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(54) **LIQUID CRYSTAL DISPLAY AND METHOD FOR ADJUSTING TEMPERATURE THEREOF**

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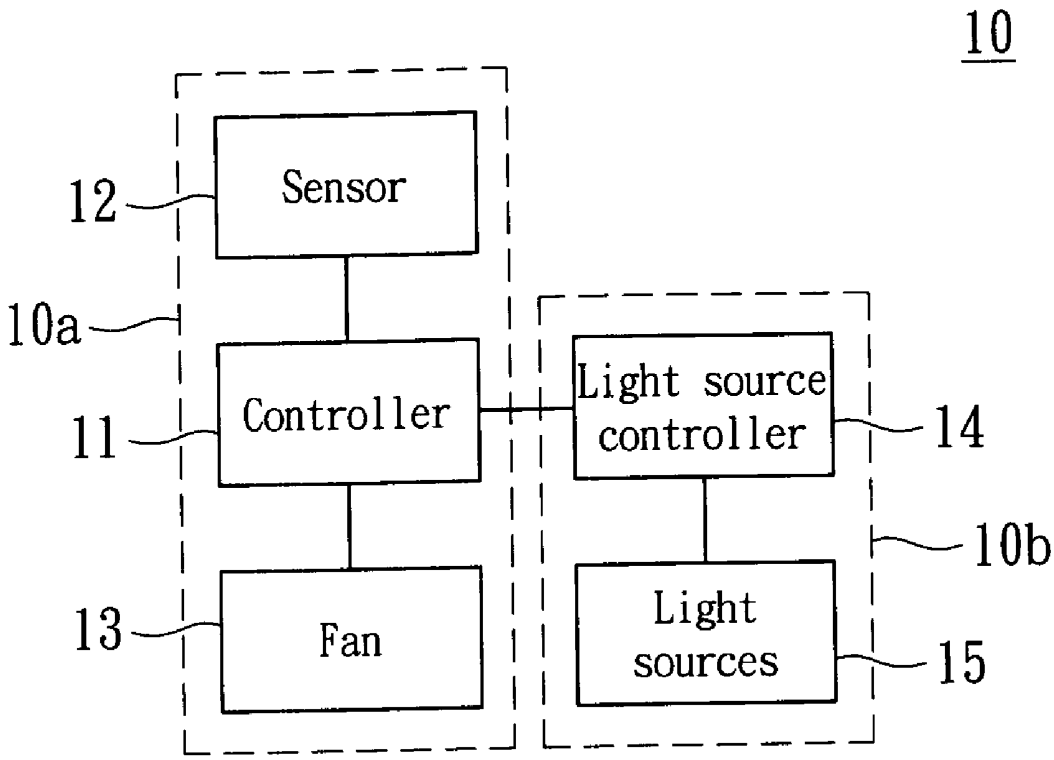
(57) **ABSTRACT**

A liquid crystal display (LCD) includes a backlight module and a heat dissipation device. The backlight module includes a frame, a reflector and several light sources. The reflector is disposed on the frame. The light sources disposed above the reflector. The heat dissipation device includes a fan, a sensor and a controller. The sensor is for sensing internal temperature of the LCD. The controller is connected to the fan and is for controlling the rotating speed of the fan according to the internal temperature of the LCD.



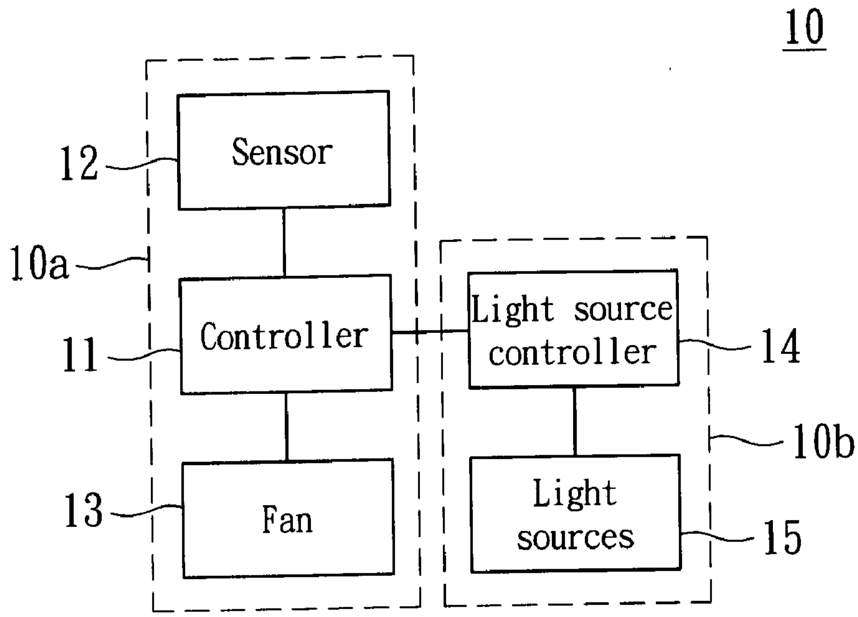

10
Sensor
12
10a
Controller
11
Light source controller
14
10b
Fan
13
Light sources
15

FIG. 1A

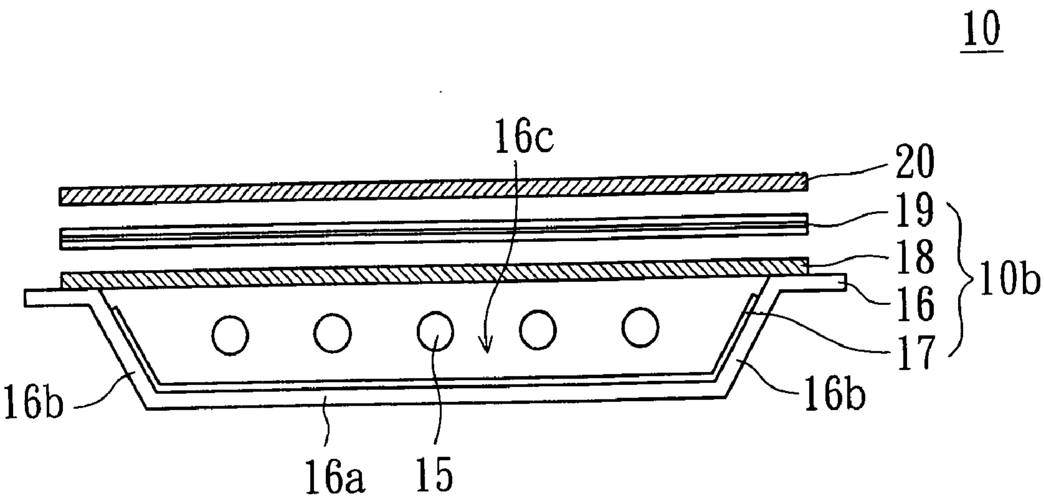

10
16c
20
19
18
16
17
10b
16b
16b
16a
15

FIG. 1B

25

	Temperature zone (°C)	Rotating speed (rpm)	
26a	70~80	2000	27a
26b	80~90	3000	27b
26c	90~	4000	27c

FIG. 2

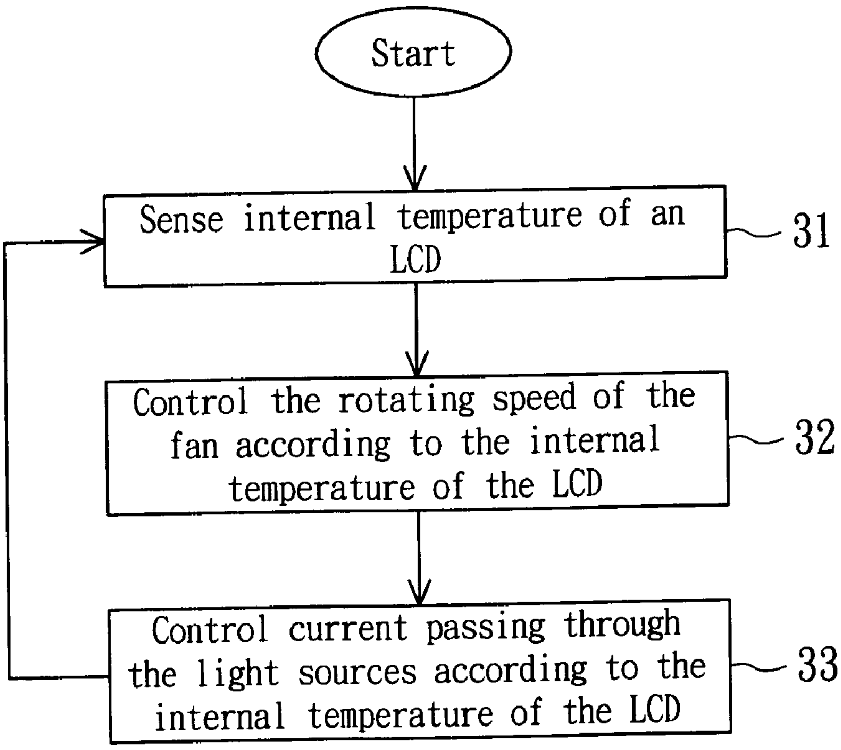


FIG. 3

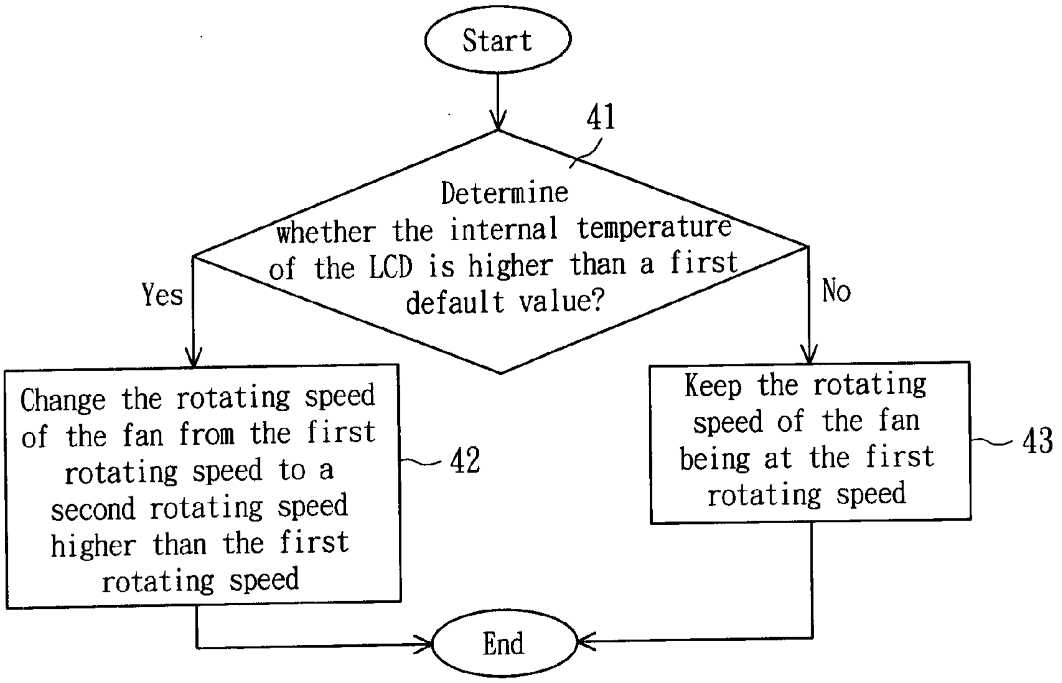

Start
41
Determine whether the internal temperature of the LCD is higher than a first default value?
Yes
No
Change the rotating speed of the fan from the first rotating speed to a second rotating speed higher than the first rotating speed
42
Keep the rotating speed of the fan being at the first rotating speed
43
End

FIG. 4

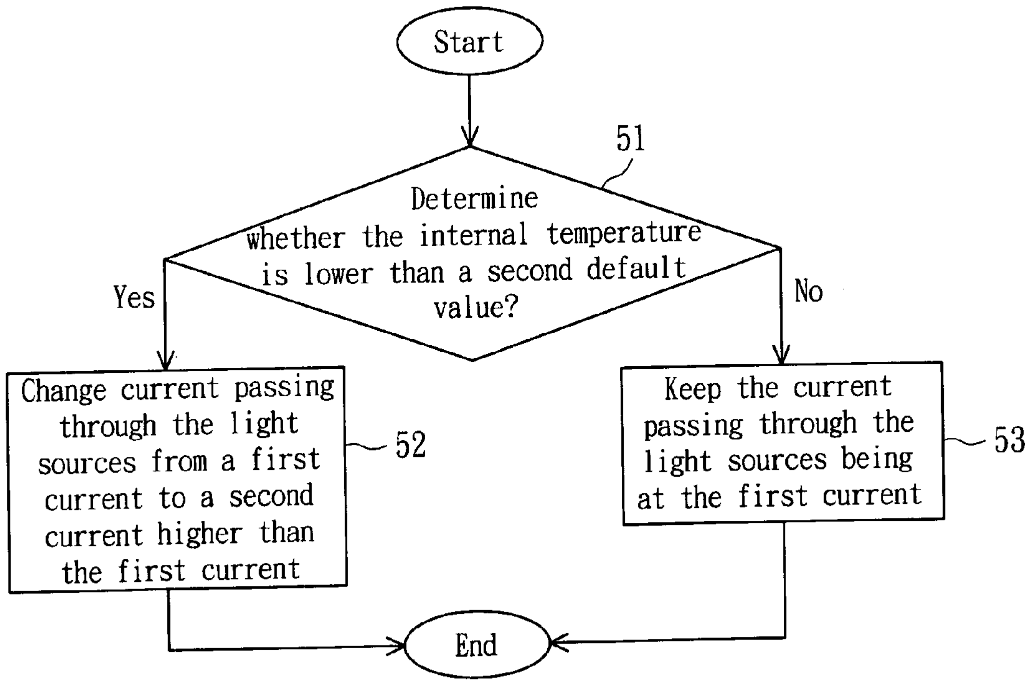

Start
51
Determine whether the internal temperature is lower than a second default value?
Yes
No
Change current passing through the light sources from a first current to a second current higher than the first current
52
Keep the current passing through the light sources being at the first current
53
End

FIG. 5

LIQUID CRYSTAL DISPLAY AND METHOD FOR ADJUSTING TEMPERATURE THEREOF

[0001] This application claims the benefit of Taiwan application Serial No. 94105956, filed Feb. 25, 2005, the subject matter of which is incorporated herein by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates in general to a liquid crystal display (LCD), and more particularly to an LCD with a heat dissipation device and a method for adjusting temperature of the LCD.

[0004] 2. Description of the Related Art

[0005] Because of the rapid advance of the technology of manufacturing the liquid crystal display (LCD) and the LCD has the advantages of light, thin, power-saving and radiationless properties, the LCDs are widely used in various electrical products, such as PDAs (Personal Digital Assistants), notebook computers, digital cameras, digital camcorders, mobile telephones, computer monitors and liquid crystal televisions. However, because the LCD panel in the LCD is a display panel that cannot emit light itself, a backlight module has to provide light so that the display function can be achieved. The conventional backlight module includes a frame, a reflector and several cold cathode fluorescent lamps (CCFLs). The reflector is disposed on the frame, and the CCFLs are disposed above the reflector to provide light.

[0006] Because the CCFL generates heat to cause a high temperature rise while emitting light, the conventional LCD adopts the heat dissipating mechanism of natural convection. However, as the required brightness of the LCD is gradually increasing, the increased brightness of the CCFL inevitably generates more heat, and the internal environmental temperature of the LCD is thus increased. Because the working environmental temperature of the CCFL is increased, the light emitting quality of the CCFL is deteriorated. In addition, if the working environmental temperature of the CCFL is decreased, the light emitting quality of the CCFL is also deteriorated. Similarly, the backlight module using light emitting diodes (LEDs) to provide light also encounters the above-mentioned problems.

SUMMARY OF THE INVENTION

[0007] It is therefore an object of the invention to provide an LCD and a method for adjusting temperature thereof. The method controls the rotating speed of the fan and the current passing through the light sources according to the sensed internal temperature of the LCD so as to help the LCD dissipate heat by increasing the rotating speed of the fan as well as to increase the output heat of the light sources by increasing the values of the currents of the light sources. Thus, the internal environmental temperature of the LCD is adjusted to fall within the best working environmental temperature of the light source such that the light source keeps the good light emitting quality.

[0008] The invention achieves the above-identified object by providing a heat dissipation device for a liquid crystal display (LCD). The heat dissipation device includes a fan, a sensor and a controller. The sensor is for sensing internal temperature of the LCD. The controller is connected to the fan and is for controlling the rotating speed of the fan according to the internal temperature of the LCD.

[0009] The invention achieves the above-identified object by providing a liquid crystal display (LCD) including a backlight module and a heat dissipation device. The backlight module includes a frame, a reflector and several light sources. The reflector is disposed on the frame. The light sources are disposed above the reflector. The heat dissipation device includes a fan, a sensor and a controller. The sensor is for sensing internal temperature of the LCD. The controller is connected to the fan and is for controlling the rotating speed of the fan according to the internal temperature of the LCD.

[0010] The invention achieves the above-identified object by providing a method for adjusting temperature of a liquid crystal display (LCD), which comprises a fan. In the method, firstly, internal temperature of the LCD is sensed. Then, the rotating speed of the fan is controlled according to the internal temperature of the LCD.

[0011] Other objects, features, and advantages of the invention will become apparent from the following detailed description of the preferred but non-limiting embodiments. The following description is made with reference to the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0012] **FIG. 1A** is a block diagram showing a partial circuit of an LCD according to a first embodiment of the invention.

[0013] **FIG. 1B** is a cross-sectional view showing a partial structure of the LCD according to the first embodiment of the present invention.

[0014] **FIG. 2** is a schematic illustration showing a rotating speed look-up table according to the first embodiment of the present invention.

[0015] **FIG. 3** is a flow chart showing a method for adjusting temperature of an LCD according to a second embodiment of the present invention.

[0016] **FIG. 4** is a flow chart showing a fan controlling step of **FIG. 3**.

[0017] **FIG. 5** is a flow chart showing a current controlling step of **FIG. 3**.

DETAILED DESCRIPTION OF THE INVENTION

[0018] **FIG. 1A** is a block diagram showing a partial circuit of an LCD according to a first embodiment of the invention. **FIG. 1B** is a cross-sectional view showing a partial structure of the LCD according to the first embodiment of the invention. Referring to **FIGS. 1A and 1B**, the liquid crystal display (LCD) **10** includes a heat dissipation device **10***a*, a backlight module **10***b* and an LCD panel **20**.

[0019] The backlight module **10***b* includes a frame **16**, a reflector **17**, several light sources **15**, a diffuser **18**, an optical film set **19** and a light source controller **14**. In this embodiment, the frame **16** has a base **16***a* and a sloped side plate **16***b*, both of which define a cavity **16***c* with an upward opening. The reflector **17** is located in the cavity **16***c* and disposed on the base **16***a* and the sloped side plate **16***b*. The light sources **15**, which include several cold cathode fluorescent lamps (CCFLs), several external electrode fluorescent lamps (EEFLs) or several light emitting diodes (LEDs), are located in the cavity **16***c* and disposed above the reflector **17**. In this example, the light sources **15** include several CCFLs.

[0020] The diffuser **18** is disposed on the frame **16** and above the light sources **15** to seal the opening of the cavity **16***c*. The optical film set **19** is disposed above the diffuser **18** and includes diffusing sheets and prism sheets. In addition, the LCD panel **20** is disposed above the optical film set **19**, and the light source controller **14** is electrically connected to the light sources **15**.

[0021] The heat dissipation device **10***a* includes a fan **13**, a sensor **12** and a controller **11**. The sensor **12** is for sensing internal temperature T of the LCD **10**. In this embodiment, the sensor **12** is configured to sense the internal temperature of the frame **16**, the reflector **17**, or the light sources **15**. In addition, the controller **11** is electrically connected to the fan **13** and is for controlling the rotating speed of the fan **13** according to the internal temperature T of the LCD **10**. Moreover, the light source controller **14** is electrically connected to the controller **11** and the light sources **15**. The light source controller **14** is for controlling current passing through the light sources **15** according to the internal temperature T of the LCD **10**.

[0022] When the controller **11** is controlling the rotating speed of the fan **13**, the LCD **10** has a first default value X**1**, and the controller **11** compares the internal temperature T of the LCD **10** with the first default value X**1** to determine whether or not the internal temperature T of the LCD **10** is higher than the first default value X**1**.

[0023] When the controller **11** has determined that the internal temperature T of the LCD **10** is higher than the first default value X**1** and the controller **11** finds that the fan **13** is rotating at a first rotating speed R**1**, it means that the internal environmental temperature of the LCD **10** is too high or exceeds the maximum value of the best working environmental temperature of the light sources **15**, and the light emitting quality of the light sources **15** tends to be deteriorated. In order to keep the good light emitting quality of the light sources **15** continuously, the controller **11** changes the rotating speed of the fan **13** from the first rotating speed R**1** to a second rotating speed R**2**, which is higher than the first rotating speed R**1**. Consequently, increasing the rotating speed of the fan **13** can help the LCD **10** dissipate heat and prevent the internal environmental temperature of the LCD **10** from exceeding the maximum value of the best working environmental temperature of the light sources **15**, such that the light sources **15** can be kept at the good light emitting quality.

[0024] When the controller **11** has determined that the internal temperature T of the LCD **10** is lower than or equal to the first default value X**1** and the controller **11** finds that the fan **13** is rotating at the first rotating speed R**1**, it means that the internal environmental temperature of the LCD **10** falls within the range of the best working environmental temperature of the light sources **15**. At this time, the controller **11** keeps the rotating speed of the fan **13** being at the first rotating speed R**1**.

[0025] When the light source controller **14** is controlling the current passing through the light sources **15**, the LCD **10** has a second default value X**2**, and the light source controller **14** compares the internal temperature T of the LCD **10** with the second default value X**2** to determine whether or not the internal temperature T of the LCD **10** is lower than the second default value X**2**.

[0026] When the light source controller **14** finds that the internal temperature T of the LCD **10** is lower than the second default value X**2** and the current passing through the light sources **15** equals a first current Cl, it means that the internal environmental temperature of the LCD **10** is too low or lower than the minimum value of the best working environmental temperature of the light sources **15**. In this case, the light emitting quality of the light sources **15** is also deteriorated. In order to keep the good light emitting quality of the light sources **15**, the light source controller **14** changes the currents passing through the light sources **15** from the first current C**1** to a second current C**2**, which is higher than the first current C**1**. In this embodiment, the second current C**2** value is substantially twice as much as the first current C**1** value. Because the light sources **15** is a heat source, the output heat of the light sources **15** can be increased by increasing the current passing through the light sources **15**. Hence, the internal environmental temperature of the LCD **10** can be increased to keep the internal environmental temperature of the LCD **10** below the minimum value of the best working environmental temperature of the light sources **15**, such that the good light emitting quality of the light sources **15** is kept.

[0027] When the light source controller **14** has determined that the internal temperature T of the LCD **10** is higher than or equal to the second default value X**2** and the current passing through the light sources **15** equals the first current C**1**, it means that the internal environmental temperature of the LCD **10** falls within the range of the best working environmental temperature of the light sources **15**. At this time, the light source controller **14** only has to keep the current passing through the light sources **15** being at the first current C**1** without changing the current passing through the light sources **15**.

[0028] In addition, the first default value X**1** and the second default value X**2** have to be configured according to the position of the sensor **12** and the to-be-sensed object. When the sensor **12** senses the tube wall temperature of the light sources **15** and the best working environmental temperature of the CCFL light sources **15** ranges from 25° C. to 70° C., it means that the maximum value and the minimum value of the best working environmental temperature of the light sources **15** are 70° C. and 25° C., and the first default value X**1** and the second default value X**2** may be set as 70° C. and 25° C., respectively. The first default value X**1** and the second default value X**2** may be stored in a storage unit, such as a memory, electrically connected to the controller **11** and the light source controller **14** in the LCD **10**.

[0029] In this embodiment, the controller **11** can grade the parameters for controlling the fan according to the extent by which the internal temperature T of the LCD **10** exceeds the first default value X**1**. As the extent by which the internal temperature T of the LCD **10** exceeds the first default value X**1** gets larger, the controller **11** adjusts the rotating speed of the fan to a higher rotating speed. For example, the LCD **10** includes a rotating speed look-up table, which has N temperature zones and N default rotating speeds corresponding to the N temperature zones, wherein N is a positive integer. When the controller **11** finds that the internal temperature T of the LCD **10** falls within the j-th temperature zone, the controller **11** looks up the j-th default rotating speed corresponding to the j-th temperature zone according to the rotating speed look-up table, and changes the rotating speed of the fan **13** from the first rotating speed R1 to the j-th default rotating speed (i.e., the second rotating speed R2), wherein j is an integer ranging from 1 to N. The controller **11** changes the rotating speed of the fan **13** from the first rotating speed to the second rotating speed higher than the first rotating speed according to a rotating speed look-up table when the internal temperature T of the LCD **10** is higher than the first default value.

[0030] **FIG. 2** is a schematic illustration showing a rotating speed look-up table according to the first embodiment of the invention. As shown in **FIG. 2**, the rotating speed look-up table **25** has, for example, three temperature zones and three default rotating speeds corresponding to the zones. When the controller **11** finds that the internal temperature T of the LCD **10** is higher than 70° C. but lower than 80° C. so that the internal temperature T of the LCD **10** falls within the first temperature zone **26***a*, the controller **11** changes the rotating speed of the fan **13** from the first rotating speed R1 to the first rotating speed **27***a* (i.e., 2000 rpm). When the controller **11** finds that the internal temperature T of the LCD **10** is higher than 80° C. but lower than 90° C. so that the internal temperature T of the LCD **10** falls within the second temperature zone **26***b*, the controller **11** changes the rotating speed of the fan **13** from the first rotating speed R1 to the second rotating speed **27***b* (i.e., 3000 rpm). When the controller **11** finds that the internal temperature T of the LCD **10** is higher than 90° C. so that the internal temperature T of the LCD **10** falls within the third temperature zone **26***c*, the controller **11** changes the rotating speed of the fan **13** from the first rotating speed R1 to the third rotating speed **27***c* (i.e., 4000 rpm). The first rotating speed R1 may be 0 rpm, which means that the fan **13** is stationary.

[0031] One of ordinary skill in the art may easily understand that the present embodiment of the invention technology is not limited thereto. For example, the controller **11** and the light source controller **14** may be integrated into a whole. In addition, the light source controller **14** may be electrically connected to the sensor **12** directly without being electrically connected to the controller **11**.

[0032] **FIG. 3** is a flow chart showing a method for adjusting temperature of the LCD according to a second embodiment of the invention. As shown in **FIGS. 3, 1A** and 1B, the method of this embodiment is used in an LCD **10**, which includes a fan **13**. First, as shown in step **31**, sense internal temperature T of the LCD **10**. The LCD **10** further includes a backlight module **10***b*, which includes a frame **16**, a reflector **17** and several light sources **15**. In step **31**, it is also possible to sense the internal temperature T of the frame **16**, the reflector **17**, or the light sources **15**.

[0033] Next, the procedure enters step **32** to control the rotating speed of the fan **13** according to the internal temperature T of the LCD **10**. Then, the procedure enters step **33** to control current passing through the light sources **15** according to the internal temperature T of the LCD **10**. Next, the procedure goes back to step **31** to continue to monitor the temperature of the LCD **10** so as to adjust the temperature of the LCD **10**.

[0034] As shown in **FIG. 4**, the above-mentioned step **32** further includes the following sub-steps. First, in step **41**, compare the internal temperature T of the LCD **10** with a first default value X1 to determining whether or not the internal temperature T of the LCD **10** is higher than the first default value X1. When the internal temperature T of the LCD **10** is higher than the first default value X1 and the fan **13** is rotating at a first rotating speed R1, the procedure enters step **42** to change the rotating speed of the fan **13** from the first rotating speed R1 to a second rotating speed R2 higher than the first rotating speed R1. Then, the procedure enters the step **33** of **FIG. 3**. When the internal temperature T of the LCD **10** is lower than or equal to the first default value X1 and the fan **13** is rotating at the first rotating speed R1, the procedure enters step **43** to keep the rotating speed of the fan **13** being at the original rotating speed (i.e., the first rotating speed R1). Then, the procedure enters the step **33** of **FIG. 3**.

[0035] This embodiment can grade the parameters for controlling the fan **13** according to the extent by which the internal temperature T of the LCD **10** exceeds the first default value X1. As the extent by which the internal temperature T of the LCD **10** exceeds the first default value X1 gets larger, a controller **11** adjusts the rotating speed of the fan to a higher rotating speed. For example, the LCD **10** further includes a rotating speed look-up table, which has N temperature zones and N default rotating speeds corresponding to the N temperature zones, wherein N is a positive integer. In the step of changing the rotating speed of the fan **13** from the first rotating speed R1 to the second rotating speed R2 higher than the first rotating speed R1, when the internal temperature T of the LCD **10** falls within the j-th temperature zone, the j-th default rotating speed corresponding to the j-th temperature zone is looked up according to the rotating speed look-up table, and the rotating speed of the fan **13** is changed from the first rotating speed to the j-th default rotating speed, wherein j is an integer ranging from 1 to N. The above-mentioned first rotating speed may be 0 rpm, which means that the fan **13** is stationary.

[0036] As shown in **FIG. 5**, step **33** further includes the following sub-steps. First, in step **51**, compare the internal temperature T of the LCD **11** with a second default value X2 to determined whether or not the internal temperature T of the LCD **11** is lower than the second default value X2. When the internal temperature T of the LCD **11** is lower than the second default value X2 and the current passing through the light sources **15** equal a first current C1, the procedure enters step **52** to change the current passing through the light sources **15** from the first current C1 to a second current C2 higher than the first current C1. Then, the procedure enters the step **31** of **FIG. 3**. The second current C2 value is substantially twice as much as the first current C1 value. When the internal temperature T of the LCD **11** is higher than or equal to the second default value X2 and the current passing through the light sources **15** equal the first current C1, the procedure enters step **53** to keep the current passing through the light sources **15** being at the original current (i.e., the first current C1). Then, the procedure enters the step **31** of **FIG. 3**.

[0037] One of ordinary skill in the art may easily understand that the present embodiment of the invention technology is not limited thereto. For example, this present embodiment of the invention can firstly perform the step **33** and then the step **32**. In addition, this present embodiment of the invention may also perform the step **32** and the step **33** simultaneously. In addition, the step **33** can be omitted from this embodiment, and only the step **31** and the step **32** are performed. Of course, the step **32** may be omitted from this embodiment, and only the step **31** and the step **33** are performed.

[0038] In the LCD and the method for adjusting temperature thereof according to the embodiments of the invention, the rotating speed of the fan and the current passing through the light sources are controlled according to the sensed internal temperature of the LCD. The present embodiment of the invention can help the LCD to dissipate heat by increasing the rotating speed of the fan so as to decrease the internal environmental temperature of the LCD. In addition, the invention may further increase the output heat of the light sources by increasing the current passing through the light sources so as to increase the internal environmental temperature of the LCD. Consequently, this present embodiment of the invention may adjust the internal environmental temperature of the LCD by controlling the rotating speed of the fan and the current passing through the light sources, such that the internal environmental temperature of the LCD falls within the range of the best working environmental temperature of the light source and the good light emitting qualities of the light sources may be kept.

[0039] While the invention has been described by way of examples and in terms of preferred embodiments, it is to be understood that the invention is not limited thereto. On the contrary, it is intended to cover various modifications and similar arrangements and procedures, and the scope of the appended claims therefore should be accorded the broadest interpretation so as to encompass all such modifications and similar arrangements and procedures.

What is claimed is:

1. A heat dissipation device for a liquid crystal display (LCD), comprising:

a fan;

a sensor for sensing internal temperature of the LCD; and

a controller, connected to the fan, for controlling the rotating speed of the fan according to the internal temperature of the LCD.

2. A liquid crystal display (LCD), comprising:

a backlight module, comprising:

a frame;

a reflector disposed on the frame; and

a plurality of light sources disposed above the reflector; and

a heat dissipation device, disposed adjacent to the backlight module, comprising:

a fan;

a sensor for sensing internal temperature of the LCD; and

a controller, connected to the fan, for controlling the rotating speed of the fan according to the internal temperature of the LCD.

3. The LCD according to claim 2, wherein the backlight module further comprises:

a light source controller, connected to the light sources, for controlling current passing through the light sources according to the internal temperature of the LCD.

4. The LCD according to claim 3, wherein the controller and the light source controller are integrated into a whole.

5. The LCD according to claim 2, wherein the sensor is configured to sense the temperature of the frame, the reflector or the light sources.

6. The LCD according to claim 2, wherein the light sources comprise a plurality of cold cathode fluorescent lamps (CCFLs), a plurality of external electrode fluorescent lamps (EEFLs) or a plurality of light emitting diodes (LEDs).

7. A method for adjusting temperature of a liquid crystal display comprising a fan, comprising:

sensing internal temperature of the LCD; and

controlling the rotating speed of the fan according to the internal temperature of the LCD.

8. The method according to claim 7, wherein controlling the rotating speed of the fan comprises:

comparing the internal temperature of the LCD with a first default value;

changing the rotating speed of the fan from a first rotating speed to a second rotating speed higher than the first rotating speed when the internal temperature of the LCD is higher than the first default value; and

keeping the rotating speed of the fan being at the first rotating speed when the internal temperature of the LCD is lower than or equal to the first default value.

9. The method according to claim 8, wherein changing the rotating speed of the fan from the first rotating speed to the second rotating speed comprises:

changing the rotating speed of the fan from the first rotating speed to the second rotating speed higher than the first rotating speed according to a rotating speed look-up table when the internal temperature of the LCD is higher than the first default value.

10. The method according to claim 9, wherein the first rotating speed is 0 rpm.

11. The method according to claim 8, wherein the first rotating speed is 0 rpm.

12. The method according to claim 8, wherein the LCD further comprises a backlight module having a frame, a reflector disposed on the frame. and a plurality of light sources disposed above the reflector, and wherein sensing the internal temperature of the LCD comprises:

sensing the temperature of the frame, the reflector or the light sources.

13. The method according to claim 12, further comprising:

controlling current passing through the light sources according to the internal temperature of the LCD.

14. The method according to claim 13, wherein controlling the current comprises:

comparing the internal temperature of the LCD with a second default value;

changing the current through the light sources from a first current value to a second current value higher than the first current value when the internal temperature of the LCD is lower than the second default value; and

keeping the current through the light sources being at the first current value when the internal temperature of the LCD is higher than or equal to the second default value.

15. The method according to claim 14, wherein the second current value is substantially twice as much as the first current value.

16. The method according to claim 7, wherein the LCD further comprises a backlight module having a frame, a reflector disposed on the frame and a plurality of light sources disposed above the reflector, and wherein sensing the internal temperature of the LCD comprises:

sensing the temperature of the frame, the reflector or the light sources.

17. The method according to claim 16, further comprising:

controlling current passing through the light sources according to the internal temperature of the LCD.

18. The method according to claim 17, wherein controlling the current comprises:

comparing the internal temperature of the LCD with a first default value;

changing the current through the light sources from a first current value to a second current value higher than the first current value, when the internal temperature of the LCD is lower than the first default value; and

keeping the current through the light sources being at the first current value, when the internal temperature of the LCD is higher than or equal to the first default value.

19. The method according to claim 18, wherein the second current value is substantially twice as much as the first current value.

* * * * *

专利名称(译)	液晶显示器及其温度调节方法

公开(公告)号	[US20060192750A1](US20060192750A1)	公开(公告)日	2006-08-31
申请号	US11/177164	申请日	2005-07-08

[标]申请(专利权)人(译)	友达光电股份有限公司
申请(专利权)人(译)	友达光电.
当前申请(专利权)人(译)	友达光电.
[标]发明人	LAI CHING KUN
发明人	LAI, CHING-KUN
IPC分类号	G09G3/36
CPC分类号	G02F1/133604 G02F2001/133628 G09G3/3406 G09G3/3611 G09G2320/041 G09G2320/0633
优先权	094105956 2005-02-25 TW
外部链接	Espacenet USPTO

摘要(译)

液晶显示器（LCD）包括背光模块和散热装置。背光模块包括框架，反射器和多个光源。反射器设置在框架上。光源设置在反射器上方。散热装置包括风扇，传感器和控制器。传感器用于检测LCD的内部温度。控制器连接到风扇，用于根据LCD的内部温度控制风扇的转速。