

SOCIETY FOR INFORMATION DISPLAY



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SHORT COURSE S-1

**Fundamentals
of
Passive- and Active-Addressed
Liquid-Crystal Displays**

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Since the birefringence depends on λ the entire intensity I perceived becomes

$$I = \sin^2 4\Theta \int_{\lambda_2}^{\lambda_1} I_0(\lambda) \sin^2 \frac{\pi}{\lambda} d\Delta n(\lambda) d\lambda.$$

The maximum of I was calculated including the loss in the polarizers to 40%.

Switching between the two stable states requires a voltage-impulse across the LC whose product pulse amplitude $\times$ pulse duration has to exceed a limit. Addressing schemes have to comply with this requirement. We discuss one of the most successful schemes outlined in fig. 48, which was proposed by Harada^[16]. The line-voltage V_e in fig. 48a and the column-voltage V_c (data-voltage) in fig. 48b define the voltage V_{LC} across the LC (fig. 48c) as shown in fig. 49 as

$$V_{LC} = V_e - V_c.$$

The width of the pulses is T_p with the exception of the two first ones in V_e where the width is $2T_p$. In the hatched area for V_{LC} in fig. 48c the product amplitude $\times$ width is sufficient for switching. The first two pulses of V_e have the task to switch the pixels in the state 2 as shown in fig. 48c, while being dc-free. From this state the new information is written in. If state 1 is desired, the waveforms for V_c on the left side of fig. 48b apply, whereas for an unchanged state the waveform on the right side is used, which is the negative of the data impulse on the right hand side.

After the switching of a pixel V_e is zero for the remainder of the frame time T_f . However other data-pulses pass the pixel generating cross talk. Even if no switching occurs the directors of the LC oscillate which is visible as flicker in the transmission as plotted in fig. 50.

4. Active matrix liquid crystal displays (AMLCD's)

The shortcomings of passive matrix addressing such as the limitation in the number of addressable lines, in the number of feasible grey shades and in the realizable contrast are overcome by active matrix addressing. In this mode an electronic switch is placed in each pixel providing an additional threshold, the means to store videoinformation on capacitors and an improved shield against parasitic couplings. AMLCDs represent the LCDs with the best performance. Electronic switches are thin film transistors (TFTs), thin film diodes (TFDs) and metal-insulator-metal elements (MIMs). The TFTs have amorphous Si saturated by H (a-Si:H), polycrystalline Si (poly-Si), polycrystalline CdSe or in a new development organic materials as semiconductors. In this paper a-Si:H- and poly-Si-TFTs will be treated. CdSe-TFTs are more seldom used because their fabrication is more complex; they, however, provide the highest electron mobilities up to $400 \text{ cm}^2/\text{Vs}$ at a low temperature manufacture of 380°C . Organic semiconductors are still in their infancy and suffer from instability and a low mobility. MIMs with various dielectrics will be explained, whereas thin film diodes with p-n-junctions will be omitted because their performance is inferior to TFTs while their fabrication is almost as expensive.

The electro-optical effects used in AMLCDs are those in TN-liquid crystals and in polymer dispersed liquid crystals (PDLCs). The operation of TN-displays was already explained in chapter 4; PDLC-displays will be introduced in this section.