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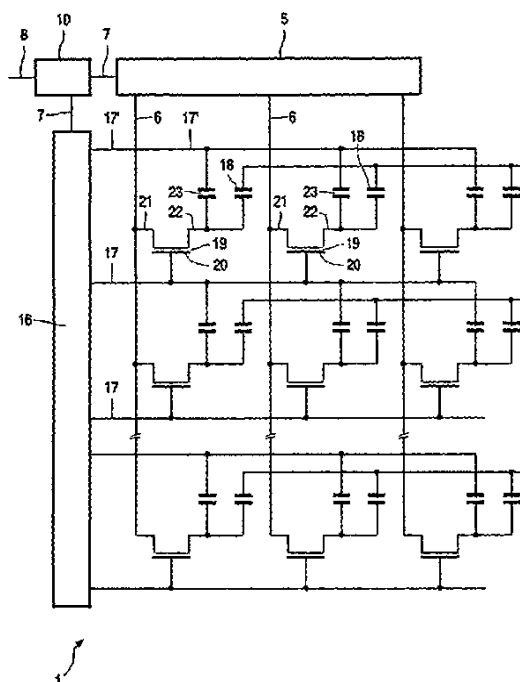
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(54) 【発明の名称】 表示装置

(57) 【要約】

画像の保持を招く、垂直配向ネマティックLCDの複数のドメインの画素における液晶分子のねじれ動作の作用が、LCDの電圧を閾値以下に低減するリセットパルスを印加することにより低減される。複数のリセット方法（複数の対向電極、列ドライバからのリセット、直接的なブロックリセット、蓄積キャパシタ下院を介したリセット）が可能である。



【特許請求の範囲】

【請求項 1】

2つの基板の間に負の誘電異方性を持つ液晶材料を有する液晶表示装置であり、前記基板の一方が、選択電極とデータ電極との交差領域に画素を伴う当該選択電極及びデータ電極のマトリクスを備え、前記画素が複数のドメイン及び少なくとも1つのスイッチング素子を有すると共に、当該液晶表示装置が前記選択電極及びデータ電極を駆動する駆動手段を更に有する液晶表示装置であって、

前記画素の両端にリセット電圧を印加する他の駆動手段を有する液晶表示装置。

【請求項 2】

前記他の駆動手段が、2フレーム期間の間に全ての画素の両端にリセット電圧を印加する請求項 1 記載の液晶表示装置。 10

【請求項 3】

前記他の駆動手段が、ライン選択期間又はライン選択期間の一部の間にデータ電極を介して前記画素の少なくとも一部の両端にリセット電圧を印加する請求項 1 記載の液晶表示装置。

【請求項 4】

前記他の駆動手段が、データ電極を介して全ての画素の両端にリセット電圧を印加する請求項 3 記載の液晶表示装置。

【請求項 5】

画素が蓄積キャパシタンスを備え、画素の選択の前に、前記他の駆動手段が前記蓄積キャパシタンスを介して前記画素の両端にリセット電圧を印加する請求項 1 記載の液晶表示装置。 20

【請求項 6】

前記他の駆動手段が、画素の選択中に対向電極の部分を介して前記画素の一部の両端にリセット電圧を印加する請求項 5 記載の液晶表示装置。

【請求項 7】

前記他の駆動手段が、前記蓄積キャパシタンスの接続電極を介して前記画素の両端にリセット電圧を印加する請求項 6 記載の液晶表示装置。

【請求項 8】

前記他の駆動手段が、前記蓄積キャパシタンスに接続された近傍の選択電極を介して前記画素の両端にリセット電圧を印加する請求項 6 記載の液晶表示装置。 30

【発明の詳細な説明】

【0001】

【発明の属する技術分野】

本発明は、2つの基板の間に負の誘電異方性を持つ液晶材料を有する液晶表示装置であり、基板の一方が、選択電極とデータ電極との交差領域に画素を伴う当該選択電極及びデータ電極のマトリクスを備え、画素が複数のドメイン及び少なくとも1つのスイッチング素子を有すると共に、当該液晶表示装置が選択電極及びデータ電極を駆動する駆動手段を更に有する液晶表示装置に関する。

【0002】

【従来の技術】

このようなアクティブマトリクス表示装置の例は、ラップトップコンピュータ及び電子手帳に用いられ、ホメオトロピック作用、例えば「垂直配向作用」に基づく TFT-LCD や AM-LCD である。

【0003】

画素は、種々の手法で、例えば、画素電極のギャップを用いて、又は局所的若しくは非局所的な凸部によりドメインに分割され得る。

【0004】

【発明が解決しようとする課題】

このような表示装置における問題は残像の発生である。他の画像により置き換えられる画 50

像が、長い時間（時には数秒に至るまで）引き続き目に見えてしまい、これは非常にいら
いらさせる作用である。

【0005】

本発明の目的は、残像が発生しない又はほとんど発生しない、冒頭の段落において説明し
たタイプの表示装置を提供することにある。

【0006】

【課題を解決するための手段】

この目的のために、本発明による表示装置は、画素の両端にリセット電圧を印加する他の
駆動手段を有している。

【0007】

本発明は、ホメオトロピック状態（電圧0ボルト又は非常に低い電圧）からネマティック
状態への画素のスイッチング中、2つのメカニズムがおそらく有効（a c t i v e）であ
るという認識に基づいている。

【0008】

駆動電圧のために、液晶分子は、上記電極を横切る、非常に速い傾斜の動きを実現する電
界に曝される。また、ギャップ及び／又は凸部は基板とほぼ平行な面に電界成分（インプ
レーン・フィールド）を生成する。傾斜の速い変化の後、液晶分子は非常に遅いオーダー
で（1秒以上）ねじられる。約1ミリ秒のオーダーで再ねじれも起こり、残像を引き起こ
す。

【0009】

本発明によれば、種々の手法で実現され得るリセットパルスによりオリジナルのねじれが
回避される。例えば、上記他の駆動手段は、画素の非選択中に全ての画素の両端にリセッ
ト電圧を印加する。

【0010】

画素の選択中にデータ電極を介して画素の少なくとも一部の両端にリセット電圧を印加す
ることが代替的に可能である。この場合、上記他の駆動手段は、1つ又はそれ以上の画素
行の選択中にデータ電極を介して画素の少なくとも一部の両端にリセット電圧を印加し得
るが、これは対向電極の部分を介しても行われ得る。

【0011】

好ましい形態では、画素が蓄積キャパシタンスを備え、画素の選択の前に、上記他の駆動
手段が蓄積キャパシタンスを介して画素の両端にリセット電圧を印加する。 30

【0012】

この出願において、「蓄積キャパシタンスを備え」という文言は、例えば、ある行に関連
する画素電極とその次の（又は前の）行に関連する行電極の一部との（部分的な）重なり
により、（補助）キャパシタを介して結合が存在することを意味すると理解されたい。

【0013】

上記他の駆動手段は、蓄積キャパシタンスの接続電極又は蓄積キャパシタンスに接続され
た近傍の選択電極を介して画素の両端にリセット電圧を印加し得る。

【0014】

本発明のこれらの観点及びその他の観点は、以下に説明する実施の形態から明らかであり 40
、以下に説明する実施の形態を参照して理解されるであろう。

【0015】

図面は模式的であり、正確な縮尺では描かれていない。対応する部分は、概して同一の参
照符号により示されている。

【0016】

【発明の実施の形態】

図1は、本発明が適用可能な表示装置1の一部の電気等価回路図である。この表示装置1
は、行又は選択電極17と列又はデータ電極6との交差領域の画素18のマトリクスを有
している。上記行電極は、行ドライバ16により逐次選択され、上記列電極はデータレジ
スタ5を介してデータを供給される。この目的のため、必要に応じて、まず処理器10に 50

において入力データが処理される。行ドライバ16とデータレジスタ5との間の相互の同期は、駆動ライン7を介してとられる。

【0017】

行ドライバ16から入力される駆動信号は、薄膜トランジスタ(TFT)19によって画素電極を選択する。上記薄膜トランジスタ19のゲート電極20は行電極17に電氣的に接続されており、ソース電極21は上記列電極に電氣的に接続されている。列電極6に存在する信号は、TFTを介して、ドレイン電極22に結合された画素18の画素電極に伝送される。他の画素電極は、例えば1つ(又はそれ以上の)共通の対向電極に接続されている。

【0018】

図1の表示装置は、また、各画素の場所に補助キャパシタ23を有している。本実施の形態では、この補助キャパシタは、一端部であるソース電極21とある画素行の画素との共通ポイントと、他端部である前の画素行の行電極との間に接続されている。代替として、例えば、上記共通ポイントと次の画素行との間、又は上記ポイントと固定(又は可変)電圧用の電極との間に補助キャパシタが接続される他の構成が可能である。

【0019】

本実施の形態では、表示装置は、画素のずれ(deviation)を防止するために追加の行電極17'を有している。

【0020】

図2は平面図であり、図3は図2のIII-III線に沿った断面図であり、例えばガラス又は(可撓性の)合成材料よりなり、(ITO又は金属)画素電極30、対向電極31をそれぞれ備えた2つの基板3,4の間に存在する液晶材料2の一部を示している。この装置は、また、上記液晶材料を上記基板の内壁に配向させる配向層32を有している。更に、この装置は偏光板(図示せず)及び(互いに垂直に交差する)検光子を有している。この例では、上記液晶材料は負の誘電異方性を持つ(ねじれ)ネマティック材料である。上記画素電極は狭い開口部24を有している。この状態において光は交差している偏光板の間を透過しない(ノーマリブラック)。詳細は後述するように、上記開口部は「広視野角」効果を得るために役割を果たす。開口部24に代えて凸部25(図3B参照)を使用することにより同じ効果が得られる。

【0021】

画素の両端がゼロ電圧であると、液晶分子(のダイレクタ27)は上記基板と垂直に配向される(負の誘電異方性)。偏光板を透過する光は、液晶分子によって影響を及ぼされず、検光子を通過する。

【0022】

ある閾値電圧以上では、液晶分子は傾斜し、更に電圧が上昇すると液晶分子(のダイレクタ27)は基板に対して角度を呈する(図4)。この傾斜は、通常、急速に(約10ミリ秒)生じる。屈折率の違い、従って入射光ビームの常成分及び異常成分の実効経路の長さの違いのために、光は検光子を通過する。上記開口部の領域における「フリッジングフィールド」のため、液晶分子は異なる方向に傾斜し、これは視野角を広くする(「広視野角」効果)。

【0023】

暗状態にスイッチングする(又は2つの中間の状態の間においてスイッチングする)と、多くの場合には画像の保持が起こる(画像が目に見えるままである)。これは、おそらく電界(図4のフィールドライン28)の影響を受けて液晶分子(のダイレクタ27)の回転により引き起こされる。このねじれ又は回転の動きは、非常に大きな時定数を有する(履歴に依存し、約1秒)。

【0024】

本発明によれば、上述したねじれ又は回転が、(例えば、短い持続時間でより低電圧の)リセットパルスにより完全に又は部分的に取り除かれる。これを実現する種々の可能性が存在する。

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【0025】

例えば、あるフレーム期間に画像が書き込まれた後、（列電極又はデータ電極における電圧により）次のフレーム期間に全画素の両端にリセット電圧が印加される。

【0026】

画素の選択中に、画素の一部の両端にデータ電極を介してリセット電圧を印加することも可能である。この場合、表示装置は、例えば5つのセグメント12a, 12b, 12c, 12d, 12e（図5）に分割される。このようなセグメントにおいて、リセット中に、例えばセグメント12aの全てのラインが選択され、リセット電圧が列電極に与えられる。ここでは、このようなセグメントが、1ライン期間でリセットされ、各セグメントに関してフレーム期間当たり一度行われる。

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【0027】

代替として、あるラインの書込みの前に、（短い）非選択期間のライン期間中に（列電極又はデータ電極における電圧により）ラインの画素の両端にリセット電圧が印加されてもよい。これは、画像の明るさの変化（アーチファクト）を招く可能性がある。図1の装置では、このようなリセットパルスは、選択期間が始まる前に、適切な電圧及び極性を有するリセットパルスを行電極17に印加することにより、容量的に生成され得る。容量性のキックバック作用のために、このリセットパルスは低い振幅でゲート電極20に伝送される。行電極17の両端におけるオリジナルのリセットパルスの振幅を選択してこれを処理することにより、画素がリセットされる。1つの対向電極を介してリセット電圧を与える代わりに、代替的として、対向電極21は、画素がリセットされるリセット中に問題にしている部分が上述したような電圧を得る状態で、セグメント12に対応する部分に分割され得る。

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【0028】

図1の実施の形態では、補助キャパシタ23が、一端部であるドレイン電極22とある画素行の画素との共通ポイントと、他端部である前の画素行の行電極との間に接続されている。補助キャパシタは、全ての補助キャパシタに関して上記ポイントと共通電極との間に存在してもよい。その場合、画素の両端のリセット電圧は、上記共通電極を介して与えられるリセットパルスにより得られる。この場合も、分割して順次リセットすることが可能である。

【0029】

本発明の保護範囲は、上記実施の形態に限定されるものではない。図2の山形状（chevron）に代えて、凸部がX字形状、（組み合わせられた）Y字形状又は他の通常形状を有していてもよい。

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【0030】

本発明は、新しい固有の特徴のそれぞれ及び全て、並びに固有の特徴の任意の組み合わせに帰するものである。特許請求の範囲における参照記号は、特許請求の範囲の保護範囲を限定するものではない。動詞「有する」及びその活用形は、特許請求の範囲に述べられている構成要素以外の構成要素の存在を排除するものではない。構成要素の前に付された冠詞「a」又は「an」の使用は、複数のそのような構成要素を排除するものではない。

【図面の簡単な説明】

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【図1】表示装置の電気回路図である。

【図2】本発明に係る表示装置の画素電極の平面図である。

【図3A】このような表示装置の応答に関する作用を示す図である。

【図3B】このような表示装置の応答に関する作用を示す他の図である。

【図4A】このような表示装置の応答に関する作用を示す更に他の図である。

【図4B】このような表示装置の応答に関する作用を示す更に他の図である。

【図5】画素の一部を示す図である。

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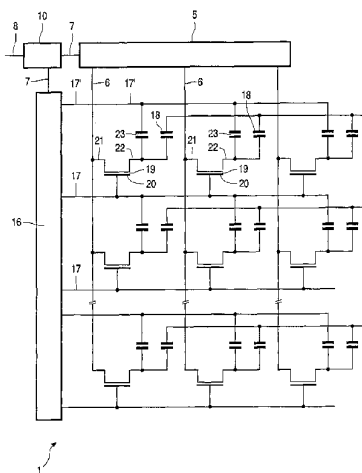
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NL-5656 AA Eindhoven (NL); DE BOER, Dirk, K., G.;For two-letter codes and other abbreviations, refer to the "Guid-
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ning of each regular issue of the PCT Gazette.

(54) Title: DISPLAY DEVICE



(57) Abstract: The effect of twisting motion of LC molecules in multi-domain pixels of vertically aligned nematic LCDs, which leads to image retention, is reduced by applying a reset pulse which reduces the LCD voltage to below threshold. Several methods of reset (multiple counter electrodes, reset from column drivers, direct block reset, reset via storage capacitor line) are possible.

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1

Display device

The invention relates to a liquid crystal display device comprising a liquid crystal material having a negative dielectric anisotropy between two substrates, one substrate of which is provided with a matrix of selection electrodes and data electrodes with a pixel at the area of a crossing of the selection electrodes and data electrodes, said pixels having a plurality of domains and at least one switching element, and further comprising drive means for driving the selection electrodes and data electrodes.

Examples of such active matrix display devices are TFT-LCDs or AM-LCDs which are used in laptop computers and in organizers and are based on a homeotropic effect, for example, the "vertically aligned effect".

The pixels may be divided into domains in different ways, for example, by means of gaps in the picture electrodes or by local or non-local protrusions.

A problem in such display devices is the occurrence of after images. An image which is replaced by another image is then still visible for a longer time (sometimes up to several seconds), which has a very irritating effect.

15

It is an object of the present invention to provide a display device of the type described in the opening paragraph, in which after images do not occur or hardly occur.

To this end, a display device according to the invention comprises further drive means for applying a reset voltage across the pixels.

The invention is based on the recognition that two mechanisms are presumably active during switching of a pixel from the homeotropic state (voltage 0 volt or very low voltage) to the nematic state.

Due to the drive voltage, the liquid crystal molecules are subjected to an electric field which is transverse to the electrodes and realizes a very fast tilting movement. Moreover, the gaps and/or protrusions produce electric field components in a plane which is substantially parallel to the substrates (in-plane field). After the fast change of the tilt, the liquid crystal molecules are twisted in a much slower order (1 or more sec). Retwisting also takes place at an order of about 1 msec and thus causes the after images.

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According to the invention, the original twist may be avoided by means of reset pulses which can be realized in different ways. It is, for example, possible that the further drive means apply a reset voltage across all pixels during non-selection of pixels.

It is alternatively possible to apply a reset voltage across at least a part of the pixels via data electrodes during selection of pixels. In this case, the further drive means may apply a reset voltage via data electrodes across at least a part of the pixels during selection of one or more rows of pixels, but this may also be done via parts of a counter electrode.

In a preferred embodiment, a pixel is provided with a storage capacitance and, prior to selection of pixels, the further drive means apply a reset voltage across the pixels via the storage capacitance.

In this application, the phrase "provided with a storage capacitance" is understood to mean that there is a coupling via an (auxiliary) capacitor, for example, by (partial) overlap of a picture electrode associated with a row and a part of the row electrode associated with a subsequent (or previous) row.

The further drive means may apply a reset voltage across the pixels via a connection electrode of the storage capacitance or via an adjacent selection electrode connected to the storage capacitance.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is an electric circuit diagram of the display device,

Fig. 2 is a plan view of a picture electrode in a display device according to the invention,

Figs. 3 and 4 show the effect on the response of such a display device, while

Fig. 5 shows a part of a pixel.

The Figures are diagrammatic and not drawn to scale; corresponding parts are generally denoted by the same reference numerals.

Fig. 1 is an electric equivalent circuit diagram of a part of a display device 1 to which the invention is applicable. It comprises a matrix of pixels 18 at the area of crossings of row or selection electrodes 17 and column or data electrodes 6. The row electrodes are

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consecutively selected by means of a row driver 16, while the column electrodes are provided with data via a data register 5. To this end, incoming data 8 are first processed, if necessary, in a processor 10. Mutual synchronization between the row driver 16 and the data register 5 takes place via drive lines 7.

5 Drive signals coming from the row driver 16 select the picture electrodes via thin-film transistors (TFTs) 19 whose gate electrodes 20 are electrically connected to the row electrodes 17 and the source electrodes 21 are electrically connected to the column electrodes. The signal which is present at the column electrode 6 is transferred via the TFT to a picture electrode of a pixel 18 coupled to the drain electrode 22. The other picture
10 electrodes are connected to, for example, one (or more) common counter electrode(s).

The display device of Fig. 1 also comprises an auxiliary capacitor 23 at the location of each pixel. In this embodiment, the auxiliary capacitor is connected between the common point of the source electrode 21 and the pixel in a given row of pixels at one end, and the row electrode of the previous row of pixels at the other end; other configurations are
15 alternatively possible, for example, between said common point and the next row of pixels, or between this point and an electrode for a fixed (or variable) voltage.

In this embodiment, the display device comprises an extra row electrode 17' so as to prevent picture deviations.

Fig. 2 is a plan view and Fig. 3 is a cross-section taken on the line III-III in
20 Fig. 2 of a part of a liquid crystal material 2 which is present between two substrates 3, 4 of, for example, glass or (flexible) synthetic material, provided with (ITO or metal) picture electrodes 30 and a counter electrode 31, respectively. The device also comprises orientation layers 32 which orient the liquid crystal material on the inner walls of the substrates. Moreover, the device comprises a polarizer (not shown) and a (mutually perpendicularly
25 crossed) analyzer. In this case, the liquid crystal material is a (twisted) nematic material having a negative dielectric anisotropy. The picture electrodes also have narrow apertures 24. No light is transmitted (normally black) between crossed polarizers in this state. As will be further described, the apertures serve for obtaining the "wide viewing angle" effect. The same effect is obtained by using protrusions 25 (see Fig. 3B) instead of the apertures 24.

30 At zero voltage across a pixel, the (directors 27 of the) liquid crystal molecules are oriented perpendicularly to the substrates (negative dielectric anisotropy). Light transmitted by the polarizer is not influenced by the liquid crystal molecules and is passed by the analyzer.

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Above a given threshold voltage, the liquid crystal molecules tilt and at a further increase of the voltage, the (directors 27 of the) liquid crystal molecules assume an angle with respect to the substrates (Fig. 4). This tilt is usually effected rapidly (about 10 msec). Due to the difference of refractive index and hence the effective path length for the normal and the abnormal component of an incident light beam, light is now passed by the analyzer. Due to "fringing fields" at the area of the apertures, the liquid crystal molecules tilt towards different directions, which enlarges the viewing angle ("wide viewing angle" effect).

When switching back to the dark state (or when switching between two intermediate states), "image retention" occurs in many cases (the images remain visible). This is presumably caused by a rotation of the (directors 27 of the) liquid crystal molecules under the influence of the electric field (field lines 28 in Fig. 4). This twist or rotating movement has a much larger time constant (about 1 sec, dependent on the history).

According to the invention, this twist or rotation may be entirely or partly eliminated by a reset pulse (for example, of a short duration and towards a lower voltage). There are various possibilities of realizing this.

For example, after an image has been written during a frame period, a reset voltage may be applied across all pixels during a subsequent frame period (via a voltage at the column electrodes or data electrodes).

It is also possible to apply a reset voltage across a part of the pixels via data electrodes during selection of pixels. In this case, the display device is divided into, for example, five segments 12a, 12b, 12c, 12d, 12e (Fig. 5). In such a segment, all lines of, for example, segment 12a are selected during reset, while the reset voltage is presented to the column electrodes. Such a segment is now reset in one line period and is performed once per frame period for each segment.

Alternatively, a reset voltage may be applied across pixels of the line (via a voltage at the column electrodes or data electrodes) during a line period for a (short) period of non-selection, prior to writing a line. This may lead to brightness variations in the image (artefacts). In the device of Fig. 1, such a reset pulse may also be generated capacitively by applying a reset pulse having the correct voltage and polarity to the row electrode 17 prior to the start of a selection period. Due to a capacitive kick-back effect, this reset pulse is transferred to the gate electrode 20, be it at a lower amplitude. By processing this in the choice of the amplitude of the original reset pulse across the row electrode 17, the pixels are reset. Instead of presenting the reset voltage via one counter electrode, the counter electrode

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21 may be alternatively divided into parts corresponding to the segments 12, with the relevant part acquiring such a voltage during resetting that the pixels are reset.

In the embodiment of Fig. 1, the auxiliary capacitor 23 is connected between the common point of the drain electrode 22 and the pixel in a given row of pixels at one end,
5 and the row electrode of the previous row of pixels at the other end. It may also be present between this point and a common electrode for all auxiliary capacitors. In that case, the reset voltage across the pixels is obtained by means of a reset pulse which is presented via this common electrode. Here again, a block-sequential reset is possible.

The protective scope of the invention is not limited to the embodiments
10 described. Instead of the chevron shape of Fig. 2, the protrusions may also have X shapes, (combined) Y shapes or other conventional shapes.

The invention resides in each and every novel characteristic feature and each and every combination of characteristic features. Reference numerals in the claims do not limit their protective scope. Use of the verb "to comprise" and its conjugations does not
15 exclude the presence of elements other than those stated in the claims. Use of the article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

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CLAIMS:

1. A liquid crystal display device comprising a liquid crystal material having a negative dielectric anisotropy between two substrates, one substrate of which is provided with a matrix of selection electrodes and data electrodes with a pixel at the area of a crossing of the selection electrodes and data electrodes, said pixels having a plurality of domains and at least one switching element, and further comprising drive means for driving the selection electrodes and data electrodes, wherein the liquid crystal display device comprises further drive means for applying a reset voltage across the pixels.
5
2. A liquid crystal display device as claimed in claim 1, wherein the further drive means apply a reset voltage across all pixels between two frame periods.
10
3. A liquid crystal display device as claimed in claim 1, wherein the further drive means apply a reset voltage across at least a part of the pixels via data electrodes during a line selection period or a part of a line selection period.
15
4. A liquid crystal display device as claimed in claim 3, wherein the further drive means apply a reset voltage across all pixels via data electrodes.
5. A liquid crystal display device as claimed in claim 1, wherein a pixel is provided with a storage capacitance and, prior to selection of pixels, the further drive means apply a reset voltage across the pixels via the storage capacitance.
20
6. A liquid crystal display device as claimed in claim 5, wherein the further drive means apply a reset voltage across a part of the pixels via parts of a counter electrode during selection of pixels.
25
7. A liquid crystal display device as claimed in claim 6, wherein the further drive means apply a reset voltage across the pixels via a connection electrode of the storage capacitance.

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8. A liquid crystal display device as claimed in claim 6, wherein the further drive means apply a reset voltage across the pixels via an adjacent selection electrode connected to the storage capacitance.

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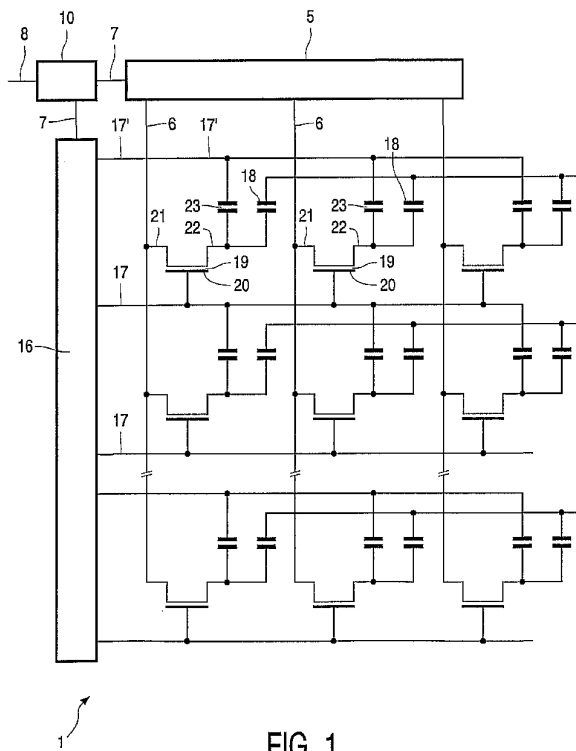


FIG. 1

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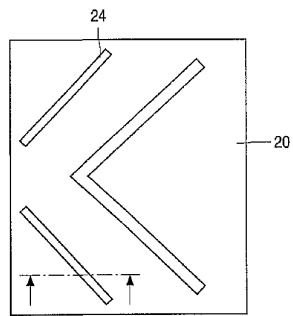


FIG. 2

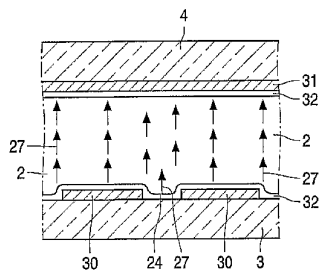


FIG. 3A

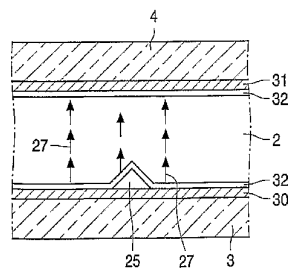


FIG. 3B

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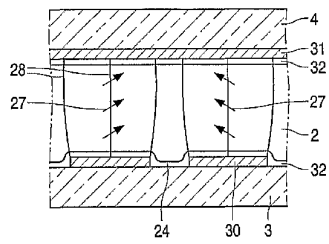


FIG. 4A

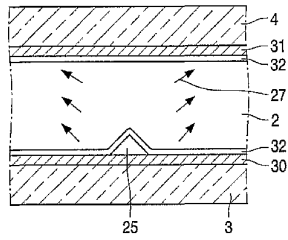


FIG. 4B

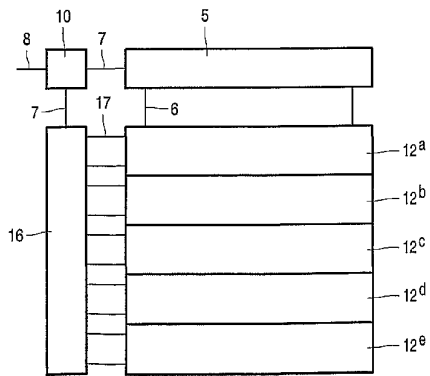


FIG. 5

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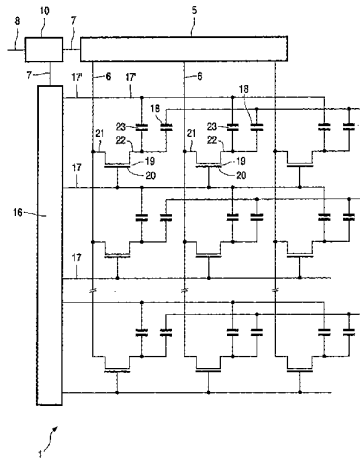
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- (51) International Patent Classification: G09G 3/36 HAAREN, Johannes, A., M., M.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
- (21) International Application Number: PCT/IB02/00286 (74) Agent: RAAP, Adriaan, Y.; Internationaal Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
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- (30) Priority Data: 01200383.6 2 February 2001 (02.02.2001) EP Published: with International search report
- (71) Applicant: KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL). (88) Date of publication of the international search report: 6 November 2003
- (72) Inventors: JOHNSON, Mark, T.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). DE BOER, Dirk, K., G.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL). VAN

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(54) Title: DISPLAY DEVICE



(57) Abstract: The effect of twisting motion of LC molecules in multi-domain pixels of vertically aligned nematic LCDs, which leads to image retention, is reduced by applying a reset pulse which reduces the LCD voltage to below threshold. Several methods of reset (multiple counter electrodes, reset from column drivers, direct block reset, reset via storage capacitor line) are possible.

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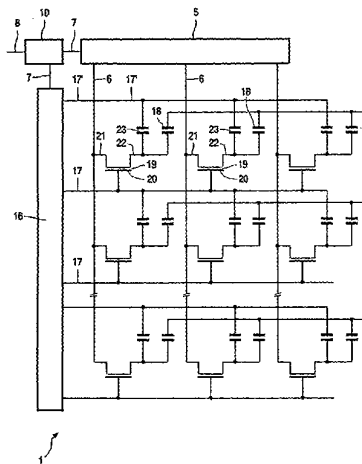
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- (21) International Application Number: PCT/IB02/00286
- (22) International Filing Date: 29 January 2002 (29.01.2002) (74) Agent: RAAP, Adriaan, Y.; International Octrooibureau B.V., Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).
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(74) Agent: RAAP, Adriaan, V.; Internationaal Octrooibureau
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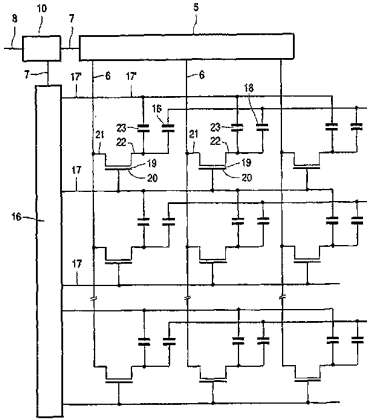
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Display device

The invention relates to a liquid crystal display device comprising a liquid crystal material having a negative dielectric anisotropy between two substrates, one substrate of which is provided with a matrix of selection electrodes and data electrodes with a pixel at the area of a crossing of the selection electrodes and data electrodes, said pixels having a plurality of domains and at least one switching element, and further comprising drive means for driving the selection electrodes and data electrodes.

Examples of such active matrix display devices are TFT-LCDs or AM-LCDs which are used in laptop computers and in organizers and are based on a homeotropic effect, for example, the "vertically aligned effect".

The pixels may be divided into domains in different ways, for example, by means of gaps in the picture electrodes or by local or non-local protrusions.

A problem in such display devices is the occurrence of after images. An image which is replaced by another image is then still visible for a longer time (sometimes up to several seconds), which has a very irritating effect.

It is an object of the present invention to provide a display device of the type described in the opening paragraph, in which after images do not occur or hardly occur.

To this end, a display device according to the invention comprises further drive means for applying a reset voltage across the pixels.

The invention is based on the recognition that two mechanisms are presumably active during switching of a pixel from the homeotropic state (voltage 0 volt or very low voltage) to the nematic state.

Due to the drive voltage, the liquid crystal molecules are subjected to an electric field which is transverse to the electrodes and realizes a very fast tilting movement. Moreover, the gaps and/or protrusions produce electric field components in a plane which is substantially parallel to the substrates (in-plane field). After the fast change of the tilt, the liquid crystal molecules are twisted in a much slower order (1 or more sec). Retwisting also takes place at an order of about 1 msec and thus causes the after images.

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According to the invention, the original twist may be avoided by means of reset pulses which can be realized in different ways. It is, for example, possible that the further drive means apply a reset voltage across all pixels during non-selection of pixels.

It is alternatively possible to apply a reset voltage across at least a part of the pixels via data electrodes during selection of pixels. In this case, the further drive means may apply a reset voltage via data electrodes across at least a part of the pixels during selection of one or more rows of pixels, but this may also be done via parts of a counter electrode.

In a preferred embodiment, a pixel is provided with a storage capacitance and, prior to selection of pixels, the further drive means apply a reset voltage across the pixels via the storage capacitance.

In this application, the phrase "provided with a storage capacitance" is understood to mean that there is a coupling via an (auxiliary) capacitor, for example, by (partial) overlap of a picture electrode associated with a row and a part of the row electrode associated with a subsequent (or previous) row.

The further drive means may apply a reset voltage across the pixels via a connection electrode of the storage capacitance or via an adjacent selection electrode connected to the storage capacitance.

These and other aspects of the invention are apparent from and will be elucidated with reference to the embodiments described hereinafter.

In the drawings:

Fig. 1 is an electric circuit diagram of the display device,

Fig. 2 is a plan view of a picture electrode in a display device according to the invention,

Figs. 3 and 4 show the effect on the response of such a display device, while

Fig. 5 shows a part of a pixel.

The Figures are diagrammatic and not drawn to scale; corresponding parts are generally denoted by the same reference numerals.

Fig. 1 is an electric equivalent circuit diagram of a part of a display device 1 to which the invention is applicable. It comprises a matrix of pixels 18 at the area of crossings of row or selection electrodes 17 and column or data electrodes 6. The row electrodes are

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consecutively selected by means of a row driver 16, while the column electrodes are provided with data via a data register 5. To this end, incoming data 8 are first processed, if necessary, in a processor 10. Mutual synchronization between the row driver 16 and the data register 5 takes place via drive lines 7.

- 5 Drive signals coming from the row driver 16 select the picture electrodes via thin-film transistors (TFTs) 19 whose gate electrodes 20 are electrically connected to the row electrodes 17 and the source electrodes 21 are electrically connected to the column electrodes. The signal which is present at the column electrode 6 is transferred via the TFT to a picture electrode of a pixel 18 coupled to the drain electrode 22. The other picture
- 10 electrodes are connected to, for example, one (or more) common counter electrode(s).

- The display device of Fig. 1 also comprises an auxiliary capacitor 23 at the location of each pixel. In this embodiment, the auxiliary capacitor is connected between the common point of the source electrode 21 and the pixel in a given row of pixels at one end, and the row electrode of the previous row of pixels at the other end; other configurations are
- 15 alternatively possible, for example, between said common point and the next row of pixels, or between this point and an electrode for a fixed (or variable) voltage.

In this embodiment, the display device comprises an extra row electrode 17' so as to prevent picture deviations.

- Fig. 2 is a plan view and Fig. 3 is a cross-section taken on the line III-III in
- 20 Fig. 2 of a part of a liquid crystal material 2 which is present between two substrates 3, 4 of, for example, glass or (flexible) synthetic material, provided with (ITO or metal) picture electrodes 30 and a counter electrode 31, respectively. The device also comprises orientation layers 32 which orient the liquid crystal material on the inner walls of the substrates. Moreover, the device comprises a polarizer (not shown) and a (mutually perpendicularly
- 25 crossed) analyzer. In this case, the liquid crystal material is a (twisted) nematic material having a negative dielectric anisotropy. The picture electrodes also have narrow apertures 24. No light is transmitted (normally black) between crossed polarizers in this state. As will be further described, the apertures serve for obtaining the "wide viewing angle" effect. The same effect is obtained by using protrusions 25 (see Fig. 3B) instead of the apertures 24.

- 30 At zero voltage across a pixel, the (directors 27 of the) liquid crystal molecules are oriented perpendicularly to the substrates (negative dielectric anisotropy). Light transmitted by the polarizer is not influenced by the liquid crystal molecules and is passed by the analyzer.

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Above a given threshold voltage, the liquid crystal molecules tilt and at a further increase of the voltage, the (directors 27 of the) liquid crystal molecules assume an angle with respect to the substrates (Fig. 4). This tilt is usually effected rapidly (about 10 msec). Due to the difference of refractive index and hence the effective path length for the normal and the abnormal component of an incident light beam, light is now passed by the analyzer. Due to "fringing fields" at the area of the apertures, the liquid crystal molecules tilt towards different directions, which enlarges the viewing angle ("wide viewing angle" effect).

When switching back to the dark state (or when switching between two intermediate states), "image retention" occurs in many cases (the images remain visible). This is presumably caused by a rotation of the (directors 27 of the) liquid crystal molecules under the influence of the electric field (field lines 28 in Fig. 4). This twist or rotating movement has a much larger time constant (about 1 sec, dependent on the history).

According to the invention, this twist or rotation may be entirely or partly eliminated by a reset pulse (for example, of a short duration and towards a lower voltage).

There are various possibilities of realizing this.

For example, after an image has been written during a frame period, a reset voltage may be applied across all pixels during a subsequent frame period (via a voltage at the column electrodes or data electrodes).

It is also possible to apply a reset voltage across a part of the pixels via data electrodes during selection of pixels. In this case, the display device is divided into, for example, five segments 12a, 12b, 12c, 12d, 12e (Fig. 5). In such a segment, all lines of, for example, segment 12a are selected during reset, while the reset voltage is presented to the column electrodes. Such a segment is now reset in one line period and is performed once per frame period for each segment.

Alternatively, a reset voltage may be applied across pixels of the line (via a voltage at the column electrodes or data electrodes) during a line period for a (short) period of non-selection, prior to writing a line. This may lead to brightness variations in the image (artefacts). In the device of Fig. 1, such a reset pulse may also be generated capacitively by applying a reset pulse having the correct voltage and polarity to the row electrode 17 prior to the start of a selection period. Due to a capacitive kick-back effect, this reset pulse is transferred to the gate electrode 20, be it at a lower amplitude. By processing this in the choice of the amplitude of the original reset pulse across the row electrode 17, the pixels are reset. Instead of presenting the reset voltage via one counter electrode, the counter electrode

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21 may be alternatively divided into parts corresponding to the segments 12, with the relevant part acquiring such a voltage during resetting that the pixels are reset.

In the embodiment of Fig. 1, the auxiliary capacitor 23 is connected between the common point of the drain electrode 22 and the pixel in a given row of pixels at one end, and the row electrode of the previous row of pixels at the other end. It may also be present between this point and a common electrode for all auxiliary capacitors. In that case, the reset voltage across the pixels is obtained by means of a reset pulse which is presented via this common electrode. Here again, a block-sequential reset is possible.

The protective scope of the invention is not limited to the embodiments described. Instead of the chevron shape of Fig. 2, the protrusions may also have X shapes, (combined) Y shapes or other conventional shapes.

The invention resides in each and every novel characteristic feature and each and every combination of characteristic features. Reference numerals in the claims do not limit their protective scope. Use of the verb "to comprise" and its conjugations does not exclude the presence of elements other than those stated in the claims. Use of the article "a" or "an" preceding an element does not exclude the presence of a plurality of such elements.

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CLAIMS:

1. A liquid crystal display device comprising a liquid crystal material having a negative dielectric anisotropy between two substrates, one substrate of which is provided with a matrix of selection electrodes and data electrodes with a pixel at the area of a crossing of the selection electrodes and data electrodes, said pixels having a plurality of domains and at least one switching element, and further comprising drive means for driving the selection electrodes and data electrodes, wherein the liquid crystal display device comprises further drive means for applying a reset voltage across the pixels.
2. A liquid crystal display device as claimed in claim 1, wherein the further drive means apply a reset voltage across all pixels between two frame periods.
3. A liquid crystal display device as claimed in claim 1, wherein the further drive means apply a reset voltage across at least a part of the pixels via data electrodes during a line selection period or a part of a line selection period.
4. A liquid crystal display device as claimed in claim 3, wherein the further drive means apply a reset voltage across all pixels via data electrodes.
5. A liquid crystal display device as claimed in claim 1, wherein a pixel is provided with a storage capacitance and, prior to selection of pixels, the further drive means apply a reset voltage across the pixels via the storage capacitance.
6. A liquid crystal display device as claimed in claim 5, wherein the further drive means apply a reset voltage across a part of the pixels via parts of a counter electrode during selection of pixels.
7. A liquid crystal display device as claimed in claim 6, wherein the further drive means apply a reset voltage across the pixels via a connection electrode of the storage capacitance.

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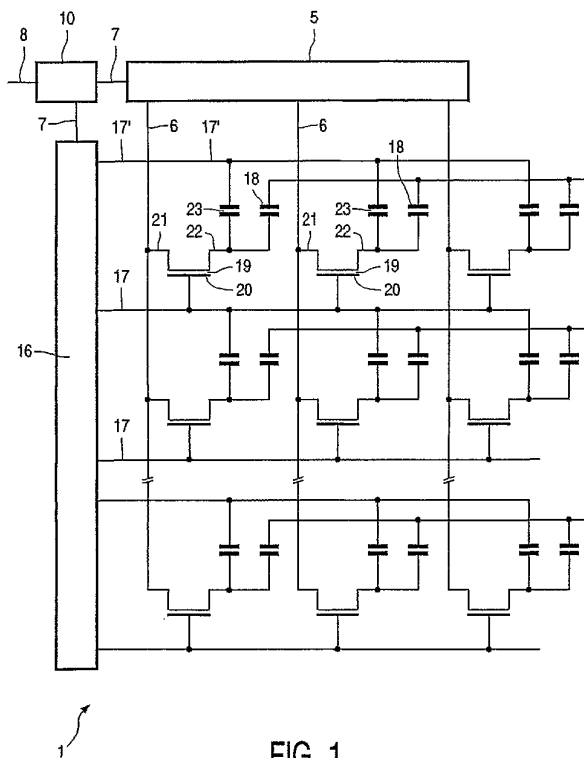
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8. A liquid crystal display device as claimed in claim 6, wherein the further drive means apply a reset voltage across the pixels via an adjacent selection electrode connected to the storage capacitance.

FIG. 1



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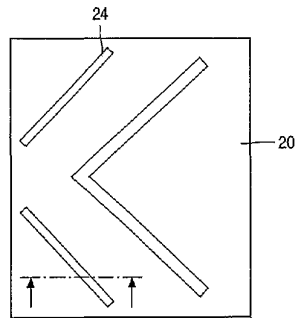


FIG. 2

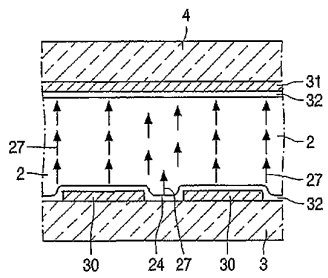


FIG. 3A

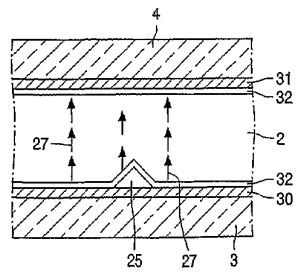


FIG. 3B

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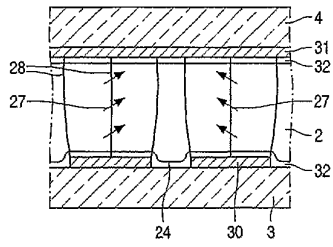


FIG. 4A

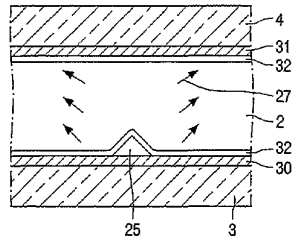


FIG. 4B

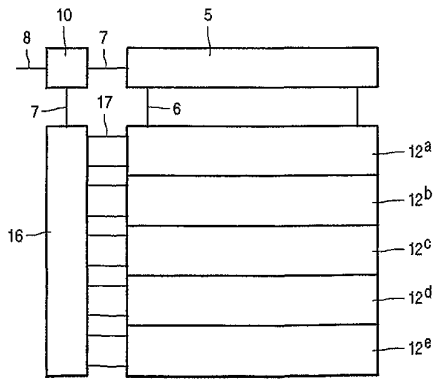


FIG. 5

【国際調査報告】

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A. CLASSIFICATION OF SUBJECT MATTER IPC 7 60963/36		
According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC 7 6096		
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Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal, WPI Data, PAJ		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	JP 2000 284755 A (TOSHIBA) 13 October 2000 (2000-10-13) & US 2002/190940 A1 (ITHO ET AL.) 19 December 2002 (2002-12-19) paragraph '0115! - paragraph '0117!	1-8
X	US 6 169 531 B1 (VERHULST) 2 January 2001 (2001-01-02) column 2, line 23 -column 3, line 23	1-8
A	WO 00 38167 A (THE SECRETARY OF STATE FOR DEFENCE (GB)) 29 June 2000 (2000-06-29) page 6, line 14 -page 9, line 15	1
A	EP 0 632 426 A (SHARP) 4 January 1995 (1995-01-04) page 25, line 19 - line 22	1
☐ Further documents are listed in the continuation of box C. ☒ Patent family members are listed in annex.		
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Date of the actual completion of the international search 3 June 2003		Date of mailing of the international search report 11/06/2003
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel: (+31-70) 340-2040, Tx: 31 651 epo nl, Fax: (+31-70) 340-3016		Authorized officer Lange, J

INTERNATIONAL SEARCH REPORT
 International Search Report on patent family members

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	G 0 9 G 3/20	6 2 4 B
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CPC分类号	G09G3/3655 G02F1/133707 G02F1/1393 G09G3/3659 G09G2300/0876 G09G2310/061 G09G2310/062 G09G2320/02 G09G2320/0257		
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F-TERM分类号	2H088/GA02 2H088/HA01 2H088/HA02 2H088/HA08 2H088/HA18 2H088/JA10 2H088/KA27 2H088/LA03 2H088/MA01 2H093/NA16 2H093/NC09 2H093/NC11 2H093/NC18 2H093/NC34 2H093/NC35 2H093/NC36 2H093/ND12 2H093/ND13 2H093/NE01 2H093/NE03 2H093/NE04 2H093/NF04 2H093/NH04 5C006/AC11 5C006/AC24 5C006/AC25 5C006/AF42 5C006/AF43 5C006/AF44 5C006/AF50 5C006/AF51 5C006/AF71 5C006/BA19 5C006/BB16 5C006/BC03 5C006/BC11 5C006/FA12 5C080/AA10 5C080/BB05 5C080/DD08 5C080/EE29 5C080/FF11 5C080/JJ02 5C080/JJ03 5C080/JJ06 5C080/KK02 5C080/KK07		
代理人(译)	宫崎明彦		
优先权	2001200383 2001-02-02 EP		
外部链接	Espacenet		

摘要(译)

通过施加将LCD的电压降低到阈值以下的复位脉冲，减小了垂直取向的向列LCD的多个像素中的液晶分子的扭转动作引起的图像保持。可以使用多种复位方法（从多个反向电极复位，列驱动器，直接块复位，通过存储电容器外壳复位）。

