LCD connectivity

Contents

OMAP2/3 LCD Connectivity

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LCD Types

OMAP2/3 devices have very flexible LCD driving capabilities. This article covers connecting different LCD types to the parallel CMOS outputs.

There are basically two types of LCDs which can be connected to the parallel CMOS outputs.

- Raster displays
- Frame buffered displays

Raster Displays

In raster mode the output from the display controller scans from left to right, sending pixels from a line of the image, and then repeats this moving from top to bottom in the image sending each subsequent line of the source image. (Just like coloring in a sheet of graph paper from left to right, then top to bottom)

The output data on the DSS_data outputs corresponds directly to the color of the desired pixel at a point in time corresponding to a position on the output image.

Once the end of the image is reached the whole process starts again, automatically.

Typically the entire image is continuously repeated at 60 times per second.

The main point to take from raster mode is that the image is output over and over and over and over....

Most standard displays such as PC monitors, TVs and projectors are raster based displays.

Different types of raster LCDs

Raster LCDs can be further split based on their interface type and timing requirements. Some examples of different interface formats are highlighted below but all these formats require the display sub system to be configured in almost identical ways with only minor configuration differences.

- Parallel CMOS
  - e.g. Sharp LQ043T3DX02
- LVDS
  - e.g. CMO V320B1-L01
- TDM (Time Division Multiplexed)
  - e.g. Samsung LMS250GF03

Connection to Parallel CMOS LCDs

Parallel CMOS LCDs are typically used for medium resolutions in the 480x272 range and may have up to 8 bits per color channel. Typical color depths are 8 bits per pixel color channel (24 bit display) and 6 bits per pixel color channel (18 bit display).

When connecting to LCDs with lower than 8 bits per color thre are 2 possible connections schemes. One method is to pack the connections in the lower data bits of the parallel output, e.g. bits 0-17 for an 18 bit LCD (6 bits per color), in which case the OMAP display sub system should be configured for 18 bit output. The second method is to configure the OMAP display sub system for 24 bit output but to connect the 6 bits of each color to the corresponding UPPER 6 bits of each OMAP output color channel. The second method has the advantage that

migration to a 24 bit color LCD at a later date will not require any software changes. A PCB board can be designed to accept either 18 bit or 24 bit LCDs (different connectors) and require no changes to software if the LCDs are of the same resolution.
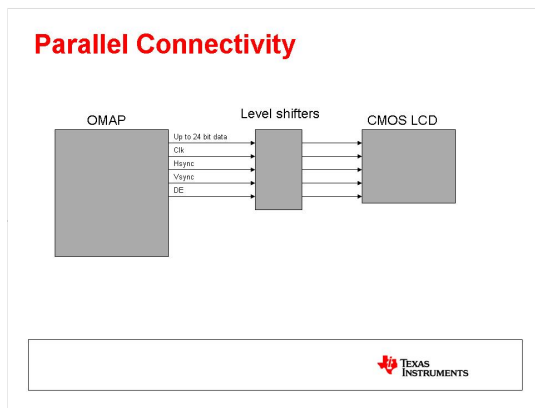
Connection to LVDS LCDs

LVDS LCDs are typically used for larger resolutions in the 800x600 and above range and typically have color depths of 8 bits per pixel color channel (24 bit display) and 6 bits per pixel color channel (18 bit display). Some newer LCD panels are extending their color depths to 10 and 12 bits per color channel. OMAP2/3 cannot take advantage of the extended dynamic range of these LCDs, but can still be connected to the upper 8 bits of each color channel.
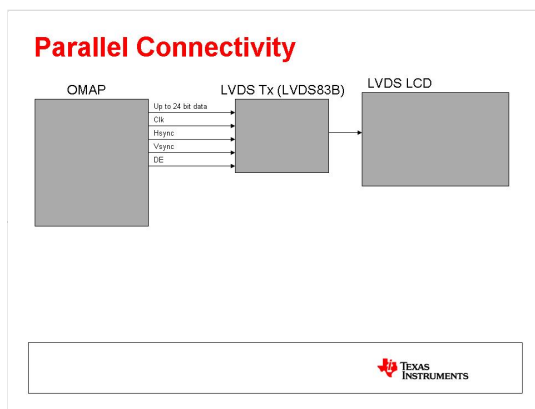

An additional consideration when connecting to LVDS LCDs is the bit assignments within the serial LVDS channels.

Currently there are 2 common color depths in LVDS LCD panels, namely 18 bit and 24 bit. When connecting to 18 bit LCDs there is a defacto-standard for the assignment of the color data bits on the LVDS serial data channels. For 24 bit LCDs there are 2 different common assignments and it is important to know what your particular LCD panel expects. Some 24 bit LCD panels can be configured in either of the 2 formats which can be extremely useful, allowing you to design hardware that can drive either 18 bit or 24 bit LCDs with no hardware or software changes.

If you are sure you will never want to switch between 18 bit and 24 bit panels then you can utilize the TI LVDS84A LVDS transmitter which has 3 pairs of LVDS data channels and a clock channel. This LVDS transmitter has 3.3V IOs so will require level shifters to convert OMAPs 1.8V to 3.3V for correct operation.

Below is an example of how to connect OMAP processors to an 18 bit LVDS LCD using a TI LVDS84A transmitter,
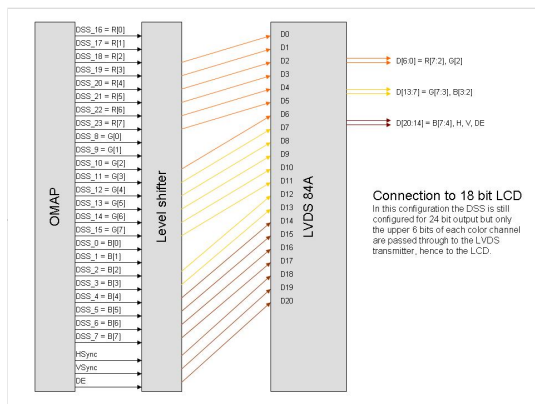

If you would like the flexibility to connect both 18 bit and 24 bit LCD panels to OMAP then it is necessary to use an LVDS transmitter with 4 data channel pairs. TI produces a 4 channel LVDS transmitter which additionally has 1.8V IOs so is better suited to connection to OMAP as shown below.
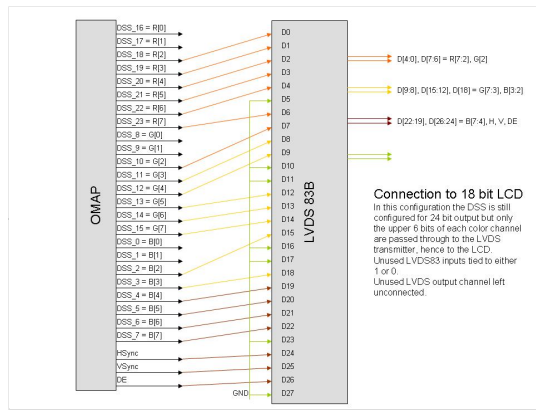
When connecting to a 24 bit LCD, as mentioned previously, there are 2 common formats. One format carries the most significant 6 color data bits on the same LVDS data pairs as the 6 bit format and adds the 2 least significant data bits from each color channel to a new fourth LVDS data pair. The second format leaves the least significant 6 color data bits for each of red, green and blue on the same LVDS data channels and adds the additional 2 data bits per color channel to an additional 4th LVDS data pair.

Format 1 is completely compatible with 18 bit LCDs allowing an 18 bit LCD to be connected to 3 of the LVDS data pairs whilst 24 a 24 bit LCD simply uses the additional 4th LVDS data pair for the additional 2 low order color bits. If the LCD panel utilizes format 2 then it would be necessary to completely swizzle the color data bits output from OMAP in order to switch between a 24 bit and an 18 bit LCD.
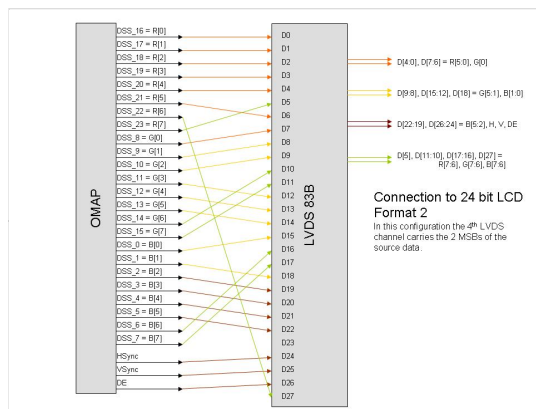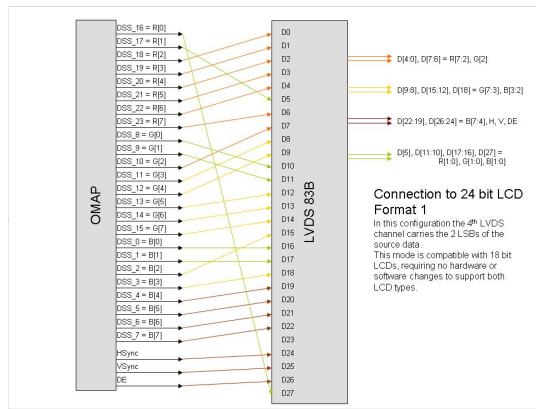
Attached below is a schematic for an LVDS daughter card which can connect to the Mistral EVM and can drive either 24 bit or 18 bit LCDs. The design includes various power supply options and can supply the LCD power from either an onboard switching regulator or directly from the EVM depending on the specific LCD panel's power supply requirements.

Media:OMAP EVM LVDS Daughter Card-2.pdf

Media:Mistral EVM LVDS Daughter Card Gerber Files.zip

Connection to TDM LCDs

TDM LCD displays are typically of smaller resolutions in the 320x240 range. These LCDs require low pixel clock frequencies and therefore can reduce the number of data pins required by increasing the data clock frequency and sending all color components of a given pixel over the same connections in a sequence such as blue, green, red.

In addition to the pixel data signals this type of LCD usually has a low speed serial programming interface such as I2C or SPI. This low speed interface is used for configuration of the LCD controller and to setup any additional internal registers which the LCD may require.

Parallel Connectivity
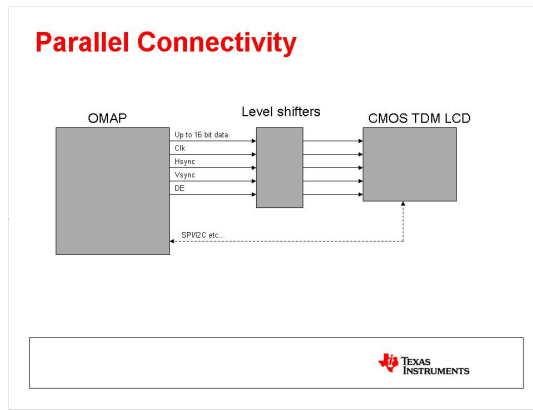
Attached below is a schematic for a daughter card which can connect a Samsung LMS250GF03 TDM LCD.

Media:Mistral EVM LMS250GF03 Daughtercard schematic.pdf

Media:Mistral EVM LMS250GF03 Daughtercard gerber.zip

Frame Buffered Displays

In RFBI mode the external LCD panel contains an integrated frame buffer so it is only necessary for OMAP to send the displayed image data when changes or updates are required. Additionally RFBI displays typically also support commands for configuration of such things as orientation etc... These commands are passed across the same physical parallel CMOS connections, but use additional pins to select between image data and commands.

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