

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization  
International Bureau



(43) International Publication Date  
20 September 2001 (20.09.2001)

PCT

(10) International Publication Number  
**WO 01/69310 A1**

(51) International Patent Classification<sup>7</sup>: **G02F 1/133.** (72) Inventor: **RUIGT, Adolphe, J., G.; Prof. Holstlaan 6, NL-5656 AA Eindhoven (NL).**  
G09G 3/36

(21) International Application Number: **PCT/EP01/01596** (74) Agent: **RAAP, Adriaan, Y.; Internationaal Octrooibureau B.V., Prof Holstlaan 6, NL-5656 AA Eindhoven (NL).**

(22) International Filing Date: 14 February 2001 (14.02.2001)

(81) Designated States (*national*): CN, JP, KR.

(25) Filing Language: English

(84) Designated States (*regional*): European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR).

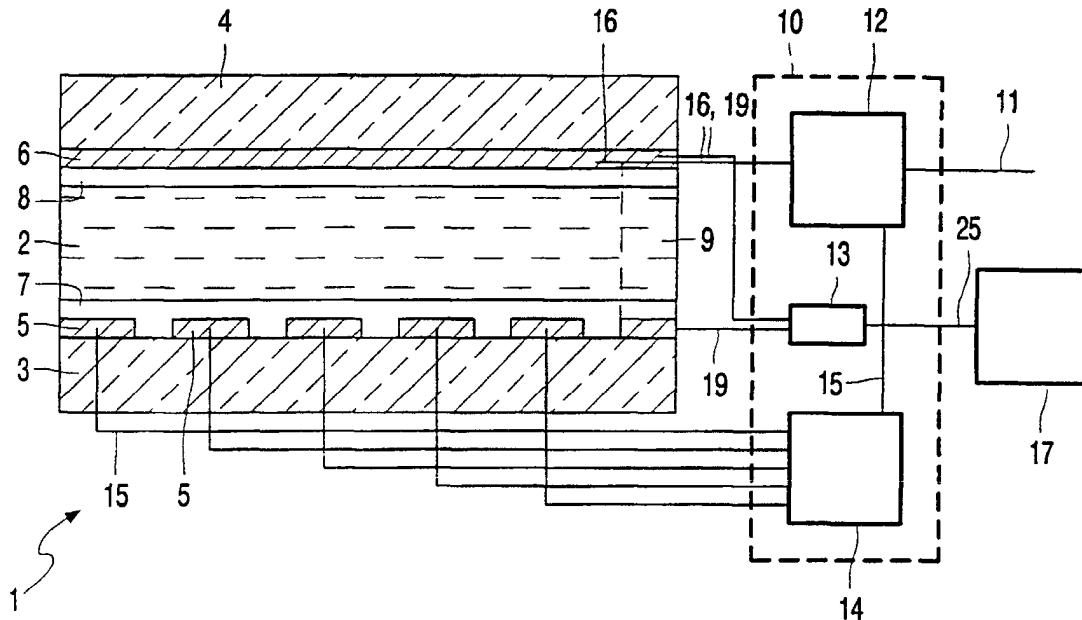
(30) Priority Data:  
00200923.1 14 March 2000 (14.03.2000) EP

Published:  
— with international search report

(71) Applicant: **KONINKLIJKE PHILIPS ELECTRONICS N.V. [NL/NL]; Groenewoudseweg 1, NL-5621 BA Eindhoven (NL).**

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: TWISTED NEMATIC LIQUID CRYSTAL DISPLAY DEVICE WITH MEANS FOR TEMPERATURE COMPENSATION OF OPERATING VOLTAGE



**WO 01/69310 A1**

(57) Abstract: A (super-) twisted nematic liquid crystal display device (1) is provided with means (10) for temperature compensation of the operating voltage by adjusting the operating voltage depending on the temperature dependent switching characteristic of a measuring element (9, 19), which can be a separate liquid crystal test cell or a pixel of the display. The temperature dependent switching characteristic is determined by measuring the switching or peak currents through, or the capacitance of, the measuring element.

## TWISTED NEMATIC LIQUID CRYSTAL DISPLAY DEVICE WITH MEANS FOR TEMPERATURE COMPENSATION OF OPERATING VOLTAGE

The invention relates to a liquid crystal display device comprising a first substrate provided with electrodes and a second substrate provided with electrodes, and a twisted nematic liquid crystal material between the two substrates, in which, viewed perpendicularly to the substrates, overlapping parts of the electrodes define pixels.

5           Liquid crystal display devices of this type are generally known and are used, for example, in display screens for alphanumerical display devices in, for example, computing apparatus and measuring apparatus but also in car radios and telephone apparatus.

10           The operating voltage is adjusted after the manufacture of such liquid crystal display devices. This is usually effected via an external circuit because it is different for each display device due to different behavior of, for example, the liquid crystal material or other parts in the display device. This adjustment involves an extra operation which renders the whole manufacture extra expensive.

15           The use of such liquid crystal display devices may also cause problems at a varying ambient temperature because characteristic values such as threshold voltage and saturation voltage are temperature-dependent for the liquid crystal material. To be able to use the liquid crystal display devices in a wide temperature range, the drive voltages are usually adapted, dependent on the temperature. However, this means that the drive voltages are  
20           chosen from a fairly large voltage range, which requires a high power supply voltage for the drive electronics. Notably in portable apparatus, such as said measuring apparatus and telephone apparatus, which are usually battery-fed, this may lead to problems. Moreover, temperature-sensitive resistors whose resistance varies linearly with the temperature are often used for this correction. Since notably the variation of the switching voltage of the liquid  
25           crystal material is not always linear, an entirely correct adaptation of the switching voltage at varying temperatures will not always take place.

It is, inter alia, an object of the present invention to largely obviate one or more of the above-mentioned problems. It is another object of the invention to provide a liquid crystal display device, notably based on the STN effect (twist angles between 150 and 360°) which can be used in a wide temperature range.

5 To this end, a liquid crystal display device according to the invention is characterized in that the display device is provided with means for adjusting the operating voltage of the liquid crystal display device in dependence upon the switching behavior of a measuring element.

10 Said means provide the possibility of automatically adjusting the operating voltage, so that said extra step is superfluous.

Moreover, the adjusted operating voltage is thereby optimal so that a minimal quantity of unnecessary power is used.

15 A first embodiment of a liquid crystal display device according to the invention is characterized in that the means for adjusting the operating voltage of the display device comprise means for measuring the capacitance of the measuring element.

However, capacitance measurements cannot easily be integrated in a drive IC of a liquid crystal display device.

20 A preferred embodiment of a liquid crystal display device according to the invention is therefore characterized in that the means for adjusting the operating voltage of the display device comprise means for raising the operating voltage and simultaneously measuring the switching current in the measuring element.

25 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 a diagrammatic cross-section of a part of the display device, together with a diagrammatic representation of the drive section,

30 Fig. 2 roughly shows the dependence of the current through a (measuring element) pixel (the capacitance of a (measuring element) pixel, respectively) as a function of the effective voltage ( $V_{rms}$ ) across the pixel,

Fig. 3 shows the derivative of the function as shown in Fig. 2,

Fig. 4 shows a possible signal for activating a measuring element, while

Figs. 5 to 7 show possible derived signals for the purpose of detection, and

Fig. 8 shows diagrammatically a part of the voltage control.

The Figures are diagrammatic and not drawn to scale. Corresponding elements are generally denoted by the same reference numerals.

5

Fig. 1 is a diagrammatic cross-section of a part of a liquid crystal display device, comprising a liquid crystal cell 1 with a twisted nematic liquid crystal material 2 present between two supporting plates or substrates 3 and 4 of, for example, glass or quartz, with selection electrodes 5 and data electrodes 6 in this embodiment. The liquid crystal material (for example, MLC3700 of the firm of Merck) has a positive optical anisotropy, a positive dielectric anisotropy and a low threshold voltage in this case. If necessary, the device comprises polarizers (not shown) whose directions of polarization are, for example, mutually crossed perpendicularly. The device further comprises orientation layers 7, 8 which orient the liquid crystal material on the inner walls of the substrates in such a way that the twist angle is, for example, 270°. The display device is of the passive type but may also be provided with active switching elements which connect picture electrodes to drive electrodes.

In the drive section 10, incoming information 11 is processed, if necessary, and stored in a data register 12, and presented to the data electrodes 6 via data signal lines 16. Pixels, here arranged in rows and columns, are selected by consecutively selecting row electrodes 5 which are connected to a multiplex circuit 14 via row signal lines 15. Mutual synchronization between the multiplex circuit 14 and the data register 12 is ensured by the line 15. After all row electrodes have been selected, this selection is repeated. The display device is also provided with a power supply source 17 shown diagrammatically, which supplies, inter alia, the operating voltage of the liquid crystal display device.

According to the invention, the display device also comprises a measuring element 9 which is shown diagrammatically and is connected via signal lines 19 to a control section 13 of the drive section 10 indicated by broken lines. A pixel, whose kind of measuring value to be described is periodically measured, may also be used as a measuring element. The variation of the current I through such a measuring element (pixel) as a function of the effective voltage ( $V_{rms}$ ) across the measuring element (pixel) is shown in fig. 2. The solid-line curve shows the actually measured curve, whereas the broken line curve represents an idealized curve. The units on the Y axis are scaled. A similar curve applies to the capacitance C of the measuring element.

As regards shape, these curves can be compared with the transmission/voltage characteristic of the pixels. Notably, the voltage associated with the steepest part of the transition and hence the peak of the differentiated curve as shown in Fig. 3 corresponds to the voltage value  $V_{50}$ , which is the value where the transmission is 50% of the maximum

5 transmission; this value is directly coupled to other characteristic values such as the threshold voltage or the saturation voltage in the transmission/voltage characteristic of the display device. This value is particularly coupled to the operating voltage  $V_{op}$  and drive voltages derived therefrom.

In the control section 13, a square-wave voltage (a, Fig. 4) rising in effective  
10 value is generated in a voltage generator at an appropriate instant, for example, by mixing a square-wave (b in Fig. 4) and a ramp voltage (c in Fig. 4), which voltage is applied to a measuring element 23 via signal lines 19' during one or more frame periods  $t_F$ . Fig. 5 shows the associated current through the measuring element which is measured in measuring unit 21 via signal lines 19. The differential circuit 22 determines the derived current, as is shown in  
15 Fig. 6. The value of the derived current is applied to computing unit 24. A sawtooth voltage related to said ramp voltage (c in fig. 4) is also applied from measuring element 23 to the computing unit 24. The computing unit 24 is adapted in such a way that the occurrence of the maximum value in the derived current, as shown in Fig. 6, is related to a coincident voltage of the sawtooth voltage and hence of the presented  $V_{rms}$ . In this way, an indication (analog or  
20 digital) for  $V_{50}$  is obtained, which is fed back via the line 25 to the power supply unit 17 in which the operating voltage is adjusted on the basis of the indication obtained. In the (diagrammatic) example of Figs. 5 to 7, the value of  $V_{50}$  is higher during the frame period  $t_{F2}$  than during the frame period  $t_{F1}$  and the operating voltage will be raised (in this example).

The invention is of course not limited to the embodiment shown, but several  
25 variations are possible within the scope of the invention. For example, intermittent measurements may take place, with  $V_{50}$  not being determined during each frame period but, for example, once per n frame periods ( $n > 100$ ). Notably in the latter case, a pixel may be used for measuring so that it is not necessary to provide an extra measuring element. Where in this example, the calibration point is determined by  $V_{50}$ , other points on the curve in Fig. 3  
30 may be chosen alternatively, for example, the points  $V_1$  and/or  $V_2$  which are related to, for example, the on and off voltages of a display element. Several variations are also possible for realizing the control section 13.

The protective scope of the invention is not limited to the embodiments shown. The invention resides in each and every novel characteristic feature and each and

every combination of characteristic features. Any reference numerals in the claims do not limit their protective scope. The use of the verb "to comprise" and its conjugations does not exclude the presence of elements other than those stated in the claims. The use of the indefinite article "a" or "an" preceding an element does not exclude the presence of a

5 plurality of such elements.

## CLAIMS:

1. A liquid crystal display device comprising a first substrate provided with electrodes and a second substrate provided with electrodes, and a twisted nematic liquid crystal material between the two substrates, in which, viewed perpendicularly to the substrates, overlapping parts of the electrodes define pixels, characterized in that the display device is provided with means for adjusting the operating voltage of the liquid crystal display device in dependence upon the switching behavior of a measuring element.  
5
2. A liquid crystal display device as claimed in claim 1, characterized in that the means for adjusting the operating voltage of the display device comprise means for measuring the switching current of the measuring element.  
10
3. A liquid crystal display device as claimed in claim 2, characterized in that the means for adjusting the operating voltage of the display device comprise means for raising the operating voltage and simultaneously measuring the switching current in the measuring element.  
15
4. A liquid crystal display device as claimed in claim 2, characterized in that the means for adjusting the operating voltage of the display device comprise means for raising the operating voltage and measuring the peak current in the measuring element.  
20
5. A liquid crystal display device as claimed in claim 1, characterized in that the means for adjusting the operating voltage of the display device comprise means for measuring the capacitance of the measuring element.
- 25 6. A liquid crystal display device as claimed in claim 1, characterized in that the measuring element comprises a pixel.

1/2

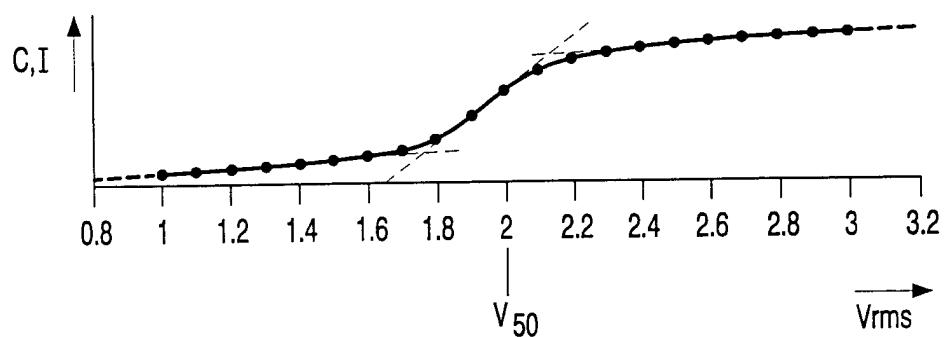
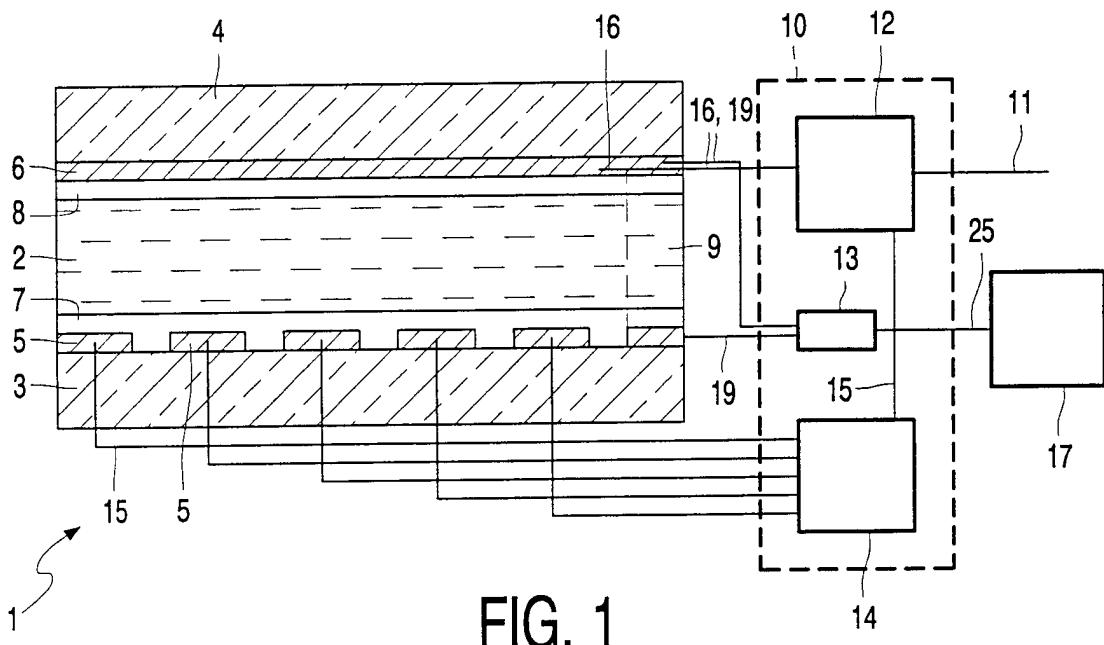


FIG. 2

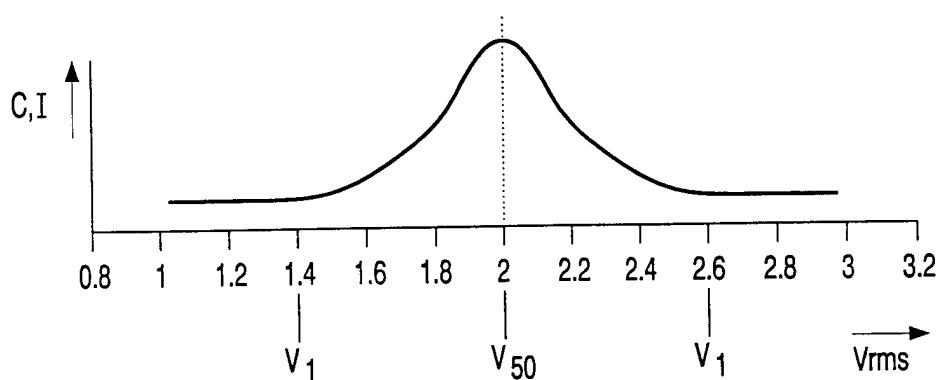


FIG. 3

2/2

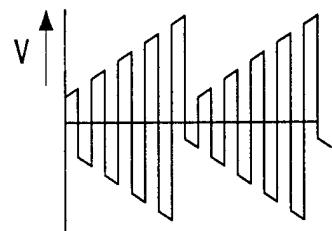


FIG. 4a

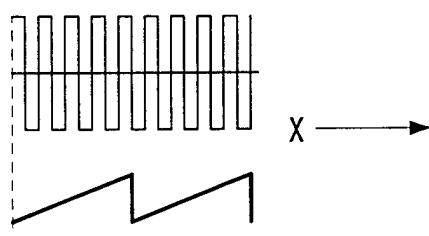


FIG. 4b



FIG. 4c

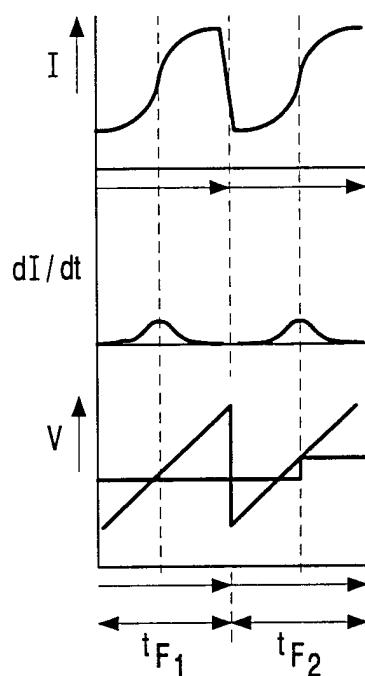


FIG. 5



FIG. 6

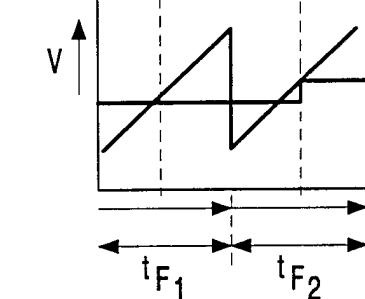


FIG. 7

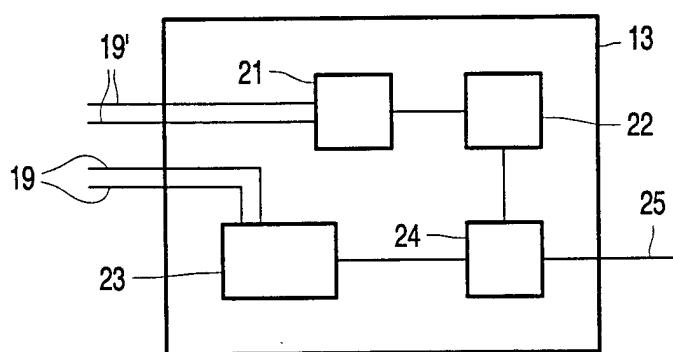


FIG. 8

# INTERNATIONAL SEARCH REPORT

International Application No

PCT/EP 01/01596

**A. CLASSIFICATION OF SUBJECT MATTER**  
 IPC 7 G02F1/133 G09G3/36

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 G02F G09G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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	US 4 298 866 A (HODEMAEKERS ANDREAS M L) 3 November 1981 (1981-11-03) column 4, line 64 -column 8, line 12; claim 1; figures 1-3 ---	1-6
Y	US 4 278 325 A (KANEKO NOBORU ET AL) 14 July 1981 (1981-07-14) column 1, paragraph 1 column 2, paragraph 1 claim 1; figures 2,4,7 ---	1-5
X	US 4 278 325 A (KANEKO NOBORU ET AL) 14 July 1981 (1981-07-14) column 1, paragraph 1 column 2, paragraph 1 claim 1; figures 2,4,7 ---	1,5,6
Y	EP 0 642 113 A (PHILIPS ELECTRONICS NV) 8 March 1995 (1995-03-08) column 2, line 4 - line 18 column 2, line 54 - line 57 column 4, line 35 -column 6, line 17; claim 1; figures 1,4 ----	1-5

Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

° Special categories of cited documents :

- "A" document defining the general state of the art which is not considered to be of particular relevance
- "E" earlier document but published on or after the international filing date
- "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
- "O" document referring to an oral disclosure, use, exhibition or other means
- "P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

Date of mailing of the international search report

21 June 2001

02/07/2001

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

Hauser, M

**INTERNATIONAL SEARCH REPORT**

International Application No

PCT/EP 01/01596

Patent document cited in search report	Publication date	Patent family member(s)		Publication date
US 4298866	A 03-11-1981	NL	7812214 A	17-06-1980
		AU	530293 B	07-07-1983
		AU	5368379 A	19-06-1980
		CA	1143490 A	22-03-1983
		DE	2963085 D	29-07-1982
		EP	0012479 A	25-06-1980
		JP	1471151 C	14-12-1988
		JP	55105292 A	12-08-1980
		JP	63011679 B	15-03-1988
US 4278325	A 14-07-1981	JP	54081879 A	29-06-1979
		GB	2010543 A, B	27-06-1979
EP 0642113	A 08-03-1995	BE	1007478 A	11-07-1995
		JP	7152015 A	16-06-1995
		US	5805131 A	08-09-1998

专利名称(译)	液晶显示装置，具有工作电压的温度补偿装置		
公开(公告)号	<a href="#">EP1181621A1</a>	公开(公告)日	2002-02-27
申请号	EP2001915240	申请日	2001-02-14
[标]申请(专利权)人(译)	皇家飞利浦电子股份有限公司		
申请(专利权)人(译)	皇家飞利浦电子N.V.		
当前申请(专利权)人(译)	皇家飞利浦电子N.V.		
[标]发明人	RUIGT ADOLPHE J G		
发明人	RUIGT, ADOLPHE, J., G.		
IPC分类号	G02F1/133 G09G3/20 G09G3/36		
CPC分类号	G09G3/3622 G09G2320/029 G09G2320/041		
代理机构(译)	RAAP, 雅迪尔ADRIAAN		
优先权	2000200923 2000-03-14 EP		
其他公开文献	<a href="#">EP1181621B1</a>		
外部链接	<a href="#">Espacenet</a>		

#### 摘要(译)

(超) 扭曲向列液晶显示装置(1)具有用于通过根据测量元件(9,19)的温度相关切换特性调节工作电压来对工作电压进行温度补偿的装置(10)，它可以是单独的液晶测试单元或显示器的像素。通过测量通过测量元件的开关或峰值电流或者测量元件的电容来确定温度相关的开关特性。