January 17, 2011

A redundancy scheme. on the LCD level

Dr Errikos Amarilio
Elbit Systems Ltd
Haifa
Israel
Errikos.amarilio@elbitsystems.com

Background

There is a growing need to introduce Large Area Displays (LAD) in critical applications. One of the most demanding applications for LAD is in the cockpit of aircraft. There is growing and insatiable need in presenting flight information, navigation information, and sensor and mission information. The classical solution for such cockpits was the use of multiple Multi- Function-Displays (MFD). The installation of multiple displays results in a very rigid layout and formatting of the displayed images. Since the size of the display is given, the information format is given. This method tends to be prohibiting in adding additional images. On the other hand the introduction of Large Area Displays allows the dynamic allocation of display area in accordance with specific needs, as they vary in accordance with the flight stage.

One of the main issues in the use of a single LAD is the issue of redundancy. In the multi display cockpit, if one display fails, there are others that can be used to present the essential information. If a LAD is installed in the cockpit, there is no room for additional displays, so that if it fails there is no imagery to fly the aircraft. In order to overcome this drawback amny different redundancy schemes have been developed. Most of the schemes provide a solution on single electronic failures, but they do not provide a solution on the LCD panel. The most advanced known solutions are those that divide the display area to two separate electronic matrices, so that if one fails, only half the display surface fails.

This paper presents a method to retain full redundancy on the LCD level, even if a there is a single LCD failure.

Full electronic redundancy on the LCD cell.

Under this scheme, under any electronic failure the LCD image is always present on the whole display surface. A typical LCD cell consists of an active matrix of transistors. These transistors make the subpixel elements of the display. The conductance of these transistors determines the voltage applied to each LCD subpixel element, thus determining the transparency of the specific element. When lit by a backlight this transparency value shows as a grey level. All the transistors are connected in a rows/ columns matrix, each transistor row is selected by a specific selection voltage on the row lines. When a specific row is selected, the exact required voltage is applied to every column, in order to set the exact brightness for each transistor (subpixel) on that row. This process repeats itself for all the rows. When all the rows have been addressed, the process repeats itself thus creating a new frame.

The selecting voltage for the rows and the exact voltage for the columns is generated by the LCD driving electronics. Typically, the driver electronics are integrated circuits, housed on a flex printed circuit board, commonly called a Tab. There are LCD cells where the drivers are mounted on the LCD glass (chip on glass) or are part of the silicon deposited on the glass.

In any configuration potential failures of the driving circuitry or its connection to the rows columns exist. The following scheme provides a redundancy scheme, on the driving electronics and their connections on the rows columns, irrelevant to the exact LCD panel configuration. In the following discussion we use the common Tab driver method, but it should be self evident that the description is valid for other methods of implementing the LCD drivers.

January 17, 2011

The proposed solution involves the use of dual driver TABS on any single row or column of the LCD matrix and a series switch, controlled by an external mechanism. One of the switches is always closed while the other switch is always open. The default mode of operation is when the first set of switches is closed while the second is open. If any failure happens on the driving electronics or continuity of the TAB conductors to the LCD , than the switches may be toggled and the failure is bypassed by the second set of drivers. This is shown schematically in the following figure .

The figure shows the layout of an LCD cell, with two sets of TABs, each set mounted on opposing edges of the LCD cell. The first set is the primary set (shown in red) and the second set is the secondary (shown in blue). Two switches are mounted on each row and column, at the entrance of the line from the TAB's. These are shown as switches P and S.

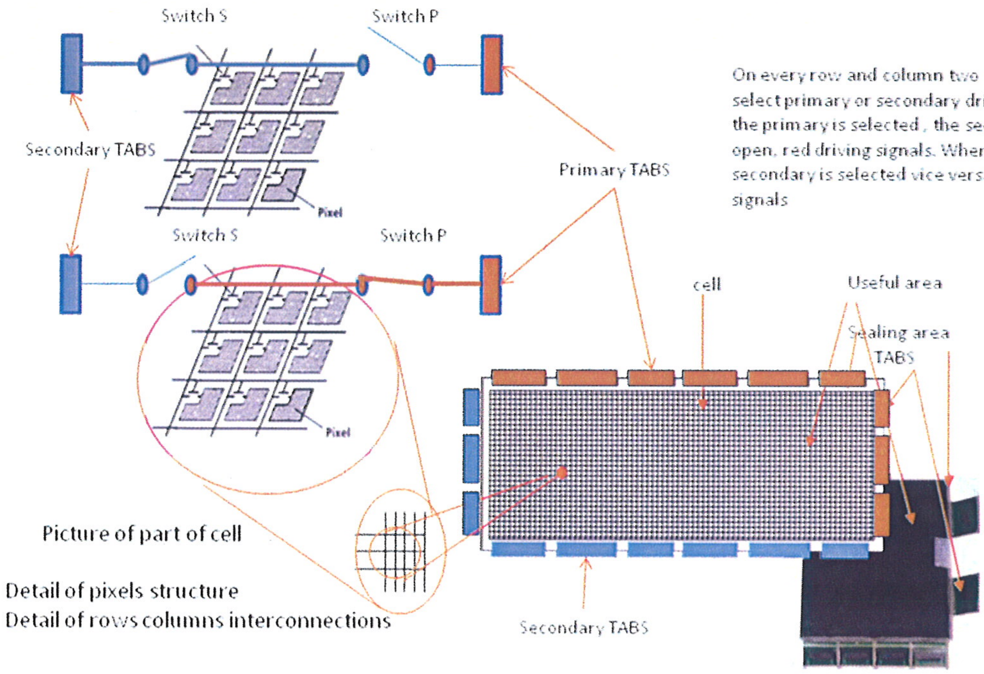

Figure Redundancy scheme on the LCD Assembly level

The figure shows two different situations.

- Primary drive is connected to the LCD, shown in red
- Secondary drive is connected to the LCD, shown in blue.

It should be evident that any TAB failure or connection failure between the TAB and the LCD glass, all the way to the switch is fully redundant. Therefore, if any failure occurs in the primary driving set, this failure is bypassed by the secondary driving set.

The Primary/Secondary switches position (open/close) is controlled by the display (LAD or other) redundancy electronics control, which is beyond the scope of this paper. Under this scheme, the display is fully redundant for any single failure, thus there is no dead area on the display active area under any single failure, be it electronic or mechanical TAB/ connectors disconnect.

This redundancy scheme is possible with any configuration of custom LCD cell. The implementation of the switches is trivial in the implementation of the LCD active TFT matrix. It should be noted that these switches are typically in a constant position and there are no dynamic requirements on their behavior.