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Cable module

Abstract

Disclosed is a cable module comprising a cable and a notch filter including a metal foil and a plurality of capacitors, wherein the metal foil is wrapped around the cable, wherein the metal foil includes a first through section and a second through section respectively arranged on opposite sides of the cable For an antenna to be placed in the through sections to capture frequency signals of the core wire by connecting to the detection device, and then the frequency signals can be collected and transmitted to the detection device for comparison and analysis, allowing for the detection of defective product. Thus, the said design eliminates the need for cumbersome disassembly of the notch filter product before detection thereof, thereby streamlining the detection process and making cable testing more efficient and precise.

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Background/Summary

CROSS-REFERENCE TO RELATED APPLICATIONS

(1) This application claims priority to Chinese Invention Application No. 202210473599.5, filed on Apr. 29, 2022. The disclosure of the application is incorporated herein for all purposes by reference in its entirety.

TECHNICAL FIELD

(2) The present disclosure relates to a cable module, in particular to a cable module comprising a notch filter.

BACKGROUND ART

(3) The Chinese patent application No. 201510443621.1 discloses that the medical cable used in nuclear magnetic resonance equipment includes a notch filter (also known as a band stop filter) with an adjustable capacitance. The reason for providing an adjustable capacitance is that the notch filter may have capacitance value deviations during manufacturing, caused by variations in the length of the metal foil, process deficiencies; or variations due to prolonged usage, thereby resulting in differences in the frequencies that the filter can effectively filter.

(4) To determine whether there are such differences in the notch filter, it is necessary to perform detection tests on the cables. The common detection method in the prior art is to connect both ends of the cable to a network analyzer for detection. However, this detection method imposes strict requirements on the types of connections and the connection strength between the product and the

detection equipment. As a result, the detection process can be quite intricate and time-consuming, leading to high detection costs.

TECHNICAL SOLUTION

(5) To overcome the limitations of current technology, the present disclosure provides a cable module, which comprises not only a notch filter on the exterior of the cable, but the metal foil, surrounding the outermost of the notch filter, having two through sections, each of the through sections penetrates to the insulating layers of the cable. By placing the transmitting antennas and receiving antennas in the two through sections, it is possible to detect the frequency signals of the core wire and the signal can be transmitted to the testing equipment for signal comparison and determination of differences. This design enables the detection process to be done wirelessly, avoiding the cumbersome disassembly and reassembly process of the notch filter before testing. The design of the notch filter may simplify the testing steps and makes the testing of cable with notch filter more efficient and accurate.

Description

DESCRIPTION OF DRAWINGS

(1) The present disclosure will be further illustrated below in conjunction with the accompanying drawings and embodiments.

(2) FIG. **1** is a schematic diagram of assembly of a cable module of the present disclosure;

(3) FIG. **2** is a schematic cross-sectional view of a cable module without an insulating envelope structure of the present disclosure;

(4) FIG. **3** is a schematic cross-sectional view of a cable module with an insulating envelope structure of the present disclosure.

LIST OF REFERENCE SIGNS

(5) **1** cable; **10** conductor; **11** insulation layer; **11**A recessed space; **2** notch filter; **22** metal foil; **22**A first through section; **22**B second through section; **23** capacitor; **231** fixed-value capacitor; **232** variable-value capacitor; **232**A adjustment interface; **24** circuit board; **241** front circuit board; **242** rear circuit board; **3** detection element group; **31** transmitting antenna; **32** receiving antenna; **4** electrically insulated cover.

Mode for Invention

(6) The following embodiments, along with the accompanying drawings, provide a clear and comprehensive explanation of the concept, specific structure, and technical effect of the present disclosure, thus facilitating a full understanding of the purpose, features, and effects of the present disclosure. It should be appreciated that the embodiments described herein are only a part of the possible embodiments of the present disclosure, rather than the entirety of them. Other embodiments of the present disclosure that can be obtained by those skilled in the art, without any additional creative efforts based on the embodiments described herein, are also within the scope of protection of the present disclosure. Additionally, all the coupling/connection relationships referred to herein do not necessarily pertain to the direct connection of components, but rather to the possibility of creating a more optimal connection structure by adding or removing connecting accessories based on specific implementation scenarios. The various technical features disclosed herein can be combined with each other as long as they do not conflict with or contradict each other.

(7) FIGS. **1** and **2** show a cable module of an embodiment comprising a cable **1** and a notch filter **2** arranged outside of the cable **1**.

(8) The design of the cable **1** is generally identical to the medical cables used in Nuclear Magnetic Resonance (NMR) equipment, which includes at least a conductor **10** and an insulation layer **11** wrapped around the conductor **10**. In an embodiment, the conductor **10** is a solid metal copper wire

or a core wire formed by twisting multiple thin copper wires. The insulation layer **11** is wrapped around the conductor **10**, which may be various common insulating materials such as ABS. When "Unit A" is wrapped around "Unit B", it means that "Unit A" surrounds and covers "Unit B", regardless of whether there are any other substances between "Unit A" and "Unit B". Therefore, "Unit A" and "Unit B" are not necessarily in direct contact. The notch filter **2** mainly includes elements such as a metal foil **22**, a plurality of capacitors **23**, a front circuit board **241**, and a rear circuit board **242**.

(9) The metal foil **22** is made of conductive metal, such as copper. The metal foil **22** includes a first through section **22**A and a second through section **22**B. In an embodiment, the first through section **22**A and the second through section **22**B are represented as through holes penetrating the inner and outer sides of the metal foil **22**. Alternatively, if needed, the first through section **22**A and the second through section **22**B can be both end portions of a common elongated groove penetrating through the metal foil **22**.

(10) The plurality of capacitors **23** may either be fixed-value capacitors **231** or variable-value capacitors **232**. In an embodiment, each notch filter **2** comprises four capacitors **23** arranged at equal intervals, and the conductor **10** is located at the center of the circles defined by the four capacitors **23**, among which three are fixed-value capacitors **231** and one is a variable-value capacitor **232**.

(11) The variable-value capacitor **232** has an adjustment interface **232**A, located at, for example, the top side of the variable-value capacitor **232**. The adjustment interface **232**A can be either a groove type or a knob type interface. The groove type interface allows a screwdriver to be inserted and rotated for capacitance value adjustment, while the knob type allows users to grip and rotate it directly without any tools. In addition, the variable-value capacitor **232** is not necessary, and the capacitor **23** can be all fixed-value capacitor **231** when needed.

(12) After assembly, the insulation layer **11** of the cable **1** and the metal foil **22** are wrapped outside of the insulation layer **11** to form a cylindrical structure, thus the metal foil **22** surrounds and covers at least a portion of cable therein. Meanwhile, two circuit boards **24** are fixed at the both ends of the cylindrical structure. The circuit boards **24** can be called the front circuit board **241** and the rear circuit board **242** based on their respective positions. The front circuit board **241** and the rear circuit board **242** can be electrically connected to the conductor **10** respectively.

(13) The front circuit board **241** has two opposite working surfaces with circuit and contact pads, one working surface is on the top and the other is on the bottom surface thereof.

(14) In an embodiment, the fixed-value capacitor **231** and the variable-value capacitor **232** are respectively fixed on two different working surfaces of the circuit board **24**, and the plurality of capacitors **23** are electrically insulated from the circuit board **24**. Alternatively, the fixed-value capacitor **231** and the variable-value capacitor **232** can also be placed on the same working surface formed thereon when needed. In addition, one end of the insulation layer **11** corresponding to the front circuit board **241** has a recessed space **11**A for the variable-value capacitor **232** fixed onto the circuit board **24** to be disposed therein. The metal foil **22** is electrically connected to the conductor **10** in the cable **1** via the capacitors **23**.

(15) In this way, the capacitance value provided by the metal foil **22** between the metal foil **22** and the cable **1** can be adjusted, such that the frequency of cable **1** can be adjusted conveniently by the adjustment of the variable-value capacitor **232** when the cable **1** produces loss, thereby enhancing the convenience of frequency adjustment for cable **1**.

(16) In summary, the frequency offset of the notch filter **2** can be adjusted by the design of metal foil **22** and capacitors **23** which located at the periphery of the cable **1**, which also eliminates the need to trim the metal foil **22** when the cable **1** experiences frequency offset due to various reasons, thereby improving the product yield. More specifically, the metal foil **22** and the capacitor **23** are electrically connected either by wires welded on their surfaces or by direct contact, and the plurality of capacitors **23** and the conductor **10** are, for example, directly electrically connected by

solder.
(17) In addition, in the final product, the first through section **22**A and the second through section **22**B on the metal foil **22** are respectively arranged on opposite sides of the cable **1**. The insulation layer **11** is exposed through the first through section **22**A and the second through section **22**B, that is, the insulation layer **11** is not covered by the first through section **22**A and the second through section **22**B. In other word, the insulation layer **11** of the cable **1** blocks the bottoms of the first through section **22**A and the second through section **22**B, or say, insulation layer **11** closes off or covers up the bottom of the first through section **22**A and the second through section **22**B. The first through section **22**A and the second through section **22**B are located on opposite sides of the cable **1**. And the space, along the shortest direct path, between the first through section **22**A and the second through section **22**B has no metal foil **22** be placed therein. In this way, the first through section **22**A and the second through section **22**B allow detection element set **3** to be embedded therein respectively for detection.
(18) The detection element set **3** may include at least a transmitting antenna **31** and a receiving antenna **32** facing each other. The transmitting antenna **31** and the receiving antenna **32** create a pathway for signal transmission and reception, therefore, by connecting the antennas to a detection device, any capacitance offset caused by stripping of metal foil **22** can be detected, and the capacitance value thereof can be adjusted accordingly by variable-value capacitor **232** or replace with another fixed value capacitor of corresponding capacitance value.
(19) The transmitting antenna **31** and receiving antenna **32** can form an induction loop with cable **1** located therebetween. When the transmitting antenna **31** and the receiving antenna **32** are connected to an external detection device, it is possible to directly detect whether the frequency of the cable **1** is decreased by comparing the received and transmitted signals, and then adjust it through a variable-value capacitor. Compared to using the network analyzer directly connected to the cable **1**, this detection process saves a significant number of operational steps, simplifies the testing method, and saves both manpower and resources. Moreover, the transmitting antenna **31** and receiving antenna **32** may be a capacitor plate respectively.
(20) It should be noted that, except for the cable **1**, no metal material should be disposed within the space between the first through section **22**A and the second through section **22**B to prevent error of the detection result of the magnetic induction.
(21) Moreover, the transmitting antenna **31** and the receiving antenna **32** may optionally be pre-embedded in the first through section **22**A and the second through section **22**B, respectively, and be a part of the notch filter **2**. By using a pair of detection probes connected to a conductive pad of the transmitting antenna **31** and the receiving antenna **32**, a circuit can be formed.
(22) Alternatively, the transmitting antenna **31** and the receiving antenna **32** can be pre-connected with the detection device are placed in the first through section **22**A and the second through section **22**B only if testing is needed, and then removed after the detection is completed.
(23) Referring to FIG. **3**, the exterior of the cable and the metal foil **22** further includes an electrically insulated cover **4**. A side opening **41** can be selectively provided on the electrically insulated cover **4** corresponding to the variable-value capacitor **232**, which allows the adjustment interface **232**A of the variable-value capacitor **232** to be exposed from the side opening **41** of the electrically insulated cover **4**, thereby enabling the user to adjust the adjustment interface **232**A. Alternatively, the electrically insulated cover **4** may not include the side opening **41** so as to cover the entire notch filter **2** and a part of the cable **1**. In addition, an opening may also be selectively provided on the electrically insulated cover **4** corresponding to the first through section **22**A and the second through section **22**B, for the antenna or probe to pass through. In this way, the capacitance value can be adjusted without dismantling the electrically insulated cover **4**, which makes the operation more convenient. The electrically insulated cover can be an assembled hollow plastic shell formed of multiple parts. Alternatively, the electrically insulated cover may also be a heat-shrinkable sleeve or similar materials with protection functions.

(24) The foregoing description has provided specific details regarding preferred embodiments of the present disclosure. However, it should be appreciated that the present disclosure is not limited to the embodiments disclosed herein, those skilled in the art may make various equivalent modifications or variants without departing from the essence of the present disclosure, and such modifications or variants are also encompassed within the scope of the claims of the present disclosure.

Claims

1. A cable module, comprising: a cable including a conductor and an insulation layer wrapped around the conductor; and a notch filter including a metal foil and a plurality of capacitors, wherein the metal foil surrounds at least a part of the cable, the metal foil and the conductor are electrically connected via the plurality of capacitors, the metal foil includes a first through section and a second through section respectively located on opposite sides of the cable, and the first through section and the second through section respectively penetrates the metal foil.
2. The cable module according to claim 1, wherein the first through section and the second through section are through holes penetrating the metal foil, and the insulation layer of the cable covers up bottoms of the first through section and the second through section.
3. The cable module according to claim 2, wherein the metal foil are not positioned in a space between the first through section and the second through section.
4. The cable module according to claim 3, wherein the notch filter further comprises a circuit board, wherein the plurality of capacitors includes at least one fixed-value capacitor and at least one variable-value capacitor, the fixed-value capacitor is arranged on a working surface of the circuit board, and the variable-value capacitor is arranged on another working surface, and the plurality of capacitors and the circuit board are electrically insulated from each other.
5. The cable module according to claim 4, wherein the insulation layer has a recessed space for the variable-value capacitor on the circuit board to be disposed therein.
6. The cable module according to claim 5, further comprises an electrically insulated cover, wherein the electrically insulated cover covers a whole of the notch filter and a part of the cable.
7. The cable module according to claim 6, wherein the electrically insulated cover includes a shell, which is an assembled hollow plastic shell.
8. The cable module according to claim 5, further comprises an electrically insulated cover for accommodating the node filter, wherein the variable-value capacitor is provided with an adjustment interface, and the shell includes a side opening, and the adjustment interface is exposed through the shell through section.
9. The cable module according to claim 1, further comprises a transmitting antenna and a receiving antenna, wherein the transmitting antenna is disposed in the first through section, and the receiving antenna is disposed in the second through section.
10. The cable module according to claim 9, wherein the transmitting antenna and the receiving antenna is a capacitor plate respectively and arranged to face each other.