

Part 1/2

## LC-Displays – Digression in monochrome technologies

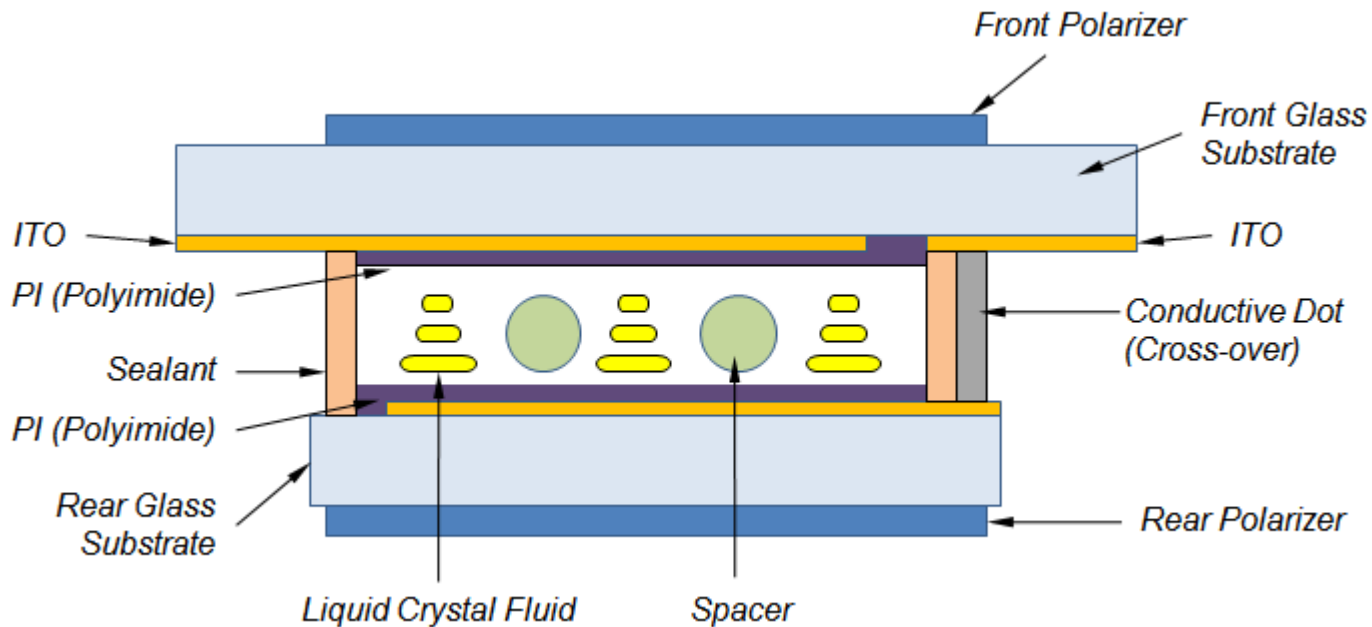
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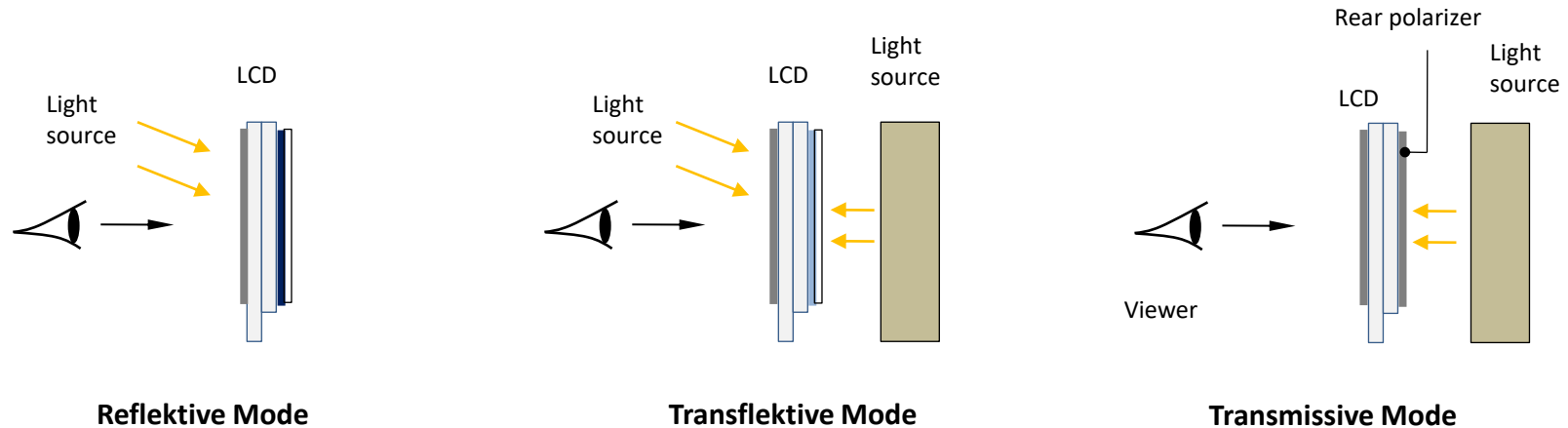
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## LCD – What is the general structure of a LC-Display



## Types of light reflection in LCD

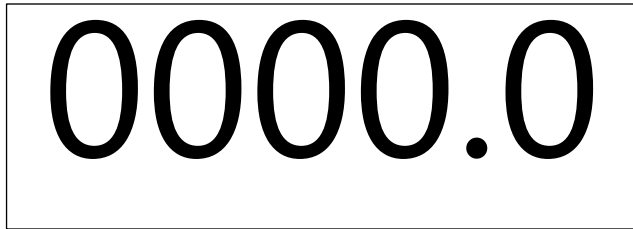


**Reflective mode** LCD involves a reflective material on rear polarizer. All light goes through the LCD and bounces back from rear polarizer to the viewer. Reflective mode applies to both indoor and outdoor applications, however, it is not suitable to apply in dark environment.

In **Transflective mode**, the rear polarizer is a combination of reflective and transmissive polarizer. It reflects ambient light passing through the LCD and allows light illuminates from backlight. Transflective mode applies to both indoor and outdoor applications.

**Transmissive mode** allows all light from backlight to pass through the LCD towards the viewer. Transmissive mode is good for indoor applications.

## The options to display information on LCD



Positive presentation of Display information

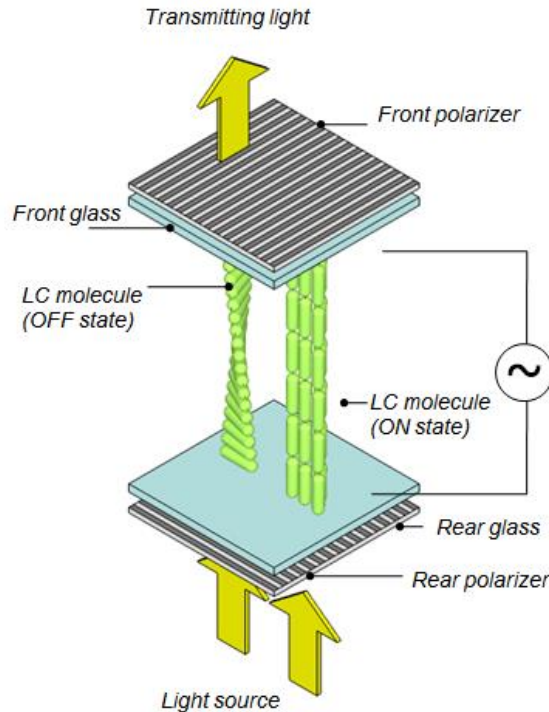


Negative presentation of Display content

**Positive Darstellung:** The display information (segments or characters) is displayed in black, the display background is bright. This form of display can be used for all 3 modes (Transmissive, Reflective and Transflective modes).

**Negative Darstellung:** The display contents (segments or characters) are displayed in white, the display background is black. Since readability of the display content in the negative representation always requires a backlight, this form of information representation can not be used with reflective LCDs.

## Basic operation of TN and HTN LCD



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### TN (Twisted Nematic) and HTN (High Twisted Nematic) LCD

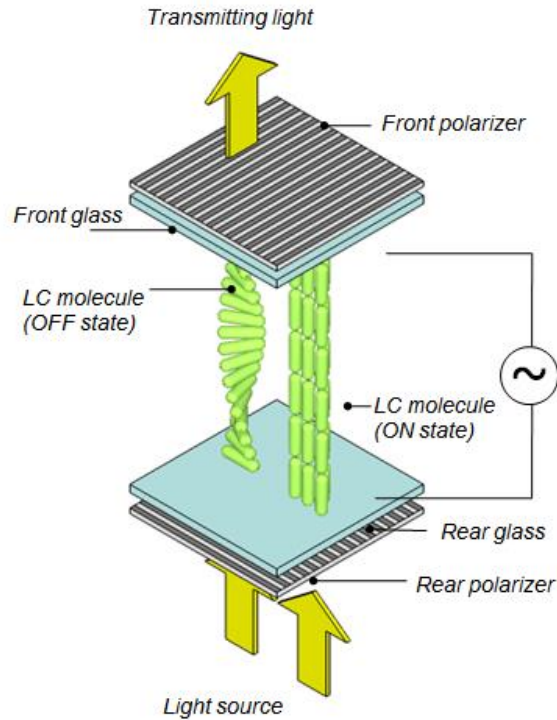
TN display consists of a thin layer of liquid crystal material inside the LCD cell. The inner surfaces of the cell are coated with polyimide, which is used to orientate the direction of the LC molecule so that they can form a 90° twist between front glass and rear glass.

On the outer surface of the glass plates, polarizers are placed so they are parallel to the orientation of LC and perpendicular to each other. In "OFF" state, light entering the rear polarizer is guided by the LC layer twist to the front polarizer, through which it is transmitted. When the cell is energized, the LC material is aligned with electric field; light transmitted through the rear polarizer is blocked by the front polarizer, forming a dark image.

The effect may be reversed if the polarizers are placed parallel to each other, and negative mode display - a light image on a dark background, is formed.

HTN has a similar working principle except the twisted angle of LC molecule is 110°, which resulting a better viewing cone.

## The STN technology

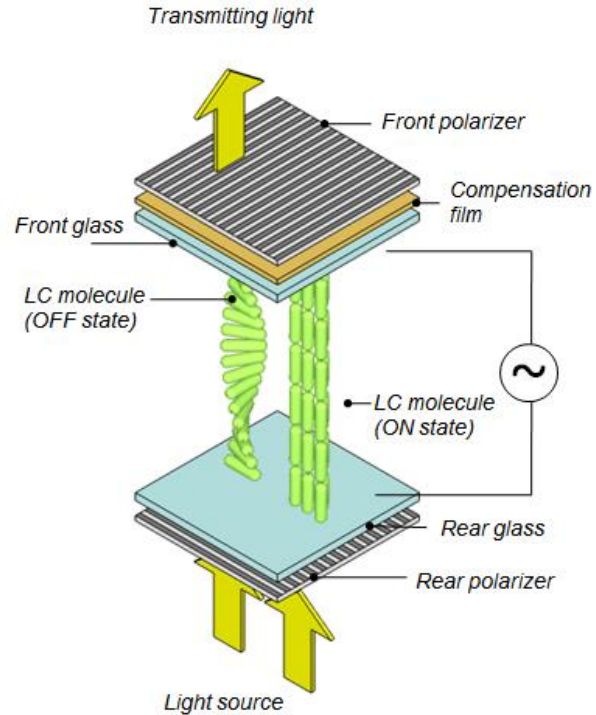


### STN (Super Twisted Nematic) Technology

LC molecule of STN has a twist angle between  $240^\circ$  and  $270^\circ$ . This higher twist angle causes the steeper electro-optical characteristic curve, which puts the ON and OFF voltages closer together and allows high multiplex ratio to be achieved.

Because the birefringence characteristic of such liquid crystal material, usually a yellow-green background color of STN LCD is appeared.

## FSTN technology

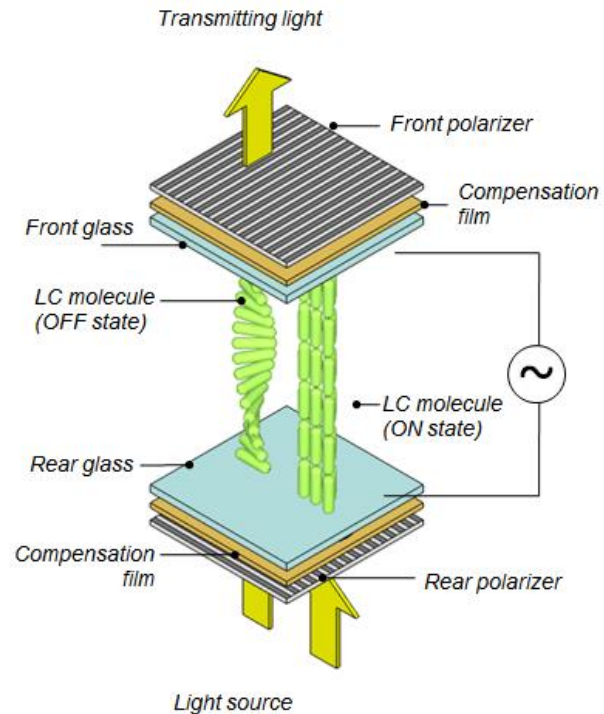


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### Film compensated STN LCDs

A retardation film is added to the front polarizer of the STN display that compensates color changed by birefringence effect. This allows a black and white display to be produced and provides for a higher contrast and wider viewing angle.

## FFSTN technology



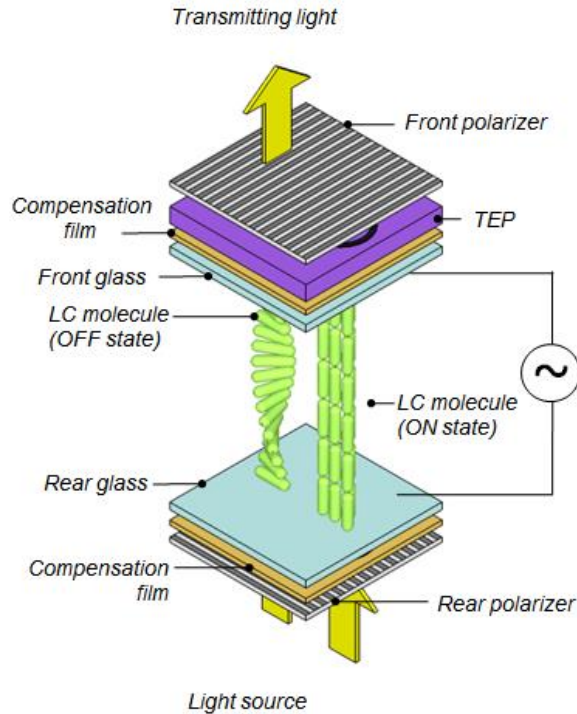
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### Film – Film compensation STN

Two compensation films are appended to the front and rear polarizers of the STN display respectively. As a result, higher contrast ratio and wider viewing angle can be achieved.



## The ASTN technology (advanced STN)

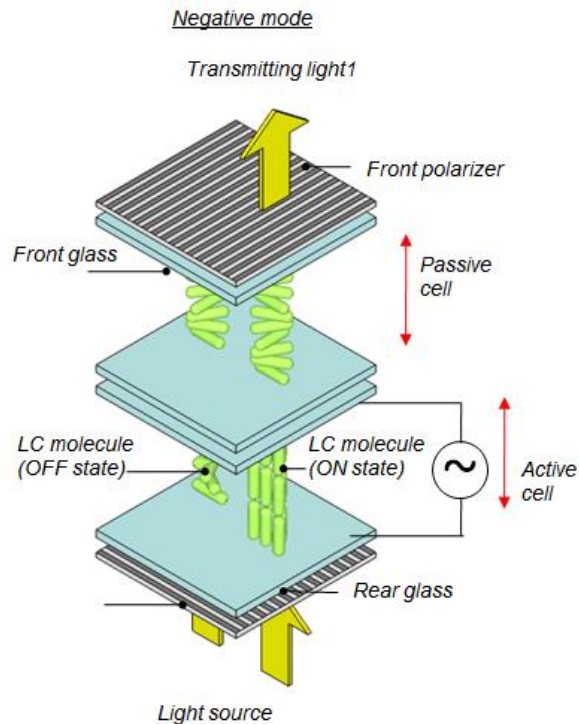


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### Advanced STN

A special TEP (Temperature match Elliptical Polarizer) is applied in ASTN LCD. The TEP itself can change its optical properties at different temperature to match the changes of LCD, therefore, ASTN LCD can work properly at low temperature and high temperature.

## The DSTN technology (double STN)

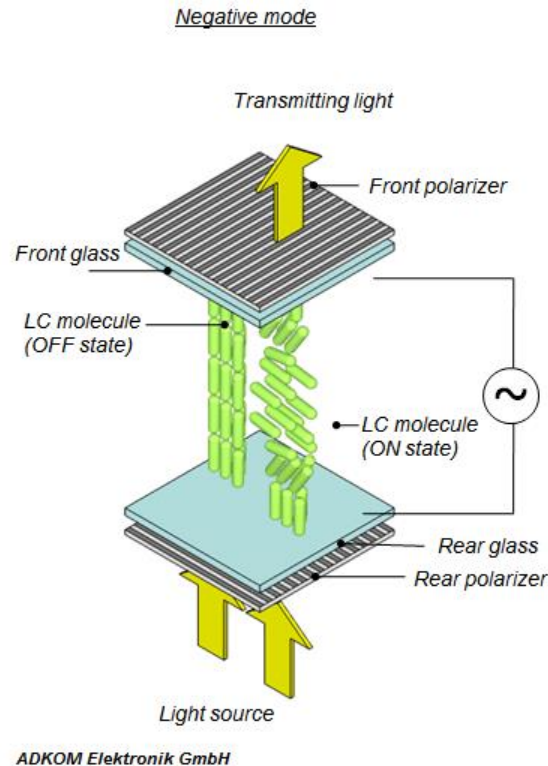


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## Double STN

DSTN consists of two STN LCDs affixed together. An extra passive filled cell, which is on the top of the active cell, acts as a compensator to compensate light dispersion and hence improve viewing properties. DSTN is suitable for negative mode display.

## The ABN technology (advanced black Nematic)



### ABN - Advanced Black Nematic

In ABN LCD (so called VA, Vertical Alignment), liquid crystal materials are switched parallel to the glass substrates by applied an electric field. However, when no voltage is applied to ABN LCD, LC materials are vertically alignment and initially produces an ideal black state between crossed polarizers. ABN LCD is therefore characterized by excellent contrast values and are generally operated in negative mode.