METHOD AND DEVICE FOR DETECTING FAULT OF SIGNAL PROCESSING EQUIPMENT AND OPTICAL INTERFACE BOARD ONLINE

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ABSTRACT

The disclosure relates to a method and device for detecting a fault of signal processing equipment and an optical interface board on line. The signal processing equipment includes n function modules F1, F2, ..., Fn, and n fault detecting points T1, T2, ..., Tn for determining whether there is a fault in said n function modules, wherein n is a natural number. When the detecting result of said detecting point Ti indicates there is a fault in the function module Fi, the corresponding detecting points of other function modules directly associated with the function module Fi are detected continuously, and the reason of the fault is determined according to all the fault function modules. The present disclosure divides the equipment or the board into different modules in accordance with functions, a fault detecting point being set in each module. Therefore, the fault source point of the equipment or the board can be detected and located quickly without artificial participation, and the self-detection can be done automatically when the board is idle to detect problems promptly, so as to improve the testability and the on-site maintainability of products.

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H04J 14/08 (2006.01)  

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Detecting a fault of the function module \( F_i \) at \( T_i \)

- Checking \( T_{i-1} \) corresponding to the function module \( F_{i-1} \)
  - Whether detecting a fault at \( T_{i-1} \)?
    - Yes
      - Checking \( T_{i-2} \) corresponding to the function module \( F_{i-2} \)
        - Whether detecting a fault at \( T_1 \)?
          - Yes: Indicating there is a fault in \( F_1 \)
          - No: Indicating there is a fault in \( F_2 \)
    - No: Indicating there is a fault in \( F_i \)
Fig. 6

Fault detection module 601 → Fault determination module 602

Detection management module 603
METHOD AND DEVICE FOR DETECTING FAULT OF SIGNAL PROCESSING EQUIPMENT AND OPTICAL INTERFACE BOARD ONLINE

BACKGROUND

As a fault of the optical network equipment may be occurred during the operation process, the rapid and effective fault location is very important for the customer and for improving the quality of the equipment. The most conventional fault location method is to inquire the running state of the board and make an alarm. In order to monitor the running state of the board, the support of the network management system is needed; when working abnormally, the board reports the fault to the network management system; then the network management system displays and alarms the maintainer. The relationship between the network management system and the SDH network element is shown by FIG. 1, wherein the SDH network element includes an optical interface board and other boards, and is controlled by a network element control board; the network manager monitors the running state of the SDH network element on a display of a server.

However, the network management system is only responsible for reporting and displaying the alarm of the fault rather than processing and analyzing the fault flexibly. That is to say, the specific fault source cannot be located automatically; the regular fault location steps are to determine gradually by workers and finally determine the fault source point by means of some loopholes. Such artificial location method not only has slow speed, but sometimes is also limited by the network management operating commands. The operable means and methods are limited; in particular, some location methods can only be finished by professionals. Therefore, troubles are made for the in-time fault location. Actually, the diagnosis process of the fault can be completely and automatically finished by the board without the artificial intervention. Here, it is called on-line fault diagnosis system which finishes the gradual fault determination on line through the board software and finally realizes the fault rapid detection and location functions, thereby bringing great convenience for the location of the fault. Besides the fault source point can be detected and located when the fault occurs, another advantage of such system is that the self-detection can be done automatically when the board is idle to detect problems promptly and isolate the fault point, so as to improve the testability and the on-site maintainability of products.

The emphasis of the method and the device for diagnosing the fault of the communication apparatus in relating technologies is to classify the faults, draw an alarm related chart; and finally the artificial operation is needed to analyze and locate the fault based on the contrast of the practical alarm and the alarm related chart.

There is another method for diagnosing a fault of a mobile communication terminal in the relating technologies, the emphasis of which is to record the condition of the occurrence in real time, but finally analyze the fault journal artificially.
detecting the fault detection point T4 of the service processing module F4 firstly; if there is no fault, indicating that the optical interface board has no fault and ending the detection;

if the detection for the fault detection point T4 indicates there is a fault in the service processing module F4, performing the detection on the fault detection point T3 of the multiplexing and de-multiplexing module F3; if there is no fault detected at T3, indicating that the fault is only in the service processing module F4 of the optical interface board; and ending the detection;

if the detection of the fault detection point T3 indicates there is a fault in the multiplexing and de-multiplexing module F3, performing the detection on the fault detection point T2; if there is a fault detected at T2, indicating that there is a fault in the clock module F2 of the optical interface board or there is a fault in the clock module F2, the multiplexing and de-multiplexing module F3 and the service processing module F4 of the optical interface board; and ending the detection;

if the detection of the fault detection point T2 indicates there is no fault in the clock module F2, performing the detection on the fault detection point T1; if there is no fault detected at T1, indicating that there is a fault in the multiplexing and de-multiplexing module F3 of the optical interface board; if there is a fault detected at T1, indicating that the fault of the optical interface board comes from the optical module F1 or an upper stream; and ending the detection; and

if the detection of the fault detection points T2 and T3 indicates there is a fault in the clock module F2 and there is no fault in the multiplexing and de-multiplexing module F3, performing the detection on the fault detection point T1; if there is no fault detected at T1, indicating that there is a fault in the service processing module F4 and the multiplexing and de-multiplexing module F2 of the optical interface board; if there is a fault detected at T1, indicating that the fault of the optical interface board comes from the upper stream; and ending the detection.

The disclosure further discloses a device for on-line detecting a fault of signal processing equipment. The signal processing equipment includes n function modules F1, F2, ..., Fn, and n fault detecting points T1, T2, ..., Tn for determining whether there is a fault in said n function modules, wherein n is a natural number. The device comprises:

a fault detection module configured to acquire a state of the fault detection point in the signal processing equipment;

a fault determination module configured to: determine whether there is a fault in a corresponding function module based on the state of the fault detection point; and a detection management module configured to: control the detection module and the fault determination module; when the fault determination module indicates there is a fault in a function module Fi, control the fault detection module to carry on acquiring a state of a corresponding detection point of other function module directly associated with the function module Fi and send the state to the fault determination module for the determination until all the function modules with fault are detected and the fault reasons are determined.

The detection management module may be further configured to: select a fault detection point Tn in the n fault detection points which has a greatest correlation with the faults of other function modules; control the fault detection module and the fault determination module to firstly detect the fault detection point Tn having greatest correlation with the fault; if the fault determination module determines there is no fault in the corresponding function module Fn, determine that there is no fault in all the function modules of the signal processing equipment; and end the detection.

When the serial numbers of the n function modules are associated with a stream direction of the signal and the signal in a function module Fi flows to the function module Fi, and if the fault determination module determines the state of the fault detection point TI acquired by the fault detection module to indicate there is a fault in the function module Fi, the detection management module is configured to control the fault detection module and the fault determination module to perform the detection on the function module Fi of all the function modules with the fault has been detected.

The device for detecting is a component of the signal processing equipment.

The method for on-line detecting the fault of the signal processing equipment and the optical interface board disclosed by this disclosure is to divide the equipment or the board into different modules in accordance with the function; each module is provided with corresponding fault detection point; the fault source point of the equipment or the board can be detected and located rapidly without artificial participation; and self-detection can be done automatically when the board is idle to detect problems promptly, so as to improve the testability and the on-site maintainability of products. The device for automatically on-line diagnosing a fault disclosed by this disclosure is an independent software detection module which can be integrated with the software module at normal state of the board, and the detection is performed by an operating system and is easy to realize.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a schematic diagram of a relationship between an SDH network element and a network management system;

FIG. 2 shows a schematic diagram of the correlation between function modules and fault detection points of the disclosure;

FIG. 3 shows a flowchart of a method for determining a fault source point by a software detection module;

FIG. 4 shows a schematic diagram of a working principle of an optical interface board in an optical communication system;

FIG. 5 shows a block diagram of function modules and fault detection points of an optical interface board for the alarm correlation analysis; and

FIG. 6 shows a structural diagram of an on-line fault detection device of this disclosure.

DETAILED DESCRIPTION

A further detailed description is made for the disclosure by combining with the following figures and specific implementation ways.

The disclosure includes three parts as follows: analysis and establishment of board alarm correlation, establishment of a fault dictionary, and establishment of a detection software module.

Firstly, analysis and establishment of board alarm correlation includes that: dividing the board at the designing stage into different modules in accordance with functions, wherein each module should have a respective fault detection point. The module division needs to be according to certain basis; that is to say, there is a certain logic relationship between a function module and a fault detection point, between two function modules or between two fault detection points. For example, if the fault detection point TI depends on the function module Fi, there is a fault in the function module Fi when the test result of the fault detection point Ti is abnormal. In
contrast, if the fault detection point Ti passes through the
detection, it proves that the function module Fi is normal, that
is say, the fault detection point Ti is associated with the
function module Fi. Meanwhile, the function module Fi+1 also
depends on the function module Fi, and if the detection
point Ti of the function module Fi is abnormal, it is possible
to detect that the detection point Ti+1 of the function module
Fi+1 is abnormal, which indicates the function module Fi is
associated with the function module Fi+1. Finally, providing
that only one function module has problem at the same
moment, said method can be used for diagnosing the
problems one by one when there are problems in multiple function
modules at the same time.

The division of the module may be on basis of the stream
direction of the signal of the signal processing equipment.
The relationship between the function module and the
detection point is shown in FIG. 2: the function module F1,
the function module F2 and the function module F3 are
connected in sequence; the detection point of the function modu-
le F1 is T1; the detection point of the function module F2
is T2; and the detection point of the function module F3 is T3.

Secondly, establishing the fault dictionary based on the
result of the alarm correlation analysis, wherein a function
module Fi is set as a lengthwise coordinate and a fault detec-
tion point Ti is set as a transverse coordinate so as to form a
two-dimensional matrix. All the rows in each column are
added so that a fault correlation R can be obtained; the
preferential detection point is the one with maximum value of the
fault correlation R; during the establishment of the fault dic-
tionary, in order to bring convenience for the following writ-
ing of a fault detection software, the serial number of the
modules can be adjusted suitably so that the function module
with greatest serial number corresponds to the item with the
maximum value of the fault correlation R; thus, in the process
for determining the preferably detected detection point, the
detection point of the function module with greatest serial
number is the preferential detection point. If there is no fault
at the preferential detection point, there is no fault in the
whole board.

Thirdly, perfecting board software based on the fault dic-
tionary by establishing a software detection module, wherein
different task modules of the board software structure are
called by adopting an operating system, the software detec-
tion module is performed at the idle state of each level of CPU
and is a task module with lowest priority. The working pro-
cess of the software detection module is as follows: when
there is a faulted Ti in the current level Fi, checking the fault
detection point Ti-1 of the former level Fi-1 firstly; if there is
no fault, indicating that the fault is at the current level Fi; if there
is a fault, checking the fault detection point Ti-2 of the Fi-2
level, and so forth, finally finding the source of the fault. The
flowchart of the method for specifically determining the fault
source by the software detection module is shown in FIG. 3.

FIG. 4 is a block diagram of a working principle of a
service stream of an optical interface board in an optical
communication system; the signal entering into the optical
board is firstly subjected from the photovoltaic conversion by
an optical module to get a serial high-speed electric signal; the
serial high-speed electric signal is decomposed into multiple
paths of a low-speed parallel signal by a multiplexing and
de-multiplexing module; then the signal are sent to the service
processing module for the corresponding process and finally
the processed service is sent to other function boards through
a service bus. Similarly, the services from the other function
boards through the service bus and after the detection and
other processes by the service processing module are sent into
the multiplexing and de-multiplexing module in parallel, and
then are input into the optical module after the parallel-series
conversion so as to output the optical signals after the electro-
optical conversion. The clock supply module provides a clock
signal to the multiplexing and de-multiplexing module. The
detection point in the optical interface board shown in FIG. 4
includes input optical signal detection, receiving clock detec-
tion, transmitting clock detection and output optical signal
detection.

The optical interface board shown in FIG. 4 is divided into
four parts in accordance with the functions: an optical module
F1, a clock module F2, a multiplexing and de-multiplexing
module F3, and a service processing module F4; the corre-
spondingly detection points are respectively T1, T2, T3 and
T4; and FIG. 5 shows the block diagram of the function
module and the fault detection point used for the alarm cor-
relation analysis on the optical interface board.

In accordance with the division result of the function modu-
les, if a fault source point of the board is to be detected due
to Loss Of Frame (LOF), for the fault detection point T1 of
the optical module F1, its detection result is that the input optical
power exceeds the threshold (the input optical power is higher
than the maximum threshold); for the fault detection point T2
of the clock module F2, its detection result is PLL (Phase-
Locked Loop) loss of lock; for the fault detection point T3 for
the multiplexing and de-multiplexing module F3, its detection
result is that the receiving clock is unlocked; for the fault
detection point T4 of the service processing module F4, its
detection result is LOF. If a fault source point is to be detected
due to Loss Of Signal (LOS), for the fault detection point T1
of the optical module F1, its detection result is LOS of the
optical module; for the fault detection point T2 of the clock
module F2, its detection result is the loss of the clock for the
phase-locked loop; for the fault detection point T3 of the
multplexing and de-multiplexing module F3, its detection
result is LOS of multiplexer, for the fault detection point T4 of
the service processing module F4, its detection result is LOS of
the service.

The fault dictionary established according to the result of
said correlation analysis is as follows:

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<tr>
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<th>T4</th>
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<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
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<td>F2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>F3</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>F4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
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<td>Fault correlation R</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>4</td>
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The descriptions of 1 and 0 in the table above are as fol-
loows: if there is a fault in F1, it will detect a fault at each
detection point of T1, T3 and T4, their corresponding
coordinate is 1, and there is no fault at T2 and its corresponding
coordinate is 0; if there is a fault in F2, there is no fault at T1,
and there will detect a fault at each detection point of T2, T3
and T4, and thus the coordinate of the F2 corresponding to T1
is 0, and the coordinates of the F2 corresponding to T2, T3 and
T4 are 1; if there is a fault only in F3, there is no fault detected
at T1 and T2, and there will detect a fault only at detection
points T3 and T4; if there is a fault in F4, there is no fault
detected at T1, T2 and T3, and there will detect a fault at T4.

The determination of the preferential detection point is as fol-
loows: adding all rows in each corresponding column of
said table to obtain the fault correlation R; regarding the point
with the maximum R as the preferential detection point; for
example, if the addition result of the first column is 1, the
addition result of the second column is 1, the addition result of
the third column is 3, and the addition result of the fourth column is 4, then the T4 is selected as the preferential detection point (namely the first detection point) according to the strongest correlation with other function modules, that is to say, according to the principle with biggest fault occurrence possibility. The software module writes the software detection module based on the fault dictionary in such way: only detecting T4 by a detection module when the fault detection is started; if there is no fault detected at T4, indicating that there is no fault in the four function modules on the service stream of the whole unit; once there is a fault detected at T4, indicating there is a fault at F4 or there is a fault possibly in F2 and F3 associated with F4; thus, detecting whether there is a fault at T3 firstly; if not, indicating that there is no fault in F2 as F2 provides a clock signal to F3 and F4, and indicating there is a fault only in F4; in contrast, if there is a fault at T3, detecting T as the fault of F2 will be brought to both F3 and F4, if there is a fault detected at T2, indicating there is a fault in F2; if there is no fault at T2, detecting F1; if there is a fault detected at T1, indicating that the fault is possibly from F1 or the upper stream; in contrast, if there is no fault detected at T1, indicating there is a fault in F3.

FIG. 6 is the structural diagram of the on-line fault detection device of the disclosure, the device comprises:

a fault detection module 601 configured to acquire a state of the fault detection point in the signal processing equipment;

a fault determination module 602 configured to determine whether there is a fault in a corresponding function module based on the state of the fault detection point and a detection management module 603 configured to: control the detection module 601 and the fault determination module 602; when the fault determination module 602 indicates there is a fault in a function module Fi, control the fault detection module 601 to carry on acquiring a state of a corresponding detection point of other function module directly associated with the function module Fi and send the state to the fault determination module 602 for the determination until all the function modules with fault are detected and the fault reasons are determined.

The detection management module 603 is further configured to: select a fault detection point Tn in the n fault detection points which has a greatest correlation with the faults of other function modules; control the fault detection module 601 and the fault determination module 602 to firstly detect the fault detection point Tn having greatest correlation with the fault; if the fault determination module 602 determines there is no fault in the corresponding function module Tn, determine that there is no fault in all the function modules of the signal processing equipment; and end the detection.

When the serial numbers of the n function modules are associated with a stream direction of the signal and the signal in a function module Fi flows to the function module Fi and if the fault determination module 602 determines the state of the fault detection point Tn acquired by the fault detection module 601 to indicate there is a fault in the function module Fi, the detection management module 603 is configured to control the fault detection module and the fault determination module to perform the detection on the function module Fi until all the function modules with the fault has been detected.

The device for detecting is a component of the signal processing equipment.

As mentioned above, the method can detect and locate the fault source point rapidly without artificial participation and carry out self-detection automatically when the board is idle to detect faults promptly and isolate the fault point, so as to improve the testability and the on-site maintainability of products.

INDUSTRIAL APPLICABILITY

The method for on-line detecting a fault of the signal processing equipment and the optical interface board disclosed by this disclosure is to divide the equipment or the board into different modules in accordance with the function; each module is provided with corresponding fault detection point; the fault source point of the equipment or the board can be detected and located rapidly without artificial participation; and self-detection can be done automatically when the board is idle to detect problems promptly, so as to improve the testability and the on-site maintainability of products. The device for automatically on-line diagnosing a fault disclosed by this disclosure is an independent software detection module which can be integrated with the software module at normal state of the board, and the detection is performed by an operating system and is easy to realize.

What is claimed is:

1. A method for on-line detecting a fault of an optical interface board by an on-line fault detection device, the optical interface board comprising an optical module F1 and a fault detection point T1 thereof, a clock module F2 and a fault detection point F2 thereof, a multiplexing and de-multiplexing module F3 and a fault detection point T3 thereof, a service processing module F4 and a fault detection point F4 thereof, and the method comprising:

(a) detecting a voltage of an electrical signal at the fault detection point T4 of the service processing module F4 firstly; if there is no fault, indicating that the optical interface board has no fault and ending the detection;

(b) if the detection for the fault detection point T4 indicates the electrical signal is lost, i.e., there is a fault in the service processing module F4, performing the detection on a voltage of a clock signal at the fault detection point T3 of the multiplexing and de-multiplexing module F3; if there is no fault detected at T3, indicating that the fault is only in the service processing module F4 of the optical interface board; ending the detection;

(c) if the detection of the fault detection point T3 indicates the clock signal losses lock, i.e., there is a fault in the multiplexing and de-multiplexing module F3, performing the detection on a voltage of a Phase-Locked Loop (PLL) at the fault detection point T2; if it is detected at T2 that the PLL loses lock, i.e., there is a fault detected at T2, indicating that there is a fault in the clock module F2 of the optical interface board or there is a fault in the clock module F2, the multiplexing and de-multiplexing module F3 and the service processing module F4 of the optical interface board; ending the detection;

(d) if the detection of the fault detection point T2 indicates there is no fault in the clock module F2, performing the detection on an optical power of an optical signal at the fault detection point T1; if there is no fault detected at T1, indicating that there is a fault in the multiplexing and de-multiplexing module F3 of the optical interface board; if it is detected at T1 that the optical power exceeds a maximum threshold, i.e., there is a fault detected at T1, indicating that the fault of the optical interface board comes from the optical module F1 or an upper stream; and ending the detection;

(e) if the detection of the fault detection points T2 and T3 indicates there is a fault in the clock module F2 and there is no fault in the multiplexing and de-multiplexing mod-
ule F3, performing the detection on the fault detection point T1; if there is no fault detected at T1, indicating that there is a fault in the service processing module F4 and the multiplexing and de-multiplexing module F2 of the optical interface board; if there is a fault detected at T1, indicating that the fault of the optical interface board comes from the upper stream; and ending the detection.