UM10764

Vertical Alignment (VA) displays and NXP LCD drivers

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Document information

Info	Content
Keywords	Vertical Alignment, Twisted Nematic, LCD, PCA85232U, PCA85233UG, PCA8576FUG, PCF21219DUGR, PCA85262ATT, PCA85276ATT
Abstract	Compared to the traditional Twisted Nematic (TN) displays, VA displays have deeper black back-ground color, much higher contrast ratio, much wider viewing angle and better image quality at extreme temperatures. However, the VA display technology has stronger requirements for the display drivers than the TN displays, mainly in terms of higher LCD supply voltage (V_{LCD}) and/or higher frame frequency (f_{fr}). NXP has extended their LCD driver portfolio to specifically drive Vertical Alignment (VA) displays.

Revision history

Rev	Date	Description
v.1	20131111	new user manual, first revision

Contact information

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1. Introduction

NXP extended the LCD drivers to specifically drive the high-contrast, true black background and wide viewing angle Vertical Alignment (VA) displays.

2. Vertical Alignment display technology

Vertical Alignment (VA) is a display technology in which the liquid crystals naturally align vertically to the glass substrates (homeotropic alignment). When no voltage is applied, the polarized light passes through the cell without a change in polarization and the light is completely blocked by the second polarizer set at 90° to the first, creating a perfectly black state. When voltage is applied, the LC molecules rotate to a horizontal position allowing light to pass through and create a white display image.

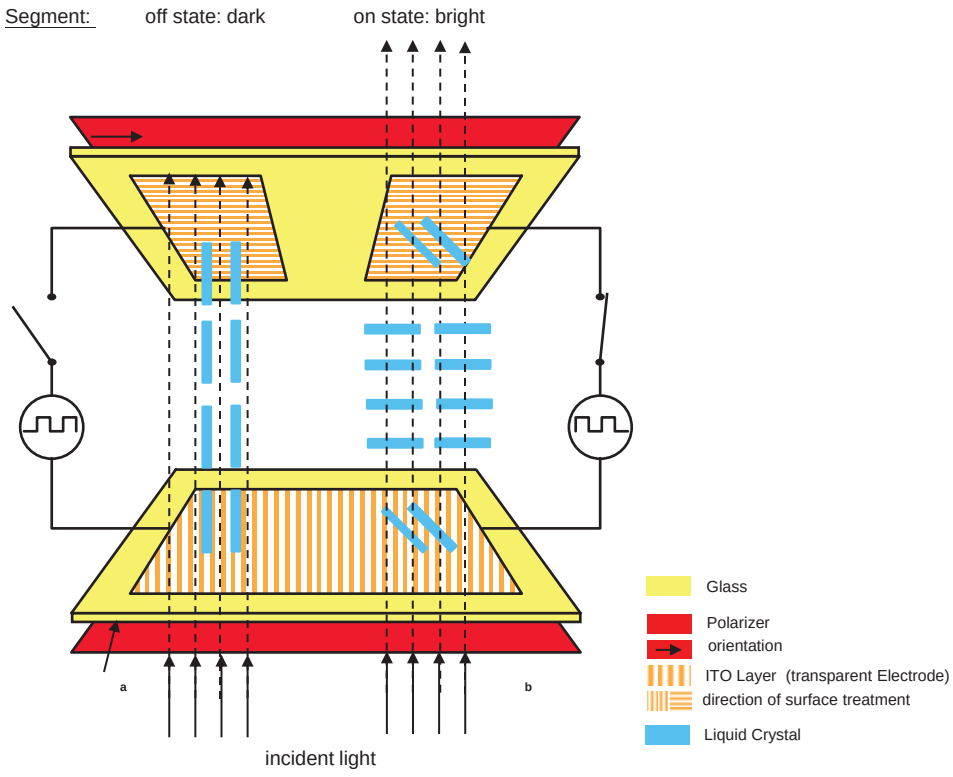


Fig 1. Vertical Alignment display technology

3. Vertical Alignment (VA) compared to Twisted Nematic (TN) displays

In the traditional Twisted Nematic (TN) displays, the alignment layers used in the top and bottom glasses are oriented orthogonal to each other creating a 90° twist of the LCD molecules. The polarized light passes through the LC medium, where is twisted due to the wave guiding of the LC and passes through the top polarizer (also called analyzer) creating a bright state (this configuration is also called the normally white mode as opposed to the normally black mode in which the polarizer are placed in parallel position). Upon application of an electric field, the LC molecules align parallel to the electric field

due to their dielectric anisotropy, and the wave guiding nature of the LC medium is lost. Thus, the polarized light from the first polarizer remains unchanged and is blocked by the analyzer, creating the black state.

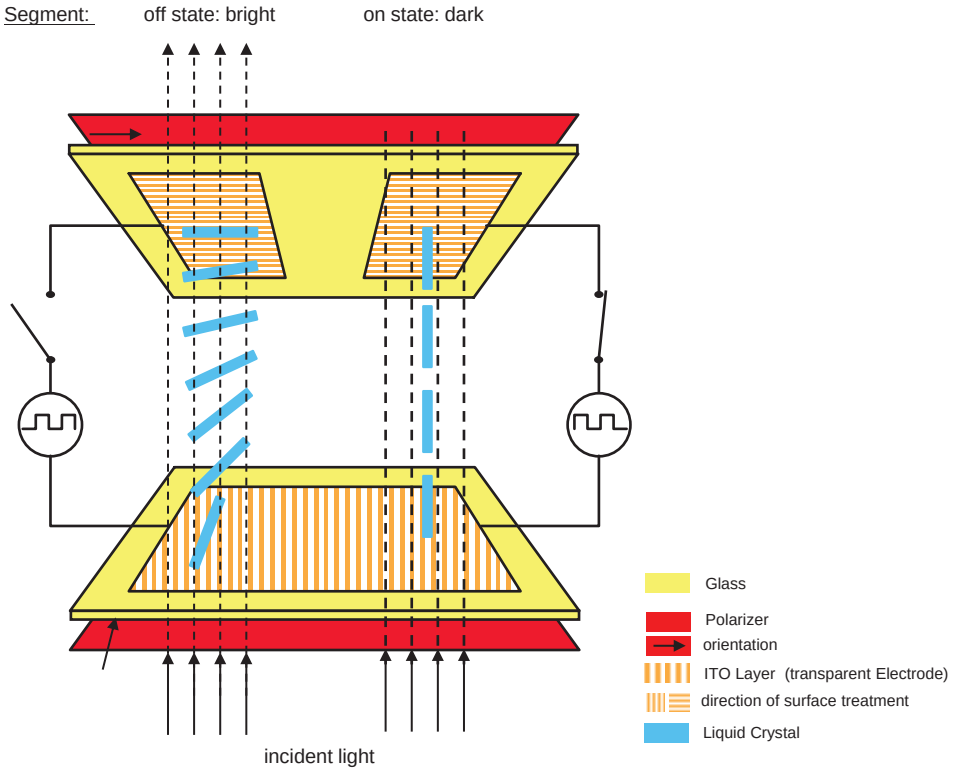


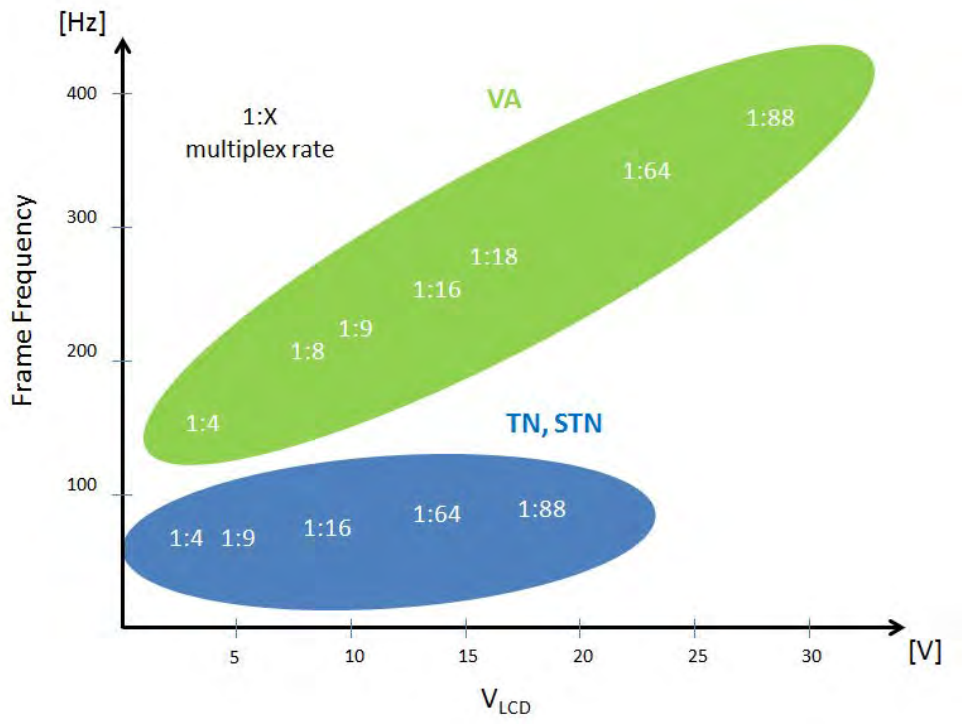
Fig 2. Twisted Nematic display technology

Compared to the traditional Twisted Nematic (TN) displays, VA displays have deeper black back-ground color, much higher contrast ratio, much wider viewing angle and better image quality at extreme temperatures. This new break through display technology is particularly well suited for applications where the display is

1. exposed to sunlight, i.e. needs to be readable in sunlight,
2. is mounted on a black background, e.g. in instrument clusters in the car or
3. is located sideways from the viewer, e.g. in the center stack of a car, and thus needs to be viewable under a wide angle.

VA displays are in growing demand for many applications, such as automotive, white goods, home, and medical equipment.

However, the VA display technologies have stronger requirements for the display drivers than the TN displays, mainly in terms of higher LCD supply voltage (V_{LCD}) and/or higher frame frequency (f_{fr}). The requirements depend on the specific VA technology developed by each LCD manufacturer as well as on the multiplex rates (backplane drive configuration) used in application. See Figure 3:



Note that the VA displays in mass production are only available with multiplex rates up to 1:64. The major LCD manufacturing companies are working to develop the VA technology for higher multiplex rates.

Fig 3. VA display requirements

4. NXP LCD drivers meet the VA requirements

Regardless of the manufacturer, NXP expanded its LCD drivers' portfolio in order to meet the strictest VA requirements in the industry. See Figure 4:

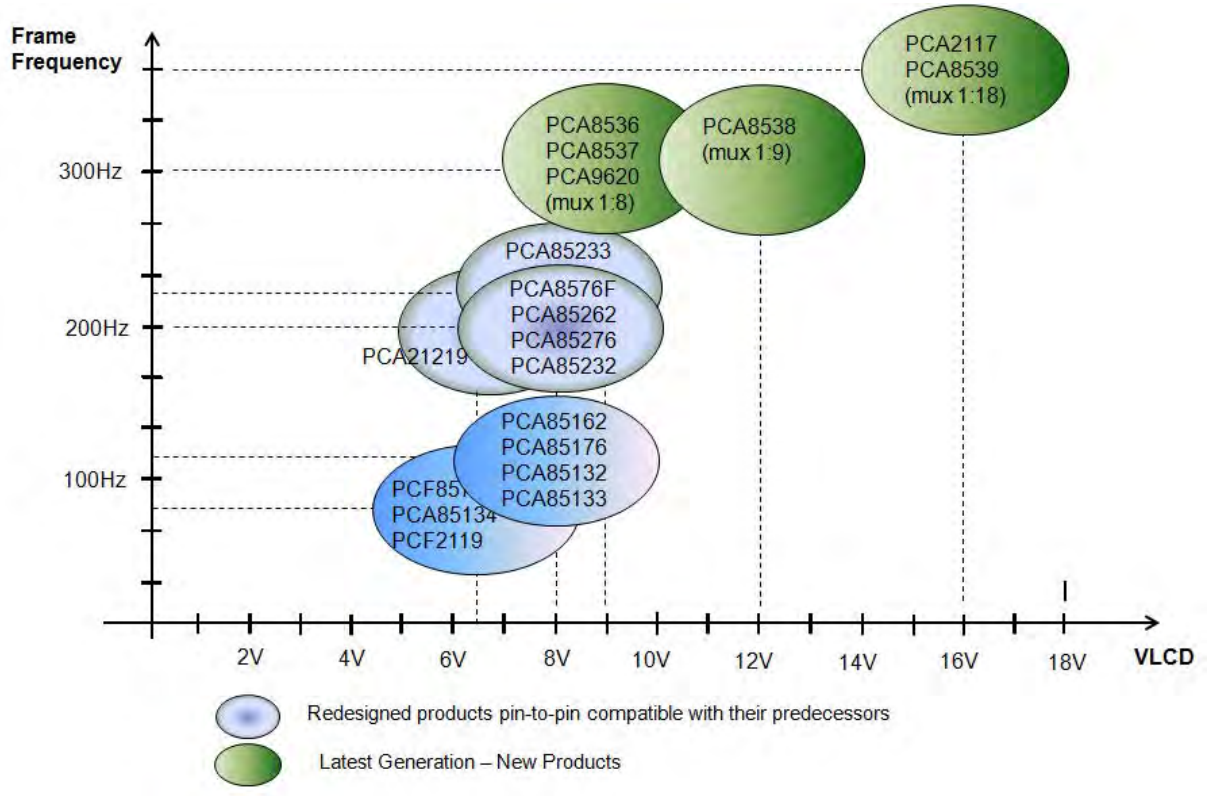


Fig 4. NXP LCD drivers (re)designed for VA displays

From one side, all the new Chip-On-Glass (COG) and packaged LCD drivers have been specifically designed to drive the VA displays. The maximum value of the V_{LCD} voltage has been increased to 9.0 V in the drivers with multiplex drive mode up to 1:8, to 12 V in the drivers with multiplex drive mode up to 1:9 (PCA8538UG) and to 16 V in the drivers with multiplex drive mode up to 1:18 (PCA8539DUG). Similarly, the frame frequency has been designed programmable in a wider range typically from 60 Hz up to 300 Hz or even up to 360 Hz as in the drivers with multiplex rate up to 1:18.

Fig 5. Displays of the demo boards driven by the PCA8538 and PCA8539

From the other side, the existing LCD drivers have been upgraded with new versions, which are pin-to-pin compatible with their respective predecessors, but delivering higher V_{LCD} and/or higher frame frequency. In such a way, the customers can easily replace the existing NXP LCD drivers with the new ones. This allows the usage of the better performing VA displays with no or minimal hardware and software changes. Table 1 lists the NXP products upgraded to meet the VA display requirements:

Table 1. Existing NXP products upgraded to meet the VA display requirements

New NXP product	Predecessor product	Package	Maximum resolution	$V_{LCD(max)}$ [V]	$f_{fr(typical)}$ [Hz]	Notes
PCA85232U	PCA85132U	COG	4 x 160	8.0	117 to 176	f_{fr} programmable, in production
PCA85233UG	PCA85133U	COG	4 x 80	8.0	150 to 220	f_{fr} programmable, in production
PCA8576FUG	PCA8576DU	COG	4 x 40	8.0	200	Up to 105 °C, release Nov. 2013
PCF21219DUGR	PCF2119RU	COG	2 lines x 16 characters	6.5	200	Internal V_{LCD}; Release Jan. 2014
PCA85262ATT	PCA85162T	TSSOP48	4 x 32	8.0	200	Up to 105 °C, release Dec. 2013
PCA85276ATT	PCA85176T	TSSOP56	4 x 40	8.0	200	Up to 105 °C, release Dec. 2013

5. References

[1] **AN10170 —** Design guidelines for COG modules with NXP monochrome LCD drivers

[2] **PCA85232U —** LCD driver for low multiplex rates. Data sheet

[3] **PCA85233 —** Universal LCD driver for low multiplex rates. Data sheet

[4] **PCA8576F —** Automotive LCD driver for low multiplex rates. Data sheet

[5] **PCF21219 —** LCD controllers/drivers. Data sheet

[6] **PCA85262 —** 32 x 4 automotive LCD driver for low multiplex rates. Data sheet

[7] **PCA85276 —** Automotive LCD driver for low multiplex rates. Data sheet

[8] **R_10015 —** Chip-On-Glass (COG) - a cost-effective and reliable technology for LCD displays

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