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# Datasheet for the decision of 29 March 2022

**Case Number:** T 1457/18 - 3.4.03

**Application Number:** 14177943.9

**Publication Number:** 2863379

**IPC:** G09G3/32

**Language of the proceedings:** EN

**Title of invention:**
Organic light emitting diode display device and method of driving the same

**Applicant:**
LG Display Co., Ltd.

**Headword:**

**Relevant legal provisions:**
EPC Art. 52(1), 54, 56

**Keyword:**
Novelty - main request (no) - auxiliary request 1 (yes)
Inventive step - auxiliary request 1 (yes)

**Decisions cited:**

**Catchword:**

Europäisches Patentamt
European Patent Office
Office européen des brevets

**Beschwerdekammern**

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**Case Number: T 1457/18 - 3.4.03**

# D E C I S I O N
# of Technical Board of Appeal 3.4.03
# of 29 March 2022

| | |
|---|---|
| **Appellant:** (Applicant) | LG Display Co., Ltd.<br>128, Yeoui-daero<br>Yeongdeungpo-gu<br>Seoul 150-721 (KR) |
| **Representative:** | Ter Meer Steinmeister & Partner<br>Patentanwälte mbB<br>Nymphenburger Straße 4<br>80335 München (DE) |
| **Decision under appeal:** | **Decision of the Examining Division of the European Patent Office posted on 19 December 2017 refusing European patent application No. 14177943.9 pursuant to Article 97(2) EPC.** |

**Composition of the Board:**

| | |
|---|---|
| **Chair** | T. Häusser |
| **Members:** | M. Papastefanou |
| | T. Bokor |

## Summary of Facts and Submissions

I. The appeal is against the decision of the examining division refusing the European patent application No. 14 177 943.

In the decision under appeal, the examining division held that claim 1 of the former Main Request contained added subject-matter (Article 123(2) EPC), and lacked clarity (Article 84 EPC) and novelty (Articles 52(1) and 54 EPC). Additional objections of lack of clarity, added subject-matter, and lack of novelty and inventive step were raised against the auxiliary requests then on file.

II. Reference is made to the following documents:
D1: US 2013/0088417 A1
D2: US 2013/0120228 A1
D6: US 2007/0164959 A1

III. The appellant (applicant) requested initially that the decision under appeal be set aside and that a patent be granted on the basis of the Main request, or one of Auxiliary requests 1 to 10, all filed with the statement of grounds of appeal. Moreover, it requested reimbursement of the appeal fee (Rule 103(1)(a) EPC) because of a series of substantial procedural violations purportedly committed by the examining division.

IV. After the board had issued its preliminary opinion, the appellant submitted with letter dated 22 February 2022 new Auxiliary requests 1 to 3 replacing the corresponding requests then on file.
During the oral proceedings the appellant withdrew

Auxiliary Requests 1 and 3 to 10 and promoted Auxiliary Request 2 to Auxiliary Request 1. The request for reimbursement of the appeal fee was also withdrawn.

V. The appellant's final requests were thus that the decision under appeal be set aside and that a patent be granted on the basis of the Main Request, filed with the statement of the grounds of appeal, or alternatively, on the basis of Auxiliary Request 1 consisting of the following documents:

- Claims: no. 1 to 9 filed with letter dated 22 February 2022 as Auxiliary Request 2
- Description: pages 1 to 3, 3a, 3b filed with letter dated 22 February 2022, pages 4 to 22 as filed
- Drawings: sheets 1/9 to 9/9 as filed.

VI. Claim 1 of the **Main Request** is worded as follows:

*An organic light emitting diode (OLED) display device comprising:*
*a first transistor (T1) configured to supply a data voltage to a first node (N1) according to a scan signal (Scan[n]);*
*a first capacitor (C1) connected to the first node (N1) at one end of the first capacitor (C1), and connected to a second node (N2) at the other end;*
*a second transistor (T2) configured to supply a reference voltage to the second node (N2) according to a sensing signal (Sense[n]);*
*a driving transistor (Tdr) including a gate electrode connected to the second node (N2), and a source electrode connected to a third node (N3); and*
*an organic light emitting diode (OLED) including a cathode electrode configured for receiving a low-level source voltage (VSS) and an anode electrode connected*

*to the third node (N3),*
*characterized*
*in that the driving transistor (Tdr) further includes a drain electrode configured for receiving a high-level source voltage (VDD) or an initial voltage (Vinitial),*
*in that the drain electrode of the driving transistor (Tdr) is configured for receiving the initial voltage (Vinitial) in units of at least two frames.*

VII. Claim 1 of **Auxiliary Request 1** has the following wording:

*An organic light emitting diode (OLED) display device comprising:*
*a first transistor (T1) configured to supply a data voltage to a first node (N1) according to a scan signal (Scan[n]);*
*a first capacitor (C1) connected to the first node (N1) at one end of the first capacitor (C1), and connected to a second node (N2) at the other end;*
*a second transistor (T2) configured to supply a reference voltage to the second node (N2) according to a sensing signal (Sense[n]);*
*a driving transistor (Tdr) including a gate electrode connected to the second node (N2), and a source electrode connected to a third node (N3);*
*an organic light emitting diode (OLED) including a cathode electrode configured for receiving a low-level source voltage (VSS) and an anode electrode connected to the third node (N3);*
*a second capacitor (C2) connected between the first node (N1) and the third node (N3);*
*a third transistor (T3) configured to connect the first node (N1) to the third node (N3) according to the sensing signal (Sense[n]); and*
*a fourth transistor (T4) configured to supply the*

*reference voltage to the third node (N3) according to the scan signal (Scan[n]),*
*characterized*
*in that the driving transistor (Tdr) further includes a drain electrode and the OLED display device is configured for supplying alternatively a high-level source voltage (VDD) and an initial voltage (Vinitial) to the drain electrode of the driving transistor (Tdr), in that the OLED display device is configured for supplying the initial voltage (Vinitial) in units of at least two frames to the drain electrode of the driving transistor (Tdr).*

VIII. Independent claim 6 of **Auxiliary request 1** is worded as follows:

*A method of driving an organic light emitting diode (OLED) display device including first to fourth transistors (T1, T2, T3, T4), a driving transistor (Tdr), first and second capacitors (C1, C2), and an organic light emitting diode (OLED), the method comprising:*
*when the second (T2) and third transistors (T3) are turned on and an initial voltage (Vinitial) is being applied to a drain electrode of the driving transistor (Tdr), initializing a voltage of a first node (N1) and a voltage of a third node (N3) to the initial voltage (Vinitial), and initializing a voltage of the second node (N2) to a reference voltage (Vref), wherein the first node (N1) is connected to one end of each of the first (C1) and second capacitors (C2), the third node (N3) is connected to the other end of the second capacitor (C2) and a source electrode of the driving transistor (Tdr), and the second node (N2) is connected to the other end of the first capacitor (C1) and a gate electrode of the driving transistor (Tdr);*

*when the second (T2) and third transistors (T3) are turned on and a high-level source voltage (VDD) is being applied to the drain electrode of the driving transistor (Tdr), maintaining the voltage of the second node (N2) as the reference voltage, and storing, by the first capacitor (C1), a threshold voltage of the driving transistor (Tdr);*
*when the first and fourth transistors (T1, T2, T3, T4) are turned on, applying a data voltage to the first node (N1); and*
*when the first to fourth transistors (T1, T2, T3, T4) are turned off, emitting light from the OLED, wherein an anode electrode of the OLED is connected to the third node (N3),*
*wherein the initializing and the storing are executed in units of at least two frames.*

IX. The appellant argued essentially that the subject-matter of claim 1 of the Main request was new over document D1 and that the subject-matter claimed according to Auxiliary Request 1 involved an inventive step over documents D1, D2 and D6.

## Reasons for the Decision

1. The claimed invention

1.1 The application relates to an organic light emitting diode (OLED) display device and a method of driving it.

1.2 In a display device using OLEDs, each pixel corresponds to an OLED, which is driven by a circuit comprising, among others, a driving transistor (see for example Figure 2). The current flowing in the OLED is controlled by the driving transistor. The intensity of the current that flows through the OLED and the

intensity of the light emitted by the diode depend on the gate voltage of the driving transistor. This voltage is a combination of the data voltage supplied to the pixel circuit and the threshold voltage of the driving transistor.

1.3 A common problem that occurs in such pixel circuits is that there is a deviation of the threshold voltage of the driving transistor, i.e. a difference between the theoretical (nominal) and the actual value of the threshold voltage. This deviation can be due to a change in the characteristics of the transistor during manufacture or it can occur during the operation life-time of the transistor through deterioration. A deviation of the threshold voltage of the driving transistor will result in an inaccurate gate voltage applied, which will affect the intensity of the current supplied to the OLED and ultimately the intensity of the emitted light, which may thus not correspond to the supplied data voltage. This may negatively affect the quality of the displayed pixel and the entire image.

1.4 A common solution to this problem is to use a compensation circuit that is able to compensate the deviation of the threshold voltage of the driving transistor, thus avoiding the negative effects (see par. [0003] to [0009] of the published application).

1.5 The operation of such a compensation circuit is based on sensing the actual threshold voltage of the driving transistor and storing it in a capacitor of the compensation circuit in order to apply it subsequently to the driving transistor. This operation requires several phases in one operation cycle of the pixel circuit (frame): firstly the circuit is initialised, then the driving voltage of the driving transistor is

sensed and stored in a capacitor, then the data voltage is sampled, and finally the OLED is activated. From these four phases, the pixel is active ("on") only during the fourth (see also paragraphs [0010] to [0014] and Figure 3).

1.6 The application proposes an OLED display device where the first and second phases (initialising and sensing/storing of the threshold voltage) are not carried out in every frame, but in units of at least every two frames (i.e. every two, three, etc. frames). In this way there is more overall emission time for the pixels resulting in an improved image quality of the display device (see e.g. Figure 4).

2. Main request - Novelty (Article 54 EPC)

2.1 It was common ground that D1 disclosed the preamble of claim 1 of the Main Request (see Figure 2 of D1). The appellant contested, however, that D1 disclosed the characterising features of claim 1, as the examining division had held. These characterising features are the following (numbering by the board):

(i) *the driving transistor (Tdr) further includes a drain electrode configured for receiving a high-level source voltage (VDD) or an initial voltage (Vinitial)*
(ii) *the drain electrode of the driving transistor (Tdr) is configured for receiving the initial voltage (Vinital) in units of at least two frames*.

2.2 In the decision under appeal, the examining division held in its first interpretation of those features, that neither of them was *a device feature related to the driving transistor and this did not impose any restriction on the device feature "drain electrode" of*

*the driving transistor itself; as a result the configuration of the claimed driving transistor was not distinguishable, in terms of its device features, from that of Tdr of D1, both having their drain electrodes connected to a supply line* (see points a) on page 5, and a') on page 6 of the contested decision).

2.3 The appellant pointed out that the claim related to the display device as a whole and not only to the driving transistor. Feature (i) meant that the drain electrode of the driving transistor was connected to the sources of both the high-level source voltage (VDD) and the initial voltage (Vinitial).

It was implicit that the display device comprised a controller which controlled the voltage supply and was set to supply both the initial voltage Vinitial and the high-level source voltage VDD to the drain electrode of the driving transistor, with Vinitial being supplied every at least two frames. The skilled person would thus understand that these features were not features of the driving transistor but of the display device as a whole, i.e. that the display device was configured to supply both voltages to the drain electrode of the driving transistor and Vinitial every at least two frames. The voltages were included in the claim and features (i) and (ii) related to supplying the voltages to the circuit. It was only the drain electrode of the driving transistor that received both voltages.

In the pixel circuit of D1, Vinitial was not supplied to the drain electrode of the driving transistor (see D1, Figure 2) and it was supplied each frame. D1 did not disclose any of features (i) and (ii) and, hence, claim 1 of the Main Request was new.

2.4 The board agrees that claim 1 defines a display device and not only a driving transistor. It notes, however, that the claim does not comprise any features related to a controller or anything similar. Moreover, according to the claim, it is the *drain electrode* of the driving transistor which is configured for receiving the high-level source voltage (VDD) and the initial voltage (Vinitial), and the Vinitial in units of at least two frames. The board thus does not accept the appellant's interpretation that this should be understood as the *display device* being configured for supplying the voltage accordingly.

2.5 The board agrees therefore with the examining division that there is no feature of the drain electrode of the driving transistor itself that configures it in a particular way to receive the voltages as defined in features (i) and (ii) above. This rather depends on how often and/or how long the initial voltage is applied to the drain electrode, something that is outside the operation and the control of the electrode or the transistor proper. It might well be that there is a controller in the display device set to supply the voltage according to these two features, but this is not part of the claim.

2.6 The board's conclusion is, thus, that these features do not provide any additional limitation to the claimed device when compared to D1. Claim 1 of the Main request is therefore found to lack novelty (Article 52(1) and 54(1) and (2) EPC).

3. Auxiliary request 1

3.1 Amendments, Clarity (Articles 123(2) and 84 EPC)

3.1.1 Claim 1 of Auxiliary request 1 is based on a combination of orignal claims 1, 2 and 4. Correspondingly, independent claim 6 is based on a combination of original claims 8, 9 and 11.

3.1.2 With the addition of the specification that the second transistor (T2) is configured to supply a reference voltage to the second node (N2) *according to a sensing signal (Sense (n))* (underlining by the board), the corresponding objection under Article 123(2) EPC in the impugned decision (see point 9 of the Reasons) has been overcome.

3.1.3 The board is, thus satisfied that the requirements of Article 123(2) EPC are fulfilled.

3.1.4 Regarding the examining division's objection under Article 84 EPC, the appellant has submitted an amended description adapted to the claims of Auxiliary Request 1. In particular, the definition of the invention and of the technical problem to be solved correspond to the definition of the invention in claims 1 and 6, as well as to the problem solved by the features distinguishing these claims from D1 (see discussion on inventive step below).

3.1.5 The board is, thus, satisfied that the objections of the examining division have been overcome and the requirements of Article 84 EPC are fulfilled.

3.2 Novelty (Article 54 EPC)

3.2.1 Claim 1 of Auxiliary request 1 defines explicitly that it is the OLED device which is configured for supplying alternatively a high-level source voltage (VDD) and an initial voltage (Vinitial) to the drain electrode of

the driving transistor (Tdr) and for supplying Vinitial in units of at least two frames to the drain electrode of the driving transistor (Tdr).

3.2.2 Compared to claim 1 of the Main request, these features are now explicitly formulated as technical features of the claimed device. The board agrees with the appellant that these features are not disclosed in D1 and, hence, claim 1 is new over D1. Since none of the other prior documents discloses the combination of the features of claim 1, the board is satisfied that claim 1 is new.

The same applies to independent claim 6, which defines a corresponding method with technical features corresponding to those of claim 1.

The subject-matter of independent claims 1 and 6 and dependent claims 2 to 5 and 6 to 9 of Auxiliary Request 1 is therefore new (Articles 52(1), 54(1) and (2) EPC).

3.3 Inventive step (Article 56 EPC)

3.3.1 It is common ground that D1 is the most suitable starting point for the assessment of inventive step. D1 discloses an OLED display device with a pixel circuit comprising a compensation circuit for the threshold voltage of the driving transistor. The devices of claim 1 and D1 have very similar circuits (see Figure 2 of the application and Figure 2 of D1).

It is also common ground that D1 discloses the preamble of claim 1 of Auxiliary request 1.

3.3.2 The OLED display device differs therefore from the one in D1 in that:

- *the OLED display device is configured for supplying alternatively a high-level source voltage (VDD) and an initial voltage (Vinitial) to the drain electrode of the driving transistor (Tdr);* and
- *the OLED display device is configured for supplying the initial voltage (Vinitial) in units of at least two frames to the drain electrode of the driving transistor (Tdr).*

In D1, the initial voltage Vinitial is supplied through a separate transistor (T4 - see Figure 2). Moreover, there is no indication that it is done in any other way but in each frame (see, for example, paragraph [0049]).

3.3.3 The appellant argued that these two distinguishing features combined to provide the technical effect of a better image quality of the OLED display device.

By providing both VDD and Vinitial to the drain electrode of the driving transistor, there was no need for a dedicated transistor for this purpose, as in D1 (T4 - see Figure 2). The pixel circuit of the claimed device circuit comprised thus fewer parts, which meant it occupied less space on the surface of the display device. This contributed to an increase of the display's aperture ratio, i.e. the ratio of the surface emitting light to the surface of the pixel circuits. Increased aperture ratio led to a better image quality of the display device.

By providing Vinitial every at least two frames, the initialising and sensing/storing phase (see Figure 3 of the published application) were not present in each frame. This resulted in longer emission phases (t4 - see Figure 3) for the frames without initialising and sensing/storing phase (see Figure 4), increasing the

overall emission time of the display. This also led to a better image quality of the display device.

3.3.4 Regarding the first distinguishing feature, the board does not agree with the appellant that it contributes to a better image quality. Without any details about the topology of the pixel circuit, it cannot be said that by removing a transistor the footprint of the circuit is inevitably decreased. It is common practice, for example, that in such circuits the transistors are formed as layers which are placed on top of each other. In such a case, removing a layer would not change the footprint of the circuit. The board considers, thus, that the technical effect obtained by the first distinguishing feature relates rather to a simplification of the pixel circuit than to any improvement in the image quality of the display device.

Regarding the second distinguishing feature, the board agrees with the appellant that it permits longer emission time, contributing to a better image quality.

Thus the two distinguishing features solve different technical problems and are to be assessed separately.

3.3.5 Starting from D1, the skilled person is thus faced with the partial technical problem of improving the quality of the displayed image.

As mentioned above, D1 does not provide any indication that the initialising of the circuit and the sensing/ storing of the threshold voltage is carried out in any other way than in each frame. The skilled person would not find suggestion or motivation in D1 to change this.

3.3.6 D2 describes an OLED display device with a pixel circuit comprising a compensation circuit for the threshold voltage of the driving transistor (see Figure 2). Although the circuit is slightly different from the one in D1 and that of the claimed device, it is based on the same principles of initialising the circuit and sensing/storing the threshold voltage at a capacitor in order to apply it to the driving transistor at an emission phase (see Figures 3 and 4). As in D1, there is no indication in D2, either, that the initialising and sensing/storing phases are carried out other than in each frame. Thus D2 would not motivate the skilled person, either, to modify this aspect of D1's device.

3.3.7 D6 also describes an OLED display device with a compensation circuit for the threshold voltage of the driving transistor (see Figure 3), which is based on the same concepts of initialising the circuit and sensing/storing the threshold voltage of the driving transistor (see paragraphs [0013] to [0035]).

According to D6, the threshold voltage measurement can be done every frame but it does not need to be performed this frequently, as the compensation required derives more from variations across the substrate than differential ageing. The threshold voltage measurement can be carried out at the beginning of a display cycle, for example each time the display is turned on (paragraphs [0063] and [0064]).

3.3.8 Based on this disclosure, the examining division held that the skilled person would have understood from D6 that it was not necessary to measure the threshold voltage of the driving transistor for each frame. They would thus have modified the display device of D1 so that the initialising and sensing/storing did not take

place during every frame and arrive at the identified distinguishing feature in an obvious way.

3.3.9 The board does not share the examining division's view.

Firstly, the board notes that D6 suggests that the threshold voltage is measured only once every operation cycle of the display, e.g. when the display is turned on. This is not the same as specified by the claimed feature, which implies a periodic (regular) measurement of the threshold voltage every at least two frames. Hence, even if the skilled person would have applied this teaching to the device of D1, they would not have arrived at the claimed feature.

Secondly, the board considers it questionable whether D6 would lead the skilled person to the general teaching that the threshold voltage did not need to be measured/sensed every frame but could be measured in units of at least two frames. D6 merely indicates that the threshold voltage can be measured once every operation cycle instead of each frame. However, there is no suggestion about a periodic (regular) measurement that should take place every certain number of frames (more than one). Moreover, as the appellant pointed out, the compensation circuits of D1 and D6 are different and are based on different operating principles ("source follower" in D1 vs "diode connection" in D6). The board therefore does not consider it self-evident that any general technical teaching derived from D6 could be applied in D1 in a straightforward manner.

The board's conclusion is, thus, that the skilled person would not combine D1 with D6, and, even they did, they would not obtain the identified

distinguishing feature.

3.3.10 Finally, the question of whether there was an obvious trade-off between the accuracy of the threshold voltage compensation and the image quality was discussed.

The sensed threshold voltage of the driving transistor, which is stored in the capacitor, gradually decreases as the capacitor is being discharged over time. Furthermore, the threshold voltage of the transistor varies in time - this is the problem the compensation circuit is trying to solve. So, regarding the accuracy of the measured threshold voltage and, consequently, the accuracy of the intensity of the current supplied to the OLED, it is important to sense/store the threshold voltage of the driving transistor as frequently as possible.

At the same time, the initialising and sensing/storing phases are negatively affecting the emission time of the OLED and, so, the quality of the image.

Less frequent measurement/sensing and storing of the threshold voltage of the driving transistor may thus result in applying an inadequate driving voltage at the driving transistor, resulting in an inadequate intensity of the OLED driving current. At the same time, more frequent measurement/sensing and storing of the threshold voltage has a negative impact on the overall emission time of the OLED and image quality.

When trying to improve the image quality in one way (by increasing emission time) the skilled person would cause its deterioration in another way (less frequent measurement of the threshold voltage may lead to less accurate compensation). The question is, thus, whether

this trade-off would be obvious for the skilled person.

3.3.11 As the appellant explained - and the board accepts - it is precisely the recognition of this trade-off and the claimed resolution that underlies the invention. In particular, the invention lies in the recognition that the deviation in the threshold voltage of the driving transistor would not change so quickly that it had to be measured every frame. The accuracy problem was, thus, mainly related to the discharging of the capacitor storing the sensed threshold voltage.

Furthermore, it lies in the recognition that the improvement in the image quality obtained by the increase of the emission time was more significant than any inaccuracies introduced by a less frequent measurement/sensing of the threshold voltage and that a limit had to be observed, i.e. the sensing had to be done regularly (periodically) every certain number of frames in order to keep an acceptable accuracy of the driving voltage applied to the driving transistor. In particular, the solution suggested in D6 (to measure the threshold voltage once in every operational cycle) should not be applied.

3.3.12 The board comes therefore to the conclusion that the subject-matter of claim 1 of Auxiliary Request 1 involves an inventive step (Article 52(1) EPC) within the meaning of Article 56 EPC. There is therefore no need to assess the other identified distinguishing feature (see point 3.3.2 above).

The same conclusion also applies to independent claim 6, which defines a corresponding method for driving an OLED display device. The remaining claims depend directly or indirectly on claim 1 or claim 6 and

are thus also inventive.

4. The board is thus satisfied that the application according to Auxiliary Request 1 and the invention to which it relates meet the requirements of the EPC and that a European patent is to be granted to the applicant according to Article 97(1) EPC.

**Order**

**For these reasons it is decided that:**

1. The decision under appeal is set aside.

2. The case is remitted to the Examining Division with the order to grant a patent in the following version:

   - Claims: no. 1 to 9 filed with letter dated 22 February 2022 as Auxiliary Request 2;
   - Description: pages 1 to 3, 3a, 3b filed with letter dated 22 February 2022, pages 4 to 22 as filed;
   - Drawings: sheets 1/9 to 9/9 as filed.

The Registrar: The Chair:

S. Sánchez Chiquero T. Häusser

Decision electronically authenticated