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Datasheet for the decision
of 8 April 2014

Case Number:	T 1051/10 - 3.4.03
Application Number:	02781889.7
Publication Number:	1449193
IPC:	G09G3/36
Language of the proceedings:	EN

Title of invention:
LIQUID CRYSTAL DISPLAY AND DRIVING METHOD THEREOF

Applicant:
Samsung Display Co., Ltd.

Headword:

Relevant legal provisions:
EPC 1973 Art. 83

Keyword:
Sufficiency of disclosure - (no)

Decisions cited:

Catchword:

Case Number: **T 1051/10 - 3.4.03**

D E C I S I O N
of Technical Board of Appeal 3.4.03
of 8 April 2014

Appellant: (Applicant)	Samsung Display Co., Ltd. 95, Samsung 2 Ro Giheung-Gu Yongin-City, Gyeonggi-Do (KR)
Representative:	Modiano, Micaela Nadia Modiano Josif Pisanty & Staub Ltd Thierschstrasse 11 80538 München (DE)
Decision under appeal:	Decision of the Examining Division of the European Patent Office posted on 11 December 2009 refusing European patent application No. 02781889.7 pursuant to Article 97(2) EPC.

Composition of the Board:

Chairman:	G. Eliasson
Members:	R. Bekkering
	T. Bokor

Summary of Facts and Submissions

I.   The appeal is against the refusal of application no. 02
        781 889 for lack of clarity, Article 84 EPC, and lack
        of an inventive step, Article 56 EPC (main request),
        for added subject-matter, Article 123(2) EPC, and lack
        of clarity, Article 84 EPC (first auxiliary request),
        for lack of an inventive step, Article 56 EPC (second
        auxiliary request) and for lack of clarity, Article 84
        EPC, and lack of an inventive step, Article 56 EPC
        (third auxiliary request).

II.   A summons to oral proceedings was issued by the board,
        provided with an annex in which a provisional opinion
        of the board on the matter was given.

        In particular, the appellant was informed that the
        application would not appear to disclose the invention
        in a manner sufficiently clear and complete for it to
        be carried out by a person skilled in the art, contrary
        to the requirement of Article 83 EPC 1973.

III.   At the oral proceedings before the board held on 8
        April 2014, the appellant requested that the decision
        under appeal be set aside and that a patent be granted
        on the basis of the following:

        Main request:

        Claims 1 to 9 according to the main request filed with
        the letter of 7 March 2014,

        First auxiliary request:

Claims 1 to 9 according to the first auxiliary request
filed with the letter of 7 March 2014,

Second auxiliary request:

Claims 1 to 9 according to the second auxiliary request
filed with the letter of 7 March 2014.

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

"*A liquid crystal display (LCD), comprising:
an LCD panel (100) comprising a plurality of gate lines
(S_1-S_n) for transmitting scanning signals, a plurality
of data lines (D_1-D_m) that are insulated from and that
cross the gate lines for transmitting image signals,
and a plurality of pixels that are formed in an area
surrounded by the gate lines (S_1-S_n) and the data lines
(D_1-D_m) and that are arranged as a matrix pattern and
that have switching elements (110) connected to the
gate lines and data lines;
a data gray signal modifier (400) for receiving gray
signals (G_n) from a data gray signal source, and for
outputting modification gray signals (G_m') by
considering gray signals of present (G_n) and previous
frames (G_{n-1}) according to one or more modification
parameters;
wherein the one or more modification parameters are at
least one of a temperature, an image quality selected
by a user, and an environment of the LCD,
a gate driver (200) for sequentially supplying the
scanning signals; and
a data driver (300) for changing the modification gray
signals into corresponding data voltages and outputting
the image signals,*

*a storage device including look-up tables (LUTs)
storing compensation values to modify the data gray
signal for the one or more modification parameters; and
a sensor for measuring the present temperature of the
LCD;*
characterized in that
*the LUT is made of compensation values MSB 4-bits among
8-bit gray signals, wherein each compensation value
within a LUT is represented by G_{ij}, and wherein the
value for y=4 representing said most significant bits
MSB 4-bit of an 8-bit gray signal, the present frame
gray signal G_n in a row of the LUT is expressed as
$G_n=(i-1)\times2^{(8-y)}$, and the previous frame gray signal G_{n-1}
of a column of the LUT is expressed as $G_{n-1}=(j-1)\times2^{(8-y)}$;
wherein G_{ij} represents a cell which is located in the i-
row and the j-column of the LUT,
and in that the LCD further comprises
a LUT selector (445) adapted to select a suitable LUT
for performing a LUT conversion; and
a LUT converter (446) modifies the compensation value
G_{ij} of the selected LUT so as to produce a compensation
value G_{ij}' corresponding to a present measured
temperature that satisfies the following equation when
the present measured temperature does not correspond to
a predetermined temperature and the predetermined
temperature of which the difference from the present
temperature is the smallest among a plurality of the
predetermined temperatures:*
$G_{ij}'=G_{ij}+\alpha(G_{ij}-G_{ii})+\beta(G_{ij}-G_{ii})^2+\gamma(G_{ij}-G_{ii})^4+...$
*where $G_{ii}=(i-1)\times2^{(8-y)}$, and
α, β and γ are modification coefficients for
compensating the difference between the present
measured temperature and the predetermined temperature
of a certain point of the LCD, wherein α>1 when the
present temperature is lower than the predetermined*

temperature and α<1 when the present temperature is
higher than the predetermined temperature."

V.   Claim 1 of the first auxiliary request corresponds to
         claim 1 of the main request, however, with the
         following characterising portion:

"*characterized in that*
the LUT is made of compensation values MSB 4-bits among
8-bit gray signals, wherein each compensation value
within a LUT is represented by G_{ij}, and wherein the
value for y=4 representing said most significant bits
MSB 4-bit of an 8-bit gray signal, the present frame
gray signal G_n in a row of the LUT is expressed as
$G_n=(i-1)\times2^{(8-y)}$, and the previous frame gray signal G_{n-1}
of a column of the LUT is expressed as $G_{n-1}=(j-1)\times2^{(8-y)}$;
wherein G_{ij} represents a cell which is located in the i-
row and the j-column of the LUT; and
wherein the data gray signal modifier (400) comprises:
a frame storage device for receiving the gray signals
from the data gray signal source, storing the gray
signals for a period of one frame, and outputting the
same;
a controller (430) for controlling writing and reading
the gray signals of the frame storage device; and
a data gray signal converter (440) for considering the
gray signals of a present frame transmitted by the data
gray signal source and the gray signals of a previous
frame transmitted by the frame storage device, and
outputting the modification gray signals, and
wherein a clock signal frequency synchronized with the
gray signal provided by the data gray signal source is
different from that synchronized with the controller
(430)."

VI.   Claim 1 of the second auxiliary request reads as
       follows:

       "*A liquid crystal display (LCD), comprising:*
       an LCD panel (100) comprising a plurality of gate lines
       (S_1-S_n) for transmitting scanning signals, a plurality
       of data lines (D_1-D_m) that are insulated from and that
       cross the gate lines for transmitting image signals,
       and a plurality of pixels that are formed in an area
       surrounded by the gate lines (S_1-S_n) and the data lines
       (D_1-D_m) and that are arranged as a matrix pattern and
       that have switching elements (110) connected to the
       gate lines and data lines;
       a data gray signal modifier (400) for receiving gray
       signals (G_n) from a data gray signal source, and for
       outputting modification gray signals (G_m') by
       considering gray signals of present (G_n) and previous
       frames (G_{n-1}) according to a modification parameter,
       wherein the modification parameter is a temperature;
       a gate driver (200) for sequentially supplying the
       scanning signals; and
       a data driver (300) for changing the modification gray
       signals into corresponding data voltages and outputting
       the image signals,
       a storage device including look-up tables (LUTs)
       storing compensation values to modify the data gray
       signal for predetermined temperatures; and
       a sensor for measuring the present temperature of the
       LCD;
       characterized in that
       the LUT is made of compensation values MSB 4-bits among
       8-bit gray signals, wherein each compensation value
       within a LUT is represented by G_{ij}, and wherein the
       value for y=4 representing said most significant bits
       MSB 4-bit of an 8-bit gray signal, the present frame

gray signal G_n in a row of the LUT is expressed as $G_n=(i-1)\times2^{(8-y)}$, and the previous frame gray signal G_{n-1} of a column of the LUT is expressed as $G_{n-1}=(j-1)\times2^{(8-y)}$; wherein G_{ij} represents a cell which is located in the i-row and the j-column of the LUT,

and in that the LCD further comprises

a LUT selector (445) adapted to select a suitable LUT for performing a LUT conversion; and

a LUT converter (446) adapted to modify the compensation value G_{ij} of the selected LUT so as to produce a compensation value G_{ij}' corresponding to a present measured temperature that satisfies the following equation when the present measured temperature does not correspond to the predetermined temperature of the selected LUT and the predetermined temperature of which the difference from the present temperature is the smallest among a plurality of the predetermined temperatures:

$G_{ij}'=G_{ij}+\alpha(G_{ij}-G_{ii})+\beta(G_{ij}-G_{ii})^2+\gamma(G_{ij}-G_{ii})^4+...$

where $G_{ii}=(i-1)\times2^{(8-y)}$, and

α, β and γ are modification coefficients for compensating the difference between the present measured temperature and the predetermined temperature of a certain point of the LCD, wherein $\alpha>1$ when the present temperature is lower than the predetermined temperature and $\alpha<1$ when the present temperature is higher than the predetermined temperature."

VII.   The appellant submitted in substance the following arguments relevant to this decision:

As well known in the art, it was conceivable that only the four most significant bits (MSB) of the gray level signal were taken into account and the four least significant bits (LSB) thereof were ignored if such an

approximation level was acceptable for a particular use. Accordingly, the look-up table (LUT) could be also reduced and did not include all possible values in the range of 0 to 255.

Moreover, there was no teaching in the application that the temperature compensated value of G_{ij} had to be necessarily always positive. In the equation 11, there was certainly a number of cases which lead to a positive result and a number of cases which lead to a negative result (for instance when β and γ are 0 and $(1 + \alpha) G_{ij} < \alpha G_{ii}$). This would mean that a negative or reversed voltage was applicable.

Furthermore, concerning the question how the temperature difference between the actual display temperature and the predetermined temperature for the LUT to be modified was taken into account, reference was made to the description (page 21, line 5).

Therefore, the requirements of Article 83 EPC were met.

Reasons for the Decision

1.   The appeal is admissible.

2.   Main request

2.1   Sufficiency of disclosure

2.1.1 As far as clear from the application, the look-up table (LUT) used provides compensated grayscale values G_{ij} as a function of the grayscale value of the present frame

G_n and the grayscale value of the previous frame G_{n-1}.
The grayscale values in the table represent the four
most significant bits of the 8-bit grayscale data used
in the LCD panel (cf page 18, line 17 to page 24, line
21). An example of such a table is given in figure 6.

However, it remains unclear from the application as a
whole how compensated grayscale values should be
derived from the LUT for grayscale data of the present
and previous frame not corresponding to any of the
values of G_n and G_{n-1} provided in the table.

The appellant argued that the four least significant
bits of the 8-bit grayscale data should be discarded.
This would provide an acceptable approximation. Yet, as
the grayscale data were modified to take account both
of the previous frame grayscale data and of the actual
temperature of the display, an image of better quality
was achieved.

However, to the board this argument is not convincing.

First of all, at no point in the description is it
stated that the least significant bits should be
discarded.

Moreover, the starting point for the application is a
known display with 8-bit grayscale data with
modification of the grayscale data to take account of
the previous frame grayscale data.

According to the application, the known display
"*generates a compensation data voltage by considering
data voltages of present and previous frames, and
provides the compensation data voltage to a data line
of the LCD panel so that the pixel voltage becomes the*

*target level immediately, and thereby the response
quality is enhanced. The compensation data voltage is
determined according to a dynamic capacitance and a
response speed of the liquid crystal. However, the
dynamic capacitance and the response speed vary
according to temperature. For example, when the
temperature increases, the capacitance of liquid
crystal decreases and the response speed of liquid
crystal increases. Conversely, when the temperature
decreases, the capacitance of the liquid crystal
increases and the response speed decreases*".
The known display "*compensates data voltage based on a
predetermined compensation value with respect to a
specific temperature, but parameters for setting the
compensation value according to temperature vary as
described above. Accordingly, over compensation occurs
when a present temperature is higher than the specific
temperature, and under compensation occurs when the
present temperature is lower than the specific
temperature, so correct data voltage compensation
cannot be performed*" (cf application, page 2, line 6 to
page 3, line 4).

The object of the application is to overcome this
deficiency. The application is, thus, concerned with
further improving the image quality of what is already
a high quality 8-bit grayscale image. Clearly, reducing
the 8-bit grayscale data to only the four most
significant bits to this end would not make sense as it
rather would dramatically reduce the image quality and
render the proposed subtle fine-tuning of the image
quality by the more accurate temperature compensation
irrelevant.

According to the description at one point, the
remaining z least significant bits are modified by

calculation (cf page 22, lines 9 to 13). This
calculation is, however, nowhere disclosed in a manner
sufficiently clear and complete for it to be carried
out by a person skilled in the art.

According to the description at another point, a
modification for the z least significant bits is made
in a LUT (cf page 29, line 16 to page 30, line 6). This
LUT is, however, nowhere explained in the application.

Accordingly, as essentially acknowledged by the
appellant at the oral proceedings, the treatment of the
least significant bits of the grayscale data remains
unclear, so that the application is not considered to
disclose the invention in a manner sufficiently clear
and complete for it to be carried out by a person
skilled in the art, contrary to the requirement of
Article 83 EPC 1973.

2.1.2   Furthermore, according to the application, in order to
provide an accurate temperature compensation, a
plurality of LUTs is provided for different
predetermined temperatures. The LUT converter provides
a modified LUT if the display temperature does not
correspond to any of the predetermined temperatures.
The modified LUT is produced based on the LUT of the
closest predetermined temperature using the following
equation:

$G_{ij}'=G_{ij}+\alpha(G_{ij}-G_{ii})+\beta(G_{ij}-G_{ii})^2+\gamma(G_{ij}-G_{ii})^4+...$ (equation
11)

According to the description, "*Such α, β, and γ of each
term of equation 11 are factors for compensating the
difference between the present temperature and the
predetermined temperature*" (page 21, lines 4 to 15).

For example, according to the description, "*when only the first term in equation 11 is used (that is, β=γ=...=0), and if much compensation is required because the present temperature is lower than the predetermined temperature, the compensation is performed as α>1. If small compensation is reduced because the present temperature is higher than the predetermined temperature, the compensation is performed as α<1*" (cf page 21, line 20 to page 22, line 3).

However, for example, assuming that the actual display temperature is 20 $^{\circ}$C and LUTs are provided for 0 $^{\circ}$C, 25 $^{\circ}$C and 40 $^{\circ}$C as in the example on page 20, according to the application the LUT for 25 $^{\circ}$C is to be modified using equation 11 above. With eg β=γ=...=0 and α>1 as suggested in the application (cf page 21, line 20 to page 22, line 3), for the exemplary compensation value G_{23} of page 20, lines 14 to 17 (ie a grayscale value of 16 for the present frame and a grayscale value of 32 for the previous frame (ie i=2, j=3 in the table of figure 6)), a negative compensation value G_{23}' is obtained:

$$G_{23}' = G_{23} + \alpha(G_{23}-G_{22}) = 8 + \alpha(8-16) < 0.$$

In fact, as can be easily verified, for parts of the table of figure 6 (ie where $(1 + \alpha)\, G_{ij} < \alpha G_{ii}$) negative values for G_{ij}' are obtained.

In the board's opinion, however, grayscale data useable in the display of the application, which uses 8-bit grayscale data, should always be between 0 and 255.

The appellant argued that there was no teaching in the

application that the temperature compensated value of Gij had to be necessarily always positive. Negative values meant that a negative or reversed voltage was applicable.

However, negative grayscale values and the application, as a consequence, of negative or reversed voltage signals to the display, would be so uncommon that the application certainly would have mentioned if such values or signals were intended. In the absence of any indication in this respect in the application, the appellant's contention that negative compensation values would be acceptable is considered implausible.

Moreover, it remains unclear how the actual temperature, or the temperature difference between the actual temperature and the predetermined temperature for the LUT to be modified, is taken into account in the calculation of the temperature modified compensation values. In particular, the application is completely silent as to how the coefficients α, β, γ are calculated as functions of the temperature. Since the object of the invention is to take account of the actual temperature of the display in order to provide a better quality image, this aspect clearly is crucial in the present case. The appellant was not able to shed light on this issue either.

Hence, it must be concluded from the above that also the calculation of the temperature modified compensation values is not disclosed in a manner sufficiently clear and complete for it to be carried out by a person skilled in the art.

2.1.3 Accordingly, the application does not disclose the invention in a manner sufficiently clear and complete

for it to be carried out by a person skilled in the
art, contrary to the requirement of Article 83 EPC
1973.

The appellant's main request is, therefore, not
allowable.

3.   *First auxiliary request*

In claim 1 according to the first auxiliary request, the
LUT converter providing the temperature modified LUT in
claim 1 of the main request has been omitted.

However, as for the main request, the treatment of the
least significant bits of the grayscale data in the
determination of the modified grayscale data remains
unclear. Accordingly, also for the first auxiliary
request the requirement of Article 83 EPC 1973 is not
met.

Hence, the appellant's first auxiliary request is not
allowable either.

4.   *Second auxiliary request*

Also for the second auxiliary request, for the same
reasons given with respect to the main request, the
determination of the modified grayscale data remains
unclear.

Accordingly, also for the second auxiliary request the
requirement of Article 83 EPC 1973 is not met.

The appellant's second auxiliary request is, therefore,
not allowable either.

Order

For these reasons it is decided that:

The appeal is dismissed.

The Registrar: The Chairman:

S. Sánchez Chiquero   G. Eliasson

Decision electronically authenticated