METHOD AND APPARATUS FOR SUPERVISING AN AUDIO CIRCUIT WITH CONTINUOUS AUDIO

An apparatus (100) and method for monitoring an audio circuit while the audio circuit is simultaneously generating an audio signal. Specifically, an AC audio signal and DC current source supervision signal are superimposed over a speaker circuit. These signals are superimposed at the junction where a first DC filter and a first AC filter are connected.
METHOD AND APPARATUS FOR SUPERVISING AN AUDIO CIRCUIT WITH CONTINUOUS AUDIO

This application claims the benefit of U.S. Provisional Application No. 60/144,718 filed on July 20, 1999, which is herein incorporated by reference.

The present invention relates to a method and apparatus for monitoring an electrical circuit. More particularly, the invention relates to a method and apparatus for monitoring an audio circuit while the audio circuit is simultaneously generating a continuous audio signal.

BACKGROUND OF THE DISCLOSURE

Commercial facilities, such as manufacturing plants, office buildings and the like, often have comprehensive and sophisticated facility alarm system. Such facility alarm system may include a fire alarm system, a paging system, a security system and the like. Since safety is a paramount goal, stringent requirements or governmental codes must be satisfied in the deployment of such systems.

Specifically, fire alarm system is traditionally deployed separately from that of a voice announcement or paging system. The rationale for such duplicity is the high priority that is placed with the fire alarm system, where its proper operation is paramount. To ensure that the fire alarm system is extremely reliable, regulations often prohibit the sharing of fire alarm system components for other functions, such as paging, thereby requiring duplication and increasing the cost of deployment of such systems.

However, as reliability of fire alarm systems have been demonstrated over the years, regulations have been relaxed and there is a trend where fire alarm system components can be shared with other systems, provided that fire alerting functions are given priority over that of other secondary functions such as paging. The ability to share system components is desirable and will significantly reduce the cost of deploying such systems. For example, the speakers that are deployed for broadcasting fire alarms can now be adapted to provide voice announcement functions.
However, fire alarm system often requires constant supervision of its alert components to ensure that they are in proper operating order. For example, a fire alarm system often polls its alert components and/or wiring in regular time periods, e.g., every 90-200 seconds, to verify that there is no short circuit, open circuit or fault at any of its alert components. This creates an unique problem, if the speakers of the fire alarm system also serve voice announcement functions. Namely, a voice announcement may be interrupted every 90 seconds when the fire alarm system is performing its supervising or monitoring functions. In fact, if the speakers of the fire alarm system are used to provide continuous broadcast, e.g., providing background music in an elevator, then the continuous broadcast will be interrupted every 90 seconds. Such interruptions are simply impractical.

Thus, there is a need for an apparatus and method for monitoring an audio circuit while the audio circuit is simultaneously generating an audio signal.

**SUMMARY OF INVENTION**

In one embodiment of the present invention, an apparatus and method for monitoring an audio circuit while the audio circuit is simultaneously generating an audio signal is disclosed. Specifically, an AC audio signal and DC current source supervision signal are superimposed over a speaker circuit.

In operation, an AC current source (audio signal) is passed through a first DC filter to the field wiring, whereas a DC current source flows through a first AC filter to the field wiring. These signals are superimposed at the junction where the first DC filter and the first AC filter are connected. The field wiring may consist of supervised speakers and an end of line resistor (EOLR). Second DC filter at each speaker blocks DC current flow, when the AC signal is played through the speakers. This unique configuration provides the ability to monitor an audio circuit for fault conditions while the audio circuit is simultaneously generating an audio signal. The detected fault conditions may include open circuit and short circuit.
BRIEF DESCRIPTION OF THE DRAWINGS

The teachings of the present invention can be readily understood by considering the following detailed description in conjunction with the accompanying drawings, in which:

FIG. 1 depicts a block diagram of a monitoring apparatus of the present invention;

FIG. 2 depicts a schematic block diagram of the monitoring apparatus of FIG. 1; and

FIG. 3 depicts an alternate schematic block diagram of the monitoring apparatus of FIG. 1.

DETAILED DESCRIPTION OF THE INVENTION

In a typical audio system, the wiring of the system is supervised for an end of line device in the normal (stand-by) state. However, when the audio signal is played, the supervision function stops. Such interruption in the supervision function may not meet fire alarm system requirements. Conversely, if supervision function is consistently maintained, then the audio signal may have to be interrupted during broadcast, which is undesirable in practice.

FIG. 1 depicts a block diagram of a monitoring apparatus 100 of the present invention. This circuit allows simultaneous supervision of fault conditions, i.e., supervision of the end of line device, and the playing of an audio signal through one or more speakers. The monitoring apparatus 100 comprises a monitoring circuit 110 (e.g., a DC current source and detect circuit), an audio amplifier 120, an AC (alternate current) filter 130, DC (direct current) filters 140 and 150, an end of line device 160 and one or more audible devices 170 (e.g., speakers).

In operation, an audio signal (e.g., an AC signal) and a supervision signal (e.g., a DC current source supervision signal) are superimposed over a speaker circuit. The audio signal is optionally received and amplified by the audio power amplifier 120, which is then passed to the DC filter 140 (first DC filter). The DC current through the audio power amplifier is blocked by the DC filter 140.

Similarly, the supervision signal is generated and monitored by the monitoring circuit 110, which is then passed to the AC filter 130 (first AC filter). The AC current through the monitoring circuit 110 is blocked by
the AC filter 130. Both, the audio signal and the supervision signal are superimposed at junction 145.

DC filters 150_{s.n} (second DC filter) are deployed with corresponding audible devices, i.e., speakers 170_{s.n}, to block DC currents. An end of the line device 160 is deployed to assist in the wire monitoring function.

FIG. 2 depicts a schematic block diagram of the monitoring apparatus 100 of FIG. 1. Audio signal from the power amplifier 120 is an AC current source (audio signal) coupled through the transformer (T1) and through the DC filter 140 (C1) to the field wiring. The power amplifier 120, transformer (T1), and DC filter 140 (C1) are coupled in series. DC current through the amplifier is blocked by C1. It should be noted that the transformer T1 is optional depending on the amplifier design. For example, the output of the amplifier can be capacitively coupled using the same ground reference as that of the circuit, e.g., changing the value of C1.

The monitoring circuit 110 comprises two comparators (U1 and U2) 210 and 212, a resistor (R1) 214 and a capacitor (C2) 216. In operation, DC flows through resistor R1 and inductor L1 to the field wiring. Thus, the supervision signal and the audio signal are superimposed at the junction 145, where inductor L1 and capacitor C1 are connected. The field wiring consists of one or more supervised speakers 170_{s.n} and an end of line resistor (EOLR). The DC filters 150_{s.n} (i.e., bypass capacitors (Cs)) at each speaker block DC current flow as the AC signal is played through the speakers.

In one embodiment, R1 and EOLR are of equal value and form a voltage divider (the resistance if the inductor is small compared to R1). The two comparators form a window of accepted resistance for EOLR. For example, an open circuit in the speaker circuit wiring or missing EOLR will cause V sense to go above 2/3 VDC and cause comparator U1’s output to go low, thereby indicating an open circuit condition. Conversely, a short circuit in the speaker wiring will cause V sense to go below 1/3 VDC and cause comparator U2’s output to go low, thereby indicating a short circuit condition.

Table 1 provides actual values for various components of FIG. 2 in one embodiment. It should be noted that the values of these components can be adapted and modified as required in a particular application.
<table>
<thead>
<tr>
<th>Component</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>470uf</td>
</tr>
<tr>
<td>C2</td>
<td>100uf</td>
</tr>
<tr>
<td>Cs</td>
<td>10uf</td>
</tr>
<tr>
<td>R1</td>
<td>10k</td>
</tr>
<tr>
<td>EOLR</td>
<td>10k</td>
</tr>
<tr>
<td>L1</td>
<td>1 H</td>
</tr>
</tbody>
</table>

Table 1

FIG. 3 depicts an alternate schematic block diagram of the monitoring apparatus 100 of FIG. 1. Specifically, the alternate schematic block diagram of FIG. 3 is identical to that of FIG. 2 with the exception of an additional RC (resistor-capacitor) circuit (second AC filter) serving as an additional AC filter. Resistor (R2) 320 and capacitor (C3) 310 are placed at the input to smooth out any AC transient signal. The additional AC filter may be useful where the size of the inductor L1 is reduced for different application to ensure AC filtering.

Table 2 provides actual values for various components of FIG. 3 in one embodiment. It should be noted that the values of these components can be adapted and modified as required in a particular application.

<table>
<thead>
<tr>
<th>Component</th>
<th>Values</th>
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</thead>
<tbody>
<tr>
<td>C1</td>
<td>220uf</td>
</tr>
<tr>
<td>C2</td>
<td>10uf</td>
</tr>
<tr>
<td>C3</td>
<td>1uf</td>
</tr>
<tr>
<td>Cs</td>
<td>10uf</td>
</tr>
<tr>
<td>R1</td>
<td>10k</td>
</tr>
<tr>
<td>R2</td>
<td>100k</td>
</tr>
<tr>
<td>EOLR</td>
<td>10k</td>
</tr>
<tr>
<td>L1</td>
<td>1.4 MH</td>
</tr>
</tbody>
</table>

Table 2
Although the present invention is illustrated as being deployed in part or in whole within a fire panel, it should be noted that the present invention is not so limited. Namely, the present invention can be implemented as a separate module disposed between the fire panel and the speakers.

It should be noted that although the present invention is described using various resistor, capacitor and inductor combinations to implement various filters, those skilled in the art can implement these filters in view of the present disclosure using other components or combinations to effect similar results. Thus, although various embodiments that incorporate the teachings of the present invention have been shown and described in detail herein, those skilled in the art can readily devise many other varied embodiments that still incorporate these teachings.
What is claimed is:

1. An apparatus (100) for monitoring an audio circuit while the audio circuit is providing an audio output signal, said apparatus comprising:
   a monitoring circuit (110) for detecting a supervision signal for monitoring a fault condition in the audio circuit;
   a first alternating current (AC) filter (130), coupled to said monitoring circuit, for filtering AC; and
   a first direct current (DC) filter (140), coupled to said first AC filter, for filtering DC to an audio signal source.

2. The apparatus (100) of claim 1, wherein said supervision signal and the audio output signal are superimposed.

3. The apparatus (100) of claim 2, wherein said first AC filter (130) is an inductor.

4. The apparatus (100) of claim 2, wherein said first DC filter (140) is a capacitor.

5. The apparatus (100) of claim 2, further comprising:
   an end of line device (160), coupled to said first AC filter.

6. The apparatus (100) of claim 5, wherein said end of line device (160) is a resistor.

7. The apparatus (100) of claim 5, further comprising:
   a second DC filter (150a), coupled to said first AC filter.

8. The apparatus (100) of claim 7, wherein said second DC filter (150a) is a capacitor.

9. The apparatus (100) of claim 7, further comprising:
   an audible device (170a), coupled to said second DC filter.
10. The apparatus (100) of claim 9, wherein said audible device (170a) is a speaker.

11. The apparatus (100) of claim 1, wherein said fault condition is an open circuit.

12. The apparatus (100) of claim 1, wherein said fault condition is a short circuit.

13. The apparatus (100) of claim 3, further comprising:
   a second AC filter (310, 320), coupled to said inductor.

14. The apparatus (100) of claim 13, wherein said second AC filter comprises a resistor and a capacitor.

15. The apparatus (100) of claim 1, wherein said monitoring circuit comprises:
   a first comparator (212);
   a second comparator (210), coupled to said first comparator;
   a resistor (214), coupled to said first comparator; and
   a capacitor (216), coupled to said first comparator.

16. The apparatus (100) of claim 1, further comprising:
   a transformer (T1), coupled to said first DC filter.

17. A method for monitoring an audio circuit while the audio circuit is providing an audio output signal, said method comprising the steps of:
   (a) detecting a supervision signal for monitoring a fault condition in the audio circuit;
   (b) applying a first alternating current (AC) filter, for filtering AC; and
   (c) applying a first direct current (DC) filter, for filtering DC to an audio signal source.

18. The method of claim 17, wherein said supervision signal and the audio output signal are superimposed.
19. The method of claim 18, wherein said fault condition is an open circuit.

20. The method of claim 19, wherein said fault condition is a short circuit.
FIG. 3