ethernet transmission port PT**3** is determined to be lower than a fourth threshold, the powered device **220** stops sending the second packet, and ends the operating method S**300**.
[0050] On the other hand, when the maximum allowable power value providable to the powered device **230** is determined to be higher than or equal to the third threshold and the output voltage value of the Ethernet transmission port PT**3** is determined to be higher than or equal to the fourth threshold, Step S**310** may be operated. In Step S**310**, the powered device **220** and the powered device **230** are connected. Similar to Step S**301** above, the powered device **220** may first complete power activation for the powered device **230** based on the Power over Ethernet standard (for example, IEEE standard 802.3af/at/bt). Then, the powered device **220** sends the second packet to the powered device **230** in Step S**311**. The second packet includes the output voltage value provided to the Ethernet transmission port PT**3** of the powered device **230** and the maximum allowable power value providable to the powered device **230**.
[0051] In Step S**312**, the powered device **230** measures the input voltage value and the input current value received by the powered device **230**. In Step S**313**, the powered device **230** calculates a power loss between the powered device **220** and the powered device **230**, and ends the operating method S**300**.
[0052] In an embodiment, the first packet and the second packet are multicast packets or broadcast packets. The power sourcing equipment (for example, the power sourcing equipment **210** or the power sourcing equipment **310**) and the powered device having PSE function (for example, the powered device **220**, the powered device **320**, the powered device **330**, or the powered device **340**) periodically send the multicast packet or the broadcast packet to the next-level powered device, such as Steps S**302**, S**303**, and S**304** and S**308**, S**309**, and S**311** of the operating method. The next-level powered device may re-calculate the allowable power value according to the content of the received multicast packet or broadcast packet to limit its power loading. The multicast packet or the broadcast packet includes the output voltage value of the Ethernet transmission port of the power

sourcing equipment or the powered device coupled to the next-level powered device and the maximum allowable power value allowed to be used by the next-level powered device.
[0053] In summary, the powered device can accurately calculate the actually allowable power value of the powered device and the power loss of the Power over Ethernet system. Therefore, the Power over Ethernet system and the operating method can obtain the accurate power consumption. In addition, the Power over Ethernet system may determine or design the allowable cable length between the power sourcing equipment and the powered devices and the number of cascaded powered devices based on the power loss.
[0054] Although the disclosure has been disclosed in the above embodiments, the embodiments are not intended to limit the disclosure. A person having ordinary skill in the art may make some changes and modifications without departing from the spirit and scope of the disclosure. Therefore, the protection scope of the disclosure shall be defined by the appended claims.

Claims

1. A powered device for Power over Ethernet, comprising: a first Ethernet transmission port, coupled to a power sourcing equipment and configured to receive a first power and a first packet from the power sourcing equipment, wherein the first packet comprises a first output voltage value and a first maximum allowable power value; a second Ethernet transmission port, coupled to a next-level powered device and configured to provide a second power to the next-level powered device; a power meter, configured to measure a first input voltage value and a first input current value of the powered device; and a controller, configured to send a second packet to the next-level powered device via the second Ethernet transmission port, wherein the second packet comprises a second output voltage value and a second maximum allowable power value.
2. The powered device according to claim 1, wherein the controller is further configured to subtract the first input voltage value from the first output voltage value to obtain a voltage difference value, and multiply the voltage difference value by the first input current value to obtain a power loss.
3. The powered device according to claim 1, wherein: the controller is further configured to calculate the second maximum allowable power value providable to the next-level powered device and obtain the second output voltage value; and when the second maximum allowable power value is higher than or equal to a first threshold and the second output voltage value is higher than or equal to a second threshold, the controller sends the second packet to the next-level powered device.
4. The powered device according to claim 3, wherein when the second maximum allowable power value is lower than the first threshold and/or the second output voltage value is lower than the second threshold, the controller stops sending the second packet.
5. A Power over Ethernet system, comprising: a power sourcing equipment, comprising: a first Ethernet transmission port; and a first controller, coupled to the first Ethernet transmission port and configured to provide a power and send a first packet via the first Ethernet transmission port, wherein the first packet comprises an output voltage value and a maximum allowable power value; and a powered device, comprising: a second Ethernet transmission port, coupled to the first Ethernet transmission port and configured to receive the power and the first packet; a power meter, configured to measure an input voltage value and an input current value of the powered device; and a second controller, coupled to the second Ethernet transmission port and the power meter, and configured to obtain an allowable power value of the powered device according to the output voltage value, the input voltage value, and the maximum allowable power value.
6. The Power over Ethernet system according to claim 5, wherein the second controller is further configured to subtract the input voltage value from the output voltage value to obtain a voltage difference value, and multiply the voltage difference value by the input current value to obtain a power loss.

7. The power over Ethernet system according to claim 6, wherein: the second controller is further configured to subtract the power loss from the maximum allowable power value to obtain the allowable power value of the powered device.
8. The power over Ethernet system according to claim 6, wherein: the first controller is further configured to calculate a maximum allowable power value providable to the powered device and obtain the output voltage value at the first Ethernet transmission port, and when the maximum allowable power value is higher than or equal to a first threshold and the output voltage value is higher than or equal to a second threshold, the first controller sends the first packet to the powered device.
9. The Power over Ethernet system according to claim 8, wherein when the maximum allowable power value is lower than the first threshold and/or the output voltage value is lower than the second threshold, the first controller stops sending the first packet.
10. An operating method for a Power over Ethernet system, wherein the Power over Ethernet system comprises a power sourcing equipment and a powered device, the operating method comprising: sending, by the power sourcing equipment, a first power and a first packet to the powered device, wherein the first packet comprises a first output voltage value and a first maximum allowable power value; measuring, by the powered device, an input voltage value and an input current value of the powered device; and obtaining, by the powered device, an allowable power value of the powered device according to the first output voltage value, the input voltage value, and the maximum allowable power value.
11. The operating method according to claim 10, further comprising: subtracting, by the powered device, the input voltage value from the first output voltage value to obtain a voltage difference value, and multiplying, by the powered device, the voltage difference value by the input current value to obtain a power loss.
12. The operating method according to claim 10, wherein sending the first packet by the power sourcing equipment comprises: calculating, by the power sourcing equipment, the first maximum allowable power value providable to the powered device and obtaining the first output voltage value; sending, by the power sourcing equipment, the first packet to the powered device when the first maximum allowable power value is higher than or equal to a first threshold and the first output voltage value is higher than or equal to a second threshold.
13. The operating method according to claim 12, further comprising: stop sending, by the power sourcing equipment, the first packet when the first maximum allowable power value is lower than the first threshold and/or the first output voltage value is lower than the second threshold.
14. The operating method according to claim 10, wherein the first packet is a multicast packet or a broadcast packet.
15. The operating method according to claim 10, wherein the Power over Ethernet system further comprises a next-level powered device, the operating method further comprising: sending, by the powered device, a second power to the next-level powered device; and sending, by the powered device, a second packet to the next-level powered device, wherein the second packet comprises a second output voltage value and a second maximum allowable power value.
16. The operating method according to claim 15, wherein sending the second packet by the powered device comprises: calculating, by the powered device, the second maximum allowable power value providable to the next-level powered device and obtaining the second output voltage value; sending, by the powered device, the second packet to the next-level powered device when the second maximum allowable power value is higher than or equal to a third threshold and the second output voltage value is higher than or equal to a fourth threshold.
17. The operating method according to claim 16, further comprising: stop sending, by the powered device, the second packet when the second maximum allowable power value is lower than the third threshold and/or the second output voltage value is lower than the fourth threshold.

18. The operating method according to claim 15, wherein the second packet is a multicast packet or a broadcast packet.