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(54) **TN liquid crystal display device and touch control method thereof**

TN-Flüssigkristallanzeigevorrichtung und Berührungssteuerungsverfahren dafür

Dispositif d'affichage à cristaux liquides TN et son procédé de commande tactile

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(73) Proprietor: **Shanghai Tianma Micro-electronics Co., Ltd.**
Pudong New District
Shanghai 201201 (CN)

(72) Inventors:
- **Ma, Jun**
  201201 Shanghai (CN)
- **Zhao, Lijun**
  201201 Shanghai (CN)

(74) Representative: **Maiwald Patentanwalts GmbH**
Elisenhof
Elisenstrasse 3
80335 München (DE)

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Description

FIELD OF THE INVENTION

[0001] The invention relates to liquid crystal display (LCD) technology, and in particular to a TN (twisted nematic) LCD device and a touch control method thereof.

BACKGROUND OF THE INVENTION

[0002] With the development of the liquid crystal display (LCD) technology, touch panels, as the most simple, convenient and natural way of human-machine interaction, are increasingly applied to the field of LCD.

[0003] Depending on differences of the operational principle and media for transmitting information, the touch panels may be classified into four types: resistive touch panels, capacitive touch panels, infrared touch panels and surface acoustic wave touch panels. The capacitive touch panel technology is popular due to the simple process, long service life and high transmittance.

[0004] In the existing TN (twisted nematic) LCD device integrated with the touch control function, a touch panel is directly disposed on a TN LCD panel. Each of the LCD panel and xthe touch panel includes two substrates which are generally glass substrates. That is, the existing TN LCD device with the touch control function requires at least four glass substrates to be jointed together. In view of the requirements for thinner, more convenient display device at the right now and in the future, the TN LCD device with the touch control function mentioned above is inadequate considering its complex structure, great thickness, complex manufacturing process and high manufacturing costs, therefore, it may be needful to reduce the manufacturing costs, simplify the manufacturing process and provide a lighter, thinner, more convenient display device with simple structure.

[0005] EP 2 506 128 A2 relates to a touch sensor integrated type display device including gate lines and data lines, which are formed on a substrate to cross each other. The display device further includes a plurality of pixel electrodes formed in areas defined by the crossing of the gate lines and the data lines and a common electrode including at least two touch driving electrodes, which overlap the pixel electrodes with an insulating layer interposed between them.

[0006] WO 2012/118514 A1 relates to electrical shield line systems that are provided for openings between common electrodes near data lines of display and touch screens. Multiple common electrodes can be included that can have openings between the individual common electrodes. Moreover, the openings in the common electrodes can allow an electric field to extend from a data line through the common electrode layer.

[0007] EP 2075 677 A2 relates to a touch sensible display device in which a first sensing unit is connected to a row sensor data line and outputs a first sensing signal according to a touch and a second sensing unit is connected to a column sensor data line and outputs a second sensing signal according to the touch. A sensing signal processor alternately applies a reset voltage to the row sensor data line and the column sensor data line and generates a sensing data single according to the first sensing signal and the second sensing signal, and a touch determiner processes a sensing data signal to generate touch information.

SUMMARY OF THE INVENTION

[0008] In view of the mentioned above, the present invention provides a TN LCD device integrated with a touch control function and a touch control method thereof according to the independent claims.

[0009] In order to achieve the object mentioned above, the following technical solutions are provided according to embodiments of the present invention.

[0010] One inventive aspect is a twisted nematic liquid crystal display device integrated with a touch control function. The device includes, inter alia, an array substrate, a color film substrate disposed opposite the array substrate, and a liquid crystal layer disposed between the array substrate and the color film substrate. The device also includes a common electrode layer disposed on a surface of the color film substrate facing the liquid crystal layer. The common electrode layer includes a plurality of sensing electrodes, a plurality of driving electrodes, and a plurality of dummy electrodes located between the sensing electrodes and the driving electrodes. In addition, the sensing electrodes, the driving electrodes, and the dummy electrodes are insulated from one another..

[0011] The TN LCD device further includes a black matrix layer located between the color film substrate and the common electrode layer, wherein the sensing electrodes, the driving electrodes and the dummy electrodes are isolated and insulated from each other by gaps in the common electrode layer, and the gaps are covered by the black matrix layer.

[0012] Preferably, the driving electrodes located in a same row are connected to one another through a first wiring to form a driving line, and the sensing electrodes in a particular column are connected to one another through a second wiring to form a sensing line; or the driving electrodes in a particular column are connected to one another through a first wiring to form a driving line, and the sensing electrodes in a particular row are connected to one another through a second wiring to form a sensing line.

[0013] Preferably, the common electrode layer and the first wiring for electrically connecting the driving electrodes to one another are on a particular conductive layer, and the second line for electrically connecting the sensing electrodes is a conductive bridging which is on a different conductive layer from the common electrode layer; or the common electrode layer and the second wiring for electrically connecting the sensing electrodes to one another are on a particular conductive layer, and the first wiring for electrically connecting the driving electrodes to one another is a conductive bridging which is on a different conductive layer from the common electrode layer.

[0014] Preferably, all the dummy electrodes are electrically connected to one another.

[0015] Preferably, the plurality of driving electrodes are square electrodes arranged in an array, strip-shaped sensing electrodes are disposed between every two adjacent columns of driving electrodes, and the dummy electrodes are disposed between the driving electrode and sensing electrode adjacent to the driving electrode, each of the dummy electrodes is in an H shape and the H-shaped dummy electrodes in each row being connected to one another; or the plurality of sensing electrodes are square electrodes arranged in an array, strip-shaped driving electrodes are disposed between every two adjacent columns of sensing electrodes, and the dummy electrodes are disposed between the sensing electrode and the driving electrode adjacent to the driving electrode, each of the dummy electrodes is in an H shape and the H-shaped dummy electrodes in each row being connected to one another.

[0016] Preferably, the dummy electrodes in a particular row are electrically connected to one another through a third wiring, and the common electrode layer and the third wiring are on a same conductive layer.

[0017] Preferably, the driving electrodes and the sensing electrodes are rhombic and are arranged in an array, the dummy electrode are disposed between the sensing electrode and the driving electrode adjacent to each other, and the dummy electrode is a hollowed-out rhombic electrode having a hollowed-out part in which driving electrode or the sensing electrode is disposed.

[0018] Preferably, the sensing electrodes in a particular column are connected to one another to form a sensing line, and the driving electrodes in a particular row are connected to one another to form a driving line.

[0019] Preferably, the dummy electrodes in a particular row or in a particular column are electrically connected to one another through a conductive bridging which is on a different conductive layer from the common electrode layer.

[0020] The TN LCD device further comprises: a gate electrode layer disposed on a surface of the array substrate facing the liquid crystal layer, wherein the gate electrode layer comprises gate electrodes and scanning lines; a first insulating layer disposed on the gate electrode layer; a silicon island disposed on the first insulating layer; a source/drain electrode layer disposed on the silicon island, wherein the source/drain electrode layer comprises source electrodes, drain electrodes and data lines, and the gate electrode within the gate electrode layer, the first insulating layer, the silicon island, the source electrode and the drain electrode collectively form a thin film transistor structure; a second insulating layer disposed on the source/drain electrode layer; a pixel electrode layer disposed on the second insulating layer; and a third insulating layer disposed between the second insulating layer and the pixel electrode layer.

[0021] Preferably, the third insulating layer is an organic film layer.

[0022] Preferably, the thickness of the third insulating layer ranges from 1μm to 10μm.

[0023] The TN LCD device further includes a first transparent electrode layer disposed between the first insulating layer and the gate electrode layer, wherein the first transparent electrode layer covers the scanning lines of the gate electrode layer and does not cover an area of the gate electrodes at the gate electrode layer; and a fourth insulating layer disposed between the first transparent electrode layer and the gate electrode layer.

[0024] Alternatively, the first transparent electrode layer is disposed between the second insulating layer and the third insulating layer, wherein the first transparent electrode layer covers the data lines and the scanning lines, but does not cover an area of the thin film transistors.

[0025] In both cases,, the first transparent electrode layer is disposed opposite to the common electrode layer, and plan views of the areas of the first transparent electrode layer and the common electrode layer which are opposite to each other are the same except for the area of the thin film transistors.

[0026] Preferably, the dummy electrode block of the first transparent electrode layer is connected to the sensing electrode block located in the hollowed-out part of the dummy electrode block.

[0027] Another inventive aspect is a method of controlling a twisted nematic liquid crystal display device, for performing detection of touch signal. The method includes dividing a time-sharing period during display into a first duration and a second duration, where during the time-sharing period, the common electrode layer is configured to detect a touch signal and to provide a common electrode signal. The second duration is shorter than a retention time of liquid crystal molecules and is longer than or equal to a scanning time for one detection of the touch signal by the common electrode layer. In addition, the retention time of liquid crystal molecules is a time period during which the liquid crystal molecules maintain a previous state when a driving voltage of the common electrode layer changes. The method also includes, during the first duration, applying a same common potential to a plurality of sensing electrodes, to a plurality of driving electrodes, and to a plurality of dummy electrodes of the common electrode layer to achieve normal display. The method also includes, during the second duration, grounding the dummy electrodes and applying a driving voltage for touch detection to the sensing electrodes and to the driving electrodes of the common electrode layer..

[0028] During the first duration of the time-sharing period, the first transparent electrode layer is grounded, wherein during the second duration, the parts of the first transparent electrode layer opposite to the driving electrodes and the corresponding driving electrodes are applied a same signal, and the parts of the first transparent electrode layer opposite to the sensing electrodes and the dummy electrodes are grounded.

[0029] Preferably, the duration of the time-sharing period is equal to the duration of a scanning period of the LCD device.

[0030] Preferably, the duration of the first duration is greater than half of the duration of the time-sharing period and the second duration is less than half of the duration of the time-sharing period.

[0031] Preferably, the duration of the second duration is less than 8ms.

[0032] Preferably, the duration of the second duration is equal to 3ms.

[0033] Compared to the prior art, the solutions according to the embodiment of the present invention may have at least one of the following advantages.

[0034] The TN LCD device of the present invention comprises the common electrode layer on a surface of the color film substrate facing the liquid crystal layer, and the common electrode layer comprises a plurality of sensing electrodes, driving electrodes and dummy electrodes for performing functions of touch control. As compared to the existing TN LCD device integrated with the touch control function, two glass substrates in the touch panel of the existing TN LCD device may be saved. That is, the TN LCD device of the present invention is lighter and thinner, the thickness and manufacturing costs of the whole device are reduced, and the manufacturing process is simplified.

[0035] The control method of a TN LCD device according to the present invention is performed by the TN LCD device. During the display, a common voltage and a driving voltage of touch detecting are sequentially applied to corresponding electrodes in the common electrode layer in one time-sharing period, to achieve normal display and touch detection. Furthermore, it is guaranteed that the duration for the touch driving process is shorter than the retention time of liquid crystal molecules and longer than or equal to the scanning time for one detection of touch signal performed by the common electrode layer, so as to maintain normal display during the touch detection, namely, the touch detection is achieved during normal display.

BRIEF DESCRIPTION OF THE DRAWINGS

[0036]

Figure 1 is a schematic sectional diagram of a TN LCD device according to a first example useful for understanding the present invention;
Figure 2 is a plan view of a common electrode layer according to the first example;
Figure 3 is a plan view of a common electrode layer according to a second example useful for understanding the present invention;
Figure 4 is a schematic diagram showing a certain principle of touch detection in a capacitive touch panel;
Figure 5 is a schematic diagram showing another principle of touch detection in a capacitive touch panel;
Figure 6 is a schematic sectional diagram of a TN LCD device according to a third example useful for understanding the present invention;
Figure 7 is a schematic sectional diagram of a TN LCD device according to a first embodiment of the present invention;
Figure 8 is a schematic plan view of a first transparent electrode layer according to the first embodiment of the present invention;
Figure 9 is a schematic diagram showing the control means for electrodes of a TN LCD device according to a second embodiment of the present invention; and
Figure 10 is a schematic diagram showing the control means for driving electrodes and sensing electrodes on a common electrode layer of a TN LCD device according to the second embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0037] In order to make objects, technical solutions and advantages of embodiments of the present invention to be clearer, in the following the technical solutions according to the embodiments of the present invention will be clearly and fully described in conjunction with the drawings. Apparently, the embodiments to be described are only some of the embodiments of the present invention but not all the embodiments of the present invention.

[0038] As described in the background of the present invention, the existing TN LCD device integrated with a touch control function requires at least four glass substrates, causing a greater thickness and a higher manufacturing cost of the TN LCD device.

[0039] In view of this, a TN LCD device is provided. The TN LCD device includes: an array substrate, a color film substrate disposed opposite to the array substrate, and a liquid crystal layer disposed between the array substrate and the color film substrate; a common electrode layer disposed on a surface of the color film substrate facing the liquid crystal layer, wherein the common electrode layer includes a plurality of sensing electrodes, a plurality of driving electrodes and a plurality of dummy electrodes located between the sensing electrodes and the driving electrodes, and the sensing electrodes, the driving electrodes and the dummy electrodes are insulated from each other.

[0040] Since the common electrode layer comprises a plurality of sensing electrodes, a plurality of driving electrodes and a plurality of dummy electrodes, the common electrode layer can perform functions of touch control. Therefore, a touch panel is saved, which allows the TN

LCD device integrated with the touch control function to be lighter and thinner.

[0041] A control method of the TN LCD device for performing detection of touch signal during normal display, includes: dividing a time-sharing period during normal display into a first duration and a second duration. The time-sharing period refers to a period in which the common electrode layer performs detection of touch signal and provides common electrode signal. The second duration is shorter than the retention time of liquid crystal molecules and longer than or equal to the scanning time for one detection of touch signal performed by the common electrode layer. The retention time of liquid crystal molecules refers to the time duration in which the liquid crystal molecules maintain the previous state when a driving voltage applied to the common electrode layer changes. During the first duration, the sensing electrodes, driving electrodes and dummy electrodes of the common electrode layer are applied a same common potential to achieve normal display. During the second duration, a driving voltage of touch detecting is applied to the sensing electrodes and the driving electrodes of the common electrode layer and the dummy electrodes are grounded for the detection of touch signal.

[0042] According to the method, a common voltage and a driving voltage of touch detecting are sequentially applied to corresponding electrodes in the common electrode layer to achieve normal display and touch detection. Furthermore, it is guaranteed that the duration for the touch driving process is shorter than the retention time of liquid crystal molecules and longer than or equal to the scanning time for one detection of touch signal performed by the common electrode layer, so the normal display is maintained during the touch detection, namely, the touch detection is achieved during normal display.

[0043] The core ideas of the present invention are described above. In the following, the technical solutions according to embodiments of the present invention will be clearly, fully described in conjunction with the drawings. Apparently, the described embodiments are only some of but not all the embodiments of the present invention.

First example

[0044] A TN (twisted nematic) LCD device is disclosed according to a first example useful for understanding the present invention. As shown in the sectional view in Figure 1, the LCD device includes:

an array substrate 109, a color film substrate 101 disposed opposite to the array substrate 109, and a liquid crystal layer 103 disposed between the array substrate 109 and the color film substrate 101; wherein the array substrate and the color film substrate are generally glass substrates;

a gate electrode layer disposed on a surface of the array substrate 109 facing the liquid crystal layer 103, where the gate electrode layer includes gate electrodes 111 and scanning lines (not shown), the scanning lines and the gate electrodes 111 are formed on a same conductive layer and electrically connected to each other, the scanning line is used to switch on/off of a thin film transistor (TFT), and the gate electrode layer may be made of a metal or a transparent conductive material such as indium tin oxide;

a first insulating layer 107 disposed on the gate electrode layer, wherein the first insulating layer 107 is made of at least one of silicon nitride, silicon oxide and silicon oxynitride, and preferably is made of silicon nitride in this example; a silicon island disposed on the first insulating layer 107, wherein the silicon island includes a amorphous silicon layer 112 and a heavily doped amorphous silicon layer 113 both are located above the first insulating layer 107, and preferably the heavily doped amorphous silicon layer 113 is a N-type heavily doped amorphous silicon layer;

a source/drain electrode layer 114 disposed on the silicon island, wherein the source/drain electrode layer 114 includes source electrodes, drain electrodes and data lines, and the gate electrode within the gate electrode layer, the first insulating layer, the silicon island, the source electrode and the drain electrode form a TFT structure collectively;

a second insulating layer 106 disposed on the source/drain electrode layer 114 for isolating the source/drain electrode layer 114 from a pixel electrode layer;

the pixel electrode layer 104 disposed on the second insulating layer 106, wherein the pixel electrode layer 104 is a transparent conductive layer, which is made of indium tin oxide (ITO), indium zinc oxide (IZO) or the combination of ITO and IZO; the source electrode of the TFT is connected to the data line and the drain electrode of the TFT is connected to the pixel electrode to control the display of the pixel electrode; and

a common electrode layer 102 disposed on a surface of the color film substrate 101 facing the liquid crystal layer, wherein the common electrode layer 102 includes a plurality of sensing electrodes, a plurality of driving electrodes and a plurality of dummy electrodes located between the sensing electrodes and the driving electrodes, the sensing electrodes, the driving electrodes and the dummy electrodes are insulated from each other.

[0045] According to this example, the common electrode layer 102 may be preferably a transparent conductive layer, and be made of ITO, IZO or the combination of ITO and IZO.

[0046] The plan view of the common electrode layer 102 according to this example is shown in Figure 2. The driving electrodes 1021 and the sensing electrodes 1022 are rhombic electrodes arranged in an array. A dummy electrode 1023 is disposed between a driving electrode 1021 and a sensing electrode 1022 which are adjacent to each other. The dummy electrode 1023 is a hollowed-out rhombic electrode having a hollowed-out part in which a driving electrode 1021 or a sensing electrode 1022 is disposed. Specifically, taking the first right column in Figure 2 as an example, driving electrodes 1021 are disposed in the hollowed-out parts of the dummy electrodes 1023; and taking the second right column in Figure 2 as an example, sensing electrode 1022 are disposed in the hollowed-out parts of the dummy electrodes 1023.

[0047] The driving electrode 1021, the sensing electrode 1022 and the dummy electrode 1023 are isolated and insulated from each other by gaps between any two of them. In this example, the gaps are preferably overlapped with a black matrix layer on the color film substrate in order to further improve the aperture ratio of the LCD device. That is, the black matrix layer, located between the color film substrate and the common electrode layer, may cover the gaps.

[0048] According to the example, a plurality of driving electrodes 1021 in a same row are connected to one another through a first wiring to form a driving line 1026, and a plurality of sensing electrodes 1022 in a same column are connected to one another through a second wiring to form a sensing line 1027. Since the first wiring is inevitably intersected with the second wiring, one of the first wiring and the second wiring must connect to the corresponding electrodes in a form of a conductive bridging in order to guarantee that the first wiring and the second wiring are insulated from each other.

[0049] Specifically, the plurality of driving electrodes 1021 are connected in such a way that the common electrode layer 102 and the first wirings for electrically connecting the driving electrodes to one another are on a same conductive layer, and meanwhile the plurality of sensing electrodes 1022 are connected in such a way that the second wirings for electrically connecting the sensing electrodes 1022 are conductive bridgings 1024 which are on a different conductive layer from the common electrode layer 102. Alternatively, the plurality of sensing electrodes 1022 are connected in such a way that the common electrode layer 102 and the second wirings for electrically connecting the sensing electrodes 1022 to one another are on a same conductive layer, and meanwhile the plurality of driving electrodes 1021 are connected in such a way that the first wirings for electrically connecting the driving electrodes 1021 are conductive bridgings 1024 which are on a different conductive layer from the common electrode layer.

[0050] To facilitate the applying of a same potential to all the electrodes of the common electrode layer simultaneously for implementing normal display, in the example, all the dummy electrodes 1023 are electrically connected to one another. For the connection of a column of dummy electrodes perpendicular to the driving line 1026, the dummy electrodes at the intersection with the driving line 1026 need to be electrically connected to the conductive bridging which is on a different conductive layer from the common electrode layer 102. For the connection of a row of dummy electrodes perpendicular to the sensing line 1027, the dummy electrodes at the intersection with the sensing line 1027 need to be electrically connected to the conductive bridging which is on a different conductive layer from the common electrode layer 102.

[0051] In other words, the dummy electrodes in a same row or a same column are electrically connected to one another via a third wiring to form a dummy electrode line 1028, and the third wiring is a conductive bridging on a different conductive layer from the common electrode layer 102. Thereafter, all the dummy electrode lines 1028 are applied a same potential or all the dummy electrode lines 1028 are extended through a same electrode lead, so that all the dummy electrodes 1023 are electrically connected together.

[0052] It is to be understood by those skilled in the art that the arrangement of the driving electrodes and the sensing electrodes may be interchangeable. In the example, explanation is made by taking the case that the driving lines are arranged in the horizontal direction and the sensing lines are arranged in the vertical direction as an example. In other examples, the driving lines may be arranged in the vertical direction and the sensing lines may be arranged in the horizontal direction. That is, driving electrodes 1021 in a same column are connected to one another through the first wiring to form a driving line and sensing electrodes 1022 in a same row are connected to one another through the second wiring to form a sensing line.

Second example

[0053] Different from the structure of the common electrode layer of the TN LCD device disclosed in the above example, the plan view of the common electrode layer 102 of the TN LCD device according to the second example useful for understanding the present invention is shown in Figure 3. A plurality of driving electrodes 21 are square electrodes arranged in an array, and strip-shaped sensing electrodes 22 are disposed between every two adjacent columns of driving electrodes. A dummy electrode 23 is disposed between a driving electrode 21 and a sensing electrode 22 adjacent to each other. Each of the dummy electrodes 23 is in a H shape and the H-shaped dummy electrodes in each row are connected to one another.

[0054] Similar to the first example, driving electrodes 21 in a same row are connected to one another through a first wiring to form a driving line 26, strip-shaped sensing electrodes 22 in a same column are connected to one another through a second wiring to form a sensing line 27 and dummy electrodes 23 in a same row are connected to one another through a third wiring to form a dummy electrode line 28. Furthermore, in this example, all the dummy electrodes 23 are electrically connected to one another. As shown in Figure 3, dummy electrode lines 28 in different rows are extended through a same electrode lead in order to apply a same voltage to all the dummy electrodes simultaneously.

[0055] Since the first wiring is intersected with the second wiring, one of them is located on a same conductive layer as the common electrode layer 102 and the other is inevitably a conductive bridging which is on a different conductive layer from the common electrode layer 102. That is, the intersection 24 of the first wiring with the second wiring is inevitably configured in a conductive bridging structure. Similarly, since the second wiring is intersected with the third wiring, one of them is on a same conductive layer as the common electrode layer 102 and the other is inevitably a conductive bridging on a different conductive layer from the common electrode layer 102.

[0056] Due to a smaller width of the intersection 25 of the H-shaped dummy electrode 23 and the strip-shaped sensing electrode 22, the third wiring is preferably on a same conductive layer as the common electrode layer 102, that is, the strip-shaped sensing electrodes 22 are electrically connected to one another through conductive bridgings, to reduce the complexity of forming through-holes for bridgings.

[0057] Of course, the shape of the driving electrode may be exchanged with the shape of the sensing electrode. In other words, the plurality of driving electrodes are square electrodes arranged in an array, strip-shaped sensing electrodes are disposed between every two adjacent columns of driving electrodes, and the dummy electrode is disposed between the driving electrode and the sensing electrode adjacent to each other. Each of the dummy electrodes is in a H shape and the H-shaped dummy electrodes in each row are connected to one another. Furthermore, the arrangement of the driving electrodes may be exchanged with the arrangement of the sensing electrodes, that is, driving electrodes in a same column are connected to one another through the first wiring to form a driving line and sensing electrodes in a same row are connected to one another through the second wiring to form a sensing line.

[0058] In the above example, the common electrode layer 102 on the color film substrate includes a plurality of sensing electrodes, a plurality of driving electrodes and a plurality of dummy electrodes, wherein the common electrode layer 102 can perform functions of touch panel. Therefore, the touch panel is saved and the LCD is lighter and thinner as compared to the prior technology.

[0059] It is to be noted that the common electrode layer 102 in this example is further adapted to perform detection of touch signal in additional to normal display.

Third example

[0060] Based on the TN LCD device disclosed in each of the above two examples, the TN LCD device integrated with the touch control function disclosed in this third example useful for understanding the present invention performs detection of touch signal by the principle of touch detection preferably in a capacitive touch panel. The capacitive touch panel may determine whether a touch occurs and detect the position of the occurring touch through detecting changes in the mutual capacitance between the sensing electrodes and the driving electrodes.

[0061] The principle of touch detection in the capacitive touch panel is shown in Figure 4. A driving signal is applied to the driving electrode by the signal source 41, and a detecting circuit 42 is used for signal detection. When a pointing object (generally a finger) touch the surface of the touch panel, there exists a current flowing into the finger, and ideally only the capacitance value of the mutual capacitor C1 between the sensing electrode and driving electrode is changed, and then the minor change of the current caused by the change of the mutual capacitor C1 is detected by the detecting circuit 42, thus the position where the touch occurs is determined.

[0062] In this example, most areas of the common electrode layer 102 are disposed with conducting electrodes, and when the conducting electrodes are used for touch detection, parasitic capacitors inevitably exist between the common electrode layer 102 with any one of the pixel electrodes, the data lines, the scanning lines and the lower COM (located on a surface of the array substrate facing the liquid crystal layer, and used to form storage capacitors with the pixel electrodes). The parasitic capacitors formed between the driving electrodes of the common electrode layer 102 and any of the structures listed above are driving parasitic capacitors C2, and the parasitic capacitors formed between the sensing electrodes and any of the structures listed above are sensing parasitic capacitors C3.

[0063] Accordingly, in practical operation, when the signal source 41 sends an AC signal, the AC signal is sent into the detecting circuit 42 through a driving electrode resistor R1, the mutual capacitor C1 and an sensing electrode resistor R2; while the greater driving parasitic capacitor C2 and sensing parasitic capacitor C3 have smaller capacitive reactance with respect to the AC signal sent from the signal source 41, and respective equivalent resistor R3 and inductor of the data line and the scanning line may prevent the AC signal from flowing into the ground; thus the AC signal is allowed to sequentially pass through the driving parasitic capacitor C2 and the sensing parasitic capacitor C3, which form a current channel 43. After the AC signal passes through the current channel 43, a great basal signal (noise signal) is formed at the detecting circuit 42. Furthermore, since the signal corresponding to the change in the capacitance of mutual capacitor C1 is generally minor and tends to be submerged in the greater basal signal, it is difficult to detect the signal corresponding to the change in the capacitance of mutual capacitor C1 by the detecting circuit 42, causing failure in detection and decrease in the sensitivity of the touch control sensitivity of the LCD device.

[0064] In order to improve the sensitivity in touch control of the LCD device, as shown in Figure 6, the LCD device may further include a third insulating layer 105 disposed between the second insulating layer 106 and the pixel electrode layer 104. The third insulating layer 105 may be an organic film, and the thickness J of the organic film may be limited as following: $1\mu m <= J <= 10\mu m$,

[0065] The presence of the third insulating layer 105 functions to increase the distance between the two plates of the parasitic capacitor, thus the capacitances of the driving parasitic capacitor C2 and the sensing parasitic capacitor C3 are reduced, the capacitance change caused from the presence of the parasitic capacitor when the touch occurs is reduced in turn, and the noise is reduced, resulting in the improvement of sensitivity in touch control of the LCD device.

First embodiment

[0066] In order to further reduce the effect of the parasitic capacitor on touch detection, as shown in Figure 7, different from the above examples, the TN LCD device according to the first embodiment further includes: a first transparent electrode layer 108 disposed between the first insulating layer 107 and the gate electrode layer, where the first transparent electrode layer 108 covers the scanning lines of the gate electrode layer but does not cover an area of the gate electrodes at the gate electrode layer, and does not affect the normal operation of the TFTs; a fourth insulating layer 110 disposed between the first transparent electrode layer 108 and the gate electrode layer is used for isolating the gate electrode layer from the first transparent electrode layer 108.

[0067] Preferably, the first transparent electrode layer 108 is partially overlapped with the pixel electrodes to form storage capacitors with the pixel electrodes. That is, the first transparent electrode layer 108 servers as the lower COM of the LCD device and there is no need to additionally form the lower COM.

[0068] It is to be noted that the first transparent electrode layer 108 in this embodiment is arranged opposite to the common electrode layer 102, and plan views of the areas of the first transparent electrode layer 108 and the common electrode layer 102 which are opposite to each other are the same (namely in the area where the first transparent electrode layer 108 does not cover the TFTs), except for the area of the TFTs.

[0069] Taking the common electrode layer 102 disclosed in the first example as an example, the plan view of the first transparent electrode layer 108 according to the first embodiment is shown in Figure 8. Each of the dummy electrode blocks 33 in a same row on the first transparent electrode layer 108 is electrically connected to a sensing electrode block 32 in the hollowed-out part of the dummy electrode block 33 through a fourth wiring which is on a same conductive layer as the first transparent electrode layer 108. The dummy electrode blocks 33 and sensing electrode blocks 32 are leaded to a non-display area of the LCD device through second electrode leads 35.

[0070] The driving electrode blocks 31 in a same row on the first transparent electrode layer 108 are electrically connected to one another through a fifth wiring which is on a same conductive layer as the first transparent electrode layer 108, and the driving electrode blocks in respective rows are leaded to the non-display area of the LCD device through first electrode leads 34. That is, it is not necessary to use conductive bridgings for the connecting the electrode blocks to each other on the first transparent layer 108.

Second embodiment

[0071] with regard to the TN LCD device disclosed in the first embodiment, the control method of said TN-type LCD device is disclosed according to the second embodiment.

[0072] The control method is used to implement touch detection during normal display. The schematic diagram showing the means for performing control of the pixel electrodes, the scanning lines, the data lines, and individual electrodes on the first transparent conductive layer 108 is shown in Figure 9, and the schematic diagram showing the control of the driving electrodes and sensing electrodes of the common electrode layer is shown in Figure 10. In combination of the structure of the mentioned above TN-type LCD device, the method includes:

dividing a time-sharing period T during normal display into a first duration t1 and a second duration t2, where the time-sharing period is a period during which the common electrode layer 102 performs detection of touch signal and provides common electrode signal; the first duration t1 is the time duration for normal display and the second duration t2 is the time duration for touch driving.

[0073] It is to be noted that the length of the time-sharing period is not limited, as long as one complete touch detection can be accomplished in one time-sharing period. Generally, the time-sharing period has an equal length as the scanning period of the LCD device, namely the length of the time-sharing period generally equals to the reciprocal of the driving frequency of the LCD device.

[0074] Specifically, the second duration is shorter than the retention time of liquid crystal molecules and longer than or equal to the scanning time for one detection of touch signal performed by the common electrode layer (hereinafter referred to as touch scanning time, namely, the second duration t2), in order to guarantee that at least one touch scan can be performed during the second duration. Therefore, touch detection may be achieved when normal display is maintained.

[0075] It is to be noted that liquid crystal molecules have the characteristics of retention, that is, the inter-electrode capacitor may not disappear at once after the voltage applied to the liquid crystal molecules disappears, and the steering angle of the liquid crystal molecules may not be recovered to the original state and may be maintained until a voltage is applied again to the liquid crystal molecules. The retention time of liquid crystal molecules described in this embodiment is the time period in which the liquid crystal molecules maintain the previous state when the driving voltage applied to the common electrode layer 102 changes. In this embodiment, the first duration t1 is preferably greater than half of the duration of the time-sharing period and the second duration t2 is less than half of the duration of the time-sharing period.

[0076] Moreover, since the retention time t3 of liquid crystal molecules is often constant, generally about 8ms, and the time for one touch scanning of the common electrode layer is about 3ms, accordingly in this embodiment the second duration is preferably less than 8ms and more preferably is 3ms.

[0077] In the first duration, the driving electrodes 1021, sensing electrodes 1022 and dummy electrodes 1023 are applied a same common potential to achieve normal display. At this time, the pixel electrodes, scanning lines and data lines on the array substrate are driven in the normal display mode, and storage capacitors are formed between the first transparent electrode layer 108 and the pixel electrodes. Since the potential of the pixel electrodes during the normal display process is not zero, respective electrodes on the first transparent electrode layer 108 are always grounded;

[0078] It is to be noted, during the first duration t1, in order to prevent the ageing of the liquid crystal operating under the driving voltage in a same direction for a long time, the driving voltage applied to the pixel electrodes needs to change over time and the duration of the same voltage level should be less than the ageing time of the liquid crystal. Preferably, in this embodiment the driving voltage applied to the pixel electrodes is in the form of square wave, and the polarity of the square wave is changed in an alternating way with respect to the grounding state (zero potential in this embodiment). The manner for applying voltage to the scanning lines and the data lines is the same as that for the conventional display drive in the prior art, and will not be described here. Figure 9 is only used to show that the potentials of the scanning lines and the data lines are not zero during normal display.

[0079] During the second duration t2, a driving voltage of touch detecting is applied to the sensing electrodes 1022 and driving electrodes 1021 of the common electrode layer 102 and the dummy electrodes 1023 are grounded for detection of touch signal.

[0080] It is to be noted that during the second duration t2, the potential of the pixel electrodes is floating (may not be zero) and the power supply to the scanning lines and data lines is stopped; the parts in which the first transparent electrode layer 108 opposite to the driving electrodes 1021 (i.e., the areas of the driving electrode blocks 31 on the first transparent electrode layer 108) are connected to a same signal as the corresponding driving electrodes 1021, and the parts on the first transparent electrode layer 108 corresponding to the sensing electrodes 1022 and dummy electrodes 1023 (i.e., the areas of the sensing electrode blocks 32 and the dummy electrode blocks 33 on the first transparent electrode layer 108) are grounded.

[0081] Specifically, the control for the driving electrodes and sensing electrodes of the common electrode layer will be explained in conjunction with Figure 10. Tx indicates the driving line formed by electrically connecting the driving electrodes in a same row of the common electrode layer, Rx indicates the sensing line formed by electrically connecting the sensing electrodes in a same column of the common electrode layer. The horizontal coordinate indicates time and the vertical coordinate indicates voltage.

[0082] During the second duration t2, driving voltages (i.e., the Tx signals shown in Figure 10) are sequentially applied to individual driving lines (i.e., from driving line Tx2 to driving line Txn), and sensing signals are obtained by corresponding sensing lines Rx. Thereafter, the sensing signals are detected by the detecting circuit to determine the position where the touch occurs. Taking the driving line Tx1 as an example, a driving voltage is applied to the driving line Tx1 during time duration t21, and then a common voltage (i.e., COM voltage) is applied to the driving line Tx1 during time duration t22. Similarly, the driving voltages and the common voltage are sequentially applied to the driving lines (from driving line Tx2 to driving line Txn), to achieve the touch detection. During the first duration t1, the common voltage is simultaneously applied to all the driving lines, sensing lines and dummy electrode lines of the common electrode layer to achieve normal display.

[0083] In conjunction with Figure 4, Figure 5 and Figure 7, the parasitic capacitor between the common electrode layer 102 and the pixel electrode layer 104 will be analyzed. The mechanism of the parasitic capacitor affecting the detection process of the detection circuit 42 is that the charge-discharge process of the parasitic capacitor affects the charge-discharge of the mutual capacitor by the signal voltage which is provided by the signal source 41. Since the quantity of electricity of the pixel electrode is constant when the pixel electrode is floating, the floating pixel electrode can not be charged-discharged in the touch detection process. The floating pixel electrode will not be taken into account when the driving parasitic capacitance and sensing parasitic capacitance are calculated, because the floating electrode only affects the quantity of electricity and voltage of parasitic capacitor and does not affect the capacitance variation of parasitic capacitor, thus reducing the intensity of noise at the detecting circuit 42.

[0084] Next, the parasitic capacitor between the common electrode layer 102 and the first transparent electrode layer 108 will be analyzed. In the touch detection process, the potential applied to the driving electrode block 31 of the first transparent electrode layer 108 is the same as that applied to a driving electrode 1021 of the corresponding the common electrode layer 102, which is equivalent to apply a same potential to the two plates of the driving parasitic capacitor. Therefore, there is no current flowing through the driving parasitic capacitor, thus the effect of driving parasitic capacitor on the current variation measured by the detecting circuit is further eliminated.

[0085] Furthermore, since driving electrode block 31, the sensing electrode block 32 and the dummy electrode block 33 of the first transparent electrode layer 108 are isolated and separated from each other, and also the driving electrode 1021, the sensing electrode 1022 and the dummy electrode 1023 of the common electrode layer 102 are isolated and separated from each other, the channel of the driving parasitic capacitor formed between driving electrode 1021 and the driving electrode block 31 and the channel of the sensing parasitic capacitor formed between the sensing electrode 1022 and the sensing electrode block 32 are opened, as shown in Figure 5, the current path 43 in the Figure 4 is grounded, thus significantly reducing the AC signal sent by the signal source 41 which reaches the detecting circuit 42 through the driving parasitic capacitor C2 and the sensing parasitic capacitor C3, significantly reducing the intensity of basal signal formed at the detecting circuit 42 and improving the accuracy of the touch detection.

[0086] Next, the parasitic capacitor between the common electrode layer 102 and the scanning lines, and the parasitic capacitor between the common electrode layer 102 and data lines will be analyzed. Since the first transparent electrode layer 108 covers the scanning lines completely, the effect of signal variations in the scanning lines and data lines on the common electrode layer 102 are shielded, and thus the intensity of basal signal formed at the detecting circuit 42 is further reduced and the accuracy of the touch detection is improved.

Third embodiment

[0087] Different from the above embodiments, the first transparent electrode layer of the TN LCD device disclosed in this embodiment is disposed between the second insulating layer 106 and the third insulating layer 105, and the first transparent electrode layer covers the data lines and the scanning lines but does not cover the area of the TFTs.

[0088] The control method of the TN-type LCD device is the same as that disclosed in above embodiments, and difference between this embodiment and the above embodiments lies in that, since the first transparent electrode layer covers the data lines and the scanning lines, with regard to the parasitic capacitor between the common electrode layer 102 and the data lines and the parasitic capacitor between the common electrode layer 102 and the scanning lines, the first transparent electrode layer may shield effects of the data lines and scanning lines on the common electrode layer 102 due to the fact that the potential applied to the driving electrode block 31 of the first transparent electrode layer is same as that applied to the driving electrode 1021, therefore, the intensity of the basal signal formed at the detecting circuit 42 is further reduced to improve the accuracy of the touch detection.

[0089] The description of respective parts in the specification is made in a progressive way, each part focuses on a difference from the other parts, and the sameness between one part and other parts may be referred to by each other.

[0090] With the above descriptions of the disclosed embodiments, the skilled in the art may practice or use the present invention. Various modifications to the embodiments are apparent for the skilled in the art. The general principle suggested herein can be implemented in other embodiments without departing from the scope of the present invention. Therefore, the present invention should not be limited to the embodiments disclosed herein, but has the scope of the appended claims.

Claims

1. A twisted nematic liquid crystal display device integrated with a touch control function comprising:

an array substrate (109), a color film substrate (101) disposed opposite to the array substrate (109), and a liquid crystal layer (103) disposed between the array substrate (109) and the color film substrate (101); and

a common electrode layer (102) disposed on a surface of the color film substrate (101) facing the liquid crystal layer (103), wherein the common electrode layer (102) comprises a plurality of sensing electrodes (1022), a plurality of driving electrodes (1021) and a plurality of dummy electrodes (1023) located between the sensing electrodes (1022) and the driving electrodes (1021), and the sensing electrodes (1022), the driving electrodes (1021) and the dummy electrodes (1023) are insulated from one another; and

the twisted nematic liquid crystal display device further comprises:

a black matrix layer located between the color film substrate (101) and the common electrode layer (102), wherein the sensing electrodes (1022), the driving electrodes (1021) and the dummy electrodes (1023) are isolated and insulated from each other by gaps in the common electrode layer (102), and the gaps are covered by the black matrix layer;

a gate electrode layer disposed on a surface

of the array substrate (109) facing the liquid crystal layer (103), wherein the gate electrode layer comprises gate electrodes (111) and scanning lines;
a first insulating layer (107) disposed on the gate electrode layer;
a silicon island disposed on the first insulating layer (107);
a source/drain electrode layer (114) disposed on the silicon island, wherein the source/drain electrode layer (114) comprises source electrodes, drain electrodes and data lines; and the gate electrode (111) within the gate electrode layer, the first insulating layer (107), the silicon island, the source electrode and the drain electrode collectively form a thin film transistor structure;
a second insulating layer (106) disposed on the source/drain electrode layer (114);
a pixel electrode layer (104) disposed on the second insulating layer (106); and
a third insulating layer (105) disposed between the second insulating layer (106) and the pixel electrode layer (104); and
the twisted nematic liquid crystal display device further comprises one of:

1) a first transparent electrode layer (108) disposed between the first insulating layer (107) and the gate electrode layer, wherein the first transparent electrode layer (108) covers the scanning lines of the gate electrode layer and does not cover an area of the gate electrodes (111) at the gate electrode layer; and a fourth insulating layer (110) disposed between the first transparent electrode layer (108) and the gate electrode layer; and
2) a first transparent electrode layer (108) disposed between the second insulating layer (106) and the third insulating layer (105), wherein the first transparent electrode layer (108) covers the data lines and the scanning lines and does not cover an area of the thin film transistors; and

the first transparent electrode layer (108) is disposed opposite to the common electrode layer (102), and plan views of the areas of the first transparent electrode layer (108) and the common electrode layer (102) which are opposite to each other are the same except for an area of the thin film transistors.

2. The twisted nematic liquid crystal display device according to claim 1, wherein the driving electrodes (1021) in a particular row are connected to one another through a first wiring to form a driving line (1026), and the sensing electrodes (1022) in a particular column are connected to one another through a second wiring to form a sensing line (1027); or the driving electrodes (1021) in a particular column are connected to one another through a first wiring to form a driving line (1026), and the sensing electrodes (1022) in a particular row are connected to one another through a second wiring to form a sensing line (1027).

3. The twisted nematic liquid crystal display device according to claim 2, wherein the common electrode layer (102) and the first wiring for electrically connecting the driving electrodes (1021) to one another are on a same conductive layer, and the second wiring for electrically connecting the sensing electrodes (1022) to one another is a conductive bridging (1024) which is on a different conductive layer from the common electrode layer (102); or the common electrode layer (102) and the second wiring for electrically connecting the sensing electrodes (1022) to one another are on a same conductive layer, and the first wiring for electrically connecting the driving electrodes (1021) to one another is a conductive bridging (1024) which is on a different conductive layer from the common electrode layer (102).

4. The twisted nematic liquid crystal display device according to claim 1, wherein all the dummy electrodes (1023) are electrically connected to one another.

5. The twisted nematic liquid crystal display device according to claim 1, wherein the plurality of driving electrodes (1021) are square and are arranged in a array, strip-shaped sensing electrodes (1022) are disposed between every two adjacent columns of driving electrodes (1021), the dummy electrodes (1023) are disposed between the driving electrode (1021) and the sensing electrode (1022) adjacent to the driving electrode (1021), each of the dummy electrodes (1023) is in an H shape and the H-shaped dummy electrodes (1023) in each row are connected to one another; or the plurality of sensing electrodes (1022) are square electrodes arranged in an array, strip-shaped driving electrodes (1021) are disposed between every two adjacent columns of sensing electrodes (1022), the dummy electrodes (1023) are disposed between the sensing electrode (1022) and the driving electrode (1021) adjacent to the driving electrode (1022), each of the dummy electrodes (1023) is in an H-shape and the H-shaped dummy electrodes (1023) in each row are connected to one another, and the dummy electrodes (1023) in a particular row are electrically connected to one another through a third wiring, and the common electrode layer (102) and the third wiring are on a same conductive layer.

6. The twisted nematic liquid crystal display device according to claim 2, wherein the driving electrodes (1021) and sensing electrodes (1022) are rhombic and are arranged in an array, the dummy electrode (1023) are disposed between the driving electrode (1021) and the sensing electrode (1022) adjacent to each other, the dummy electrode (1023) is a hollowed-out rhombic electrode having a hollowed-out part in which driving electrode (1021) or sensing electrode (1022) is disposed, and the dummy electrodes (1023) in a particular row or in a particular column are electrically connected to one another through a conductive bridging (1024) which is on a different conductive layer from the common electrode layer (102).

7. The twisted nematic liquid crystal display device according to claim 1, wherein the dummy electrode block (33) of the first transparent electrode layer (108) is connected to the sensing electrode block (32) which is located in the hollowed-out part of the dummy electrode block (33).

8. A method of controlling the twisted nematic liquid crystal display device according to any one of claims 1 to 7 for performing detection of touch signal, the method comprising:

dividing a time-sharing period during display into a first duration and a second duration, wherein during the time-sharing period, the common electrode layer is configured to detect a touch signal and to provide a common electrode signal, wherein the second duration is shorter than a retention time of liquid crystal molecules and is longer than or equal to a scanning time for one detection of the touch signal by the common electrode layer, and wherein the retention time of liquid crystal molecules is a time period during which the liquid crystal molecules maintain a previous state when a driving voltage of the common electrode layer changes;
during the first duration, applying a same common potential to the plurality of sensing electrodes, to the plurality of driving electrodes, and to the plurality of dummy electrodes of the common electrode layer to achieve normal display; and
during the second duration, grounding the dummy electrodes and applying a driving voltage for touch detection to the sensing electrodes and to the driving electrodes of the common electrode layer; and
wherein during the first duration of the time-sharing period, the first transparent electrode layer (108) is grounded all the time; during the second duration, parts of the first transparent electrode layer (108) opposite to the driving electrodes (1021) and the corresponding driving electrodes (1021) are applied a same signal, and parts of the first transparent electrode layer (108) opposite to the sensing electrodes (1022) and the dummy electrodes (1023) are grounded.

9. The control method according to claim 8, wherein the duration of the time-sharing period is equal to the duration of a scanning period of the liquid crystal display device, the duration of the first duration is greater than half of the duration of the time-sharing period, and the duration of the second duration is less than half of the duration of the time-sharing period.

Patentansprüche

1. Ein Display basierend auf verdrillten nematischen Flüssigkristallen mit integrierter Touch-Bedienung, umfassend:

ein Array-Substrat (109), ein Substrat für eine Farbdünnschicht (101), welches gegenüberliegend zum Array-Substrat (109) angeordnet ist, und eine Flüssigkristallschicht (103), welche zwischen dem Array-Substrat (109) und dem Substrat für die Farbdünnschicht (101) angeordnet ist; und
eine gemeinsame Elektrodenschicht (102), welche auf einer Oberfläche des Substrats für die Farbdünnschicht (101) angebracht ist, welche der Flüssigkristallschicht (103) zugewandt ist,
wobei die gemeinsame Elektrodenschicht (102) eine Vielzahl von Sensorelektroden (1022) aufweist, eine Vielzahl von Treiberelektroden (1021) eine Vielzahl von Dummyelektroden (1023), welche zwischen den Sensorelektroden (1022) und den Treiberelektroden (1021) angeordnet sind,
wobei die Sensorelektroden (1021), die Treiberelektroden (1021) und Dummyelektroden (1023) voneinander isoliert sind; und
wobei das Display basierend auf verdrillten nematischen Flüssigkristallen aufweist:

eine schwarze Matrixschicht, welche zwischen dem Substrat für die Farbdünnschicht (101) und der gemeinsam Elektrodenschicht (102) angeordnet ist, wobei die Sensorelektroden (1022), die Treiberelektroden (1021) und die Dummyelektroden (1023) voneinander durch Spalte in der gemeinsamen Elektrodenschicht (102) isoliert

sind, wobei die Spalte durch die schwarze Matrixschicht bedeckt sind;
eine Gate-Elektrodenschicht, welche auf einer Oberfläche des Array-Substrats (109) angeordnet ist und welche der Flüssigkristallschicht (103) zugewandt ist, wobei die Gate-Elektrodenschicht Gateelektroden (111) aufweist und Scanlinien;
eine erste Isolationsschicht (107), welche auf der Gate-Elektrodenschicht angeordnet ist;
eine Siliziuminsel, welche auf der ersten Isolationsschicht (107) angeordnet ist;
Eine Source/Drain-Elektrodenschicht (114), welche auf der Siliziuminsel angeordnet ist, wobei die Source/Drain-Elektrodenschicht (114) SourceElektroden, Drain-Elektroden und Datenleitungen aufweist; und die Gate-Elektrode (111) innerhalb der Gate-Ektrodenschicht und der ersten Isolationsschicht (107) angeordnet ist, wobei die Siliziuminsel, die Source-Elektrode und die Drain-Elektrode gemeinsam eine Dünnfilm-Transistorstruktur bilden;
eine zweite Isolationsschicht (106), welche auf der Source/Drain-Elektrodenschicht (114) angeordnet ist;
eine Pixel-Elektrodenschicht (104), welche auf der zweiten Isolationsschicht (106) angeordnet ist; und
eine dritte Isolationsschicht (105), welche zwischen der zweiten Isolationsschicht (106) und der Pixel-Elektrodenschicht (104) angeordnet ist; und
wobei das Display auf Basis von verdrillten nematischen Flüssigkristallen aufweist:

1) eine erste transparente Elektrodenschicht (108), welche zwischen der ersten Isolationsschicht (107) und der Gate-Elektrodenschicht angeordnet ist, wobei die erste transparente Elektrodenschicht (108) die Scanlinien der Gate-Elektrodenschicht bedeckt und nicht eine Fläche der Gate-Elektrodenschicht (111) bedeckt an der Gate-Elektrodenschicht, und eine vierte Isolationsschicht (110), welche zwischen der ersten transparenten Elektrodenschicht (108) und der Gate-Elektrodenschicht angeordnet ist; und
2) eine erste transparente Elektrodenschicht (108), welche zwischen der zweiten Isolationsschicht (106) und der dritten Isolationsschicht (105) angeordnet ist, wobei die erste transparente Elektrodenschicht (108) die Datenleitungen und die bedeckt Scanlinien bedeckt und nicht eine Fläche der Dünnfilmtransistoren bedeckt; und

wobei die erste transparente Elektrodenschicht (108) gegenüber der gemeinsamen Elektrodenschicht (102) angeordnet ist, und Ebenenansichten der Flächen der ersten transparenten Elektrodenschicht (108) und der gemeinsamen Elektrodenschicht (102) welche gegenüberliegend zueinander angeordnet sind, das gleiche sind, ausgenommen von einer Fläche der Dünnfilmtransistoren.

2. Das Display basierend auf verdrillten nematischen Flüssigkristallen gemäß Anspruch 1, wobei die Treiberelektroden (102) in einer bestimmten Reihe miteinander verbunden sind durch eine erste Verdrahtung, um eine Antriebsleitung (1026) zu bilden und die Sensorelektroden (1022) in einer bestimmten Spalte miteinander verbunden sind durch eine zweite Verdrahtung, um eine Sensorverdrahtung (1027) zu bilden; oder die Treiberelektroden (1021) in einer bestimmten Spalte miteinander durch eine erste Verdrahtung verbunden sind, um eine Treiberverdrahtung (1026) zu bilden, und die Sensorelektroden (1022) in einer bestimmten Reihe miteinander verbunden sind durch eine zweite Verdrahtung, um eine Sensorleitung (1027) zu bilden.

3. Das Display basierend auf verdrillten nematischer Flüssigkristalle gemäß Anspruch 2, wobei die gemeinsame Elektrodenschicht (102) und die erste Verdrahtung zur elektrischen Verbindung der Treiberelektroden (1021) miteinander auf einer gleichen leitfähigen Schicht sind, und die zweite Verdrahtung zur elektrischen Verbindung der Sensorelektroden (1022) miteinander eine leitfähige Überbrückung (1024) ist, welche auf einer zur gemeinsamen Elektrodensicht (102) unterschiedlichen leitfähigen Schicht angeordnet ist; oder die gemeinsame Elektrodenschicht (102) und die zweite Verdrahtung zur elektrischen Verbindung der Sensorelektroden (1022) miteinander auf einer gemeinsamen leitfähigen Schicht angeordnet sind, und die erste Verdrahtung zur elektrischen Verbindung der Treiberelektroden (1021) miteinander eine leitfähige Überbrückung (1024) ist, welche auf einer unterschiedlichen leitfähigen Schicht angeordnet ist, als die gemeinsame Elektrodenschicht (102).

4. Das Display basierend auf verdrillten nematischen Flüssigkristallen gemäß Anspruch 1, wobei alle Dummyelektroden (1023) miteinander verbunden sind.

5. Das Display basierend auf verdrillten nematischen Flüssigkristallen gemäß Anspruch 1, wobei die Vielzahl an Treiberelektroden (1021) quadratisch sind und in einem Array angeordnet sind, streifenförmige Sensorelektroden (1022) sind zwischen jeder zweiten der benachbarten Spalten von Treiberelektroden (1021) angeordnet, die Dummy-Elektroden (1023) sind zwischen den Treiberelektroden (1021) und den Sensorelektroden (1022) benachbart zu den Treiberelektroden (1021) angeordnet, jeder der Dummy-Elektroden (1023) ist in einer H-Form und die H-förmige Dummy-Elektroden (1023) in jeder Reihe sind miteinander verbunden; oder die Vielzahl an Sensorelektroden (1022) sind quadratische Elektroden, welche in einem Array angeordnet sind, streifenförmige Treiberelektroden (1021) sind zwischen jeder zweiten benachbarten Spalte von Sensorelektroden (1022), die Dummy-Elektroden (1023) sind zwischen der Sensorelektrode (1022) und der Treiberelektrode (1021) benachbart zur Treiberelektrode (1022), jede der Dummy-Elektroden (1023) ist in einer H-Form und die H-förmigen Dummy-Elektroden (1023) in jeder Reihe sind miteinander verbunden, und die Dummy-Elektroden (1023) in einer bestimmten Reihe sind elektrisch miteinander verbunden durch eine dritte Verdrahtung und die gemeinsame Elektrodenschicht (102), und die gemeinsame Elektrodenschicht (102) und die dritte Verdrahtung sind auf einer gemeinsamen leitfähigen Schicht.

6. Das Display basierend auf verdrillten nematischen Flüssigkristallen gemäß Anspruch 2, wobei die Treiberelektroden (1021) und Sensorelektroden (1022) rhombisch sind und ihn einem Array angeordnet sind, die Dummy-Elektrode (1023) zwischen der Treiberelektrode (1021) und der Sensorelektrode (1022) benachbart zueinander angeordnet sind, die Dummy-Elektrode (1023) ist eine ausgehöhlte rhombische Elektrode, welche einen ausgehölten Teil aufweist, in welchem die Treiberelektrode (1021) oder sind Sensorelektrode (1022) angeordnet ist, und die Dummy-Elektroden (1023) in einer bestimmten Reihe oder in einem bestimmten Spalte elektrisch miteinander verbunden sind durch eine leitfähige Überbrückung (1024), welche auf einer unterschiedlichen leitfähigen Schicht zur gemeinsamen elektrischen Schicht (102) angeordnet ist.

7. Das Display basierend auf verdrillten nematischen Flüssigkristallen gemäß Anspruch 1, wobei der Dummy-Elektrodenblock (33) der ersten transparenten Elektrodenschicht (108) mit dem Sensor-Elektrodenblock (32) verbunden ist, welcher in dem ausgehöhlten Teil des Dummy-Elektrodenblocks (33) angeordnet ist.

8. Ein Verfahren zur Steuerung des Displays basierend auf verdrillten nematischen Flüssigkristallen entsprechend einem der Ansprüche 1 bis 7 zur Durchführung einer Detektion eines Berührungssignals, wobei das Verfahren umfasst:

Unterteilen einer Time-Sharing-Zeitspanne während dem Anzeigen in eine erste Zeitspanne und eine zweite Zeitspanne, wobei während der Time-Sharing-Zeitspanne, die gemeinsame Elektrodenschicht ausgebildet ist, ein Berührungssignal zu detektieren und ein gemeinsames Elektrodensignal bereitzustellen, wobei die zweite Zeitspanne kürzer ist als eine Verweilzeit von Flüssigkristall-Molekülen und länger oder gleichlang ist wie eine Scanzeit für eine Detektion eines Berührungssignals durch die gemeinsame Elektrodenschicht, und wobei die Verweilzeit der Flüssigkristall-Moleküle eine Zeitspanne ist, während welcher die Flüssigkristall-Moleküle einen vorhergehenden Status aufrechterhalten, wenn eine Antriebsspannung der gemeinsamen Elektrodenschicht sich verändert;
während der ersten Zeitspanne, Anwenden eines gleichen gemeinsamen Potenzials auf die Vielzahl von Sensorelektroden, auf die Vielzahl von Treiberelektroden und auf die Vielzahl von Dummy-Elektroden der gemeinsamen Elektrodenschicht, um ein normales Anzeigen zu erhalten; und
während der zweiten Zeitspanne, legen der Dummy-Elektroden auf Masse und Anlegen einer Betriebsspannung an die Sensorelektroden zur Berührungsdetektion und an die Treiberelektroden der gemeinsamen Elektrodenschicht; und
wobei während der ersten Zeitspanne der Time-sharing-Zeitspanne, die erste transparente Elektrodenschicht (108) auf Masse gelegt wird während der gesamten Zeit; während der zweiten Zeitspanne, an einem Teil der ersten transparenten Elektrodenschicht (108) gegenüberliegend zur Treiberelektrode (1021) und der korrespondierenden Treiberelektrode (1021) ein gleiches Signal angelegt wird, und Teile der ersten transparenten Elektrodenschicht (108) gegenüberliegend der Sensor-Elektroden (1022) und der Dummy-Elektroden (1023) auf Masse gelegt sind.

9. Das Steuerverfahren gemäß Anspruch 8, wobei die Zeitdauer der Time-Sharing-Zeitspanne gleich ist zur Dauer einer Scan-Zeitspanne des Flüssigkristall-Displays, die Zeitdauer der ersten Zeitspanne größer ist als die Hälfte der Time-Sharing-Zeitdauer, und die Dauer der zweiten Zeitspanne geringer ist als die Hälfte der Dauer der Time Sharing-Zeitspanne.

Revendications

1. Un dispositif d'affichage à cristaux liquides nématiques torsadés ayant une fonction de commande tactile intégrée, comprenant :

un substrat formant réseau (109), un substrat formant un film coloré (101), disposé à l'opposé du substrat formant réseau (109), et une couche de cristaux liquides (103) disposée entre le substrat formant réseau (109) et le substrat formant un film coloré (101) ; et
une couche formant électrode commune (102) disposée sur une surface du substrat formant un film coloré (101) tournée vers la couche de cristaux liquides (103),
la couche formant électrode commune (102) comprenant une pluralité d'électrodes de détection (1022), une pluralité d'électrodes de commande (1021) et une pluralité d'électrodes fictives (1023) situées entre les électrodes de détection (1022) et les électrodes de commande (1021), et les électrodes de détection (1022), les électrodes de commande (1021) et les électrodes fictives (1023) étant isolées les unes des autres ; et
le dispositif d'affichage à cristaux liquides nématiques torsadés comprend en outre :

une couche de matrice noire située entre le substrat formant un film couleur (101) et la couche formant électrode commune (102), les électrodes de détection (1022), les électrodes de commande (1021) et les électrodes fictives (1023) étant isolées les unes des autres par des espaces présents dans la couche formant électrode commune (102), et les espaces étant recouverts par la couche de matrice noire ;
une couche formant électrode de grille disposée sur une surface du substrat formant réseau (109) tournée vers la couche de cristaux liquides (103), la couche formant électrode de grille comprenant des électrodes de grille (111) et des lignes de balayage ;
une première couche isolante (107) disposée sur la couche formant électrode de grille ;
un îlot de silicium disposé sur la première couche isolante (107) ;
une couche formant électrode de source / drain (114) disposée sur l'îlot de silicium, dans lequel la couche formant électrode de source / drain (114) comprend des électrodes de source, des électrodes de drain et des lignes de données; et l'électrode de grille (111) à l'intérieur de la couche formant électrode de grille, la première couche isolante (107), l'îlot de silicium, l'électrode de source et l'électrode de drain formant collectivement une structure de transistor à couche mince ;
une deuxième couche isolante (106) disposée sur la couche formant électrode de source / drain (114) ;
une couche formant électrode de pixel (104) disposée sur la deuxième couche isolante (106) ; et
une troisième couche isolante (105) disposée entre la deuxième couche isolante (106) et la couche formant électrode de pixel (104) ; et
le dispositif d'affichage à cristaux liquides nématique torsadé comprend en outre un parmi :

1) une première couche formant électrode transparente (108) disposée entre la première couche isolante (107) et la couche formant électrode de grille, la première couche formant électrode transparente recouvrant les lignes de balayage de la couche formant électrode de grille et ne recouvrant pas une zone des électrodes de grille (111) au niveau de la couche formant électrode de grille ; et une quatrième couche isolante (110) disposée entre la première couche formant électrode transparente (108) et la couche formant électrode de grille ; et
2) une première couche formant électrode transparente (108) disposée entre la deuxième couche isolante (106) et la troisième couche isolante (105), la première couche formant électrode transparente (108) recouvrant les lignes de données et les lignes de balayage et ne recouvrant pas une zone des transistors à couches minces ; et

la première couche formant électrode transparente (108) est disposée à l'opposé de la couche formant électrode commune (102), et des vues en plan des zones de la première couche formant électrode transparente (108) et de la couche formant électrode commune (102) qui sont opposées l'une à l'autre sont les mêmes à l'exception d'une zone des transistors à couche mince.

2. Le dispositif d'affichage à cristaux liquides nématiques torsadés selon la revendication 1, dans lequel les électrodes de commande (1021) d'une rangée particulière sont reliées entre elles par un premier câblage pour former une ligne de commande (1026) et les électrodes de détection (1022) d'une colonne particulière sont connectées l'une à l'autre par l'intermédiaire d'un deuxième câblage pour former une ligne de détection (1027) ; ou les électrodes de commande (1021) d'une colonne particulière sont connectées les unes aux autres par un premier câblage pour former une ligne de commande (1026), et les électrodes de détection (1022) d'une rangée particulière sont connectées entre elles par un deuxième câblage pour former une ligne de détection (1027).

3. Le dispositif d'affichage à cristaux liquides nématiques torsadés selon la revendication 2, dans lequel la couche formant électrode commune (102) et le premier câblage pour connecter électriquement les électrodes de commande (1021) les unes aux autres sont sur une même couche conductrice, et le deuxième câblage pour relier électriquement les électrodes de détection (1022) les unes aux autres est un pontage conducteur (1024) qui se trouve sur une couche conductrice différente de la couche formant électrode commune (102) ; ou la couche formant électrode commune (102) et le deuxième câblage pour connecter électriquement les électrodes de détection (1022) les unes aux autres sont sur une même couche conductrice, et le premier câblage pour connecter électriquement les électrodes de commande (1021) les unes aux autres est un pontage conducteur (1024) qui est sur une couche conductrice différente de la couche formant électrode commune (102).

4. Le dispositif d'affichage à cristaux liquides nématiques torsadés selon la revendication 1, dans lequel toutes les électrodes fictives (1023) sont connectées électriquement les unes aux autres.

5. Le dispositif d'affichage à cristaux liquides nématiques torsadés selon la revendication 1, dans lequel les électrodes de la pluralité d'électrodes de commande (1021) sont carrées et sont agencées selon un réseau, des électrodes de détection en forme de bande (1022) sont disposées entre chaque paire de colonnes adjacentes d'électrodes de commande (1021), les électrodes fictives (1023) sont disposées entre l'électrode de commande (1021) et l'électrode de détection (1022) adjacente à l'électrode de commande (1021), chacune des électrodes fictives (1023) est en forme de H et les électrodes fictives (1023) en forme de H dans chaque rangée sont connectées les unes aux autres ; ou les électrodes de la pluralité d'électrodes de détection (1022) sont des électrodes carrées agencées selon un réseau, des électrodes de commande (1021) en forme de bande sont disposées entre chaque paire de colonnes adjacentes d'électrodes de détection (1022), les électrodes fictives (1023) sont disposées entre l'électrode de détection (1022) et l'électrode de commande (1021) adjacente à l'électrode de détection (1022), chacune des électrodes fictives (1023) est en forme de H et les électrodes fictives (1023) en forme de H dans chaque rangée sont connectées à les unes aux autres, et les électrodes fictives (1023) d'une rangée particulière sont connectées électriquement les unes aux autres par un troisième câblage, et la couche formant électrode commune (102) et le troisième câblage sont sur une même couche conductrice.

6. Le dispositif d'affichage à cristaux liquides nématiques torsadés selon la revendication 2, dans lequel les électrodes de commande (1021) et les électrodes de détection (1022) sont rhombiques et sont agencées selon un réseau, l'électrode fictive (1023) étant disposée entre l'électrode de commande (1021) et l'électrode de détection (1022) adjacente l'une à l'autre, l'électrode fictive (1023) est une électrode rhombique évidée ayant une partie évidée dans laquelle est disposée une électrode de commande (1021) ou une électrode de détection (1022), et des électrodes fictives (1023) d'une rangée particulière ou d'une colonne particulière sont reliées électriquement les unes aux autres par un pont conducteur (1024) qui se trouve sur une couche conductrice différente de la couche formant électrode commune (102).

7. Le dispositif d'affichage à cristaux liquides nématiques torsadés selon la revendication 1, dans lequel le bloc d'électrode fictive (33) de la première couche formant électrode transparente (108) est connecté au bloc d'électrode de détection (32) qui est situé dans la partie évidée du bloc d'électrode fictive (33).

8. Un procédé de commande du dispositif d'affichage à cristaux liquides nématiques torsadés selon l'une quelconque des revendications 1 à 7 pour effectuer une détection de signal tactile, le procédé comprenant :

le fait, durant l'affichage, de diviser une période de partage de temps en une première durée et une deuxième durée ; pendant cette période de partage de temps, la couche formant électrode commune est configurée pour détecter un signal tactile et pour fournir un signal d'électrode commune, la deuxième durée étant plus courte qu'un temps de rétention des molécules de cristaux liquides et étant supérieure ou égale à un temps de balayage pour une détection du signal tactile par la couche formant électrode commune, et le temps de rétention des molécules de cristaux liquides étant une période de temps pendant laquelle les molécules de cristal liquide maintiennent un état antérieur lorsqu'une tension de commande de la couche formant électrode commune change ;

pendant la première durée, le fait d'appliquer un même potentiel commun à la pluralité d'électrodes de détection, à la pluralité d'électrodes de commande et à la pluralité d'électrodes fictives de la couche formant électrode commune, afin d'obtenir un affichage normal ; et
pendant la deuxième durée, le fait de mettre à la masse les électrodes fictives et d'appliquer une tension de commande pour la détection tactile aux électrodes de détection et aux électrodes de commande de la couche formant électrode commune ; et
pendant la première durée de la période de partage de temps, la première couche formant électrode transparente (108) est mise à la masse tout le temps ; pendant la deuxième durée, des parties de la première couche formant électrode transparente (108) opposée aux électrodes de commande (1021) et des électrodes de commande correspondantes (1021) se voient appliquer un même signal, et des parties de la première couche formant électrode transparente (108) opposée aux électrodes de détection (1022) et aux électrodes fictives (1023) sont mises à la masse.

9. Le procédé de commande selon la revendication 8, dans lequel la durée de la période de partage de temps est égale à la durée d'une période de balayage du dispositif d'affichage à cristaux liquides, la durée de la première durée étant supérieure à la moitié de la durée période de partage de temps, et la durée de la deuxième durée est inférieure à la moitié de la durée de la période de partage de temps.

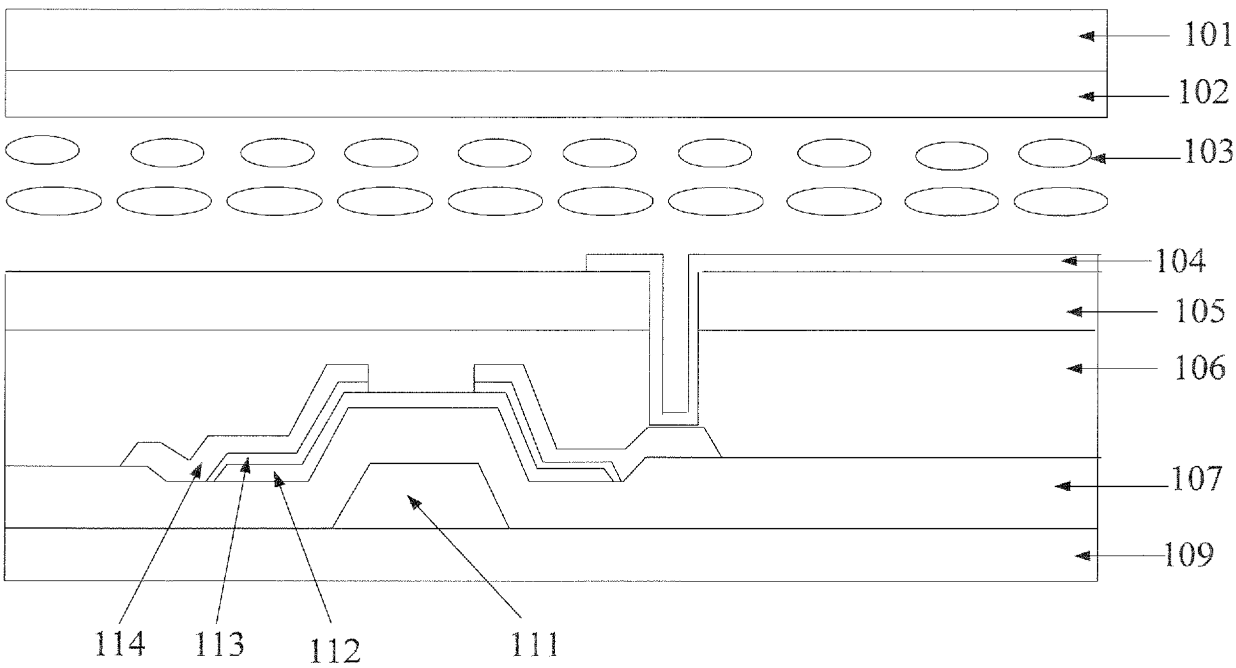

Figure 1

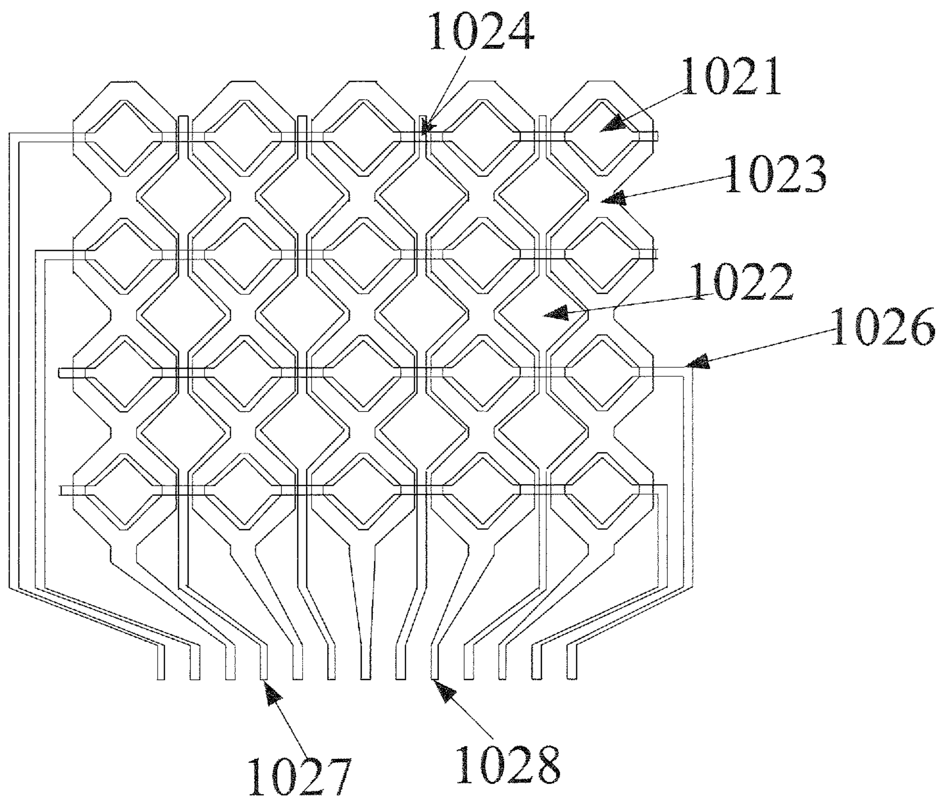

Figure 2

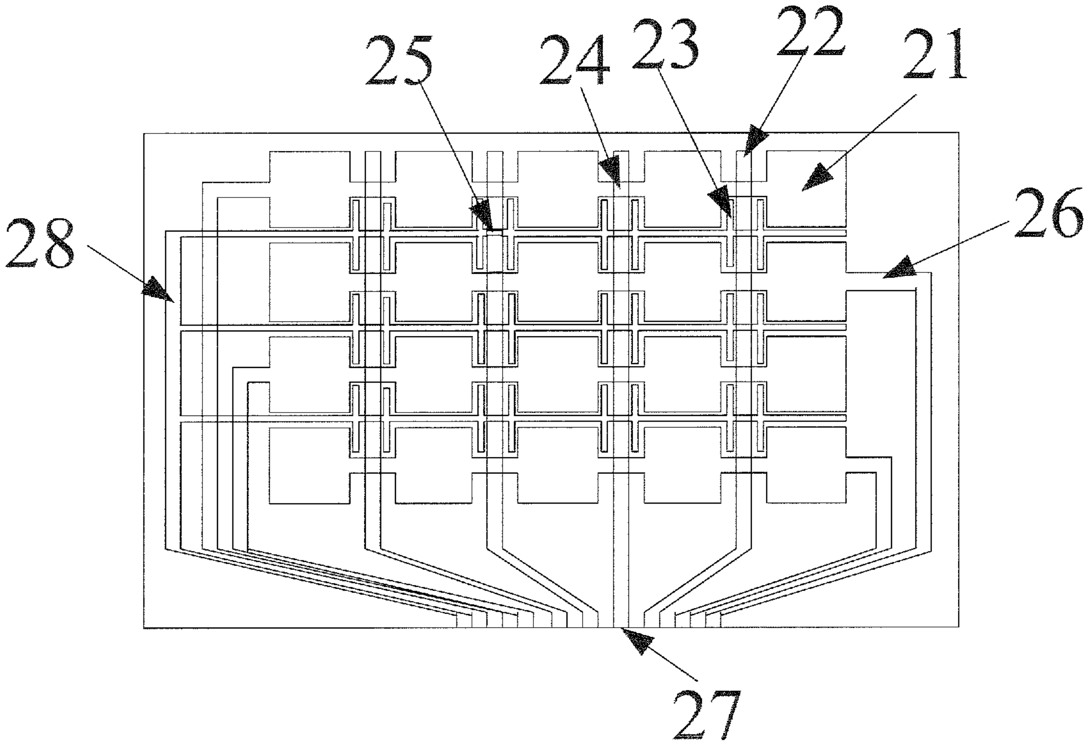

Figure 3

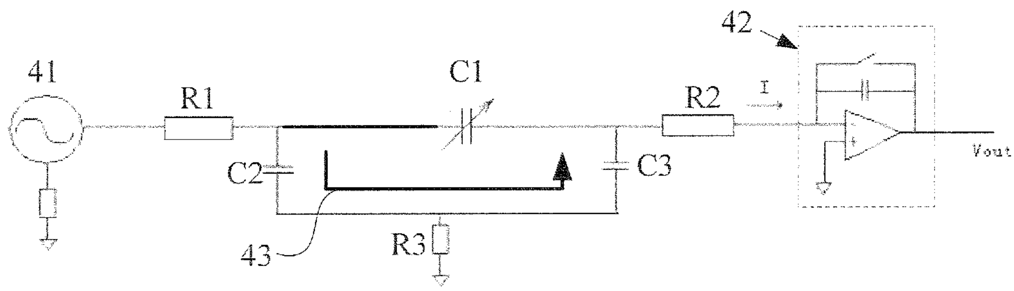

Figure 4

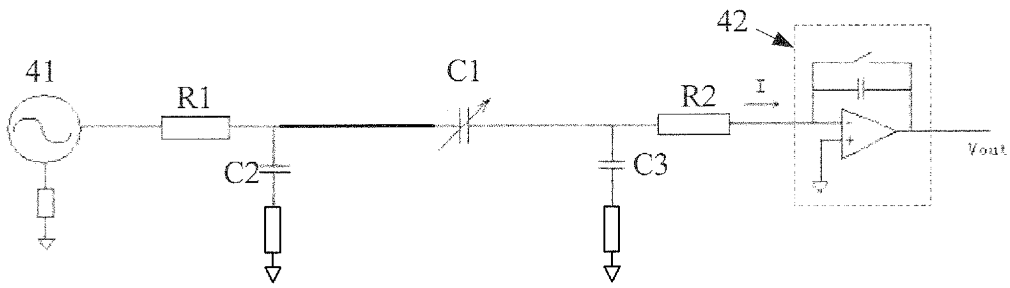

Figure 5

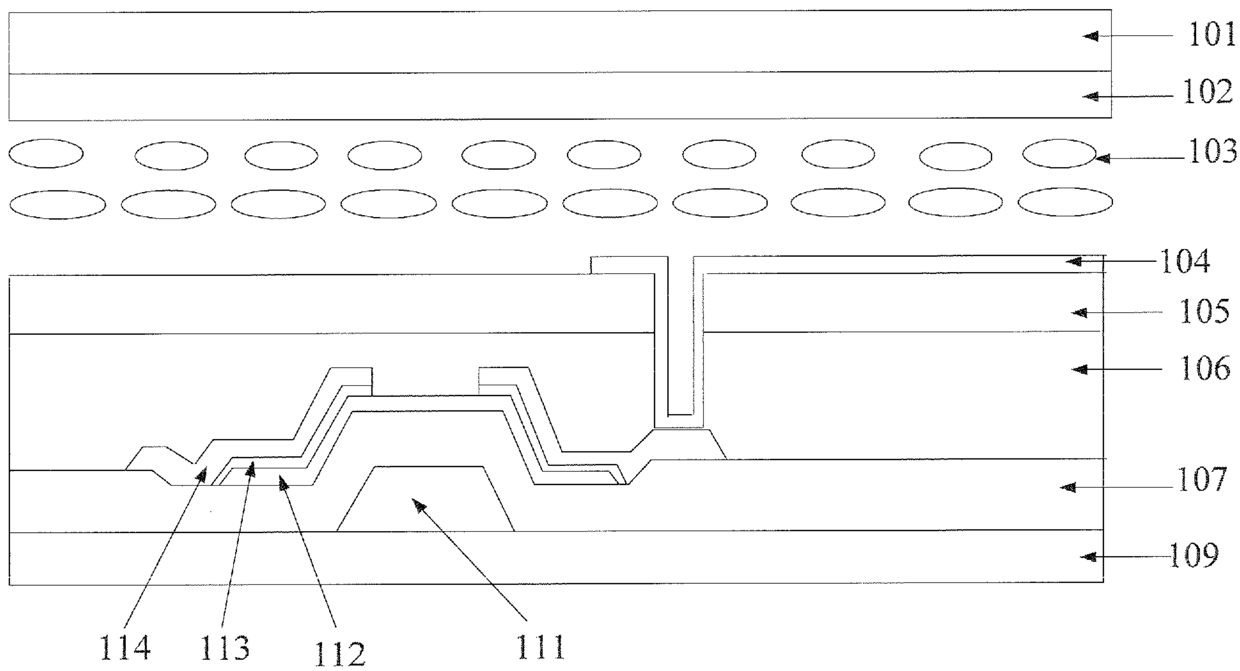

Figure 6

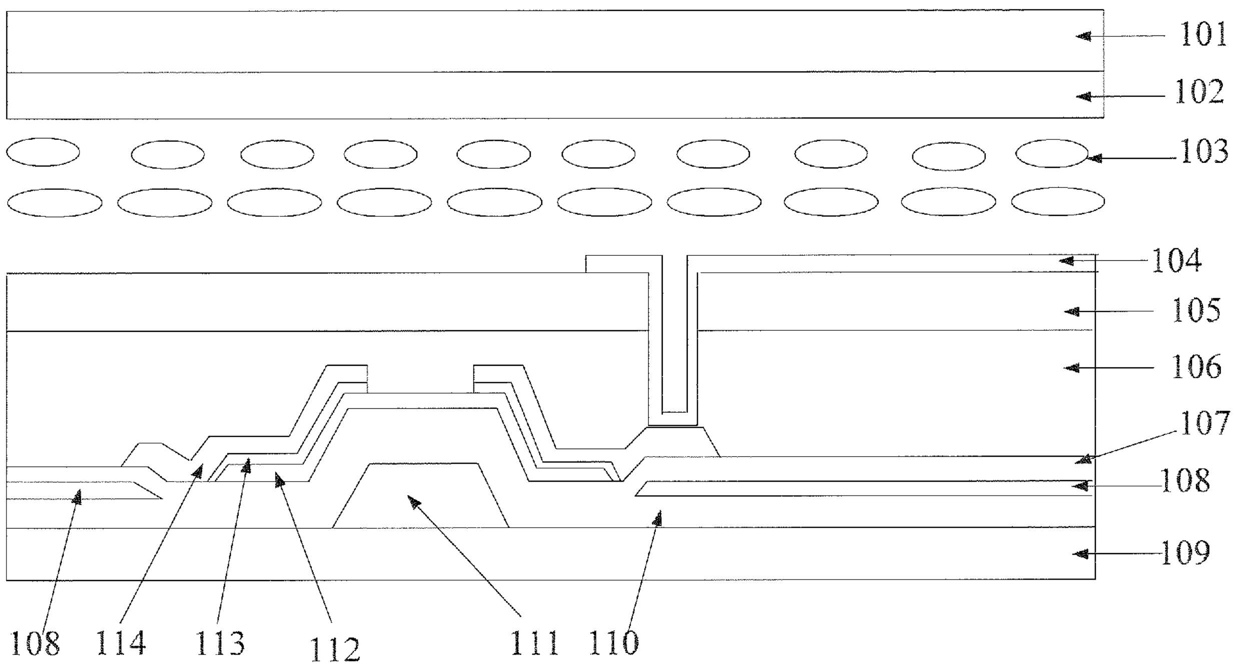

Figure 7

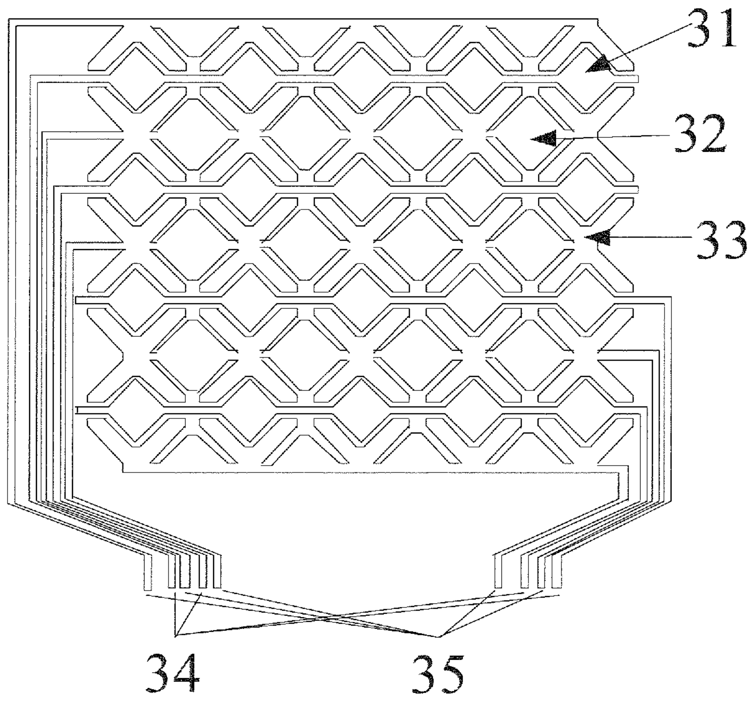

Figure 8

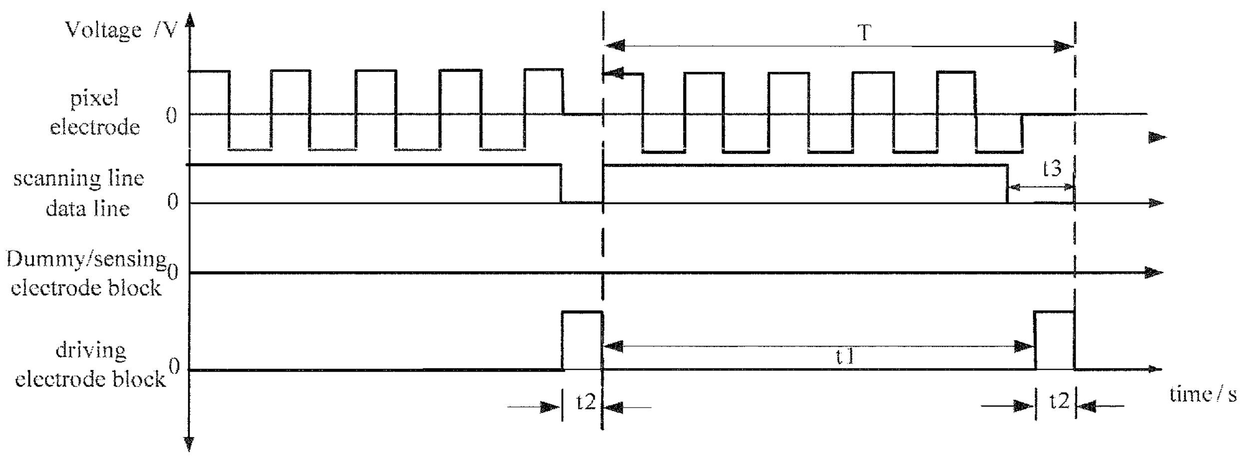

Figure 9

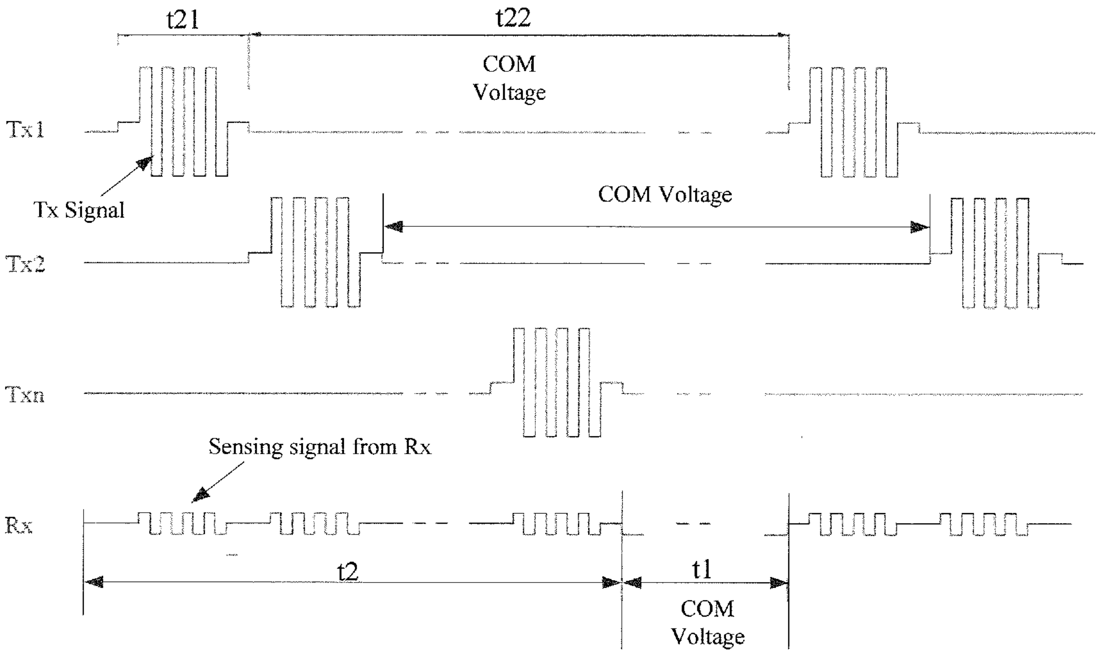
t21
t22
COM
Voltage
Tx1
Tx Signal
COM Voltage
Tx2
Txn
Sensing signal from Rx
Rx
t2
t1
COM
Voltage

Figure 10

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- EP 2506128 A2 **[0005]**
- WO 2012118514 A1 **[0006]**
- EP 2075677 A2 **[0007]**

专利名称(译)	TN液晶显示装置及其触控方法		
公开(公告)号	EP2746840B1	公开(公告)日	2018-02-14
申请号	EP2013193968	申请日	2013-11-22
[标]申请(专利权)人(译)	上海天马微电子有限公司		
申请(专利权)人(译)	上海天马微电子有限公司.		
当前申请(专利权)人(译)	上海天马微电子有限公司.		
[标]发明人	MA JUN ZHAO LIJUN		
发明人	MA, JUN ZHAO, LIJUN		
IPC分类号	G02F1/1333 G02F1/1343 G06F3/041 G06F3/044 G02F1/139		
CPC分类号	G02F1/13338 G02F1/134309 G02F1/1396 G02F2001/134318 G06F3/0412 G06F3/044 G06F3/041		
代理机构(译)	MAIWALD专利ADVOCATE GMBH		
优先权	201210567635.0 2012-12-24 CN		
其他公开文献	EP2746840A1		
外部链接	Espacenet		

摘要(译)

公开了一种集成有触控功能的扭曲向列液晶显示装置。该装置包括阵列基板（109），与阵列基板相对设置的彩膜基板（101），以及设置在阵列基板和彩膜基板之间的液晶层（103）。该器件还包括设置在彩色薄膜基板的面向液晶层的表面上的公共电极层（102）。公共电极层包括多个感测电极（1022），多个驱动电极（1021），以及位于感测电极和驱动电极之间的多个虚设电极（1023）。另外，感测电极，驱动电极和虚设电极彼此绝缘。

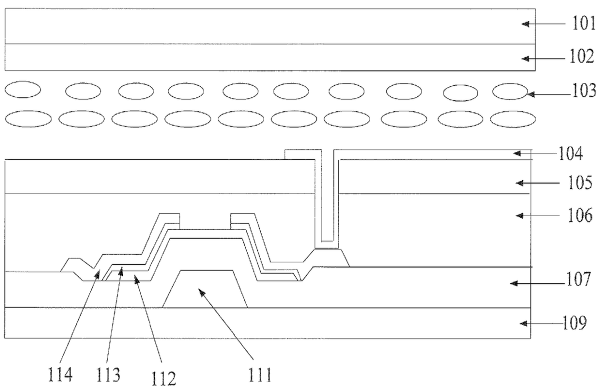

Figure 1