OPTIONS FOR DIGITAL HIGH-SPEED VIDEO AND MULTIMEDIA CONTENT TRANSPORT

Radu ARSINTE (*), Laurentiu GAVRA(**), Dorin PETREUS(*)

(*)Technical University Cluj-Napoca, str. Baritiu 26-28, Cluj-Napoca, phone:064-195699, fax:064-193148, e-mail: Radu Arsinte@com.utcluj.ro
(**) Tedelco SRL – Calea Turzii 42, Cluj-Napoca, phone: 064-195613, fax: 064-192257, e-mail:laurentiu.gavra@tedelco.ro

Abstract: Today's enhanced format of LCD panels both in resolution and in color depth, continuously needs enhancing of high-speed interfaces for video data content transport. The paper presents some options present today in this field. The paper presents also an implementation using a 12" LCD panel in public transport infotainment. This implementation is based on PanelLink chipset of Silicon Image.
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I. INTRODUCTION

There are two types of interfaces: analog and digital. In analog interface information is presented in fundamental colors (RGB), and horizontal and vertical synchronization pulses. This type of interface is commonly present in actual CRT displays and TFT-LCD panels.

Information transport from video controller to scanning system of the video terminal is similar in both cases. Host processor forms in buffer RAM of video controller an image representation. Every image pixel consists of three-color pixels, each represented in 6 or 8 bits of information. This means 18 bits per pixel or 24 bits per pixel. In analog interface a Digital To Analog converter transform every set of values (RGB) in analog form.

In digital displays data content transport is done in digital format. This information is interpreted by so called "digital-displays".

Digital display interface levels can be divided in four groups:

- Interface between video controller and display in Notebook computers (length 30…50cm)
- Interface between video controller and external display (length 120…150cm)
- Internal interface for data transport between local LCD controller and column driver IC's (length 30…50cm)
- Interface between video controller and remote LCD monitor (length 10…100m)

For LCD panels, up to VGA resolution (640x480 pixels), a direct way to transmit information was used. With rising of display formats, data transmission speed increased in such way that a LCD panel needs to include a synchronization circuit, receivers and transmitters, a display controller (TCON- Timing Controller) (fig.1). In this concept a display link must have the following components:

- Data transmission lines from video controller to display controller
- Internal display interface lines between display controller and LCD panel columns

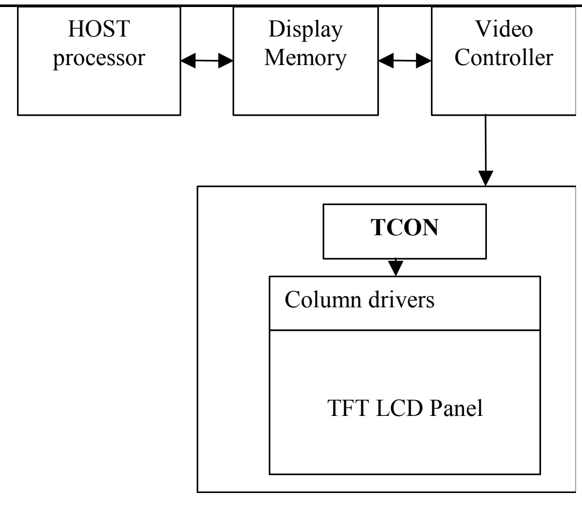

Fig.1. Block schematic for a video display system

To have a clear image of the transfer speed needed in every case, Table 1 contains an overview of display formats used today.

For every format presented in the table, a rough calculation of data transmission rate needed in every case is based on the following formula.

$$\mathbf{F = H \times V \times 3 \times \log_2 N \times Fh} \qquad (1)$$

Where:
H and **V** - resolutions in horizontal and vertical directions
3 – number of color layers in every image pixel (RGB)
N - number of shades in every color
Fh – vertical frequency (in Hz)

For SVGA+ format for example with vertical frequency of 85Hz and 256 shades for every color, data transfer rate needed is about 374 Mbyte/s. Transfer of this huge amount of information in traditional (single ended) way is possible for distances up to 30-50 cm. For long distance video data transfer, special interfaces were designed. This type of interface manipulates the signal in differential way.

Table 1

Format name	Resolution H/ V	Aspect H / V	Data volume (Mpixel)
CIF	352 x 288	4:3	0.1
VGA	640x480	4:3	0.3
SVGA	800x600	4:3	0.5
XGA	1024x768	4:3	0.8
HDTV (720 lines)	1280x720	16:9	0.9
SXGA	1280x1024	5:4	1.3
SXGA+	1400x1050	4:3	1.5
UXGA	1600x1200	4:3	1.9
HDTV (1080 lines)	1920x1080	16:9	2.1
QXGA	2048x1536	4:3	3.1
VXGA	2048x2048	1:1	4.2
GXGA/QSXGA	2560x2048	5:4	5.2
Photo CD (16Base)	3072x2048	3:2	6.3
Photo CD (64 Base)	6144x4096	3:2	25.0

II. PROPOSED SOLUTIONS

There are many commercial implementations for digital video interfaces. In the following lines we are presenting shortly two of them. All interfaces are based on DVI standards [1] and VESA standards [2] and also are complying with Plug&Display concept [3].

- LVDS – National Semiconductor

LVDS (TIA/EIA644) low voltage differential signaling is an interface designed to carry out information. It is used under the generic name of FPD –link. Other companies (Texas Instruments) uses names like FlatLink. This serial bus manipulates 24 bits of information for every pixel clock, converting incoming dataflow in four differential lines, multiplying the clock frequency 7 times. Clock is transmitted using a separate pair of signals. Sync signals and additional information is transmitted in additional 4 bits. This means 7clock x 4 pairs = 28 bits/pixel. Maximum pixel clock frequency initially was 40MHz, and rose up to 65MHz or even 85MHz lately.

Signal level is 345mV, driving current 2,47 to 4,54 mA., load impedance 100 ohm. This set of features allows a reliable data throughput of 455Mbit/s.

Figure 2 presents internal structure of receiver (TFP403 –Texas Instruments).

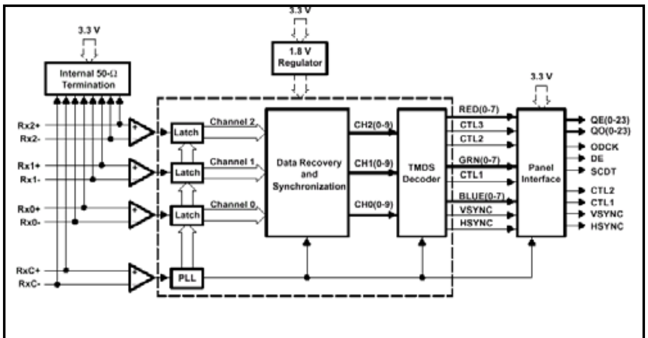

Fig.2 Block diagram for FlatLink receiver

As we can see, the receiver contains:

1. Integrated load resistors (50 ohm)
2. 4 channel serial differential receiver
3. A PLL divider by 7
4. Data latches for every channel (Channel0…Channel 2)
5. Serial to parallel converter for three channels
6. TMDS decoder (10 bit->8bit) and sync recovery
7. LCD panel controller
8. Internal voltage supply (1,8V)

- PanelLink™ – Silicon Image

For long distance transmission FlatLink and similar buses are not well suited. For this type of applications Silicon Image developed a bus called PanelLink. This type of bus was registered by VESA under the name TMDS (Transition Minimized Differential Signaling). Main differences from LVDS are:

1. TMDS transmitter not only ensures parallel to serial conversion but also transforms 8bit code in a 10bit code to minimize the number of transitions, and balances the DC component of signal. For coding they uses a patented technology;
2. TMDS is not a pure differential technology – a current source is placed between two lines;
3. Incoming data is latched at every front of clock signal – this means a higher speed. This allows reducing the number of pairs at only three.

For our panel we chose this technology, which allows reliable data link at least 10m. Extending the distance is possible including in every panel a transmitter that re-encodes the signal. In this way is possible to extend the length indefinitely.

Transmitter (Sil 150) is presented in Figure 3 ([5]).

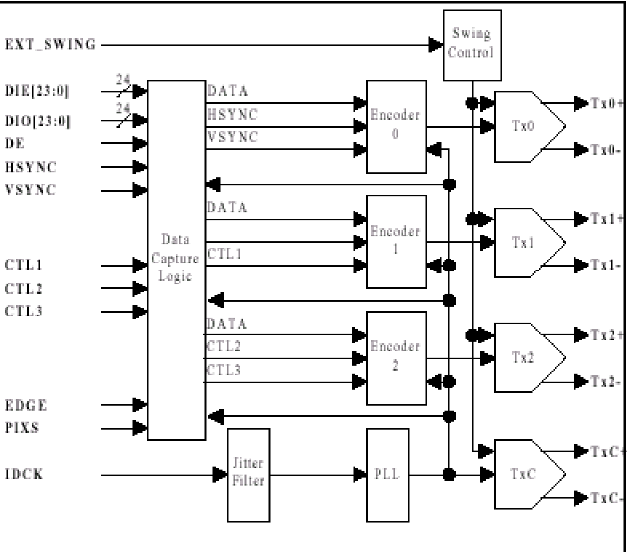

Fig.3. PanelLink transmitter

Suitable for internal digital display interface applications requiring a 24 or 48-bit interface, SiI 150A uses PanelLink® Digital technology to support displays ranging from VGA to SXGA (25 - 112 Mpps). The Sil 150A transmitter supports up to true color panels (24 bit/pixel, 16.7M colors) in 1 or 2 pixels/clock mode. An advanced on-chip jitter filter is also added to extend tolerance to VGA clock jitter.

Block schematic of receiver (Sil 151) is presented in figure 4([6]).

Since the receiver PLL uses only the frequency information (and not the clock edge location) from the received clock signal, the receiver is immune to clock-to-data skew and extremely tolerant to data-to-data skew. In addition, the receiver data output is time staggered to reduce ground bounce which affects EMI. These features together provide a robust transmission system that drives

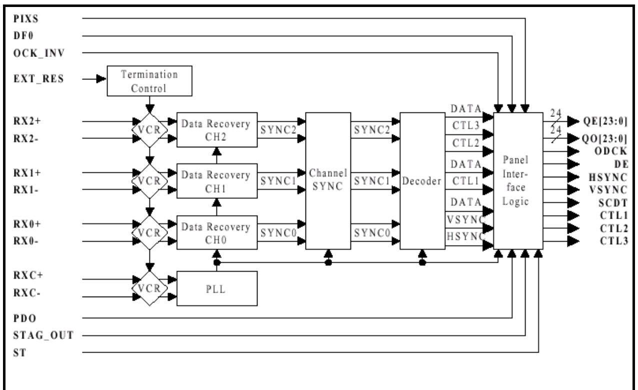

Fig. 4. PanelLink receiver

long cables distances. Besides video, most interfaces allow the transmission of so called "ancillary data" with non-standardized content. This transmission can take place in horizontal and vertical retrace interval, similar to conventional (analog) video transmission. Ancillary information can be audio, text, data, making this type of connection a real multimedia transport stream. The task of content definition is reserved LCD panel developer.

III. INTERFACE INTEGRATION IN LCD DISPLAY

This interface is implemented for a custom passenger information ([7]) display, used in automotive information system. The complete information system exists out of:

1. Multimedia PC
2. Passenger information displays
3. Power supply
4. Network
5. WIN2000 operating software
6. Presentation software

Using this system it is possible to present different kinds of information to passengers. Information examples are: advertisements, traveling information, video streams and a lot of other kinds of data, which can be useful for the passenger. To keep the interest of the passengers and to allow advertisers to address their advertisement on time to the passenger, the information needs to be actualized several times per day or even continuously.

The Panel Link interface is designated to ensure the translation between the DVI interface and the LCD panel, to remotely display of information of the main computer.

As the secondary function, the interface must verify local conditions (temperature, video signal presence etc.) and validate/invalidate the display. The interface must also ensure the bi-directional communication through a special interface of the main computer using RS485 standard. This allows to individual remotely control some functions of every panel.

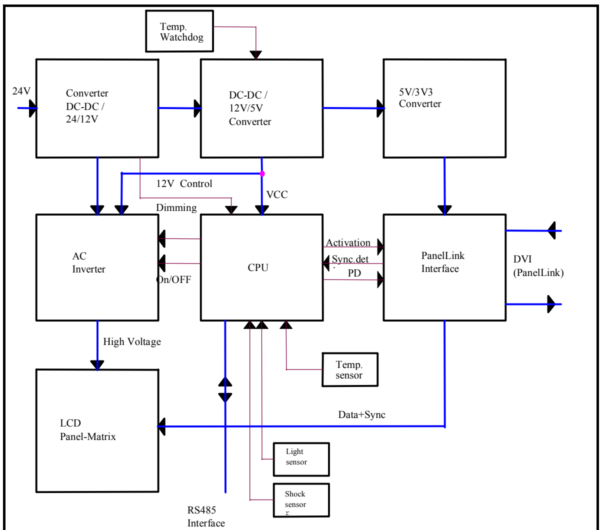

Fig. 5. LCD panel block schematic

Block schematic of LCD panel is presented in figure 5.

Main parts of the display are:

· Power supply – delivers 12V, 5V, 3,3V voltages needed by different parts of the LCD multimedia display. Those voltages are obtained using the 24V input voltage;
· AC inverter – delivers the high voltage for neon lamps used to backlight the LCD;
· LCD matrix panel – displays the information
· Panel Link interface – receives serial video from DVI video controller and sends the information to the local LCD matrix panel;
· CPU – controls the local functions of display, communicates with remote RS485 controller.

PanelLink bus interface is implemented using Sil150/151 chipset pair. On every panel incoming information is decoded (Sil151) and applied to LCD display part. The same information is applied to Sil150 encoder and re-encoded. This ensures information regeneration and guarantees data transfer over long distances. This is clearly superior to a multi-drop connection. The only disadvantage is the fact that every panel (even in stand-by) must be energized to maintain signal path integrity.

IV. EXPERIMENTAL RESULTS

LCD panel is realized in a compact enclosure, including controller, serial interface, backlight inverter. This interface was successfully tested and implemented in public transport. Implementation phase revealed a good immunity to environmental noise, good reliability at a performance level similar to other products ([8]).

Briefly, the panel has the following performances:

- Resolution 800x600 (expandable to 1024x768)
- Color depth 262.144 (18 bit/pixel)
- Dimension 12”
- Power consumption <12W
- Temperature 0-45°C (functional) -25-70°C (stand-by)

V. CONCLUSIONS

Using serial TMDS transmission seems to be the only efficient way to achieve multimedia content transport over medium and long distances. PanelLink is not the only way to transmit information, via cables or optical fiber link. The choice is based on both technical and economical considerations.

In future developments, other interfaces with improved speed and reliability can be used for better versions of LCD panel. A very good example is Gigastar interface described in ([9]). Data transport in such interfaces is done using a single pair of wires or an optical fiber. Additionally, this type of interface will offer more options for supplementary information (audio, sill images) for a real multimedia content transport.

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