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(54) **Organic electroluminescent display with integrated resistive touch screen**

(57) An organic electroluminescent display with integrated touch screen, includes: a transparent substrate having two faces; a transistor switching matrix and a light emitting layer forming an active matrix electroluminescent display located on one face of the substrate for emitting light through the substrate; touch sensitive elements of a touch screen located on the other face of the substrate; components of a touch screen controller located on the one face of the substrate; and an electrical connector for connecting the components of the touch screen controller on the one face of the substrate to the touch screen elements on the other face of the substrate.

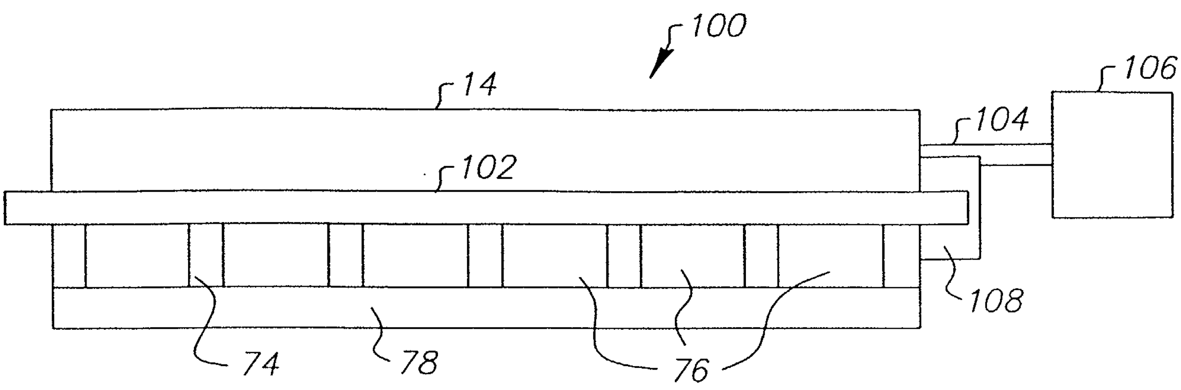

FIG. 5A

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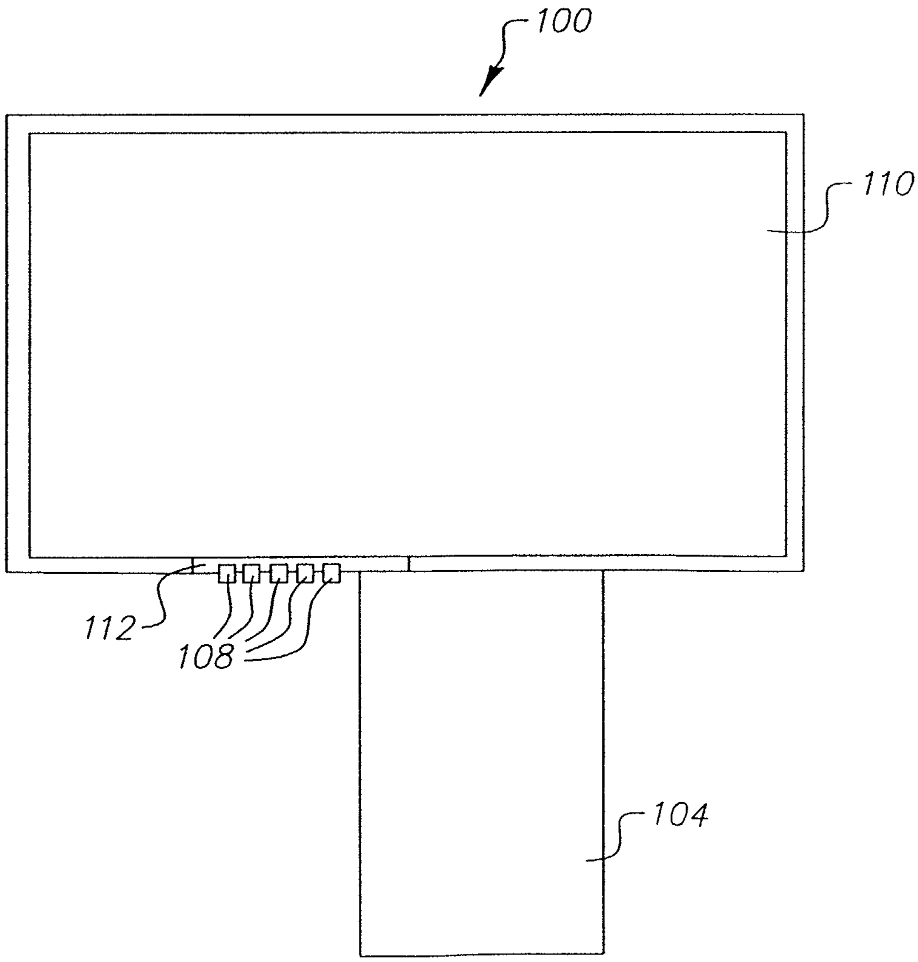


FIG. 5B

Description

[0001] This invention relates generally to color flat panel displays and, more particularly, to an electroluminescent flat panel display with a resistive touch sensitive panel.

[0002] Modern electronic devices provide an increasing amount of functionality with a decreasing size. By continually integrating more and more capabilities within electronic devices, costs are reduced and reliability increased. Touch screens are frequently used in combination with conventional soft displays such as cathode ray tubes (CRTs), liquid crystal displays (LCDs), plasma displays and electroluminescent displays. The touch screens are manufactured as separate devices and mechanically mated to the viewing surfaces of the displays.

[0003] There are three common types of resistive touch screens, 4-wire, 5-wire, and 8-wire. The three types share similar structures. Fig. 1a shows a top view of a resistive touch screen **10** and the external circuitry to which it is connected. Fig. 1b shows a side view of the resistive touch screen **10.** The touch sensitive elements **14** of the resistive touch screen **10** includes a lower circuit layer **20;** a flexible spacer layer **22** containing a matrix of spacer dots **24;** a flexible upper circuit layer **26;** and a flexible top protective layer **28.** All of these layers are transparent. The lower circuit layer **20** comprises conductive materials placed on a substrate **12,** forming a circuit pattern.

[0004] The main difference between 4-wire, 5-wire, and 8-wire touch screens is the circuit pattern in the lower circuit layer **20** and in the upper circuit layer **26,** and the means for making resistance measurements. An external controller **18** is connected to the touch screen circuitry via cable **16.** Conductors in cable **16** are connected to the circuitry within the lower circuit layer **20** and the upper circuit layer **26.** The external controller **18** coordinates the application of voltages to the touch screen circuit elements. When a resistive touch screen is pressed, the pressing object, whether a finger, a stylus, or some other object, deforms the top protective layer **28,** the upper circuit layer **26,** and the spacer layer **22,** forming a conductive path at the point of the touch between the lower circuit layer **20** and the upper circuit layer **26.** A voltage, called a touch coordinate voltage, is formed in proportion to the relative resistances in the circuit at the point of touch, and is measured by the external controller **18** connected to the other end of the cable **16.** The controller **18** then computes the (X, Y) coordinates of the point of touch. For more information on the operation of resistive touch screens, see "Touch Screen Controller Tips" by Osgood et al., Application Bulletin AB-158, Burr-Brown, Inc. (Tucson, Arizona).

[0005] The external controller **18** is typically an integrated circuit soldered to a printed circuit board **30.** Cable **16** is plugged into a connector **32** that is also soldered to the printed circuit board **30.** The conductors in the cable **16** connect to the external controller **18** via traces that are placed on the printed circuit board **30** that run between the external controller **18** and the connector **32.**

[0006] External controller **18** consists of three sub-circuits: a voltage application circuit **34,** a touch detection circuit **36,** and a multiplexing circuit **38.** The voltage application circuit **34** selects the placement of voltages on the touch screen's electrodes. The touch detection circuit **36** monitors the voltage read from the touch screen, decides when a touch has been performed, and computes the (X, Y) coordinates of the touch point. The (X, Y) coordinates of the touch point are then transferred to another integrated circuit **39** on the circuit board, often a microprocessor. External controllers are available commercially, for example, the ADS7846 by Texas Instruments (Dallas, Texas).

[0007] As shown in Fig. 2, the touch detection circuit **36** often contains an analog-to-digital converter **40** and a computation circuit **42.** Analog-to-digital converter **40** converts the analog voltage measured at the point of touch to a digital value. The computation circuit **42** is often an embedded processor or other circuit that can monitor the digital voltage value, detect the presence of a touch based on the voltage value, and compute the coordinate of the touch based on the magnitude of the digital voltage value. Other processing may be performed, such as averaging to minimize noise.

[0008] The multiplexing circuit **38** in Fig. 1a determines which conductors in the cable **16** are routed to the voltage application circuit **34** and to the touch detection circuit **36.** This routing changes for determining the X and Y coordinates. The external controller **18** is usually responsive to a clock generated on the printed circuit board **30,** and also has voltage inputs. The cable **16** would contain four conductors for 4-wire touch screens, five conductors for 5-wire touch screens, and eight conductors for 8-wire touch screens. The multiplexing circuit **38** would have two wires going to the voltage application circuit **34** and two wires going to the touch detection circuit **36** for 4-wire touch screens. The multiplexing circuit **38** would have four wires going to the voltage application circuit **34** and one wire going to the touch detection circuit **36** for 5-wire touch screens.

[0009] Fig. 3 shows a cross section view of a typical prior art electroluminescent display such as an organic light emitting diode (OLED) flat panel display **70** of the type shown in US Patent 5,937,272, issued August 10, 1999 to Tang. The OLED display includes a substrate **72** that provides mechanical support for the display device, a transistor switching matrix layer **74,** a light emission layer **78** containing materials forming organic light emitting diodes, and a cable **80** for connecting circuitry within the flat panel display to external controller **81.** The substrate **72** is typically glass, but other materials, such as plastic, may be used. The transistor switching matrix layer **74** contains a two-dimensional matrix of thin film transistors (TFTs) 76 that are used to select which pixel in the OLED display that receives image data at a given time. The thin film transistors **76** are manufactured using conventional semiconductor manufacturing processes, and therefore extra thin film transistors **76** may be used to form circuitry for a variety of uses. As mentioned in US Serial No. 09/774,221 filed January 30, 2001, by Feldman et al., the presence of TFTs within an active matrix flat panel display allow functions other than display functions to be implemented on the same substrate as the display function, producing a system-on-panel. The OLED display is responsive to control signals generated by external controller **81.** These control signals typically include a pixel clock (sometimes called a dot clock), a vertical synchronization signal (VSYNC), and a horizontal synchronization (HSYNC) signal.

[0010] Conventionally, when a touch screen is used with a flat panel display, the touch screen is simply placed over the flat panel display, and the two are held together by a mechanical mounting means such as a frame. Fig. 4 shows such an arrangement with a touch screen mounted on an OLED flat panel display. After the touch screen and the OLED display are assembled, the two substrates **12** and **72** are placed together in a frame **82,** often separated by a mechanical separator **84.** The resulting assembly contains two cables **16** and **80** that connect the touch screen and the flat panel display to external controllers **18** (see Fig. 1a) and **81** (see Fig. 3).

[0011] US Serial No. 09/826,194, filed April 4, 2001 by Siwinski et al. proposes a device in which an organic electroluminescent flat panel display is integrated with a touch screen, sharing a common substrate. This invention has advantages over existing touch screen and flat panel display combinations with decreased cost, no integration steps, decreased weight and thickness, and improved optical quality.

[0012] As mentioned above, an external controller **18** controls conventional resistive touch screens. Such resistive touch screens are manufactured for simplicity, and therefore do not contain semiconductor circuitry, such as thin film transistors, that can be used to implement a touch screen controller on the touch screen itself.

[0013] Conventionally, all signals controlling a touch screen and an active matrix flat panel display are brought into each device via conductors in two cables. Since there is similarity between the operation of a flat panel display and a touch screen, there is redundancy within the signals brought into the devices. This redundancy results in redundant conductors in the cables, adding to cable cost, and providing increased opportunities for noise to enter the devices via these conductors. Additionally, the associated connector or connectors on the printed circuit board contain redundant pins, further increasing system cost and opportunities for electronic noise injection.

[0014] There remains a need therefore for an improved touch screen-flat panel display system that minimizes device weight, removes redundant materials, decreases cost, eliminates special mechanical mounting design, and increases reliability.

[0015] The need is met according to the present invention by providing an organic electroluminescent display with integrated touch screen, that includes: a transparent substrate having two faces; a transistor switching matrix and a light emitting layer forming an active matrix electroluminescent display located on one face of the substrate for emitting light through the substrate; touch sensitive elements of a touch screen located on the other face of the substrate; components of a touch screen controller located on the one face of the substrate; and a electrical connector for connecting the components of the touch screen controller on the one face of the substrate to the touch screen elements on the other face of the substrate.

[0016] The present invention has the advantage that the number of conductors for making external connection to the device are minimized, thereby minimizing device weight, removing redundant materials, decreasing cost, eliminating special mechanical mounting design, and increasing reliability

Figs. 1a and 1b are schematic diagrams showing the basic structure of a prior art touch screen and its controller;

Fig. 2 is a schematic diagram of a prior art resistive touch screen controller;

Fig. 3 is a schematic diagram showing the structure of a prior art organic electroluminescent display;

Fig. 4 is a schematic diagram showing the combination of a touch screen with a flat panel electroluminescent display as would be accomplished using conventional techniques;

Figs. 5a and 5b are schematic diagrams showing the basic structure of an electroluminescent display with a touch screen and an integrated touch screen controller;

Fig. 6 is a schematic diagram of an electroluminescent touch screen display with components of a touch screen controller integrated on the display including a voltage selection circuit and a multiplexing circuit;

Fig. 7 is a schematic diagram of an electroluminescent touch screen display with components of a touch screen controller integrated on the display including a voltage selection circuit, a multiplexing circuit, an analog-to-digital converter, and a digital transmission circuit;

Fig. 8 is a schematic diagram of an electroluminescent touch screen display with components of a touch screen controller integrated on the display including a voltage selection circuit, a multiplexing circuit, analog-to-digital converter, a computation circuit, and a digital transmission circuit;

Fig. 9 is a schematic diagram showing a prior art 4-wire resistive touch screen;

Figs. 10a and 10b are schematic diagrams showing a 4-wire touch screen according to the present invention;

Fig. 11 is a schematic diagram of a voltage selection circuit and a multiplexing circuit for 4-wire touch screen controllers, according to the present invention;

Fig. 12 is a schematic diagram showing a prior art 5-wire resistive touch screen;

Figs. 13a and 13b are schematic diagrams showing a 5-wire touch screen according to the present invention; and

Fig. 14 is a schematic diagram of a voltage selection circuit and a multiplexing circuit for 5-wire touch screen controllers, according to the present invention.

[0017] Touch screen controllers are semiconductor integrated circuits manufactured using conventional CMOS manufacturing processes, and designed to use transistor switching technology. There is a similarity in the design and manufacturing processes of an active matrix flat panel display and a touch screen controller.

[0018] Both active matrix flat panel displays and touch screen controllers are controlled by various control signals synchronized to a clock. Additionally, voltages are applied to touch screens, touch screen controllers, and flat panel displays. Therefore, there is similarity between the operation of an active matrix flat panel display and a resistive touch screen controller.

[0019] Thus, according to the present invention, one or more components of a touch screen controller is integrated on a common substrate with the transistor switching matrix of an active matrix flat panel display.

[0020] Fig. 5a and b shows a display having an integrated touch screen and touch screen control components according to the present invention. An electroluminescent display generally designated **100** includes a single substrate **102** having a transistor switching matrix layer **74** and a light emission layer **78** containing materials of an electroluminescent display formed on one face of the substrate for emitting light through the substrate, touch sensitive elements **14** of a touch screen formed on the other face of the substrate **102,** and a single flex-cable **104** that can be used for connecting the electroluminescent display **100** with external electronics **106** as disclosed in copending US Serial No. 09/855,449, filed concurrently by Feldman et al. According to the present invention, the transistor switching matrix layer **74** contains thin film transistors **76** that in addition to providing control of the electroluminescent display, also implement a complete, or partial, resistive on-panel touch screen controller **112.** The light emission layer **78** contains electroluminescent materials, located in the center part of the electroluminescent display, in an area called the active area **110** of the electroluminescent display.

[0021] The substrate **102** is made of a transparent material, such as glass or plastic, and is thick enough to provide mechanical support for the transistor switching matrix layer **74,** the light emission layer **78,** and the touch sensitive elements **14.** Conductors **108** connect the touch sensitive elements **14** to the touch screen controller **112,** and are placed on the edges of the substrate **102.** The cable **104** contains conductors that allow image data, display control signals, bias voltages, and touch screen signals to pass between external electronics **106** and the electroluminescent display **100.** The number of conductors in the cable **104** of this embodiment is less than the number of conductors needed in the cable **16** (see Fig. 1a) plus in the cable **80** (see Fig. 3) in the prior art discussed above. This improved display eliminates the need for redundant conductors within the cable **104** and places some or all of the touch screen controller functionality within the display itself. This reduces the amount of raw materials in the system, therefore decreasing system cost, manufacturing cost, and system integration complexity.

[0022] Various amounts of touch screen controller functionality may be implemented within the touch screen controller **112,** based on system design constraints. Three embodiments are considered here.

[0023] Fig. 6 shows an embodiment of the present invention where the touch screen controller circuit **112** includes an optional clock divider circuit **126,** a voltage application circuit **34,** and a multiplexing circuit **38.** The touch detection circuit is implemented in external electronics **106** (see Fig. 5a). Voltages **120** and **122** applied to the touch screen controller circuit **112** are taken from voltages used for normal image display functions. When a touch occurs, the sensed change in voltage, and therefore resistance, is sent over cable **104** to an external controller for (X, Y) coordinate extraction.

[0024] The clock divider circuit **126** divides an input clock pulse train **124** into a lower frequency. Typically, the input clock pulse train **124** is taken from a clock needed to control the image display, such as the pixel clock. Alternatively, the horizontal synchronization (HSYNC) or vertical synchronization (VSYNC) pulses may be used as the input clock, since these signals are periodic. Often, these synchronization signals do not have a 50% duty cycle, as do most regular clock signals. A 50% duty cycle may be produced using these synchronization signals by using a frequency divider, such as the clock divider circuit **126.** The pixel clock is usually the fastest of the three signals, followed by HSYNC, and then VSYNC. For flat panel displays of VGA resolution and a 60 Hz frame refresh rate, the pixel clock is approximately 30 MHz (assuming a transfer of one pixel per clock cycle), HSYNC is approximately 30 KHz, and VSYNC is 60 Hz. The signal closest in frequency to the needs of the touch screen controller may be selected, in order to minimize the size of the clock divider circuit **126.**

[0025] The output of the voltage application circuit **34** connects to the multiplexing circuit **38.** The multiplexing circuit **38** includes circuitry that routes the appropriate voltages to the appropriate conductive elements within the touch sensitive elements **14** and the touch coordinate voltage to other circuitry for processing. The exact circuit implementation of the multiplexing circuit **38** is specific to the type of touch screen (4-wire or 5-wire). The specific embodiments of the multiplexing circuit **38** are discussed below.

[0026] This embodiment of the touch screen controller circuit **112** has the advantages of placing a portion of the touch screen controller circuitry on the display itself, taking advantage of the thin film transistors lithography present in the manufacturing process of the image display. The touch screen controller circuit **112** is relatively simple and small in size, and also eliminates the need for two of the four conductors needed in the cable **104** for conventional 4-wire touch screen controllers by utilizing various signals needed for image display control and biasing. The touch screen controller circuit **112** eliminates the need for four of the five conductors needed in the cable **104** for conventional 5-wire touch screen controllers by utilizing various signals needed for image display control and biasing. The more transistor-intensive and area-intensive touch detection circuit **36** (see Fig. 1a) is placed in external electronics **106** (see Fig. 5a) on a printed circuit board, where conventional manufacturing processes for such circuitry are more efficient.

[0027] Fig. 7 shows an embodiment of the present invention where the touch screen controller circuit **112** includes an optional clock divider circuit **126,** a voltage application circuit **34,** a multiplexing circuit **38,** an analog-to-digital converter (ADC) **40,** and a digital interface circuit **128.** The operation of the clock divider circuit **126,** the voltage application circuit **34,** and the multiplexing circuit **38** are identical to that described in relation to the embodiment of Fig. 6. In the embodiment shown in Fig. 7, the touch voltage output of the multiplexing circuit **38** is routed to the input of analog-to-digital converter (ADC) **40** that converts the analog voltage measured by the touch sensitive elements into a digital form. The digitized voltage is transmitted, via digital interface circuit **128,** over one or more conductors within cable **104** to a computation circuit **42** (see Fig. 2) in external electronics **106** (see Fig. 5a), where the digital voltage is converted to a touch coordinate.

[0028] The digital interface circuit **128** may transmit the digital data serially or in parallel. Because human tactile response times are usually slow as compared to a display pixel clock, transmission of digital touch data is often performed serially, lowering the data rate, but eliminating one or more conductors associated with parallel transmission. The digital interface circuit **128** is usually synchronized to a known clock, such as the pixel clock. This embodiment has the advantage of converting the measured voltage to digital form before transmission over the cable **104** to external electronics on a printed circuit board. This significantly improves the noise immunity of the measured voltage, allowing for a more accurate touch position calculation.

[0029] Fig. 8 shows an embodiment of the present invention where the touch screen controller circuit **112** includes an optional clock divider circuit **126,** a voltage application circuit **34,** a multiplexing circuit **38,** an analog-to-digital converter (ADC) **40,** a computation circuit **42,** and a digital interface circuit **128.** The operation of the clock divider circuit **126,** the voltage application circuit **34,** the multiplexing circuit **38,** the analog-to-digital converter **40,** and the digital interface circuit **128** are identical to that described in relation to the embodiment of Fig. 7. In this embodiment, the output of the analog-to-digital converter **40** is routed to the input of the computation circuit **42.** The computation circuit **42** allows the touch screen coordinate to be computed on the electroluminescent display itself, and the touch screen coordinate to be transmitted to external electronics **106** (see Fig. 5a) via the digital interface circuit **128.** This embodiment has the advantage of producing the touch screen coordinate on the electroluminescent display **100** itself. The entire touch screen function is then contained in one device, improving system design via improved partitioning of circuit functions. Additional circuitry is not required in the external electronics **106** (see Fig. 5a) for resistive touch screen operation, improving time-to-market for systems containing an electroluminescent display **100.**

[0030] Fig. 9 shows the electrical structure of a prior art 4-wire resistive touch screen. The lower circuit layer **20** contains two parallel metal bars **50** and **51** oriented in one direction, and a resistive ITO coating **54** extending between the metal bars **50** and **51.** The upper circuit layer **26** contains two metal bars **52** and **53** perpendicular to metal bars **50** and **51,** and a resistive ITO coating **56** extending between the metal bars **52** and **53.** The lower circuit layer **20** and the upper circuit layer **26** are separated by a flexible spacer layer **22** (see Fig. 1b) containing a matrix of spacer dots. To sense a touch, an external touch screen controller applies a voltage between two parallel metal bars, forming a voltage gradient in the intervening resistive ITO coating. The other two parallel metal bars are then used as voltage probe points. When the touch occurs, two resistive ITO coatings **54** and **56** are shorted at the point of contact. The voltage at that point on the first resistive ITO coating is transferred to the second resistive ITO coating. A corresponding voltage occurs across the other set of parallel metal bars, and is transferred via conductors in cable **16** to the touch detection circuit **36** within external touch screen controller **18,** shown in Fig. 1. The touch detection circuit **36** (see Fig. 1) monitors the voltage read from the touch screen, decides when a touch has been performed, and computes the (X, Y) coordinates of the touch point the voltage placed across the first two parallel metal bars. To measure the X coordinate, a voltage gradient is applied to parallel metal bars **52** and **53.** To measure the Y coordinate, a voltage gradient is applied to parallel metal bars **50** and **51.**

[0031] An improved flat panel display and 4-wire resistive touch screen system utilizes a single substrate incorporating touch sensitive elements, light emitting materials, a single cable, and touch screen controller circuitry. Fig. 10a and b show this embodiment. The touch sensitive elements **14** shown in Fig. 5a implement a 4-wire resistive touch screen in the embodiment of Figs. 10a and 10b, and are placed on the top of the substrate **102.** An electroluminescent display having an active area **110** is formed on the bottom of the substrate **102.** Circuitry **112** implementing a portion or all of a resistive touch screen controller is also formed on the bottom face of the substrate **102.** Metal bars **50, 51, 52** and **53** in the resistive touch screen elements are connected to the resistive touch screen controller **112** via conductors **108.**

[0032] Various amounts of touch screen controller functionality may be implemented within the touch screen controller **112,** based on system design constraints, as described in relation to Figs. 6, 7 and 8. This circuitry may be used for both 5-wire and 4-wire touch screens. The main difference between implementations for the two types of touch screens is the implementation of the multiplexing circuit **38.**

[0033] Fig. 11 shows an embodiment of the present invention for a voltage application circuit **34** and a multiplexing circuit **38** used with a 4-wire touch screen. The voltage application circuit **34** contains circuitry that selects how the voltages are applied to the electrodes of the touch sensitive elements **14,** and therefore controls the coordinate of the point of touch being read. The voltage application circuit **34** consists of an X/Y coordinate selection circuit **129** and an inverter **130.** The X/Y coordinate selection circuit **129** is typically a flip-flop that may be toggled on each cycle of its input clock. When the flip-flop is in the low state, the X coordinate is being measured. When the flip-flop is in the high state, the Y coordinate is being measured. An inverter **130** is used to produce the inverse of the flip-flop output.

[0034] The multiplexing circuit **38** contains four analog tristate buffers **134, 136, 138** and **140,** and two electronic switches **142** and **144.** Each tristate buffer drives its input voltage to the appropriate metal bars when enabled, and prevents voltage transmission when disabled. For the embodiments considered here, a logic high on a tristate buffer's enable input allows the input voltage to pass to the output, while a logic low disables the transmission of the input voltage to the output. Each electronic switch passes one of two input voltages to its output, based on the logic level of its voltage selection signal. For the embodiments considered here, a logic high on the voltage selection signal passes the upper input voltage to the output of the electronic switch, as drawn in Fig. 11. A logic low on the voltage selection signal passes the lower input voltage to the output of the electronic switch.

[0035] Referring to Figs. 10a and 11, when the X/Y coordinate selection circuit **129** contains a logic high, tristate buffers **134** and **138** are enabled, while tristate buffers **136** and **140** are disabled. Thus, voltage **120** is placed on metal bar **50** and voltage **122** is placed on metal bar **51.** Metal bars **52** and **53** are not driven by either voltage **120** or **122.** A voltage gradient is then placed across resistive ITO coating **54,** allowing a touch to be detected in the Y direction. When a touch occurs, a voltage proportional to the Y coordinate of the touch location is transferred to the resistive ITO coating **56** in the upper circuit layer **26.** Accordingly, voltages are transferred to metal bars **52** and **53.** Electronic switches **142** and **144** then transfer these voltages to an analog-to-digital converter (not shown) or conductors within a cable (not shown). Using these voltages, the Y coordinate of the touch location may be computed.

[0036] When the X/Y coordinate selection circuit **129** contains a logic low, tristate buffers **136** and **140** are enabled, while tristate buffers **134** and **138** are disabled. Thus, voltage **120** is placed on metal bar **52** and voltage **122** is placed on metal bar **53.** Metal bars **50** and **51** are not driven by either voltage **120** or **122.** A voltage gradient is then placed across resistive ITO coating **56,** allowing a touch to be detected in the X direction. When a touch occurs, a voltage proportional to the X coordinate of the touch location is transferred to the resistive ITO coating **54** in the lower circuit layer **20.** Accordingly, voltages are transferred to metal bars **50** and **51.** Electronic switches **142** and **144** then transfer these voltages to an analog-to-digital converter (not shown) or conductors within a cable (not shown). Using these voltages, the X coordinate of the touch location may be computed.

[0037] Fig. 12 shows the electrical structure of a prior art 5-wire resistive touch screen. The lower circuit layer **20** contains four metal electrodes **60, 61, 62** and **63** located at the corners, connected to a resistive ITO coating **64.** The four metal electrodes 60, 61, 62 and 63 also connect to four conductors in cable 16. Also in the lower circuit layer is a metal electrode **66** that connects to a conductor in cable **16.** The upper circuit layer **26** contains one metal electrode **65** connected to a transparent metal conductive area **68.** A flexible spacer layer (not shown) separates the lower circuit layer **20** and the upper circuit layer **26.** When manufactured, metal contacts **65** and **66** are electrically connected together, transferring the voltage on the transparent metal conductive area **68** to the cable **16.** To sense a touch, an external touch screen controller (not shown) applies voltages to the four metal electrodes **60, 61, 62** and **63,** forming a voltage gradient in the intervening resistive ITO coating **64.** Normally, two of these four metal electrodes always have a constant voltage applied to them. The two metal electrodes held to constant voltages are usually diagonal to each other; for example, metal electrode **60** would have a constant voltage 5V, and metal electrode **63** would have a constant voltage 0V. The coordinate measured then depends on the voltage applied to the remaining two metal electrodes **61** and **62.** The fifth metal electrode **65** is used as a voltage probe point. When the touch occurs, resistive ITO coatings **64** and the transparent metal conductive area **68** are shorted at the point of contact. The voltage at that point on the resistive

ITO coating is transferred to the transparent metal conductive area, the attached metal electrode **65,** and to the touch detection circuit **36** (see Fig. 1a) within external touch screen controller **18** (see Fig. 1a) via a conductor in cable **16.** The touch detection circuit monitors the voltage read from the touch screen, decides when a touch has been performed, and computes the (X, Y) coordinates of the touch point.

[0038] To measure the X coordinate, a voltage gradient is placed across the resistive ITO coating **64** in the X-direction. To do so, 5V would be applied to metal electrode **62** and 0V would be applied to metal electrode **61.** To measure the Y coordinate, 5V would be applied to metal electrode **61** and 0V would be applied to metal electrode **62.**

[0039] As with 4-wire touch screens, various amounts of 5-wire touch screen controller functionality may be implemented within the touch screen controller **112** located on the electroluminescent display side of the substrate, based on system design constraints, as described in relation to Figs. 6, 7 and 8. The multiplexing circuit **38** is significantly different for a 5-wire touch screen controller.

[0040] Fig. 14 shows an embodiment of the present invention for a voltage application circuit **34** and a multiplexing circuit **38** used with a 5-wire touch screen. For the current embodiment, the voltage application circuit **34** contains an X/Y coordinate selection circuit **129.** No inverter is needed, as is required for the 4-wire embodiment. Otherwise, the operation of the voltage application circuit **34** is equivalent to that of the 4-wire embodiment described in relation to Fig. 11.

[0041] Referring to Fig. 14, the multiplexing circuit **38** consists of two electronic switches **148** and **150** that determine the voltage sent to metal electrodes **61** and **62.** Metal electrode **60** is set to voltage **120** while metal electrode **63** is set to voltage **122.**

[0042] When the X/Y coordinate selection circuit **129** contains a logic high, electronic switch **148** places voltage **120** on metal electrode **61** and electronic switch **150** places voltage **122** on metal electrode **63,** causing a voltage gradient to be formed across resistive ITO coating **64** in the Y direction. When the X/Y coordinate selection circuit contains a logic low, electronic switch **148** places voltage **122** on metal electrode **61** and electronic switch **150** places voltage **120** on metal electrode **63,** causing a voltage gradient to be formed across resistive ITO coating **64** in the X direction. Metal electrode **65** is always connected, via the multiplexing circuit, to either an analog-to-digital converter **40** (not shown), or to a conductor in cable **104** (not shown).

Claims

1. An organic electroluminescent display with integrated touch screen, comprising:

    a) a transparent substrate having two faces;
    b) a transistor switching matrix and a light emitting layer forming an active matrix electroluminescent display located on one face of the substrate for emitting light through the substrate;
    c) touch sensitive elements of a touch screen located on the other face of the substrate;
    d) components of a touch screen controller located on the one face of the substrate; and
    e) an electrical connector for connecting the components of the touch screen controller on the one face of the substrate to the touch screen elements on the other face of the substrate.

2. The display of claim 1, wherein the electroluminescent display is an organic light emitting diode display (OLED).

3. The display of claim 1, wherein the touch screen is a resistive touch screen, and the touch screen controller is a resistive touch screen controller.

4. The display of claim 3, where the resistive touch screen is 4-wire.

5. The display of claim 3, where the resistive touch screen is 5-wire.

6. The display of claim 3, wherein the touch screen controller is responsive to control signals that control the electroluminescent display.

7. The display of claim 1, wherein the electrical connector contains fewer conductors than is required if the touch screen controller is located external to the organic electroluminescent display.

8. The display of claim 1, wherein the substrate is glass.

9. The display of claim 1, wherein the substrate is plastic.

10. The display of claim 1, wherein the components of the touch screen located on the one face of the substrate comprise:

    a) a voltage application circuit responsive to signals present for control of the light emitting elements, and
    b) a multiplexing circuit for selection of voltage application to the touch sensitive elements and for routing the measured voltage gradient in analog form to the electrical connector for computation by an external controller.

11. The display of claim 10, wherein the components of

the touch screen located on the one face of the substrate, further comprise an analog-to-digital converter for converting a measured analog voltage to digital format for transmission over to the electrical connector for computation by an external controller.

12. The display of claim 11, wherein the components of the touch screen located on the one face of the substrate, further comprise a computation circuit for computing the coordinate of a touch.

13. The display of claim 1, further comprising means for generating a periodic signal for synchronizing the electroluminescent display operations and the touch screen controller.

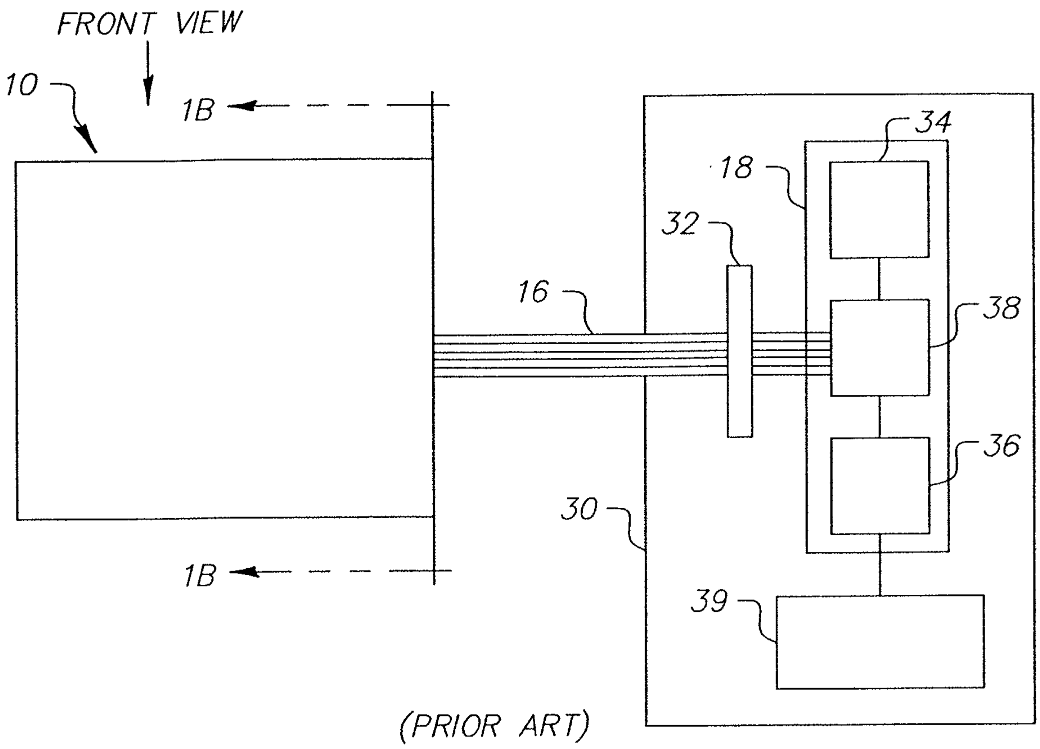
14. The display of claim 13, wherein the periodic signal is a clock signal.

15. The display of claim 14, where the clock signal is a pixel clock.

16. The display of claim 13, further comprising a divider circuit located in the touch screen controller to produce a lower periodic frequency signal for synchronizing the touch screen controller.

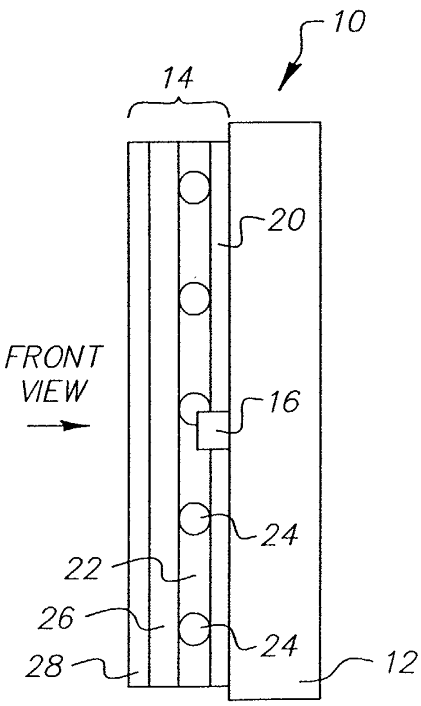
17. The display of claim 13, where the periodic signal is a horizontal synchronization signal.

18. The display of claim 13, where the periodic signal is a vertical synchronization signal.



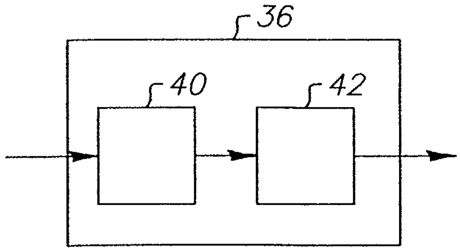
(PRIOR ART)

FIG. 1A



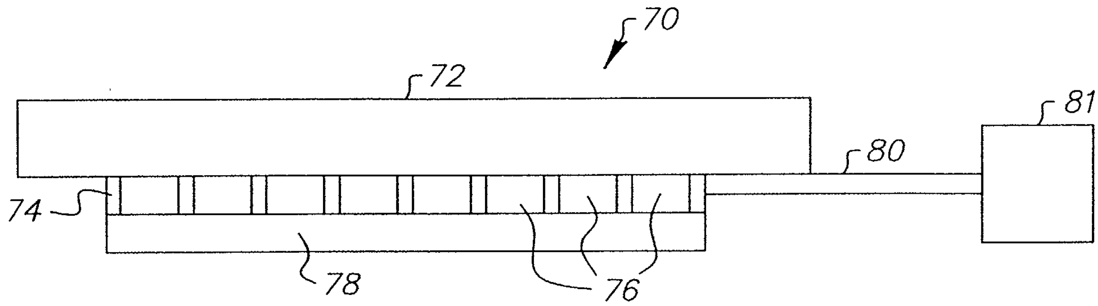
(PRIOR ART)

FIG. 1B



(PRIOR ART)

FIG. 2



(PRIOR ART)

FIG. 3

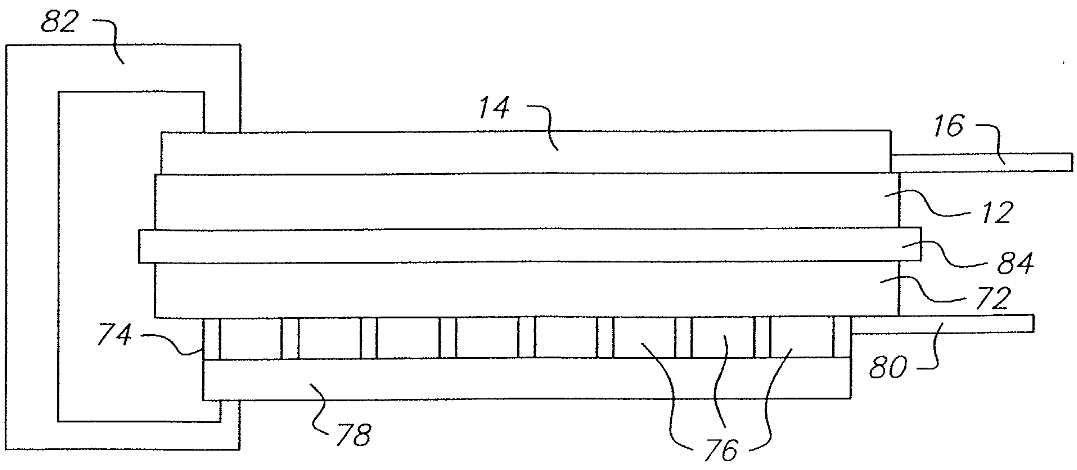


FIG. 4

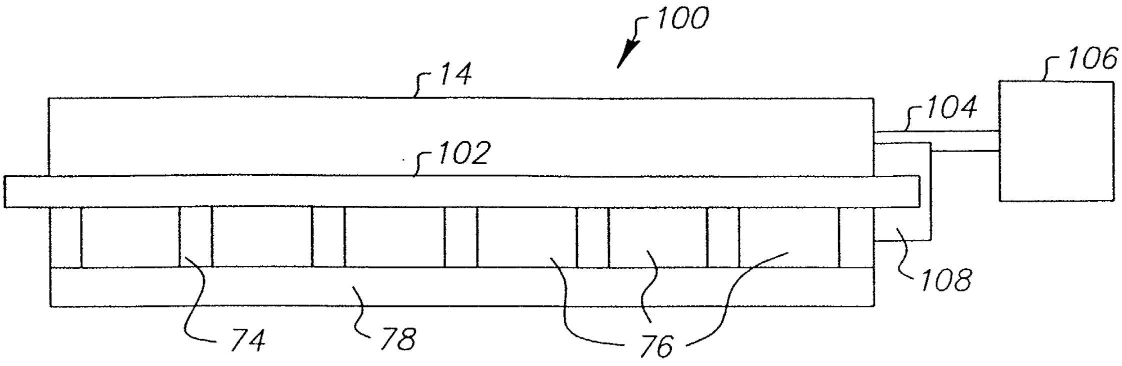


FIG. 5A

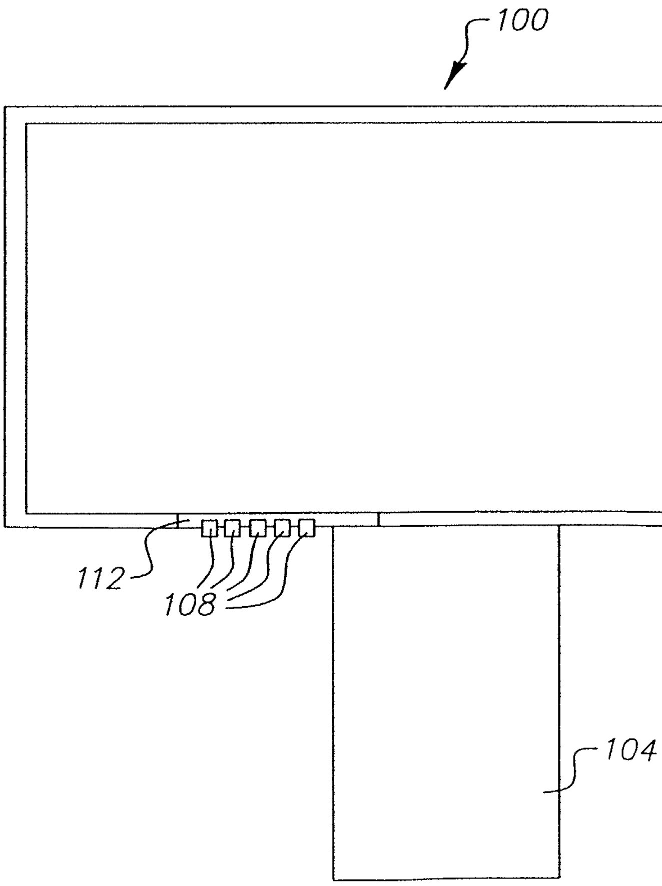


FIG. 5B

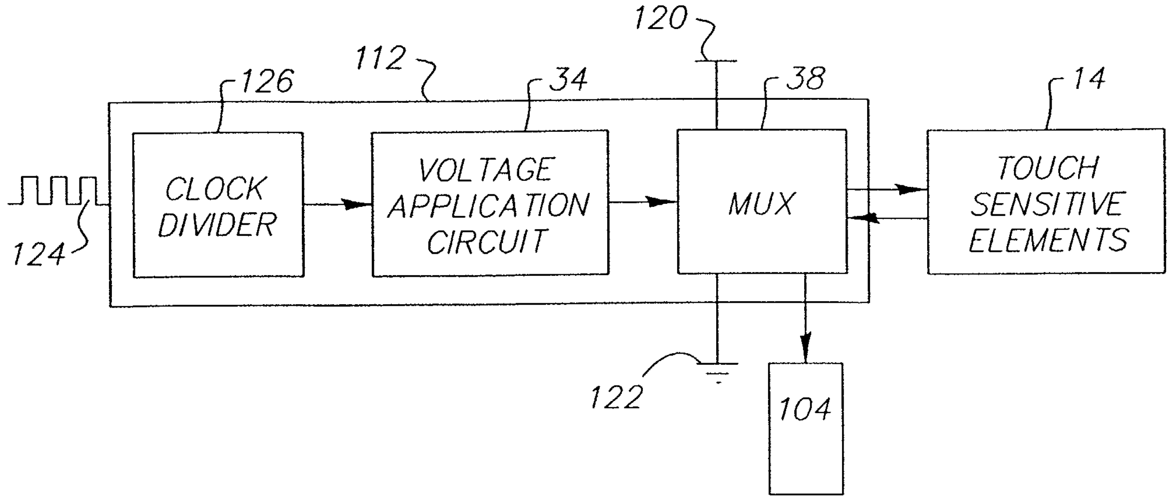

120
112
126
34
38
14
CLOCK DIVIDER
VOLTAGE APPLICATION CIRCUIT
MUX
TOUCH SENSITIVE ELEMENTS
124
122
104

FIG. 6

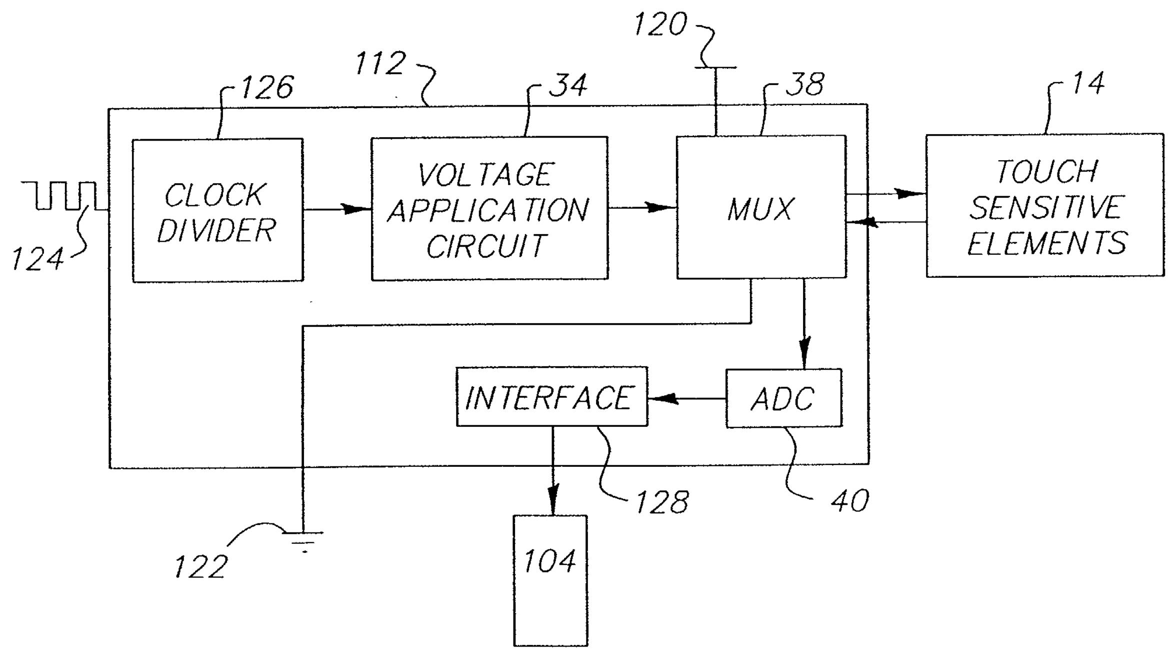

120
112
126
34
38
14
CLOCK DIVIDER
VOLTAGE APPLICATION CIRCUIT
MUX
TOUCH SENSITIVE ELEMENTS
124
INTERFACE
ADC
128
40
122
104

FIG. 7

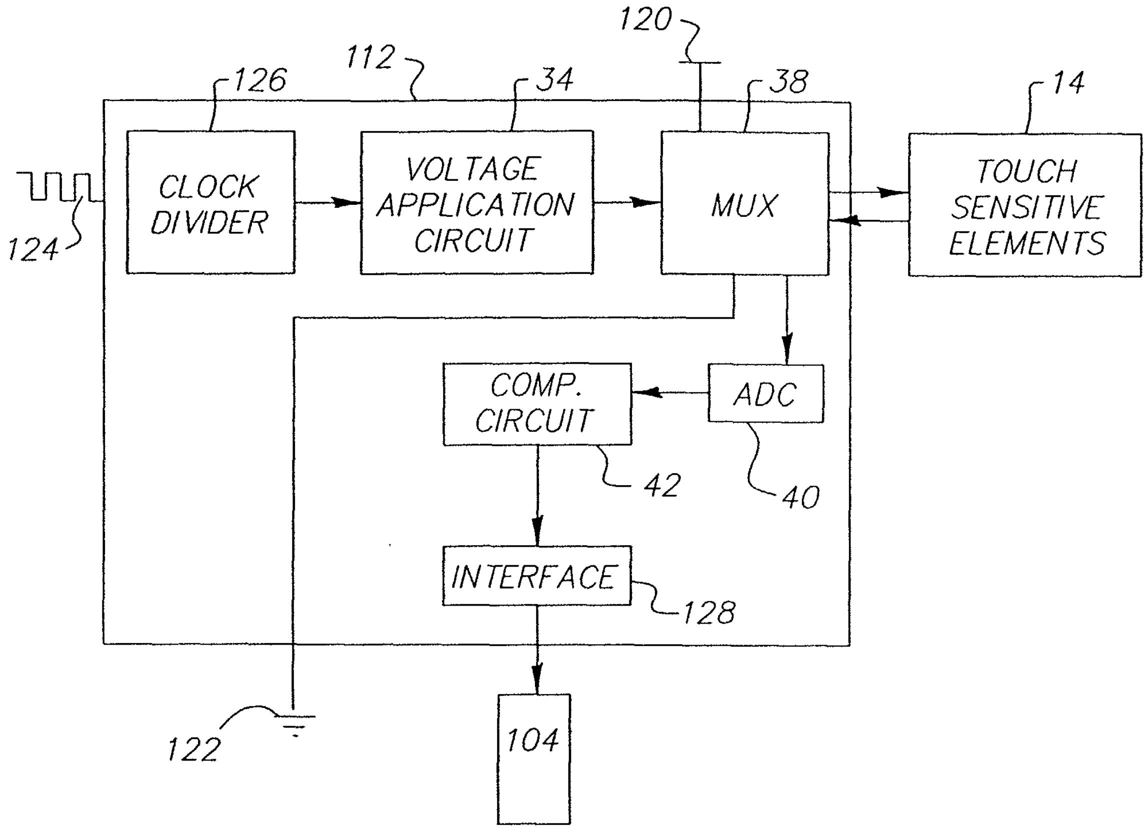
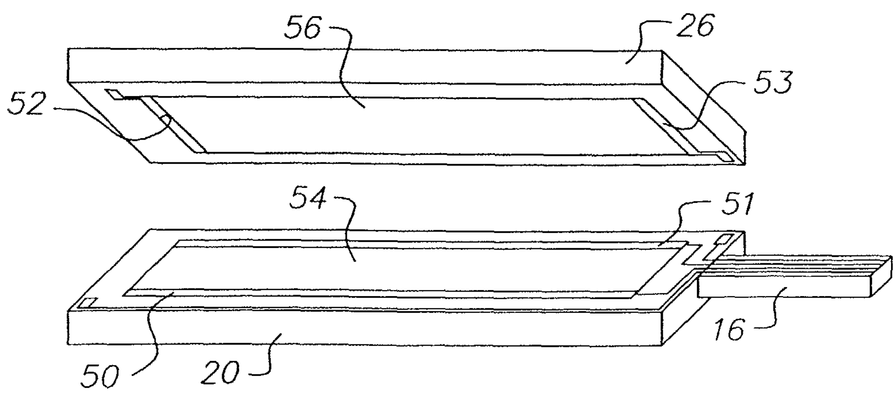
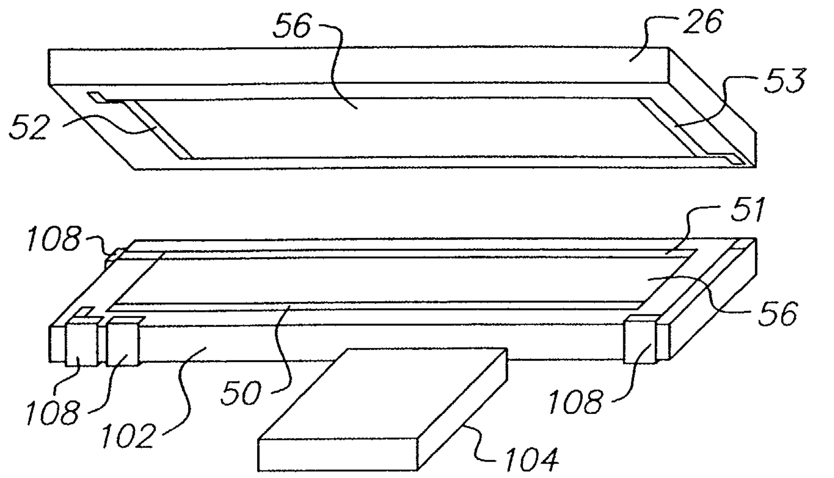


FIG. 8



(PRIOR ART)

FIG. 9



(PRIOR ART)
FIG. 10a

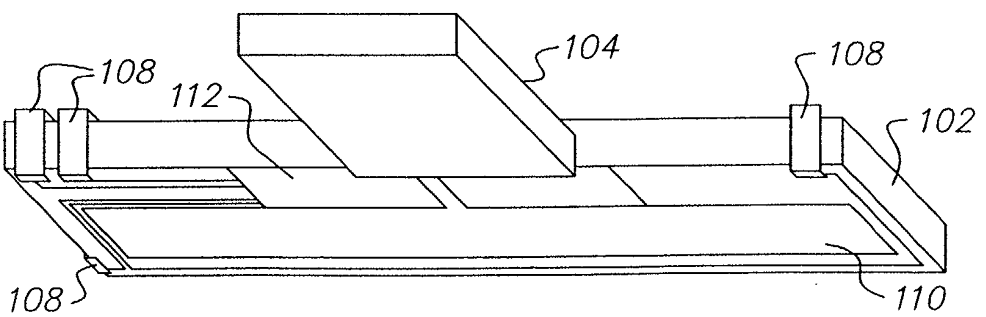


FIG. 10b

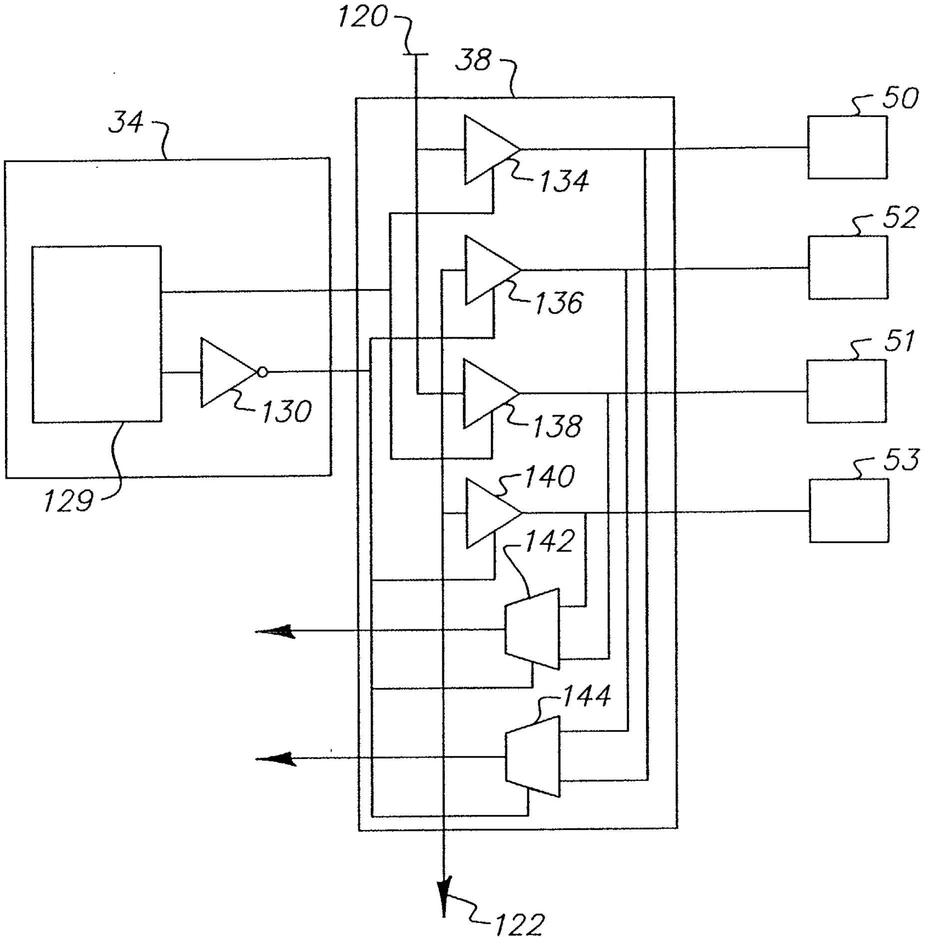
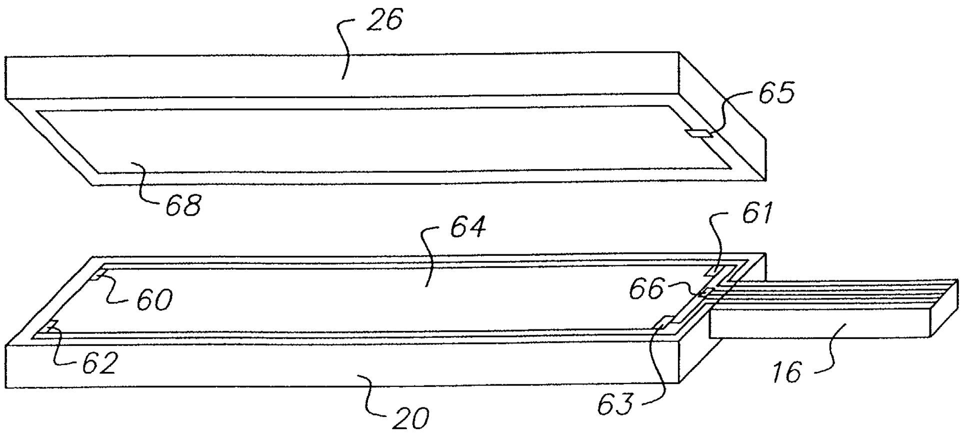


FIG. 11



(PRIOR ART)

FIG. 12

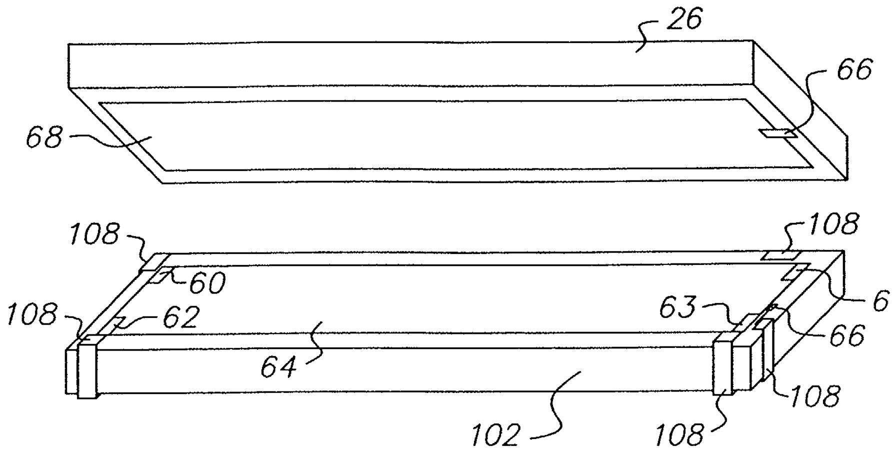


FIG. 13a

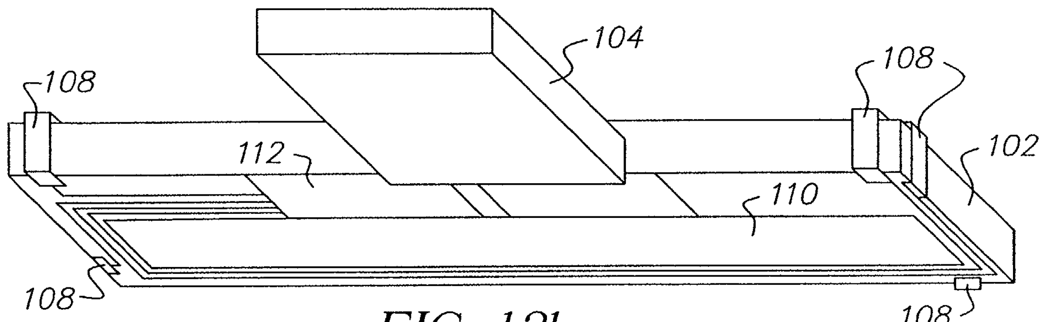


FIG. 13b

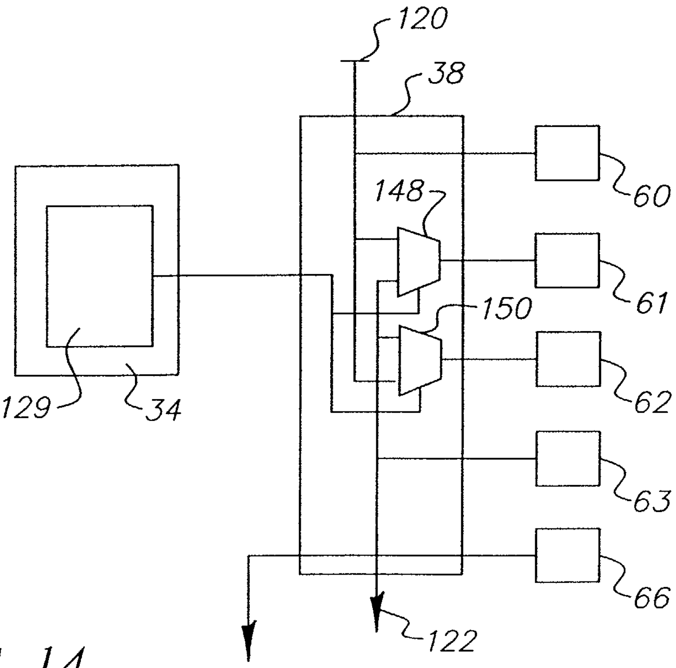


FIG. 14

patsnap

专利名称(译)	有机电致发光显示器，集成电阻式触摸屏		
公开(公告)号	EP1258922A2	公开(公告)日	2002-11-20
申请号	EP2002076758	申请日	2002-05-03
[标]申请(专利权)人(译)	伊斯曼柯达公司		
申请(专利权)人(译)	伊士曼柯达公司		
当前申请(专利权)人(译)	伊士曼柯达公司		
发明人	FELDMAN, RODNEY D., EASTMAN KODAK COMPANY		
IPC分类号	H01L27/15 H01L51/50 G06F3/033 G06F3/041 G06F3/048 G09F9/00 G09F9/30 H01L27/32 H05B33/22 H01L27/00		
CPC分类号	G06F3/045 G06F3/0412 H01H2219/02 H01H2219/037 H01L27/323		
优先权	09/855452 2001-05-15 US		
其他公开文献	EP1258922A3		
外部链接	Espacenet		

摘要(译)

一种集成触摸屏的有机电致发光显示器，包括：具有两个面的透明基板;晶体管开关矩阵和发光层，形成位于基板一面上的有源矩阵电致发光显示器，用于通过基板发光;触摸位于基板另一面上的触摸屏的敏感元件;触摸屏控制器的部件位于基板的一个面上;电连接器，用于将基板的一面上的触摸屏控制器的部件连接到基板的另一面上的触摸屏元件。

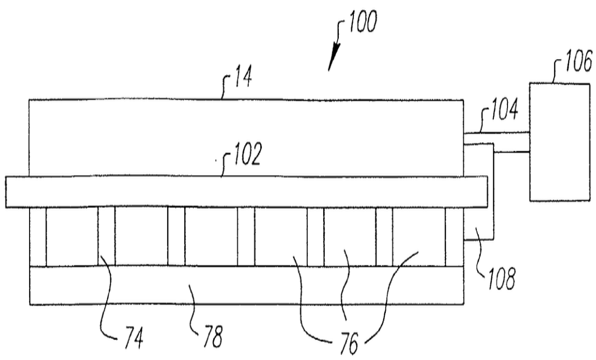


FIG. 5A