Abstract: The invention relates to a display device assembly (1) comprising a display device (5) of the transparent type, and a controllable screen (3) for reducing light coming from a rear side of the display device that is positioned at the rear side of the display device. The assembly may comprise a transparent substrate (7) to which the display device is attached, said controllable screen may also be attached to the transparent substrate (7). In an advantageous embodiment the controllable screen (3) is switchable between a substantially light blocking state and a substantially light transmitting state. If the controllable screen is in the blocking state no background radiation is shining through the transparent display device (5) and a displayed image can be viewed without artifacts.
Transparent display device

The invention relates to a display device assembly comprising a display device of the transparent type.

Nowadays there exist various display devices of the so-called transparent type. Such displays have as characteristics that they are virtually transparent in view of the thickness and/or optical characteristics of the used materials. It is foreseen that in future this type of display will be integrated with transparent substrates e.g. glass windows. This will open up many new and interesting applications.

Transparent displays often comprise emissive displays, which are displays that actively emit light when a suitable signal is supplied to the display. In this kind of displays the active light emitting material is sandwiched between electrodes, to which a current or a voltage is supplied for exciting the emitting material. Both the emitting material as well as the electrodes are almost transparent in the visible range of the electromagnetic spectrum.

The transparency of the display device allows the transparent substrate, e.g. the glass window, to be used in its conventional way when the display is not in operation. However, when the display is in operation, while simultaneously light from a rear side of the display (i.e. the so-called background radiation) is shining through the display, this will lead to an unwanted superposition of the light emitted by the display with the background radiation. Undesired color, contrast, content, motion or perception artifacts in the displayed image will be the result.

It is an aim of the invention to provide a display assembly in which the aforementioned display artifacts will not occur, while at the same time the transparency characteristics of the display device are maintained. To this end a display assembly is provided according to claim 1.

By providing the display assembly with a controllable screen positioned at a rear side of the display the screen may be switched to a state in which it blocks or reduces
background radiation. Depending upon the presence of any background radiation and the
operation of the display device the controllable screen is switched to the blocking state or the
transmitting state. In this way the occurrence of any superposition of emitted light with
background radiation is prevented. Hence no unwanted image artifacts will occur during
operation of the display device, whereas simultaneously the substrate remains transparent
when the display is not in use.

The invention is defined by the independent claim. The dependent claims
describe advantageous embodiments of the invention.

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

In the drawings:

Figs. 1A and 1B show situations in which the display assembly according to
the invention is applied on a glass window,

Fig. 2 is a cross-section of an embodiment of the display device assembly
according to the invention.

The Figures are not drawn to scale. In the Figures, like reference numerals
generally refer to like parts.

Figs. 1A and B show the use of the display assembly according to the
invention applied to a glass window as substrate.

Fig. 1A shows the use of the display during daytime. At that time background
radiation (light) from outside might shine through the display in which case the visibility of a
displayed image is hampered. This poor visibility is greatly improved when the controllable
screen is switched to the light blocking state thereby blocking any background radiation.

The situation as shown in Fig. 1A may be obtained if the display and the
controllable screen cover the entire window area, but only part of the display is used for
displaying an image and simultaneously the corresponding part of the controllable screen is
switched to the light blocking state, whereas the remaining part of the screen is switched to
the transmitting state. Likewise, the situation of Fig. 1A can be obtained if the display and the
controllable screen have smaller dimensions than the dimensions of the glass window and the
display is switched on and the full controllable screen is switched to the light blocking state.
In Fig. 1B it is shown that in the evening or night when it is dark and the display is not in operation, the controllable screen is switched into the transmissive state thereby bringing the glass window into its usual state of transparency.

Fig. 2 shows a cross-section of an embodiment of the display assembly according to the invention. The display assembly 1 comprises a display device 5 of the transparent type. Examples of such transparent display devices are e.g. PolyLED (polymer light emitting display) or smOLED (small organic molecule light emitting display), LEEC (light emitting electrochemical cells) and foil-, or oil-based displays. Also nano-crystals such as nanotubes or nanowires are known to emit light upon excitation by means of electro- or photoluminescence, and displays based on such crystals are virtually transparent.

The display device 5 comprises pixel elements 27, each pixel element having sub-pixel elements 25,25',25". Each sub-pixel may emit in a primary color, e.g. red (R), green (G) or blue (B), although more colors are also possible. It has to be noted, however, that the invention is not restricted to color displays; also single color displays or black & white displays are comprised in the invention.

An image displayed on a front side of the display is watched by a viewer 21. The direction in which the sub-pixel elements emit is indicated by arrows R,G,B.

The sub-pixels are individually addressable via address lines 23 by applying a suitable signal to the display device 5.

The display device 5 is attached to or integrated with a transparent substrate 7, e.g. a glass window. Transparent plastic materials may also be used as substrate.

The display device assembly further comprises a controllable screen 3, which is also attached to or integrated with the transparent substrate 7. With respect to the point of view of the viewer 21 the controllable screen 3 is positioned behind the display device 5.

The controllable screen 3 may be attached to the substrate 7 on the same side as to which the display device 5 is attached. In this case potential light leakage problems due to parallax are avoided, in particular when the substrate 7 has a substantial thickness. Alternatively, the screen 3 may be attached to the substrate to a side which is opposite to the side to which the display device is attached. In such case manufacturing of the display assembly is easier. All that matters is that the controllable screen 3 is positioned at a rear side of the display device for reducing light coming from a rear side of the display device 5 in which case any superposition of background radiation is prevented.

The controllable screen 3 is switchable between two states. A first state that is substantially light blocking and a second state is substantially transmissive to the light
from the background or a light source 17, i.e. all background radiation is passed. The blocking state may be realized by either absorbing light or reflecting light.

It is to be noted that the optical properties of the side that is oriented towards the viewer of the controllable screen when this is in the light blocking state also are important. If this side is reflecting it will have the advantage that light from the display is reflected towards the viewer and a higher brightness is obtained. On the other hand if this side is absorbing then the contrast of the display is increased, in particular when the light level in the room is high.

The controllable screen 3 may comprise a Liquid Crystal Display, or a switchable mirror (preferably a metal hydride optical switch as described in e.g. US-6,437,900) or arrays of bendable nano-elements.

An advantageous embodiment of the controllable screen 3 comprises blocking elements 13 that are individually addressable by applying a suitable signal to addressing lines 15. Each blocking element 13 comprises a switching layer 11 that is sandwiched between two electrodes 9, 9'.

Preferably, the number M of blocking elements 13 of the controllable screen 3 is smaller than or equal to the number N of pixel elements 27 of display device 5, hence M \leq N. The smallest size of blocking elements corresponds with M = N in which case a one-to-one correspondence exists between the blocking elements and the pixel elements; i.e. each blocking element 13 is associated with one single pixel element 27. This situation is shown in Fig. 2. The controllable screen 3 may also comprise only one blocking element (M = 1) in which case the entire screen acts as a single blocking screen.

The switching screen may be switched in dependence of the presence of background radiation and in dependence of the use of the display device. For example, if the display device 5 is operated then a light sensing means, e.g. a light sensor may be applied to measure the amount of background radiation. If the level of background radiation or light is high then the controllable screen is switched to the blocking state. If the display device is not in operation the screen is switched to the transmissive state and any background radiation is allowed to pass the transparent substrate 7 as well as the transparent display device 5.

In summary, the invention relates to a display device assembly 1 comprising a display device 5 of the transparent type, and a controllable screen 3 for modulating the intensity of light incident on a rear side of the display device that is positioned at the rear side of the display device. The assembly may comprise a transparent substrate 7 to which the display device is attached, said controllable screen may also be attached to the transparent
substrate 7. In an advantageous embodiment the controllable screen 3 is switchable between a substantially light blocking state and a substantially light transmitting state. If the controllable screen is in the blocking state no background radiation is shining through the transparent display device 5 and a displayed image can be viewed without artifacts.

It should be noted that the above-mentioned embodiments illustrate rather than limit the invention, and that those skilled in the art will be able to design many alternative embodiments without departing from the scope of the appended claims. In the claims, any reference signs placed between parentheses shall not be construed as limiting the claim. The word "comprising" does not exclude the presence of other elements or steps than those listed in a claim. The word “a” or “an” preceding an element does not exclude the presence of a plurality of such elements.
CLAIMS:

1. A display device assembly (1) comprising
   - a display device (5) of the transparent type, and
   - a controllable screen (3) for modulating the intensity of light incident on a rear
     side of the display device (5), said controllable screen (3) being positioned at the rear side of
     the display device (5).

2. A display device assembly according to claim 1, wherein the assembly further
   comprises a transparent substrate (7) to which the display device (5) is attached or integrated
   with, and said controllable screen (3) being attached to or integrated with the transparent
   substrate (7).

3. A display device assembly according to claim 1, wherein the controllable
   screen (3) is switchable between a substantially light blocking state and a substantially light
   transmitting state.

4. A display device assembly according to claim 1, wherein the display device
   (5) comprises N pixel elements (27) and the controllable screen (3) comprises M blocking
   elements (13), where the N pixel elements and the M blocking elements are each individually
   addressable and where M ≤ N.

5. A display device assembly according to claim 1, wherein the controllable
   screen (3) is switched in dependence of a level of the light coming from the rear side of the
   display.

6. A display assembly according to claim 2 in which the transparent substrate (7)
   is part of a glass window.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 G02F1/1335 H01L27/32 G09F9/33 E06B9/24 H05B33/12

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 H01L G09F E06B H05B G02F

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, PAJ, WPI Data, INSPEC, IBM-TDB, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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Further documents are listed in the continuation of box C. Patient 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
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"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
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"X" document member of the same patent family

Date of the actual completion of the international search

3 December 2004

Date of mailing of the international search report

15/12/2004

Name and mailing address of the ISA
European Patent Office, P.B. 5616 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fac. (+31-70) 340-3016

Authorized officer
Kiernan, L

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