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(54) **METHOD AND DEVICE FOR DETECTING FAULT OF SIGNAL PROCESSING EQUIPMENT AND OPTICAL INTERFACE BOARD ONLINE**

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H04B 10/077 (2013.01)
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CPC ***H04J 3/14*** (2013.01); ***H04B 10/0779*** (2013.01); ***H04L 41/0677*** (2013.01); *H04J 2203/006* (2013.01)

(58) **Field of Classification Search**
CPC ... H04B 10/0779; H04L 41/0677; H04J 3/14; H04J 2203/006
USPC 702/58
See application file for complete search history.

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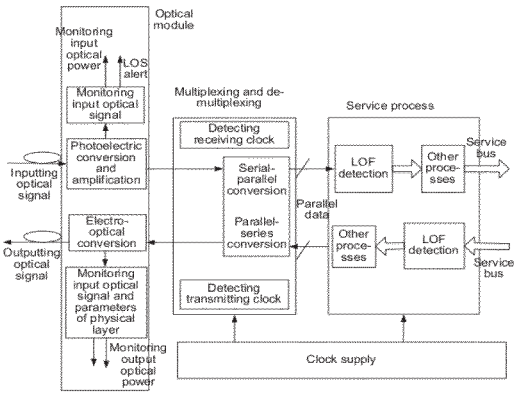
(57) **ABSTRACT**

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 F**1**, F**2**, . . . Fn, and n fault detecting points T**1**, T**2**, . . . 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.

1 Claim, 4 Drawing Sheets



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H04L 12/24 (2006.01)
H04J 14/08 (2006.01)

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Fig. 1

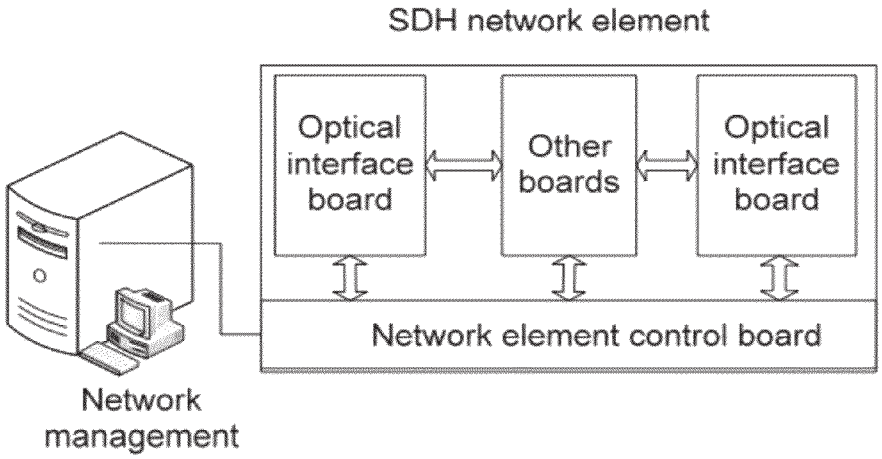

SDH network element
Optical interface board
Other boards
Optical interface board
Network element control board
Network management

Fig. 2

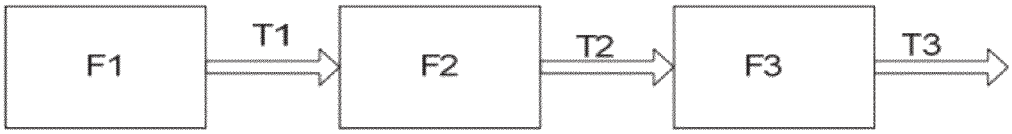

F1
T1
F2
T2
F3
T3

Fig. 3

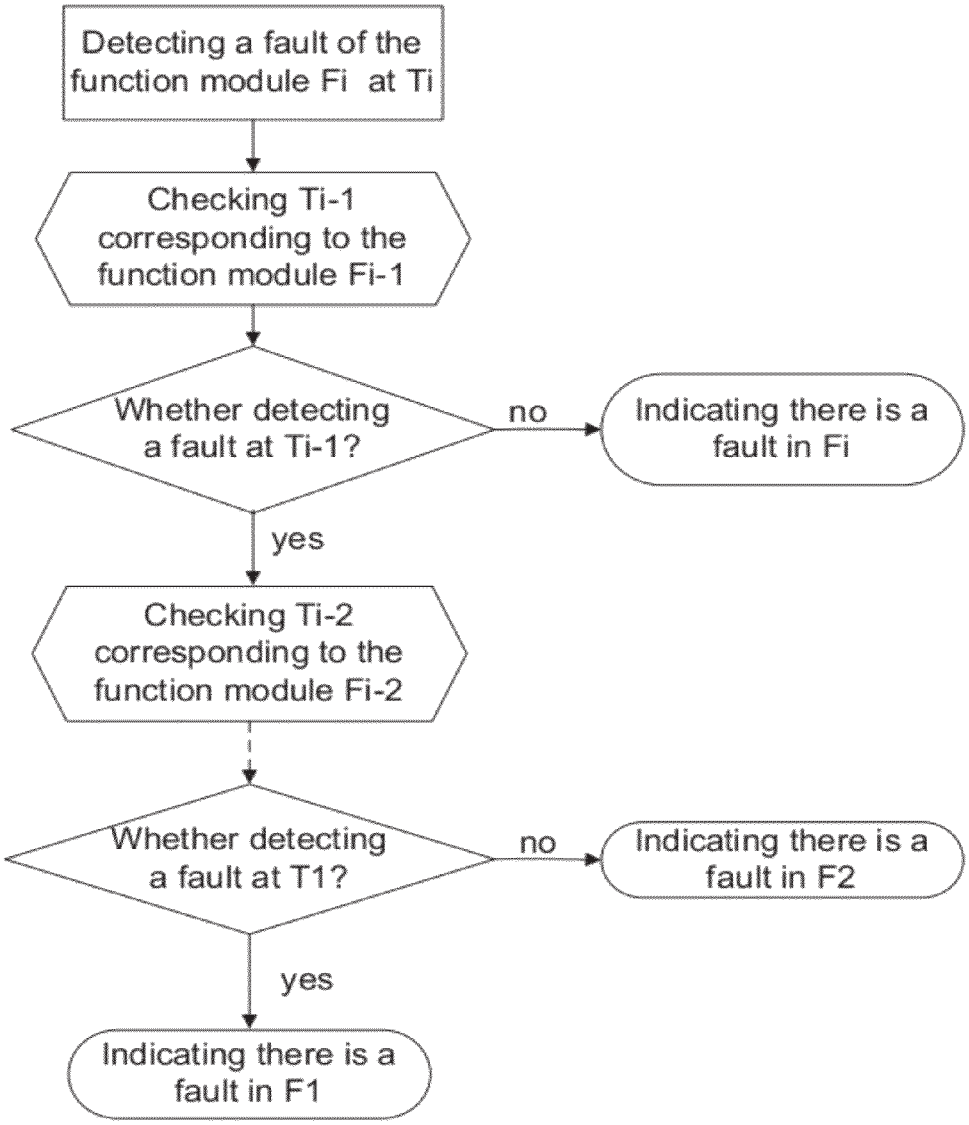

Detecting a fault of the function module Fi at Ti
Checking Ti-1 corresponding to the function module Fi-1
Whether detecting a fault at Ti-1?
no
Indicating there is a fault in Fi
yes
Checking Ti-2 corresponding to the function module Fi-2
Whether detecting a fault at T1?
no
Indicating there is a fault in F2
yes
Indicating there is a fault in F1

Fig. 4

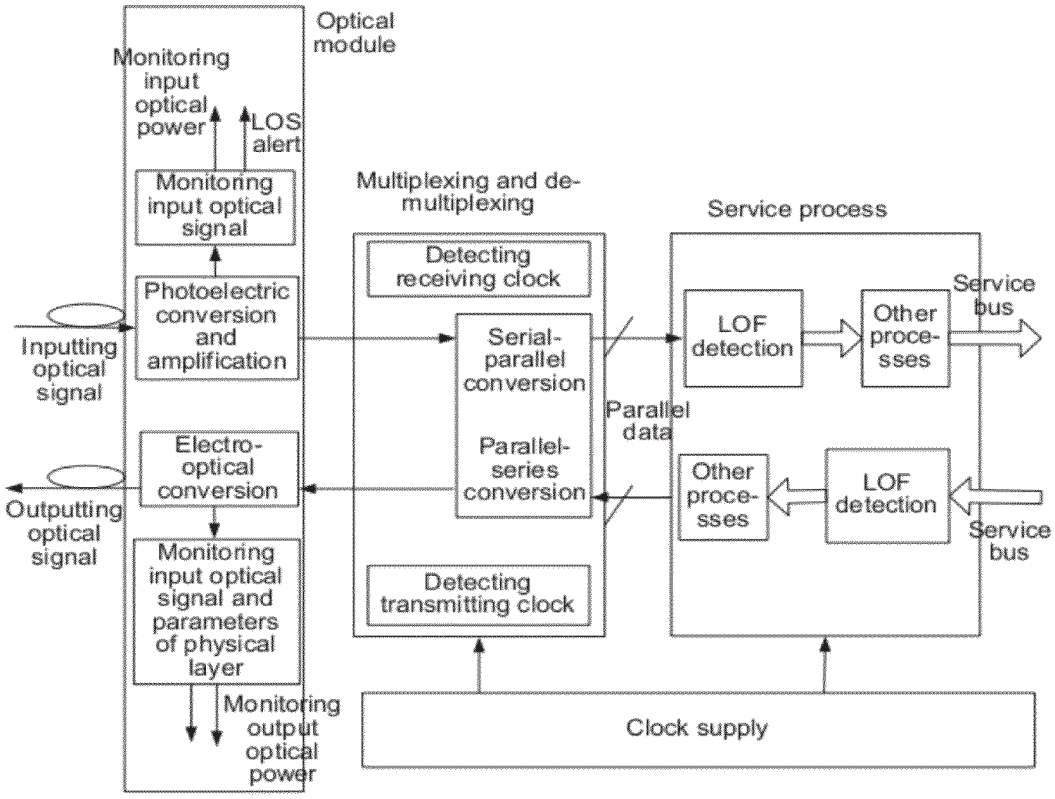

Optical module
Monitoring input optical power
LOS alert
Monitoring input optical signal
Photoelectric conversion and amplification
Inputting optical signal
Electro-optical conversion
Outputting optical signal
Monitoring input optical signal and parameters of physical layer
Monitoring output optical power
Multiplexing and de-multiplexing
Detecting receiving clock
Serial-parallel conversion
Parallel-series conversion
Detecting transmitting clock
Parallel data
Service process
LOF detection
Other proce-sses
Service bus
Other proce-sses
LOF detection
Service bus
Clock supply

Fig. 5

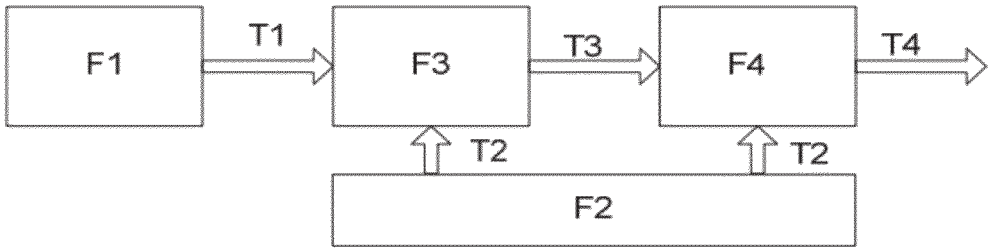
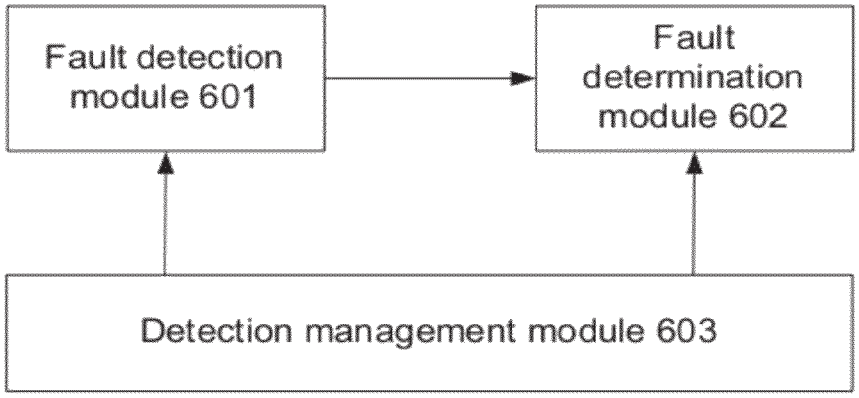

F1
T1
F3
T3
F4
T4
T2
T2
F2

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

TECHNICAL FIELD

The disclosure relates to the field of telecommunications, and in particular to a method and a device for detecting a fault of signal processing equipment and an optical interface board on line, specifically to a Built-In Test (BIT) method of an optical interface board in the equipment with optical Synchronous Digital Hierarchy (SDH).

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 loopbacks. Such artificial location method not only has slow speed, but sometime 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.

There is a further method and device for self-diagnosing a fault in the relating technologies; the diagnosis system thereof needs a great database and a fault correlation analysis module, both of which cannot be integrated with the board software independently. In addition, the implementation is to diagnose the fault of the existing equipment, and such diagnosis has been limited by the alarm output state of the running equipment. If the design of the board has not considered the outputting of enough state information, the use of such method is also limited. Finally, the analysis can be done only when the equipment provide plenty of standard alarm information which has correlation; therefore, the fault location capability is limited.

SUMMARY

The purpose of this disclosure is to provide a method for on-line detecting a fault of signal processing equipment and an optical interface board, which can detect and locate the fault automatically so that the running condition of the board can be mastered in real time.

This disclosure discloses a method for on-line detecting a fault of signal processing equipment. The signal processing equipment includes n function modules F**1**, F**2**, . . . Fn, and n fault detecting points T**1**, T**2**, . . . Tn for determining whether there is a fault in said n function modules, wherein n is a natural number. The method comprises the follows: detecting the fault detection points one by one; when the detection result of a detection point Ti indicates there is a fault in the function module Fi, performing the detection on a corresponding detecting point of other function module directly associated with the function module Fi; finding all the function modules with fault; and ending the detection, wherein i is any natural number from 1 to n.

In the method for detecting, the step of detecting the fault detection points one by one may comprise the follows: detecting the fault detection point Tn firstly, wherein the fault detection point Tn is a detection point of the n fault detection points which has a greatest correlation with the faults of other function modules; if the detection result indicates there is no fault in the function module Fn, indicating that all the function modules of the signal processing equipment have no fault.

When the detection result of the detection point Ti indicates there is a fault in the function module Fi, the step of performing the detection on the corresponding detection points of the other function module directly associated with the function module Fi may comprise the follows: when the serial numbers of n function modules are associated with a stream direction of a signal and the signal in a function module Fi-**1** flows to the function module Fi, performing the detection on a fault detection point Ti-**1** of a function module Fi-**1** if the detection result of the detection point Ti indicates there is a fault in the function module Fi.

The signal processing equipment may be an optical interface board in optical synchronous digital hierarchy equipment.

This disclosure further discloses a method for on-line detecting a fault of an optical interface board. The optical interface board includes an optical module F**1** and a fault detection point T**1** thereof, a clock module F**2** and a fault detection point T**2** thereof, a multiplexing and de-multiplexing module F**3** and a fault detection point T**3** thereof, a service processing module F**4** and a fault detection point T**4** thereof; and the method comprises the follows:

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-1 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-1 until 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 F**1**, the function module F**2** and the function module F**3** are connected in sequence; the detection point of the function module F**1** is T**1**; the detection point of the function module F**2** is T**2**; and the detection point of the function module F**3** is T**3**.

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 detection 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 dictionary, in order to bring convenience for the following writing 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 dictionary by establishing a software detection module, wherein different task modules of the board software structure are called by adopting an operating system, the software detection module is performed at the idle state of each level of CPU and is a task module with lowest priority. The working process 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 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 photoelectric 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 detection, 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 F**1**, a clock module F**2**, a multiplexing and de-multiplexing module F**3**, and a service processing module F**4**; the correspondingly detection points are respectively T**1**, T**2**, T**3** and T**4**; and FIG. **5** shows the block diagram of the function module and the fault detection point used for the alarm correlation analysis on the optical interface board.

In accordance with the division result of the function modules, if a fault source point of the board is to be detected due to Loss Of Frame (LOF), for the fault detection point T**1** of the optical module F**1**, 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 T**2** of the clock module F**2**, its detection result is PLL (Phase-Locked Loop) loss of lock; for the fault detection point T**3** for the multiplexing and de-multiplexing module F**3**, its detection result is that the receiving clock is unlocked; for the fault detection point T**4** of the service processing module F**4**, 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 T**1** of the optical module F**1**, its detection result is LOS of the optical module; for the fault detection point T**2** of the clock module F**2**, its detection result is the loss of the clock for the phase-locked loop; for the fault detection point T**3** of the multiplexing and de-multiplexing module F**3**, its detection result is LOS of multiplexer; for the fault detection point T**4** of the service processing module F**4**, its detection result is LOS of the service.

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

Function modules and detection points	T1	T2	T3	T4
F1	1	0	1	1
F2	0	1	1	1
F3	0	0	1	1
F4	0	0	0	1
Fault correlation R	1	1	3	4

The descriptions of 1 and 0 in the table above are as follows: if there is a fault in F**1**, it will detect a fault at each detection point of T**1**, T**3** and T**4**, their corresponding coordinates are 1, and there is no fault at T**2** and its corresponding coordinate is 0; if there is a fault in F**2**, there is no fault at T**1**, and there will detect a fault at each detection point of T**2**, T**3** and T**4**, and thus the coordinate of the F**2** corresponding to T**1** is 0, and the coordinates of the F**2** corresponding to T**2**, T**3** and T**4** are 1; if there is a fault only in F**3**, there is no fault detected at T**1** and T**2**, and there will detect a fault only at detection points T**3** and T**4**; if there is a fault in F**4**, there is no fault detected at T**1**, T**2** and T**3**, and there will detect a fault at T**4**.

The determination of the preferential detection point is as follows: 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 T**4** 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 T**4** by a detection module when the fault detection is started; if there is no fault detected at T**4**, 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 T**4**, indicating there is a fault at F**4** or there is a fault possibly in F**2** and F**3** associated with F**4**; thus, detecting whether there is a fault at T**3** firstly; if not, indicating that that there is no fault in F**2** as F**2** provides a clock signal to F**3** and F**4**, and indicating there is a fault only in F**4**; in contrast, if there is a fault at T**3**, detecting T as the fault of F**2** will be brought to both F**3** and F**4**, if there is a fault detected at T**2**, indicating there is a fault in F**2**; if there is no fault at T**2**, detecting F**1**; if there is a fault detected at T**1**, indicating that the fault is possibly from F**1** or the upper stream; in contrast, if there is not a fault detected at T**1**, indicating there is a fault in F**3**.

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 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-**1** flows to the function module Fi, and if the fault determination module **602** determines the state of the fault detection point Ti 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-**1** 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 F**1** and a fault detection point T**1** thereof, a clock module F**2** and a fault detection point F**2** thereof, a multiplexing and de-multiplexing module F**3** and a fault detection point T**3** thereof, a service processing module F**4** and a fault detection point F**4** thereof; and the method comprising:

detecting a voltage of an electrical signal at the fault detection point T**4** of the service processing module F**4** 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 T**4** indicates the electrical signal is lost, i.e., there is a fault in the service processing module F**4**, performing the detection on a voltage of a clock signal at the fault detection point T**3** of the multiplexing and de-multiplexing module F**3**; if there is no fault detected at T**3**, indicating that the fault is only in the service processing module F**4** of the optical interface board; and ending the detection;

if the detection of the fault detection point T**3** indicates the clock signal losses lock, i.e., there is a fault in the multiplexing and de-multiplexing module F**3**, performing the detection on a voltage of a Phase-Locked Loop (PLL) at the fault detection point T**2**; if it is detected at T**2** that the PLL loses lock, i.e., there is a fault detected at T**2**, indicating that there is a fault in the clock module F**2** of the optical interface board or there is a fault in the clock module F**2**, the multiplexing and de-multiplexing module F**3** and the service processing module F**4** of the optical interface board; and ending the detection;

if the detection of the fault detection point T**2** indicates there is no fault in the clock module F**2**, performing the detection on an optical power of an optical signal at the fault detection point T**1**; if there is no fault detected at T**1**, indicating that there is a fault in the multiplexing and de-multiplexing module F**3** of the optical interface board; if it is detected at T**1** that the optical power exceeds a maximum threshold, i.e., there is a fault detected at T**1**, indicating that the fault of the optical interface board comes from the optical module F**1** or an upper stream; and ending the detection;

if the detection of the fault detection points T**2** and T**3** indicates there is a fault in the clock module F**2** and there is no fault in the multiplexing and de-multiplexing mod-

ule F**3**, performing the detection on the fault detection point T**1**; if there is no fault detected at T**1**, indicating that there is a fault in the service processing module F**4** and the multiplexing and de-multiplexing module F**2** of the optical interface board; if there is a fault detected at T**1**, indicating that the fault of the optical interface board comes from the upper stream; and ending the detection.

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