

A SYSTEM FOR DRIVING A CAPACITIVE LOAD

FIELD OF THE INVENTION

This invention relates generally to a system for driving a capacitive load, or one or more electrical loads including one or more capacitive components.

BACKGROUND

Alternating current (AC) control is commonly used in the transmission and distribution of power supply. By employing an alternating current, many of the problems associated with electricity generation and transmission are overcome. In existing AC control, mainly inductive and resistive loads can be manipulated by controlling the number of AC cycles or by performing phase control. However, existing AC control systems cannot be used to control capacitive loads.

It is an object of the present invention to overcome, or at least substantially ameliorate, the limitation of existing AC control systems.

An example of overcoming the limitation of the existing AC control systems may be found in an advertisement display. In the field of display, the trend is toward a larger and larger display areas. This requires the use of many large load capacitors and many display panel driving circuits operating at high driving speeds. Therefore, when the capacitive-load driving circuit of the present invention is applied to such a display apparatus, not only can the cost involved in removing heat be reduced significantly, but high-voltage LSI (large scale integration circuits) can be mounted on a very limited space.

The use of the capacitive-load driving circuit of the present invention offers an enormous advantage for an advertisement display in which many capacitive loads (discharge cells, etc.) are driven using high-voltage pulses. However, the invention is not specifically limited to advertising displays, but can be applied extensively to circuits for driving various types and forms of capacitive loads.

SUMMARY OF THE INVENTION

The present invention provides a capacitor-load driving circuit including: a voltage source; a computing or processing means; a capacitor load, a first end of the capacitor load being in communication with the voltage source and the second end of the capacitor load being in communication with the computing or processing means; wherein the voltage source supplies a plurality of different voltage levels to power the capacitor load.

BRIEF DESCRIPTION OF THE FIGURES

Further objects and advantages of this invention, together with additional features contributing thereto and accruing therefrom, will be apparent from the following description of one embodiment of the present invention which is shown in the accompanying drawings with like reference numerals indicating corresponding parts throughout, wherein:

Figure 1 is a schematic layout of the capacitor load in connection with a microcontroller / microprocessor and a battery voltage source;

Figures 2 and 3 illustrate 2 different voltage waveforms experienced by the capacitor load;

Figures 4a to 4d illustrate the voltage waveforms experienced by the capacitor load during different on / off positions of the switch;

Figure 5 is an exploded view of an electroluminescent display;

Figure 6 is a front view of the rear electroluminescent panel and the display panel;

Figures 7a to 7d show the sequence of illumination of the message image on the display panel; and

Figure 8 shows the display of various message images on the electroluminescent display upon detection of passersby by the sensors;

These and additional embodiments of the invention may now be better understood by referring to the following detailed description wherein an illustrated embodiment is described.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Throughout this description, the embodiments and examples shown should be considered as examples of the principles of the invention, rather than limitations on the apparatus and methods of the present invention.

Referring now to Figure 1, a diagram of one illustrative embodiment of a capacitive load circuit and system is shown. Circuit and system 1 include an alternating voltage source 2. The AC voltage source 2 produces an alternating current (AC) voltage that is illustratively in the range of 110 V_{av} to 240 V_{av}, although the alternating voltage source may alternatively be any suitable voltage source producing any desired varying voltage. At any given time, the alternating voltage source 2 is further electrically connected with at least one of capacitor loads 3a, 3b, 3c, 3d. That is, each of the capacitor loads 3a, 3b, 3c, 3d has one terminal electrically connected with the alternating voltage source 2 and an opposite terminal electrically connected through a respective switch 4a, 4b, 4c, 4d. Each of the switches 4a, 4b, 4c, 4d is electrically connected to a computing or processing means in the form of a microcontroller / microprocessor 5. The capacitor load is charged by the alternating voltage source in a manner which will be described more fully hereinafter.

The switching on / off of the switches 4a, 4b, 4c, 4d is controlled by the microcontroller / microprocessor 5 so as to power the capacitor loads 3a, 3b, 3c, 3d in sequence. In one embodiment, triacs are used as a type of switch. An advantage of using triacs is the low cost in providing the connection of power to the capacitor load. In the illustrated embodiment, the AC voltage source 2 provides an alternating voltage to each of the capacitor load(s).

Figure 2 illustrates the voltage waveforms experienced by each of the capacitor loads when the alternating voltage is applied to the capacitor loads. As shown, the luminous output of the capacitor load of the present embodiment can be varied over a number of steps such that with an appropriate modulation, a corresponding fade-in or fade-out effect can be produced.

Figure 3 illustrates a voltage waveform experienced by the capacitor load when the alternating voltage is applied to the capacitor load. As shown, frequency of the fade-in and fade-out effect is decreased. In other words, the duration of the glow-on or glow-off period is extended. The frequency of the alternating voltage source will have a direct effect on the

smoothness of the glow-in-out effect. Studies have shown that a frequency source of about 2kHz produces a smoother effect than a source of 500Hz.

Therefore, by programming the microcontroller / microprocessor such that a fade-in and fade-out effect of the message images on the electroluminescent display results, there is no necessity for any extra components. Thus, this produces a more cost-effective product.

Figures 4a to 4d illustrate the voltage waveforms experienced by the capacitor load during different instances of operating the switches. As shown in figure 4a, there is a gradual drop in the voltage. False turn-on of other capacitor loads is thus prevented in this instance. Figures 4b and 4c show the voltage dropping sharply to zero while figure 4d shows the worst case of dV/dT . As will be apparent to those skilled in the field of electronics, the value of dV/dT should be minimized as dV/dT can create electrical noise that could falsely turn on other neighboring capacitor loads. Therefore, the optimum time to switch on the AC switch is during the moment when the value of the a.c. voltage is matched to that of the capacitive load as illustrated in figure 4b. From figure 4b, it can be seen that the value of dV/dT is at its lowest when the value of voltage is at its highest.

The preferred embodiments of the capacitive-load driving circuit and electroluminescent display device according to the present invention will be described in detail below with reference to the accompanying drawings.

The following description deals primarily with the address driving circuit of the electroluminescent display, but it will be recognized that the capacitive-load driving circuit of the invention can be applied not only just for the purposes of powering the address driving circuit of the electroluminescent display, but also for other circuits for driving capacitive loads in general (e.g. discharge cells), such as the X driving circuit and the Y driving circuit. Furthermore, the circuit technique of the invention can be applied extensively to circuits for driving various capacitive loads other than those in the electroluminescent display. For example, it may be applied to circuits for driving logic gates formed from MOS transistors wherein the gate of each transistor to be driven can be considered as a capacitor with which a capacitor or the like etc, is combined to form a capacitive load.

Referring to Figures 5 and 6, the electroluminescent display 6, in an example embodiment, comprises a rear electroluminescent panel 7, a display panel 8 and a one-way mirror 9

superimposed over each other in such order. In other words, the rear electroluminescent panel 7 is superimposed over the display panel 8, and the display panel 8 is superimposed over the one-way mirror 9.

Message images such as graphics 8a, pictures 8b and text 8c are printed on one side of the display panel 8. The display panel 8 may be made of material such as backlit film. It will be appreciated that there may exist other types of message images other than the ones shown in figures 5 and 6.

Shadow images corresponding to the shape and size of the graphics 8a, pictures 8b and text 8c are mapped onto an electroluminescent material and form electroluminescent backlights 7a, 7b, 7c respectively. The electroluminescent backlights 7a, 7b, 7c are then printed by any industrially-known method onto a rear electroluminescent panel 7; the electroluminescent backlights being capacitive loads.

Each of the electroluminescent backlights 7a, 7b, 7c (corresponding to capacitor loads 3a, 3b, 3c) are connected to a controller 5 as shown in figure 1. An alternating voltage is applied to each of the electroluminescent backlights 7a, 7b, 7c and, the electroluminescent backlights 7a, 7b, 7c are illuminated accordingly. Thus, when the rear electroluminescent panel 7 and the backlit film 8 are engaged with each other, and with the electroluminescent backlights 7a, 7b, 7c superimposed over graphics 8a, pictures 8b and text 8c respectively, the graphics 8a, pictures 8b and text 8c will be illuminated by the electroluminescent backlights 7a, 7b, 7c respectively thereby forming the message images.

In the further embodiment, a one-way mirror 9 is superimposed over the display panel 8. The one-way mirror 9 is provided to block out or obscure all the message images on the display panel 8 during the period when the message images are not being illuminated. Thus, the message images on the display panel 8 would not be visible when the message images are not being illuminated by the electroluminescent backlights.

In the example embodiment, the electroluminescent backlights 7a, 7b, 7c are electrically connected to a microcontroller / microprocessor 5 of figure 1 in which the sequence of illumination of the electroluminescent backlights 7a, 7b, 7c on the rear electroluminescent panel 7 can be controlled. The sequence of illumination of the electroluminescent backlights 7a, 7b, 7c in turn illuminate the corresponding graphics 8a, pictures 8b and text 8c on the

display panel 8 in the same sequence. The sequence of illumination of the graphics 8a, pictures 8b and text 8c is illustrated in figures 7a to 7d.

As shown in figure 7a, the microcontroller / microprocessor program is not activated and thus there is no illumination of any of the graphics 8a, pictures 8b or text 8c. As described earlier, the graphics 8a, pictures 8b and text 8c is not visible due to the one-way mirror 9 being superimposed over the display panel 8.

In figure 7b, the microcontroller / microprocessor is activated. Due to the programming set-up in the microcontroller / microprocessor, only the first switch 4a (as shown in figure 1) is switched on, and thus the electroluminescent backlight 7a corresponding to the graphics 8a is illuminated. The electroluminescent backlight 2a in turn illuminates graphics 8a as shown. After a predetermined period, the programming set-up in the microcontroller / microprocessor then switches on the second switch 4b (as shown in figure 1) and thus illuminates the electroluminescent backlight 7b corresponding to pictures 8b. In turn, the electroluminescent backlight 7b illuminates graphics 8b as shown in figure 8c. Similarly, after a predetermined period, the programming set-up in the microcontroller / microprocessor then switches on the third switch 4c (as shown in figure 1) and thus illuminates the electroluminescent backlight 7c corresponding to the pictures 8c. The electroluminescent backlight 7c in turn illuminates the graphics 8c as shown in figure 7d. It will be appreciated that the sequence of illumination of graphics 8a, pictures 8b and text 8c can be programmed in any desired order. Such sequence of illumination of graphics 8a, pictures 8b and text 8c can thus provide a more captivating and lively message to a viewer.

As shown in figure 8, sensors 11a, 11b, 11c, 11d are fixed on the electroluminescent display 1 in the example embodiment. The sensors 11a, 11b, 11c, 11d are provided to detect the presence of a passer-by which then activates the microcontroller / microprocessor. The microcontroller / microprocessor may be pre-programmed to display a message image on the electroluminescent display 1. According, different passers-by see different message images on the electroluminescent display 1. For instance, a first passer-by may see the message 10a. A second passer-by sees the message 10b. A third passer-by sees the message 10c and a fourth passer-by may see the message 10d. In the event that there are no passers-by, there will be no message images displayed on the electroluminescent display 1. In such a scenario, only a screensaver message would be displayed on the electroluminescent display 1.

In another embodiment, an audio device, for example, a speaker (not shown), is fixed and/or in communication with the electroluminescent display 1. The speaker is provided to produce an audio message which can be associated with the visual images being illuminated on the electroluminescent display 1. Thus, this can provide an even livelier and captivating message to the viewer.

In a further embodiment, the alternating voltage source 2 of figure 1 applies alternating voltage to the electroluminescent backlights 7a, 7b, 7c. By providing an integral number of cycles (See Figures 2 and 3) of the alternating voltage to the electroluminescent backlights 7a, 7b, 7c, the intensity of the of the illumination of the electroluminescent backlights 7a, 7b, 7c can be controlled. The higher the number of cycles of the voltage, the higher the intensity of the illumination. Likewise, the lower the number of cycles of the voltage, the lower the intensity of the illumination (See figures 2 and 3). In other words, the intensity of the illumination can be adjusted smoothly from zero intensity to maximum intensity (fade-in) or vice versa (fade-out) over time. Thus, the fade-in and fade-out effect of the message images can provide a soothing and/or otherwise pleasing effect to a viewer.

It will be apparent to those skilled in the art that numerous changes, modifications, and alternations to the invention illustrated herein may be made without departing from the principles of the present invention. Accordingly, the foregoing description is purely illustrative, and the invention is not to be limited other than as expressly set forth in the following claims.

Claims

1. A capacitor-load driving circuit including:
 - an alternating voltage source;
 - a computing or processing means;
 - a capacitor load, a first end of the capacitor load being in communication with the voltage source and a second end of the capacitor load being in communication with the computing or processing means;
 - wherein the voltage source supplies a plurality of different voltage levels to power the capacitor load.
2. The capacitive-load driving circuit according to claim 1, wherein the capacitor load is connected to the computing or processing means via a switch.
3. The capacitive-load driving circuit according to any one of the preceding claims, wherein the capacitive-load circuit is constructed as a driving module containing a driving integrated circuit for driving the capacitive load.
4. The capacitive-load driving circuit according to any one of the preceding claims, wherein the computing or processing means is a microcontroller / microprocessor.
5. A system for displaying a message comprising:
 - a first panel having a capacitive load, as described in claim 1, printed thereon;
 - a second panel having a plurality of message images printed thereon;
 - the second panel being superimposed over the first panel resulting in the message images being superimposed over the capacitive load;
 - whereby the alternating voltage is applied to the capacitive load thereby causing the capacitive load to illuminate the first panel, which in turn illuminates the message images on the second panel.
6. The system according to claim 5 further comprising a one-way mirror superimposed over the second panel, whereby the message images are not visible during the period when message images are not being illuminated.

7. The device according to any one of claims 5 or 6, wherein a programming setup in the microcontroller / microprocessor controls the switching on / off of the switch, and thereby controls the sequence of illumination of the capacitive load.
8. The device according to any one of the claims 5 to 7, wherein the intensity of the illumination of the capacitive load is controlled by the alternating voltage.
9. The device according to any one of claims 5 to 8, wherein the switch is switched on when the value of the alternating voltage is at its highest value.
10. The device according to any one of claims 5 to 9, further comprising a plurality of sensors.
11. The device according to any one of claims 5 to 10, further comprising a speaker.
12. The device according to any one of claims 5 to 11, wherein the message image is a graphic, a picture or a text.
13. The device according to any one of claims 5 to 11, wherein the shape of the capacitive load is mapped onto an electroluminescent material, which is then printed onto the first panel.