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Datasheet for the decision of 23 October 2018

Case Number: T 2301/13 - 3.4.03

Application Number: 06025840.7

Publication Number: 1895494

IPC: G09G3/32

Language of the proceedings: EN

Title of invention:
Display device and method of driving the same

Applicant:
LG Display Co., Ltd.

Headword:

Relevant legal provisions:
EPC 1973 Art. 56
EPC Art. 52(1), 123(2)

Keyword:
Inventive step - (yes)

Decisions cited:

Catchword:

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Case Number: T 2301/13 - 3.4.03

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 23 October 2018

Appellant: (Applicant)	LG Display Co., Ltd. 20, Yoido-dong Youngdungpo-gu Seoul 150-721 (KR)
Representative:	Viering, Jentschura & Partner mbB Patent- und Rechtsanwälte Am Brauhaus 8 01099 Dresden (DE)
Decision under appeal:	**Decision of the Examining Division of the European Patent Office posted on 5 July 2013 refusing European patent application No. 06025840.7 pursuant to Article 97(2) EPC.**

Composition of the Board:

Chairman	G. Eliasson
Members:	S. Ward
	W. Van der Eijk

Summary of Facts and Submissions

I. The appeal is against the decision of the Examining Division refusing European patent application No. 06 025 840 on the grounds that the claimed subject-matter did not meet the requirements of Articles 123(2) and 84 EPC (main request), and did not involve an inventive step within the meaning of Article 56 EPC (first and third auxiliary requests). The second auxiliary request was not admitted into the proceedings pursuant to Rule 137(3) EPC.

II. At oral proceedings held before the Board, the appellant requested that the decision under appeal be set aside and that a patent be granted on the basis of the following documents:

claims 1-6 of the main request as filed with the statement of grounds of appeal;

description: pages 1-15 as filed during oral proceedings before the Board on 23 October 2018;

drawings: sheets 1/10-10/10 as originally filed.

III. The following documents are referred to:

D1: US 2004/0085025 A1
D2: US 2005/0052448 A1

IV. Claim 1 of the main request reads as follows:

"A circuit driving device for driving a panel (300) having a plurality of pixels formed (E11, ..., E44) in

cross areas of data lines (Dl, D2, D3, D4) and scan lines (S1, S2, S3, S4), comprising:
a voltage adjusting circuit (316) configured to boost a battery voltage outputted from a battery (314), and output a driving voltage (Vcc);
a data driving circuit (312) configured to provide data currents to the data lines (D1, D2, D3, D4) using the driving voltage (Vcc) outputted from the voltage adjusting circuit (316);
a discharging circuit (308) configured to discharge the data lines (Dl, D2, D3, D4) during a first sub-discharge time (Tl; T3) of a discharge time (dcha1; dcha2), and further discharge the data lines via a zener diode (ZD) during a second sub-discharge time (T2; T4) of the discharge time (dcha1; dcha2), wherein the second sub-discharge time (T2; T4) succeeds the first sub-discharge time (Tl; T3);
a charge storing circuit (320) including a capacitor (C) configured to be coupled to the data lines (Dl, D2, D3, D4) to store charges discharged from the data lines (D1, D2, D3, D4) during the first sub-discharge time (Tl; T3), and to be disconnected from the data lines (Dl, D2, D3, D4) to provide the charges stored in the capacitor (C) to the battery (314) during the second sub-discharge time (T2; T4);
a precharging circuit (310) configured to provide precharge currents to the discharged data lines during a precharge time (pcha1; pcha2) to precharge the discharged data lines, wherein the precharge time (pcha1; pcha2) succeeds the second sub-discharge time (T2; T4);
a comparing circuit (322) configured to compare the battery voltage with a charging voltage (Vc) corresponding to the charges stored in the capacitor (C) of the charge storing circuit (320); and

a switching circuit (SW7) configured to turn on or off a coupling between the battery (314) and the charge storing circuit (320) in accordance with a comparison result of the comparing circuit (322),
wherein the switching circuit (SW7) turns off the coupling between the battery (314) and the charge storing circuit (320) when the battery voltage is the same as, or higher than the charging voltage (Vc), and the switching circuit (SW7) turns on the coupling between the battery (314) and the charge storing circuit (320) to supply the charges stored in the capacitor (C) to the battery when the battery voltage is less than the charging voltage (Vc)."

Reasons for the Decision

1. *Article 123(2) EPC*

1.1 Original claims 1-10 were directed to a display device comprising circuit driving device features defined at various levels of generality; original claims 11-16 were directed to a "circuit driving device for driving a panel". In the opinion of the Board, all of these claims can be regarded as forming part of the general disclosure of a circuit driving device and a display device comprising said circuit driving device.

1.2 Present claim 1 (directed to a circuit driving device) and present claim 4 (directed to a display device comprising *inter alia* the disclosed circuit driving device) are therefore considered to be based on claims 1-16 (in particular, claims 11-15, 16 and 5-7) in combination with features taken from the described

embodiments (in particular, for the claimed "precharging circuit", see paragraphs [0058], [0064] and Figs. 3 and 4C of the application as filed).

Dependent claims 2, 3, 5 and 6 are based on original claims 8, 14, 2, 16 and 10.

The Board thus finds that the requirements of Article 123(2) EPC are met.

2. *Background and closest prior art*

2.1 In many display devices the pixel elements introduce parasitic capacitance. For example, in an organic electroluminescent (OLED) display panel, a possible equivalent circuit for an OLED pixel is an ideal light emitting diode in parallel with a parasitic capacitor (see e.g. paragraph [0005] of D2). Because of this capacitance on the data line, there may be an excessively long time interval between applying a drive signal and the emission of light from the active OLEDs, as the drive signal initially charges up the capacitor rather than bringing the diode directly to its emission voltage.

To obviate this problem a pre-charging circuit is routinely employed, whereby, prior to applying the driving signal, a voltage is applied which very rapidly charges the parasitic capacitors of the scan line to be driven. As a result, the pixels in this scan line may be rapidly brought to an active state (i.e. an emissive state in the case of OLEDs) in the subsequent drive phase, thereby keeping the charge-up dead time to a minimum.

2.2 However, to avoid crosstalk, these pixels must be discharged before the following scan line is activated, and so a discharge phase must be incorporated between the activation of successive scan lines. The successive pre-charging and discharging of each scan line leads to a high consumption of battery power.

To limit power consumption, various schemes have been proposed whereby the charges released in the discharge phase may be stored and recycled. Such a reduction in the power consumption of the display device is the purpose of the circuit driving device of the present invention. Since this is also one of the aims of the circuit driving device disclosed in D2, this document is considered a suitable choice of closest prior art.

3. *Inventive step*

3.1 The appellant agreed with the Board's analysis that claim 1 differs from the arrangement of D2 in defining the following features:

(a) The discharge of the data lines takes place "during a first sub-discharge time (T1; T3) of a discharge time (dcha1; dcha2)" and the discharging circuit is configured to "further discharge the data lines via a zener diode (ZD) during a second sub-discharge time (T2; T4) of the discharge time (dcha1; dcha2), wherein the second sub-discharge time (T2; T4) succeeds the first sub-discharge time (T1; T3)";

(b) the capacitor is configured to be disconnected from the data lines (D1, D2, D3, D4) to provide the charges stored in the capacitor (C) to the battery

(314) during the second sub-discharge time (T2; T4)";

(c) the device comprises "a comparing circuit (322) configured to compare the battery voltage with a charging voltage (Vc) corresponding to the charges stored in the capacitor (C) of the charge storing circuit (320)";

(d) the device comprises "a switching circuit (SW7) configured to turn on or off a coupling between the battery (314) and the charge storing circuit (320) in accordance with a comparison result of the comparing circuit (322)", and

(e) "wherein the switching circuit (SW7) turns off the coupling between the battery (314) and the charge storing circuit (320) when the battery voltage is the same as, or higher than the charging voltage (Vc), and the switching circuit (SW7) turns on the coupling between the battery (314) and the charge storing circuit (320) to supply the charges stored in the capacitor (C) to the battery when the battery voltage is less than the charging voltage (Vc)."

This analysis thus identifies essentially the same differences as those identified in the contested decision in relation to the first auxiliary request (see "Grounds For The Decision - First Auxiliary request").

3.2 The three features (c)-(e) have two technical effects, as stated in feature (e) itself. Firstly, to ensure that there is no possibility that charge could be undesirably diverted from the battery to the capacitor,

and secondly to allow charge to flow from the charge storing capacitor to the battery when the battery voltage is less than the charging (capacitor) voltage.

3.3 In the arrangement of Fig. 5 of document D2, similar effects are provided by the diode D2, which is reverse biased when the voltage on the capacitor C2 is less than the battery voltage, thereby preventing any wasteful charging of the capacitor C2 by the battery B1, but which allows charge to pass from the capacitor C2 to the battery when it is forward biased.

3.4 The appellant identified a drawback with the use of a diode for this purpose, as a result of the diode's "forward voltage", i.e. the characteristic minimum forward bias voltage which must be applied before any substantial current starts to flow (in silicon diodes, for example, the forward voltage ranges from about 0.6 V to 0.8 V). According to the appellant, this drawback arises in the arrangement of D2, and is solved by the present invention, as follows:

3.5 In the arrangement of D2, if the capacitor C2 is charged to a voltage which is higher than the battery voltage by an amount less than the forward voltage, no current would flow to the battery, and the charge would remain on the capacitor. By contrast, according to the present invention, current would flow to the battery whenever the voltage on capacitor C2 is higher than the battery voltage, even by a small amount.

Similarly, in the arrangement of D2, if the voltage on capacitor C2 is higher than the battery voltage by an amount greater than the forward voltage, current would flow to the battery, but would stop when the voltage on capacitor C2 exceeded the battery voltage by an amount

equal to the forward voltage. By contrast, according to the present invention, current would continue to flow to the battery until the voltage on capacitor C2 is equal to the battery voltage. Hence, in the arrangement of document D2, an excess charge Q = C.Vf (where C is the capacitance of C2 and Vf is the forward voltage of the diode) would remain on the capacitor compared to the claimed arrangement.

3.6 In the contested decision it was acknowledged that the applicant (now the appellant) had argued in terms of the drawbacks resulting from the forward voltage of the diode in D2 (Facts and Submissions, point 1.5), but the Examining Division did not appear to acknowledge any technical effect in this regard, since the problem solved by the invention was seen as "finding an alternate way of implementing the solution of regulating the energy transfer back to the battery" (Reasons, page 13, second paragraph).

3.7 It is not entirely clear from the decision itself why the Examining Division were not persuaded by the applicant's argument that the invention provided an additional technical effect over the arrangement of D2. The Board can only presume that the Examining Division continued to hold the view expressed in a communication (dated 28 February 2013, page 5, final paragraph) that, in practice, the switching circuit of claim 1 would also have "an associated resistance and/or threshold voltage", and that, as a result, the technical effects achieved by the arrangements of claim 1 and of D2 would be identical.

3.8 The Board does not share this view. The specific technical effect in question is enabling the capacitor to discharge down to a voltage equal to the battery

voltage, and the Board believes that this effect would still be achieved even in the presence of "an associated resistance and/or threshold voltage" of the switching circuit. The reasons are as follows:

3.9 According to the claimed arrangement, the comparing circuit makes a direct comparison between the battery voltage (Vb) and the charging voltage (Vc), and if Vc>Vb, the switching circuit SW7 is closed and a current I begins to flow from the capacitor through the switching circuit to the battery. The Board accepts that the switching circuit will generally have some (small) internal resistance R, and hence a voltage equal to IR will be dropped across the switching circuit.

However, this voltage drop will not prevent the capacitor discharging down to the level of Vc=Vb, since the voltage drop is current dependent, and as the capacitor discharges the current would fall and the voltage drop would be reduced. Eventually, as the condition Vc=Vb is approached, the current through the switching circuit, and hence the voltage dropped across it, would approach zero.

3.10 Moreover, the "comparison result of the comparing circuit" is simply whether Vc>Vb or Vc≤Vb, irrespective of the *magnitude* of the difference between the two voltages, and the switching circuit (SW7) turns the coupling between the battery and the capacitor on or off "in accordance with" this comparison result.

It is implicit that, in practice, the comparing circuit would output a signal indicative of the comparison result, that this signal would form the input to the switching circuit, and that this input signal would

have a form which, dependent on the comparison result, would cause the switching circuit to adopt a suitable state (on or off), taking into account any threshold voltage the switching circuit might have.

The essential point is that any threshold voltage the switching circuit might have would not appear on the line between the capacitor and the battery, and would not prevent the capacitor discharging down to a voltage equal to the battery voltage.

By contrast, the forward voltage is an intrinsic characteristic of a p-n diode, which, in the arrangement of document D2, would not allow the capacitor to discharge down to a voltage equal to the battery voltage.

3.11 The Board therefore accepts that the claimed arrangement would provide the additional technical effect suggested by the appellant.

The Board can also accept that the technical problem can be formulated as proposed by the appellant at oral proceedings: to improve charge feedback to the battery.

3.12 Starting from D2, and faced with the above problem, it is not evident that the skilled person would immediately focus attention on the diode D2, rather than, for example, the capacitor C2. Even if the skilled person arrived at the idea that the forward voltage of diode D2 was restricting the discharging of the capacitor (which is nowhere mentioned in D2), an obvious measure would be to consider whether D2 could be replaced by a diode with a lower forward voltage.

3.13 The Board does not doubt that a skilled person, if presented with the claimed arrangement, would understand that the comparing/switching circuit would perform a similar function to the diode in document D2, and that this arrangement would enable the capacitor to discharge to a lower voltage. The relevant question, however, is whether, starting from document D2, and without prior knowledge of the claimed invention, it would be obvious to the skilled person to solve the problem of improving charge feedback to the battery by replacing diode D2 with a comparing/switching circuit.

3.14 In the opinion of the Board, obviousness could only be acknowledged if the cited prior art provided some disclosure or hint to employ comparing and switching circuits to solve the posed problem of improving charge feedback. Since this is not the case, the Board can only conclude that, on the basis of the features (c)-(e) listed above under point 3.1, the subject-matter of claim 1 would not be obvious to a person skilled in the art. Consequently, it is not necessary for the Board to consider whether features (a) and (b) are obvious.

3.15 The Board therefore judges that the subject-matter of claim 1 involves an inventive step within the meaning of Article 52(1) EPC and Article 56 EPC 1973.

Order

For these reasons it is decided that:

1. The decision under appeal is set aside.

2. The case is remitted to the department of first instance with the order to grant a patent in the following version:

   claims 1-6 of the main request as filed with the statement of grounds of appeal;

   description: pages 1-15 as filed during oral proceedings before the Board on 23 October 2018;

   drawings: sheets 1/10-10/10 as originally filed.

The Registrar: The Chairman:

S. Sánchez Chiquero G. Eliasson

Decision electronically authenticated