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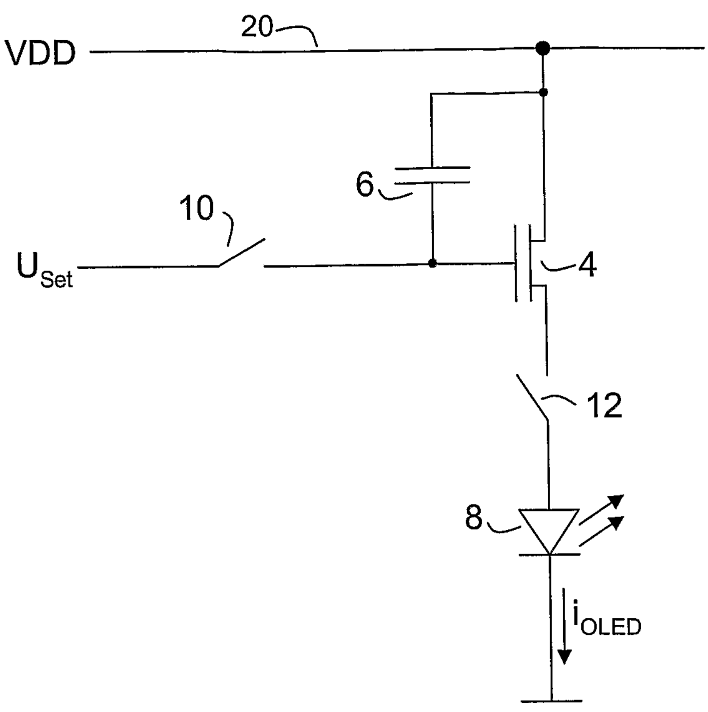
(54) **Title:** METHOD FOR DRIVING, AND A CIRCUIT OF AN ELEMENT OF AN ILLUMINATED DISPLAY



(57) Abstract: In illuminated displays with lighting elements (3) which are driven by means of a control voltage, the voltage drop on a supply line, which supplies two or more lighting elements (3), is compensated for. The currents for all of the light elements (3), which are connected to a supply line, and the known resistances are used to calculate the potential profile of the supply line (20) for this purpose. The control voltages for the light elements (3) are changed such that the actual potential on the supply line (20) for each element (3) is taken into account. Fluctuations in the brightness of the illuminated display resulting from potential differences are avoided. One element (3) of an illuminated display has a current control means (4), a signal retaining means (6), a light emitting means (8) and means (12) for interrupting the current flow through the light emitting means (8). The control voltage is adjusted with the current flow interrupted, so that no potential differences exist on the supply line. The signal retaining means (6) hold the control voltage relative to the potential on the line at the respective position of the lighting element (3). An illuminated display has adjustable voltages for the supply lines (20). The voltages are chosen to be sufficiently high that the minimum required voltage for setting the desired currents through the lighting elements (3) is achieved.

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Method for driving, and a circuit of an element of an illuminated display

The invention relates to a method for driving elements of an illuminated display, and to a circuit for elements of an illuminated display. The invention also relates to an illuminated display having two or more elements according to the invention.

Illuminated displays which produce light by means of light emitting means through which current flows have a large number of light emitting means arranged in a suitable form. The light emitting means in this case emit a light flux which is dependent on the electric current flowing through them. The expression light flux describes the total radiated power of the light source. In the following text, the expression current is used to represent the electric current. The light emitting means are combined with further circuit elements to form elements. The further circuit elements include, inter alia, switching means and current control means. Desired currents through the light emitting means are set by the switching means and the current control means. In the case of an illuminated display having two or more elements in a matrix arrangement, monochrome or polychrome images are displayed, by means of a number of pixels. In the case of monochrome images, the images are rastered into individual grey levels for the pixels. The grey levels are in this case different light flux values. One element in each case typically corresponds to one pixel, although it is also feasible for two or more elements to be combined to form one pixel. The various light flux values are produced by different currents through the light emitting means. In the case of a polychrome illuminated display, two or more monochrome elements of different colours normally interact, and form one pixel. Colours different from the original colours of the light emitting means in the elements can be displayed by additive colour mixing for each pixel. The light emitting means include, inter alia, light-emitting diodes. Light-emitting diodes can be produced on the basis of semiconductor materials (for example silicon, germanium), although light-emitting diodes are also available based on organic materials (OLED: "Organic Light Emitting Diode"). All of these light-emitting diodes have the common feature that the emitted light flux depends on the electric current through the light emitting means.

In the known light emitting means, a direct current is passed through the light emitting means in order to produce light. The light emitting means is in this case connected in the forward direction. The current control means is normally connected in series with the light emitting means. In a first way of driving the elements, the current control means is driven by a control potential which is referred to a reference ground potential. The control potential which is applied to the control electrode of the current control means causes current to flow through the current control means and through the light emitting means. The characteristics of the light emitting means and of the current control means are in this case unambiguous, so that a specific potential results in a specific electric current, and a specific electric current results in a specific light flux. The expressions potential and voltage are used synonymously in the following text, unless a different meaning is expressly stated.

Field-effect transistors (FETs) are preferably used as the current control means. These transistors are distinguished by voltage control. Apart from changing the charge on parasitic capacitances in the event of a change in the control voltage and resistive losses, the drive consumes virtually no power. The control potential is in this case applied between the gate electrode and the source electrode of the FET. The magnitude of the control voltage determines the current flow through the transistor, which can also be regarded as a controllable resistance. Bipolar transistors are also used as the current control means in other embodiments of control circuits.

An element 3 for a voltage drive is shown in Figure 1. A current control means 4 is connected in series with a light emitting means 8 between an operating voltage VDD and ground. The operating voltage is applied to the element 3 via a supply line 20. A control signal is supplied to a control input of the current control means 4 via a switch 10. In this case, the control signal is a control voltage U_{Set}. The switch 10 is in this case controlled such that only one individual element 3 in an arrangement of elements is in each case driven. It is thus possible to connect two or more elements 3 to one control line. With the drive that is required for this circuit, the time period during which the light-emitting diode emits light is relatively short. Depending on how many elements 3 of the illuminated display are connected to a common control line, the active time period is reduced. Since the human eye represents a natural system with a low-pass filter behaviour, it is possible to compensate for the short active time period by appropriately increasing the light flux during the active time period.

Illuminated displays are also feasible in which each current control means 4 is permanently driven by a control signal U_{Set}. There is then no need for the switch 10. The large number of control lines required reduces the available area of the illuminated display for the light to emerge from, however.

In the case of the element illustrated in Figure 2, a signal retaining means 6 has been added to the circuit described above, between the control electrode of the current control means 4 and the supply line 20. The signal retaining means 6 keeps the control signal U_{Set} that is applied when the switch 10 is closed constant when the switch 10 is opened until a new control signal U_{Set} is applied. It is thus possible to extend the active time period during which the element 8 emits light. The active time period now covers virtually the entire period until a new image is formed. In consequence, the required light flux which must be emitted during the active time period is reduced. Since the observer's eye can now integrate a reduced light flux over a longer time period, the same amount of light is perceived, and this results in the same image impression as that described with reference to Figure 1. Since ageing and changes to the electrooptical characteristics of OLEDs are highly dependent on the current density of the electric current through the OLEDs, this circuit offers the advantage that the characteristics change more slowly.

In illuminated displays that comprise elements, which are arranged in a matrix arrangement and have individual current control means, the individual elements are arranged in rows and columns. Two or more elements are connected to a common supply line. Depending on the nature of the elements, the common supply line is connected to a supply voltage or to a reference potential, for example ground.

Supply lines and control lines as well as the light emitting means share the available image area in illuminated displays having two or more elements. In order to make it possible to emit as much light as possible, the control and supply lines are designed to be thin. In this case, thin means that the cross section of the line is as small as possible. Furthermore, the lines may be composed of a transparent conductive material. These materials are often less conductive than a conventional conductor material. Irrespective of the particular embodiment, the control and supply lines have finite impedances. In particular, the ohmic line resistance means that the potential on the supply line may be different for different elements, depending on the set current which is passed through the elements that are connected to the supply line.

A specific control potential applied to the control electrodes of the current control means for the elements results, as stated further above, in a specific electric current, and thus in a specific light flux. The current control means refer the control potential applied to their control electrodes to the potential at one of their current-carrying connections. This reference potential is in this case, for example, the potential on the supply line at the location of a respective element. The control potential which is referred to the potential at one of the current-carrying connections is the relative control potential. The rated control potential which is applied by a drive circuit to the control electrodes of the current control means is, however, referred to a reference potential. The relative control potential varies with respect to the rated control potential, as a result of the different potential for different elements on the supply line. The varying relative control potential results in an electric current and thus a light flux which differs from the desired electric current or light flux.

The potential differences on the supply line also vary depending on the image content being displayed, because the respective currents through the elements vary depending on the image content. The differences between the rated control potential applied by the drive circuit and the relative control potential thus also vary.

As explained further above, the voltage drop on the supply line directly influences the control voltage for the current control means. The gate and source connections are two connections of field-effect transistors (FETs) which are used as the current control means. A control potential, the gate-source voltage, is applied between the gate and source connections. The source connection is in this case connected to the supply line, and the control potential is supplied to the gate connection.

The resistance of a supply line for one column or one row of elements is defined as follows:

$$R = \rho * \frac{L}{A} \qquad (1)$$

where ρ is the resistivity of the material of the supply line, for example 3 μΩcm for aluminium. L is the length of the line section, and A is the cross-sectional area of the line. The voltage drop on a section of the supply line can be calculated as follows:

$$\Delta V = R * I_{max} \qquad (2)$$

where I_{max} is the maximum current through the section, for example the sum of the currents through the elements which are supplied by that section of the supply line. If a supply line in an illuminated display has a length of 200 mm, and the cross section of the line is 20 μm × 200 nm, this results in a resistance of 1.5 kΩ. Assuming that there are 120 elements being supplied by the supply line, and the sum of the currents in one section is 120 μA, this results in a maximum voltage drop of 180 mV for this section. The voltage drop is thus in a range within which the threshold voltage of the FET that is used as the current control means also varies from one element to another. These fluctuations are dependent on the production methods and other factors. Even the variation of the threshold voltage results in a non-uniform brightness distribution in the illuminated display. The control voltage variation which results from voltage drops on the supply line further increases the non-uniform brightness distribution.

The illuminated display described in the above example is still relatively small, with 120 elements per supply line. In the case of larger illuminated displays, the effect is considerably exacerbated.

It is now desirable to improve the drive for illuminated displays having elements of the type described above. For this purpose, it is desirable to provide an improved element for illuminated displays. Finally, it is desirable to provide an illuminated display with elements according to the invention, and to provide a suitable drive method.

The method specified in Claim 1 satisfies one part of this object. The element specified in Claim 14 and the illuminated display specified in Claim 15 satisfy other parts of the object. Further developments of the invention are specified in the respective dependent claims.

The method according to the invention provides for the voltage drop or offset to be expected on a supply line to be calculated from the known resistances between the individual elements and the nominal value of the current in the individual elements. The offset which results from the calculation is combined with the respective rated control potential of the individual elements, for example by being added, thus compensating for the difference to be expected between the rated control voltage and the actual control voltage at the control electrode of the current control means. The currents in the individual elements are known, since the image content to be displayed as well as the relationship between the brightness and current of the light emitting means are known, and are unambiguous. The calculation is carried out continuously, that is to say the offset is also recalculated whenever the image content changes. The method according to the invention typically results in individual elements or groups of elements being driven cyclically.

The relationship between the brightness, the current and the voltage of the light emitting means is also referred to in the following text as the electrooptical characteristics of the light emitting means. The relationship between the voltage and the current in the current control means is referred to in the following text as the electrical characteristics of the current control means.

In one embodiment of the method according to the invention, the addition of an offset is not carried out in an external computation circuit, but is effected storing of the uncorrected rated control potential in a signal retaining means when the current flow through the light emitting means by is interrupted. In this case, a switching means is controlled during a programming phase for all of the elements connected to a common supply line, such that no current can flow through the elements. Since no current is flowing, the potential is the same along the entire supply line. The rated control signals or rated control voltages are now applied to the current control means for the individual elements, and are stored in a signal retaining means. In this case, the rated control voltages are referred to a reference potential. The signal retaining means are connected such that they hold the signal relative to the potential at the location of the supply line at which the element is connected. The switching means are now controlled for all of the elements which are supplied by the common supply line such that a current can flow through the light emitting means. This is referred to as the start of an operating phase. The potentials on the supply line for the individual elements vary as a function of the currents and as a function of the image content, respectively. The signal retaining means hold the relative control potentials with respect to the potential at the location of the supply line at which the respective elements are connected. The relative control voltage setting for each current control means, and thus the current setting through the respective light emitting means therefore remain constant. The combination of the rated control voltage and offset related to the reference potential, according to the invention, is achieved by holding the rated control voltage with respect to the location on the supply line at which the respective element is connected. The brightness fluctuations resulting from the potential differences on the supply line are thus avoided.

A further development of the above method according to the invention provides for the supply voltage to be increased from a start value continuously or in steps once the current flow through the elements has been re-established. At the same time, the current through the supply line is measured. Any increase in the supply voltage leads to a rise in the current through the individual elements until the respective set current is reached. When the current through the supply line does not change in the steady state when the voltage is increased further, the minimum required supply voltage has been reached which allows the desired current to flow through each of the elements which are connected to the same supply line. As an alternative to this, it is possible to end the increasing of the supply voltage when the change rate in the measured current is below a predetermined value. The voltage setting is now maintained until the image information for at least one of the elements which are connected to this supply line changes.

An element of an illuminated display according to the invention which can be driven using the method described above has a light emitting means and a current control means. Furthermore, a signal retaining means and a first switching means are provided, via which switching means a control signal can be supplied to the signal retaining means. According to the invention, a second switching means is provided, which optionally passes or interrupts the current flow through the light emitting means.

A first embodiment of the illuminated display according to the invention has elements according to the invention arranged in a matrix.

In a further embodiment of the illuminated display according to the invention, the electrical and electrooptical characteristics of the current control means and of the light emitting means, respectively, of elements are known and, for example, are stored in a memory. Furthermore, the supply lines are connected individually or in groups to variable voltage supplies. If the image content is known, it is therefore possible to adjust the supply voltages such that the minimum required voltage is applied to an element on the individual line or the group of lines. In the case of image contents which vary only slightly over time but vary substantially in places, or if the image brightness varies slowly with time, it is thus possible to reduce the power requirement. One example of image contents which vary slightly over time but vary particularly substantially in places is image contents of information hoardings at railway stations or airports.

In another embodiment of an illuminated display according to the invention having two or more elements, a first connection of a light emitting means in the element is connected in a known manner to a respective current control means. A second connection of all the light emitting means, which are connected to one supply line, is connected to a connecting network whose potential can be varied selectively. In this embodiment, the second switching means for interrupting the current flow during a programming phase can be omitted. During the programming phase, the potential on the connecting network is varied such that it is not possible for any current to flow through the light emitting means. In one preferred embodiment, the light emitting means are then switched to the reverse direction, for example, or the voltage across the light emitting means is too low for any current to flow, or the connecting network is switched off. The rated control signal is held in signal retaining means, in the manner described above. Once the programming of all of the elements which are connected to the same supply line has been completed, the current is allowed to flow through the connecting network again.

In a further embodiment of an illuminated display according to the invention, the potential on the supply line is variable. During the programming phase, the potential on the supply line is, for example, connected to the reference potential, that is to say to ground. Due to the lack of voltage across the current control means and the light emitting means of the elements, which are connected to the supply line, no current can flow. The control signal is now stored in the signal retaining means. In the operating phase, the supply line is connected to a potential, which is sufficient to allow the desired currents to flow in the elements. Since the signal retaining means hold the potential applied to them relative to the point to which they are connected, the selected current flows irrespective of the possible potential differences on the supply line.

The invention will be described in more detail in the following text with reference to the drawing, in which:

Figure 1 shows a known element of an illuminated display;
Figure 2 shows a further known element of an illuminated display;
Figure 3 shows a schematic illustration of a supply line with connected elements;
Figure 4 shows a further schematic illustration of a supply line with connected elements;

Figure 5 shows a schematic illustration of the calculation of a corrected control signal;

Figure 6 shows a detail of an illuminated display with supply lines which are linked to one another;

Figure 7 shows a first exemplary embodiment of an element of an illuminated display according to the invention; and

Figure 8 shows an exemplary embodiment of the operation, according to the invention, of an element of an illuminated display.

Identical or similar components are provided with the same reference symbols in the figures.

Figures 1 and 2 have already been described further above, in the introduction to the description. They will not be described again in any more detail in the following text.

Figure 3 shows a schematic illustration of a part of an illuminated display. The figure shows a supply line 20 with connected elements 3. In order to assist understanding, the elements 3 are surrounded by dashed lines. A voltage ΔV_0, ΔV_1, ΔV_2,..., ΔV_n is in each case dropped across resistors 21, with this voltage being dependent on the current $I_{row,0}$, $I_{row,1}$, $I_{row,2}$,..., $I_{row,n}$ through the resistors 21. The magnitude of the currents $I_{row,0}$, $I_{row,1}$, $I_{row,2}$,..., $I_{row,n}$ is the sum of the currents through the respective downstream elements 3, I_{OLED0}, I_{OLED1}, I_{OLED2},..., I_{OLEDn}. The resistances of the resistors 21 are known, as are the values of the currents I_{OLED0}, I_{OLED1}, I_{OLED2},..., I_{OLEDn} through the elements 3. According to the invention, the voltage drops across the individual resistors are calculated. The rated values of the control voltages $V_{Data,0}$, $V_{Data,1}$, $V_{Data,2}$,..., $V_{Data,n}$ (which come from a control circuit that is not illustrated) that are related to a reference voltage are in each case corrected for the calculated voltage drops ΔV_0, ΔV_1, ΔV_2,..., ΔV_n, in order to compensate for these voltage drops in the steady state. In the example illustrated in the figure, the respective voltage drops are calculated as follows:

$$\Delta V_0 = R * \sum_{x=0}^{n} I_{row,x} \quad (3)$$

$$\Delta V_1 = R * (\sum_{x=0}^{n} I_{row,x} - I_{OLED,0}) \quad (4)$$

$$\Delta V_2 = R * (\sum_{x=0}^{n} I_{row,x} - I_{OLED,0} - I_{OLED,1}) \quad (5)$$

...

$$\Delta V_m = R * (\sum_{x=0}^{n} I_{row,x} - \sum_{y=0}^{m-1} I_{OLED,y}) \quad (6)$$

The index n in the equations denotes the total number of elements connected to the supply line 20. The first sum in the equations represents the total current which flows into the supply line 20. Depending on the position m of the element 3 whose voltage drop is being calculated, the sum of the currents of the upstream elements 3 is subtracted from the total current. The values of the resistors 21 are assumed to be the same, for simplicity. If the resistances are different, these must be taken into account with their actual values.

The voltage on the supply line 20 at the current control means 4 for an element 3 at the location m is then calculated as follows:

$$V_m = V_{DD} - \sum_{x=0}^{m-1} \Delta V_x \qquad (7)$$

The control voltage for an element 3 at the location m must be corrected by the difference between the rated supply voltage V_{DD} and the voltage V_m on the supply line 20 at the location m, in order to set the desired current through the respective light emitting means 8.

Figure 4 shows a similar circuit to that illustrated in Figure 3. In contrast to the illustration in Figure 3, the supply line 20 is in this case a ground line. The relationships explained further above between the voltage drops and the line resistances also apply in this case, however. The supply voltage VDD is, for example, supplied over an area, so that the voltage drops are negligible in this case.

In the examples, the line resistances are related to one line. The relationships also apply analogously for two supply lines, one of which carries the supply voltage and the other carries a reference potential, such as ground.

Depending on the current control means 4 that is used and on the type of transistors used, a positive or a negative control voltage is applied to the control electrode of the current control means. This also governs whether the potential difference is compensated for by addition or subtraction of the correction voltage. However, the invention can be used analogously for both situations.

Figure 5 shows a block diagram of an example of a calculation process for the correction voltage. The illuminated display in this example is designed such that all the pixels in one row are connected to a common supply line. If the illuminated display is assumed to display the image content in rows, the data for the pixels in each row is first of all delayed by one row period in step 100. This makes it possible to determine the overall current for one row even when the data for individual pixels is transmitted sequentially, pixel by pixel. The nominal control potential is calculated in step 101. Individual or ageing-dependent fluctuations in the electrical and electrooptical characteristics of the elements 3 are also corrected for during this process. The potential difference for each pixel, that is to say for each element 3 in the row, is calculated in steps 102 to 105, and the nominal control signal is corrected accordingly in step 106. In one embodiment, the potential difference is determined by means of a technology factor 104, which represents the impedance of the line for individual elements.

The invention is not restricted to illuminated displays which have elements that are connected jointly to one supply line row-by-row. The method can also be used for displays in which elements are connected to a common supply line column-by-column. If the elements, which are connected to a common supply line, are driven in parallel, the display of the image data must be delayed until the potentials on the supply line for each element can be determined from the data for all of the elements which are connected to this supply line. The delay is then, for example, one field or frame period, depending on the chosen type of display. In the case of a field drive, the data for the respective previous field has already been calculated and can be included in the calculation.

In another embodiment of an illuminated display according to the invention, the elements in one row are connected to a common supply line. A sequential drive, element-by-element, for the illuminated display uses the known image data for the elements which have already been driven to calculate the potential profile on the supply line.

In one embodiment, those elements which have not yet been driven are switched off, that is to say no current flows through them. Those elements which have not yet been driven can be switched off, for example, via switching means in order to interrupt the current flow. The potential on the supply line for each element to be driven at that time can thus be determined by storing the values of the currents of elements which have already been driven, and by using these values to calculate the potential profile on the supply line. The control signal for the respective next element to be driven is then corrected accordingly. This method allows the memory size to be kept to a minimum. If, for example, the drive process is carried out row-by-row, the memory need only be sufficiently large to be able to store the values for the elements in a single row. Furthermore, the delay in the reproduction of image information transmitted in serial form is short, because the storage time is only short.

An even smaller memory is sufficient if the respective instantaneous value of the sum of the currents of all the already driven elements on one supply line is stored. If the resistances between individual elements are the same and the drive starts at the remote end and the supply potential is fed at the near end of a row, only the sum of the previous currents need be stored in order to make it possible to calculate the potential on the supply line at the location of the next element to be driven. This drive process is dependent on signal retaining means being provided to keep the respective control signals for the elements with respect to the supply line. If one horizontal row is driven sequentially, element-by-element, from left to right, the remote end is on the left, and the near end is on the right.

One embodiment of the method for sequentially driving an illuminated display element-by-element provides for the values, which are held in the retaining means for each element in a row or column to be driven, to be erased before each drive process. In one embodiment, the erasure process is carried out by erasing the potentials which are stored in the signal retaining means or, in general, by storage of a suitable start value. If the start value is chosen appropriately, the current control means are not switched on, and no additional switching means are required to interrupt the current flow. The erasure process is in each case expediently carried out for an entire row or column, or for those elements in a row or column which are connected to a common supply line. The advantage mentioned above of a relatively small memory and of a short delay in the reproduction of the image contents which are transmitted in serial form pixel-by-pixel is also retained in this embodiment.

In one alternative embodiment of the sequential driving of an illuminated display element-by-element according to the invention, the stored image information of the respective preceding image is used in order to calculate the potential profile on a supply line. The old and the new image content, and thus the current, are known for each element which is connected to a supply line. The potential profile on the supply line is thus also known, or can be calculated. The control signal for each element to be driven is corrected on the basis of the known or calculated potential profile. The signal retaining means for the elements in this alternative do not need to be erased before being driven again. This embodiment is particularly suitable when image contents are transmitted sequentially, row-by-row. In this case, the respective valid image content is written sequentially to the illuminated display, row-by-row, in a similar way to that in the case of a cathode ray tube.

One embodiment of the illuminated display according to the invention has an associated memory, in which the image contents of rows, columns, fields or frames, or parts of them, are stored. This makes it possible to first of all calculate the potential profiles on a supply line and then to apply the corrected control signals to the elements. The reproduction of the stored image contents is delayed in a corresponding manner. The storage of the image contents means that they are also available for further calculations.

The invention can also be used when the supply lines are connected to one another in the form of a network, as shown in Figure 6. In this case, a series of linear equations must be solved, which can be produced in accordance with Kirchhoff's node and network rules. The correction values for the control signals for the individual elements are obtained from the solutions of the linear equations. In order to assist clarity, the currents and voltage differences are denoted in the same way in the figure. Obviously, the respective values may be different. In this embodiment, it is expedient for the image contents of all the elements which are connected via the supply lines to be known before the drive process. An appropriate memory is provided, for example, for this purpose.

In one embodiment of the invention, the correction values or offset voltages are not explicitly numerically calculated. In this embodiment, the offset voltages are set automatically. One element 3 in an illuminated display according to this embodiment of the invention is illustrated in Figure 7. The element 3 has a current control means 4 and a light emitting means 8. The control signal U_{Set} is applied to the control electrode of the current control means 4 via a first switching means 10. A signal retaining means 6 holds the control signal U_{Set} when the first switching means 10 interrupts the connection to a control circuit, which is not illustrated. The control signal is applied when no current is flowing in the supply line 20. A second switching means 12 is provided for this purpose, and interrupts the current path via the light emitting means 8 to ground. In this case, there are no potential differences on the supply line 20, and the nominal control signals are applied to the current control means 4. When the respective control signals have been supplied to all of the elements 3 which are connected to a common supply line, and the first switching means 10 has been opened, the second switching means 12 is closed. The current flow results in potential differences, in a known manner. The signal retaining means 6 holds the relative control signals with respect to the potential at the point at which the respective element 3 is connected to the supply line 20. An offset voltage sets itself with respect to the reference potential to which the nominal control signals are related. The signal retaining means 6 is formed, for example, by capacitors for a voltage drive. The capacitors in one preferred embodiment are integrated capacitors, which are also produced during the process of manufacturing the illuminated display.

One method according to the invention for driving an element as described with reference to Figure 7 comprises a programming phase P1 and an operating phase P2. During the programming phase P1, the current flow through the light emitting means and through the elements 3 is interrupted, so that no steady-state potential difference exists on the supply line 20. At the end of the programming phase P1, the interruption of the current flow is cancelled, and the operating phase P2 starts. The desired current is now determined by the relative control signal, which is held in the signal retaining means 6 and is independent of potential fluctuations on the supply line 20, or follows them.

In another embodiment of the illuminated display according to the invention, no second switching means 12 is provided with the elements 3 in order to interrupt the current flow. By way of example, the elements 3 correspond to those in Figure 2. A first connection of a light emitting means 8 is connected to a supply line 20 via a current control means 4. In contrast to Figure 2, a second connection of the light emitting means 8 in the illuminated display according to the invention is not connected to ground or to a fixed reference potential, but is connected to a connecting network. The connecting network is at a variable potential. The current flow through the light emitting means can in this case be interrupted by appropriately varying the potential on the connecting network. In the case of the illuminated display according to the invention, the light emitting means 8 is, for example, switched to the reverse-biased direction by appropriately changing the potential on the connecting network, so that the current flow is interrupted. The potential in the connecting network can also be chosen such that the voltage across the light emitting means is low, and such that essentially no current flows through the light emitting means. The nominal control signals are then applied via the first switching means 10 to the signal retaining means 6 for the current control means 4. When the respective nominal control signals have been applied to the current control means 4 for all of the elements 3 which are connected to a common connecting network, the first switching means 10 is opened, and the potential on the connecting network is changed such that currents can flow through the current control means 4 and the light emitting means 8 corresponding to the control signals. The signal retaining means is in each case connected between the control inputs of the current control means 4 and the supply line 20 at the points to which the current-carrying connection of the elements is connected. The resultant potential differences on the supply line 20 thus have no adverse effect on the control potentials stored in the signal retaining means, and form the offset voltage with respect to the reference potential.

Figure 8 shows a further exemplary embodiment of a method for driving an element 3 in an illuminated display according to the invention. The potential on the supply line 20 for the illuminated display can be varied, for example, by switching it on and off. During the programming phase P1, a low potential, for example the reference potential or ground, is applied to the supply line 20. In the figure, the low potential is annotated VSS. Due to the low potential, no current can flow though the light emitting means. The nominal control signal is supplied to the signal retaining means 6 via the first switching means 10, which has now been closed. Once the control signals have been applied to the signal retaining means 6 for all of the elements 3 which are connected to a supply line 20, the first switching means 10 are opened again, and the supply line 20 is connected to a high potential, VDD in the figure. This corresponds to the operating phase P2. The potential is expediently chosen to be at least sufficiently high that the desired currents flow in all of the light emitting means 8. In the figure, the changing of the potential on the supply line 20 is indicated by the square-wave potential profile. The two phases P1 and P2 are identified in a corresponding manner.

One advantageous embodiment of the drive method according to the invention provides for driving row-by-row. In this case, only the image content of one row is ever changed at a time, while the image content of the other rows remains unchanged.

In one preferred embodiment of driving row-by-row, the image content of every alternate row is changed successively. The rows are subdivided into even-numbered rows and odd-numbered rows, depending on their position on the screen. Alternately, the image content of the even-numbered rows is changed first of all, followed by that of the odd-numbered rows. This simulates the known interlacing method.

In another embodiment of the drive method, the drive process is carried out frame by frame. In this case, the entire image content is programmed into the signal retaining means during the programming phase, after which the process switches to the operating phase.

The method according to the invention can be used, appropriately modified, for any desired illuminated displays. The nature of the arrangement of the elements in rows, columns or other groupings is intrinsically irrelevant for the method.

The image contents are expediently programmed in a time which is short in comparison to the active time during which the image contents are displayed.

Two or more elements 3 according to the invention in an illuminated display are arranged in the form of a matrix in a known manner, in one embodiment of the invention. They are driven row-by-row or column-by-column, and field-by-field or frame-by-frame. However, the drive process according to the invention can also be used for parts or groups of rows or columns, and for parts of fields or frames. In situations such as these, the elements in the illuminated display are connected appropriately and jointly to a supply line or to a connecting network.

The method according to the invention as well as the illuminated display according to the invention can be used particularly advantageously in televisions and monitors.

Claims

1. Method for controlling of an illuminated display having multiple elements (3), wherein the elements (3) include a current controlling means (4) and a light emitting means (8), wherein the light emitting means (8) light emits light when an electric current is applied, wherein multiple elements (3) are connected to a supply potential (VDD) via a common supply line (20), and wherein control potentials that are referred to a reference potential are applied to control electrodes of the current control means (4), characterised in that the nominal control potentials of the control electrodes are corrected with regard to the reference potential by means of offset voltages, such that the influence of differences in the potential of the supply line (20) that are caused by the current flow and a finite impedance of the supply line (20) are compensated for.

2. Method according to claim 1, characterised in that the offset voltages are calculated using the impedances of the supply line (20) and the currents to be set for those elements (3), which are connected to the same supply line (20), and are combined with the nominal control potentials.

3. Method according to claim 2, characterised in that image information of a line, a column, a field, a frame, or fractions thereof are stored, and that the currents through the elements (3) are calculated using the stored image information.

4. Method according to claim 3, characterised in that the corrected control potentials, which correspond to the image information, are applied to the elements (3) delayed by one line, column, field, or frame period, or fractions thereof.

5. Method according to claim 4, characterised in that the corrected control potentials are applied sequentially element-by-element to those elements (3) that are connected to a common supply line (20).

6. Method according to claim 4 or 5, characterised in that the current through the light emitting means (8) of all elements (3) that are connected to a common supply line (20) is interrupted prior to applying the control potentials, that the current through elements (3) to which a control potential has been applied is re-established, that the values of the control potentials of those elements (3) to which a control potential has been applied are stored, and that the currents through those elements (3) to which a control potential has been applied are used for calculating the offset voltages and correcting the control potentials of those elements (3) to which no control potential has yet been applied.

7. Method according to claim 6, characterised in that, for interrupting the current, a control potential that does not result in a current flow is applied to the current control means (4).

8. Method according to one of claims 1 to 7, characterised in that the minimum required supply potential (VDD) of each supply line (20) is determined from the calculated potential differences on the supply line (20) and the currents through each of those elements (3) that is connected to this supply line (20), as well as from information about electrical and electro-optical properties of the current control means (4) and the light emitting means (8), respectively, and that the minimum required supply potential (VDD) is applied to the supply line (20).

9. Method according to claim 1, characterised in that the current through the light emitting means (8) of the elements (3) is interrupted during applying the control potentials to the control electrodes of the current control means (4), that the control potential of each individual element (3) is retained with reference to the potential on the supply line (20) at that place, at which the respective element (3) is connected to the supply line (20), and that the current flow is re-established after the control potentials have been applied, wherein the potential differences on the supply line (20), which appear with activated current flow, are those offset voltages, which correct, with respect to the reference potential, the control potentials that are retained at the control electrodes of the current control means (4).

10. Method according to claim 6 or 9, characterised in that switching means (12) are controlled for interrupting the current through the light emitting means (8).

11. Method according to claim 6 or 9, characterised in that the potential of a common connection network, to which the elements (3) are connected, is modified for interrupting the current through the light emitting means (8).

12. Method according to one of claims 6, 7, 9, 10 or 11, characterised in that, after re-establishing the current, the supply potential (VDD) of the supply line (20) is increased gradually or steadily, starting from an initial value, wherein the current through the supply line (20) is measured, and wherein the increase in the supply potential is terminated when, in the event of a further increase of the supply potential (VDD), the change in the current through the supply line (20) in steady state is below a predetermined value.

13. Element (3) of an illuminated display with a light emitting means (8), which emits light when a current (iOLED) is applied, with a current control means (4), which is series-connected with the light emitting means (8), wherein a control line is connected with a control electrode of the current control means (4) via a first switching means (10), which switching means is controlled by a first switching signal, characterised in that a second switching means (12) is provided, by means of which the current through the light emitting means (8) can be interrupted, and a signal retaining means (6), which retains the potential at the control electrode of the current control means (4) relative to the potential at that place of a supply line (20), at which the respective element (3) is connected.

14. Illuminated display with a control unit for controlling of elements (3), which are arranged in a matrix arrangement, wherein the elements emit light when an electric current is applied, wherein multiple elements (3) are connected to a common supply line (20), characterised in that the control unit is apt to perform a method according to one or several of claims 1 to 12.

15. Illuminated display according to claim 14, characterised in that the control unit is assigned a memory for storing image information.

16. Illuminated display according to claim 14 or 15, characterised in that the one or several supply lines (20) are connected with a variable voltage supply.

17. Illuminated display according to claim 16, characterised in that the current through the light emitting means (8) of the elements (3) can be interrupted by changing the potential of the supply line (20).

18. Illuminated display according to claim 14, 15, 16 or 17, characterised in that the light emitting means (8) of multiple elements (3) are connected to a common connection network, which has a variable potential, and that the current through the light emitting means (8) of the elements (3) can be interrupted by modifying the potential of the connection network.

19. Television set with an illuminated display according to one or several of claims 14 to 18.

20. Monitor with an illuminated display according to one or several of claims 14 to 18.

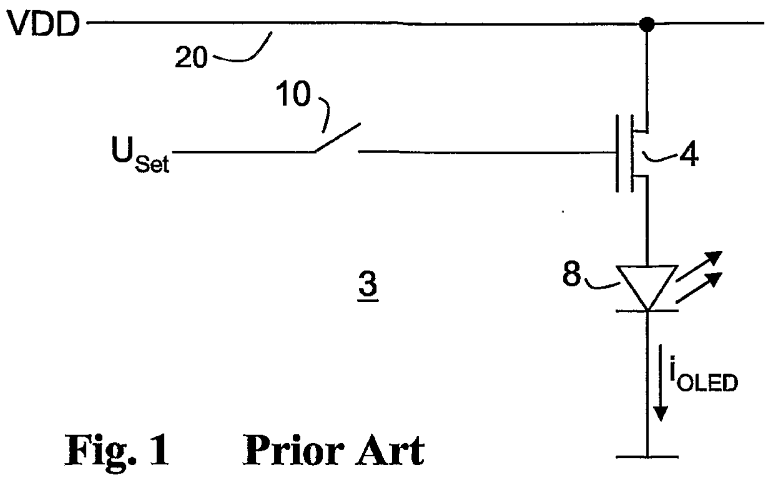

Fig. 1 Prior Art

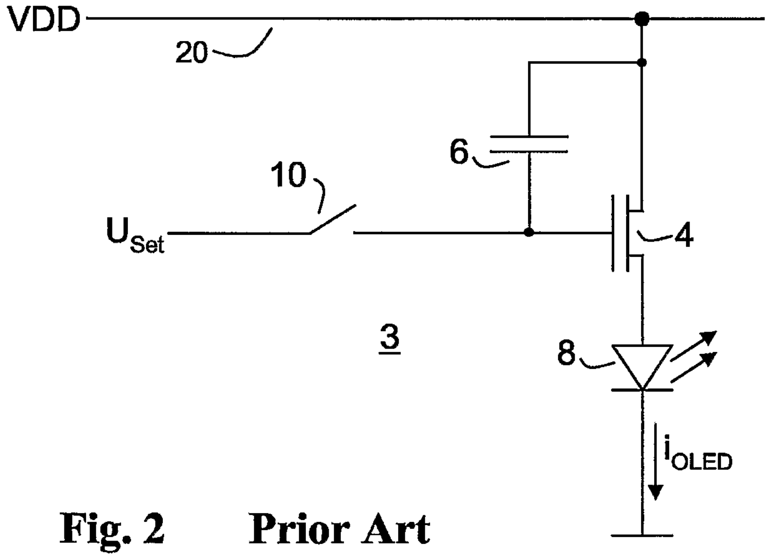

Fig. 2 Prior Art

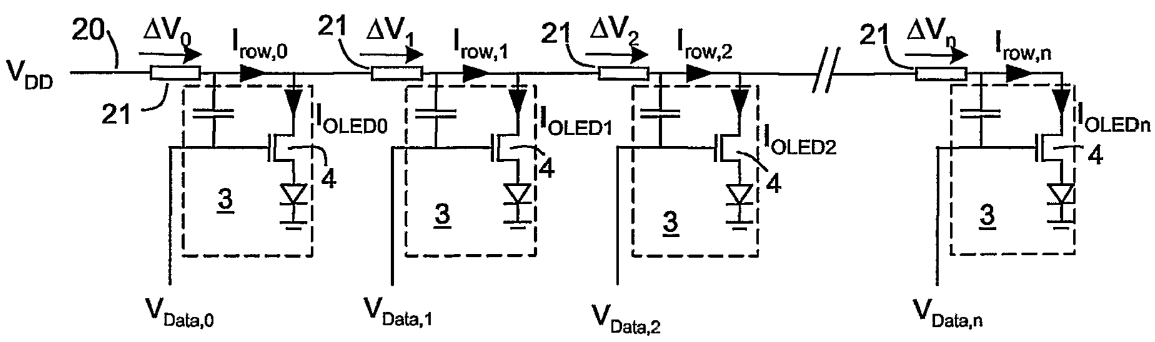

Fig.3

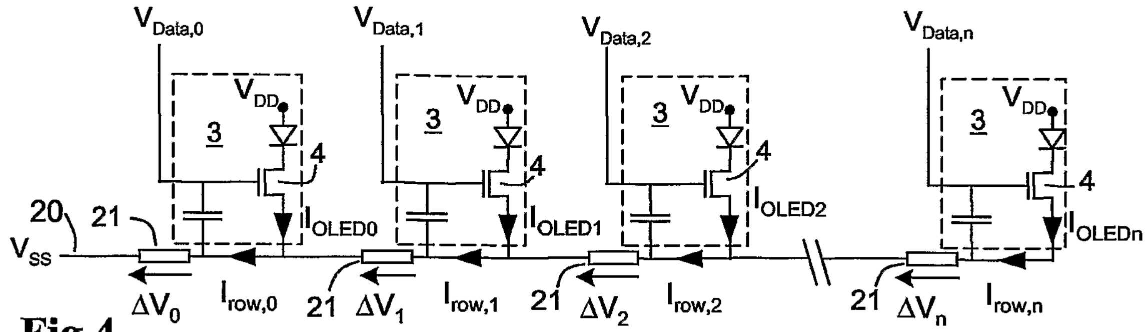

Fig.4

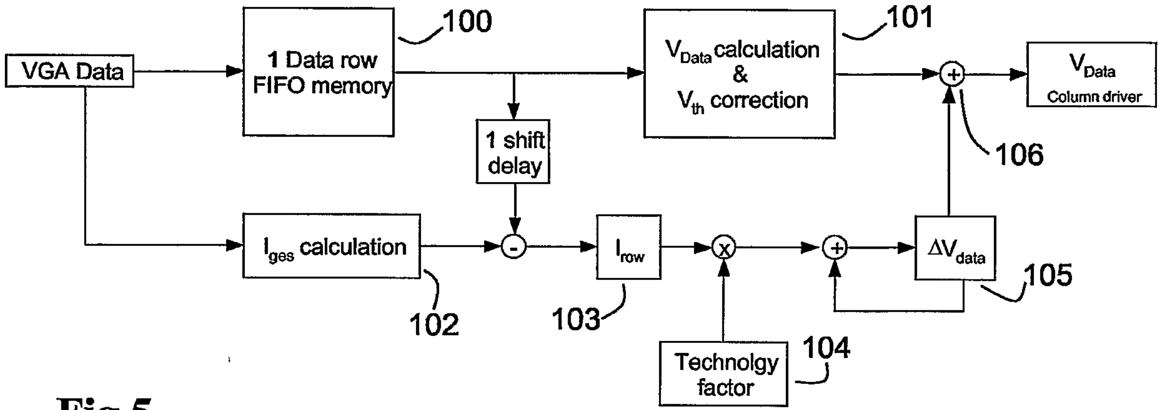

Fig.5

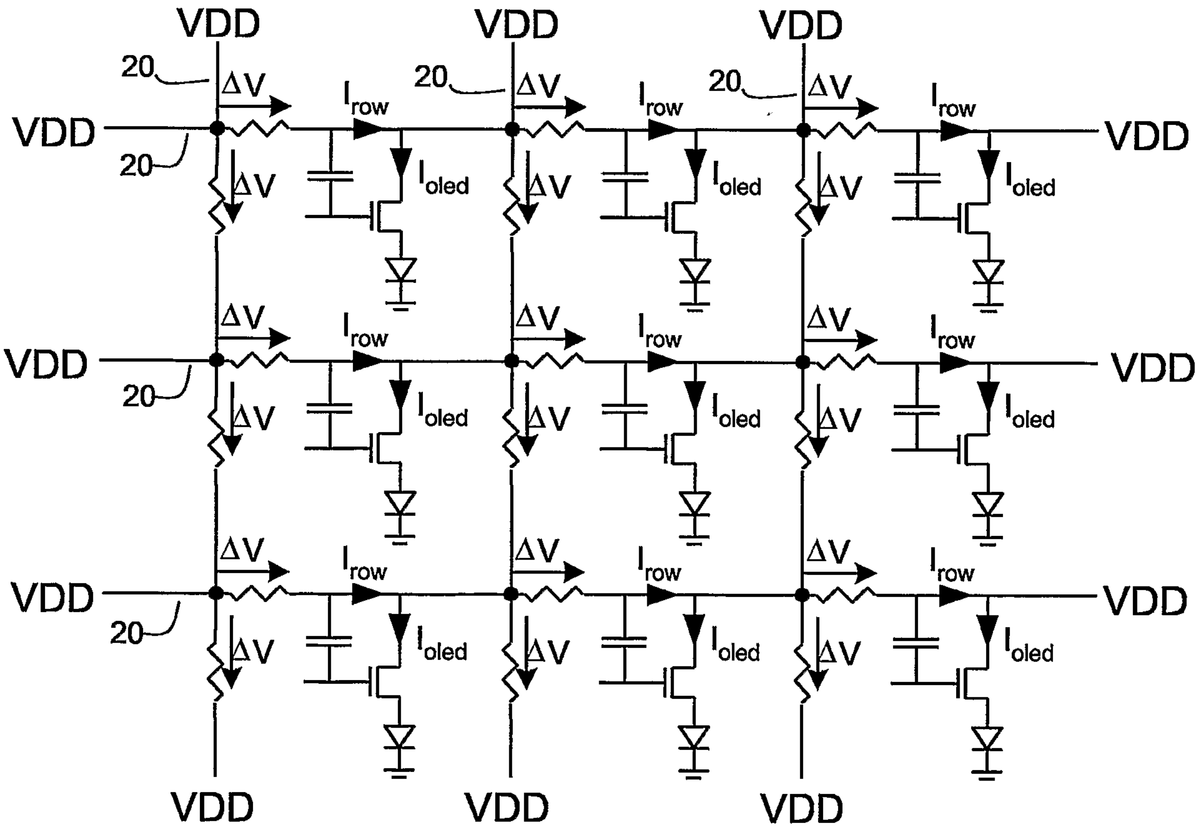

Fig.6

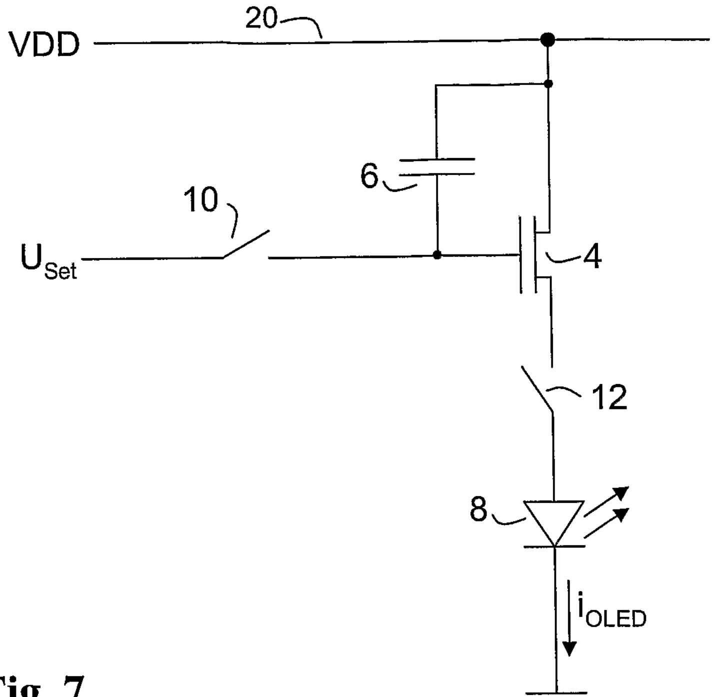
20
VDD
6
10
U_{Set}
4
12
8
i_{OLED}

Fig. 7

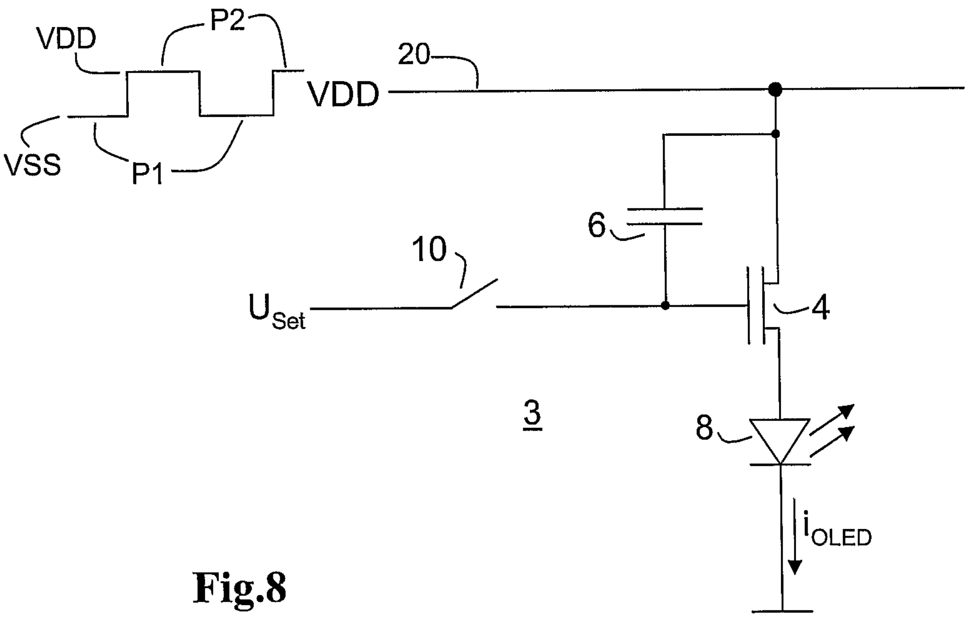
VDD
P2
20
VDD
VSS
P1
6
10
U_{Set}
4
3
8
i_{OLED}

Fig.8