

# DESIGN AND IMPLEMENTATION OF CONTROLLER FOR DISPLAY IMAGE WITH PULSE WIDTH MODULATION

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**Abstract:** Pulse width modulation technique is based on the conventional line by line addressing is proposed. A large number of gray shades can be displayed without flicker by using low cost liquid crystal drivers that are designed to drive the pixel to either ON or OFF states. Quality of image in a display depends on the contrast, colour, resolution and the number of gray shades. A large number of gray shades are necessary to display images without any contour lines. These contours are due to limited number of gray shades in the display causing abrupt changes in grayness of the image while the original image has gradual change in brightness. PWM has the capability to display a large number of gray shades with fast switching states.

**Keywords:** Pulse width modulation, liquid crystal display, line by line addressing, gray shades

## I. INTRODUCTION

Liquid crystal displays (LCDs) are thin and can be fabricated in almost any size and format. They consume less power as compared to other display devices and operate with low voltages. Hence, LCDs have an advantage over other types of displays for use in portable products. LCDs are broadly classified as passive matrix and active matrix. Passive matrix displays exploit the intrinsic non-linear electro-optic characteristics for matrix addressing or multiplexing [3, 6]. They are mostly used in applications like personal digital assistant (PDA), mobile phone and other low to moderate information content applications wherein power consumption should be as low as possible. Active matrix LCDs have a thin film transistor incorporated with each pixel. These transistors act as a switch to charge and hold the desired voltage across a pixel. Passive matrix LCDs are easy to fabricate and cost less as compared to the active matrix LCDs. Current trend demands gray scale and colour capabilities even for the displays in mobile phones. Passive matrix LCDs will be preferred as long as the cost and power consumption is low as compared to the active matrix LCDs. Hence it is important that the gray shade techniques used in passive matrix displays should not increase the hardware complexity or cost of the drive electronics. The number of gray shades is an important criterion in the choice of a technique for displaying gray shades.

## II. TECHNIQUES

### Alt Pleshko Technique

In the analysis of scanning limitation of LCDs by Alt and Pleshko [4] the selection ratio is maximized. This was possible by allowing the instantaneous voltage across an OFF pixel to exceed the threshold voltage ( $V_{th}$ ) and yet maintaining the RMS voltage below ( $V_{th}$ ). The maximum

$$\text{Selection ratio} = \frac{\sqrt{N+1}}{\sqrt{N-1}} \dots \dots \dots (1)$$

Where in N is the number of rows multiplexed in equation (1). In the addressing technique proposed by Kawakami et al. the supply voltage for the drivers was reduced with altering the effective waveform across the pixel. A reduction of nearly 50% is achieved when N, the number of lines multiplexed is large.

The performance of display depends on the display cell parameters and the addressing technique used for driving the display. The addressing techniques based on line by line selection are widely used for driving the display due to their inherent simplicity. The fundamental assumption in these techniques is that the period of addressing waveforms is small as compared to the response times of the display. Hence the small address duty factor is not a serious problem. However as the response times of the display decrease, the frame response phenomenon becomes predominant and it is necessary to find an alternate approach to drive the display.

### Choice of addressing technique

The addressing technique satisfy the following requirements

1. The selection ratio must be maximum to achieve good contrast in the display
2. The frame response must also be suppressed effectively for a high contrast in the display.
3. The brightness non-uniformity of the pixels is important for good appearance and gray shade capability of the display.
4. The amplitude of the addressing waveforms should be low to high suppress the frame response and to reduce the supply voltage of the drivers.
5. High address duty factor to suppress the frame response
6. The hardware complexity of drive electronics should be minimum to reduce the cost.
7. DC free operation to ensure long life of the display
8. Gray shade display capability in combination with one of the methods to generate gray shades in the LCDs

### Matrix display

A display is made up of a number of picture elements (pixels).The information being displayed depends on the collective state of the pixels. A matrix display is made up of an array of display elements arranged in the form of a matrix. Most of the electronic display elements require at least two terminals to activate them. Hence a group of pixels is made to share a common lead or address line. Every pixel in the matrix display is connected to a row address line and a column address line. Therefore the row and column address lines form a matrix with the individual pixels at their inter-sections. These pixels can be uniquely addressed as in the case of a two dimensional memory array.

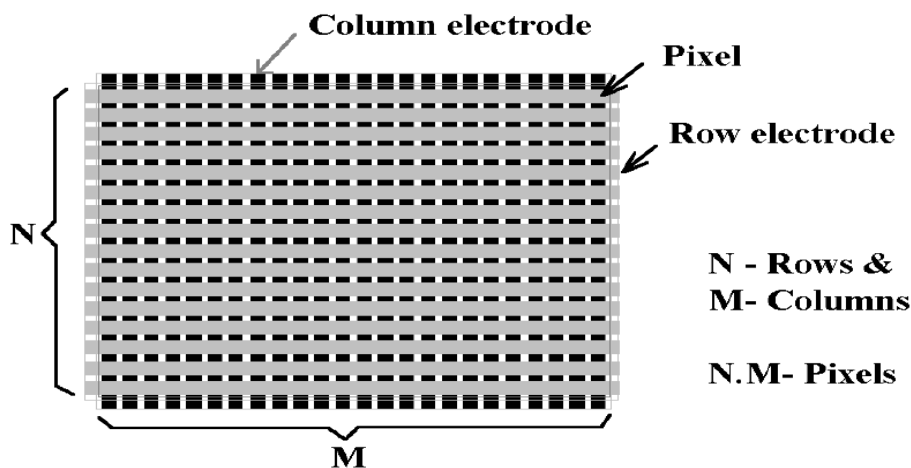


Figure1.Matrix display

A matrix display with  $N$  rows and  $M$  columns can have  $(N \times M)$  pixels, while the number of connections is just  $(N+M)$ .the number of connections to a display is minimum. The pixels in the display are organized as a square : the number of address lines in the row and column of the matrix is the same, and equal to the square-root of the number of pixels.

### Line by line addressing

The line by line addressing forms the basis for most of the addressing techniques used for multiplexing a matrix display. One set of address lines is used for scanning while the other set is used for the signals. The set with a

smaller number of address lines is preferred for scanning. The N addressing lines to be multiplexed are sequentially selected one at a time. The selected row gets voltages  $V_r$  while the unselected rows are grounded. The column voltages  $V_c$  depends on the data to be displayed in the selected row and in phase with  $V_r$  for an OFF pixel and Out of phase for an ON pixel as shown in figure 2.

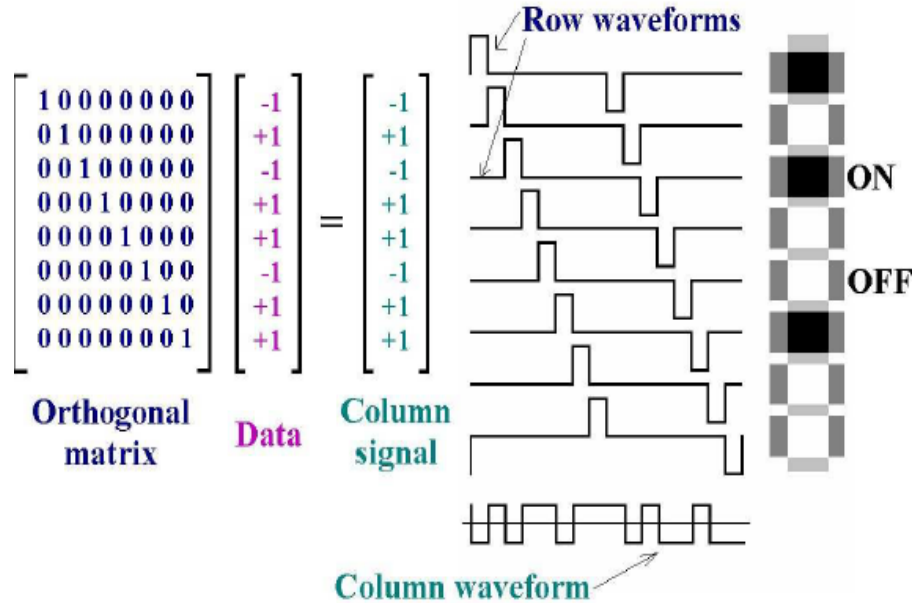


Figure 2 Line by line addressing in matrix display

Both row select patterns and column voltages are simultaneously applied to the display. A cycle is complete when all the rows are selected once.

- Addressing technique based on Half select ,one third select, APT
- Half select and one third select technique do not exploit the RMS behavior of electro optic response and they have lower contrast
- In line by line addressing brightness uniformity of the pixel s dependent on the information to be displayed
- If response time of the display is comparable to the frame period the contrast of the display decreases
- This decreases in contrast is due to a phenomenon is called frame response
- Both the brightness non uniformity and frame response reduce the quality of the displayed image
- 

**Frame modulation**

Frame modulation is also known as frame rate control [5]. Here, the pixels are either turned ON or OFF in successive frames. These pixels appear gray, depending upon the number of times a pixel is switched ON during a cycle consisting of several frames. While switching pixels between ON and OFF states would appear as flicker in fast responding displays, a gray shade is perceived in LCDs due to their slow response and persistence of vision. The rms voltage across a pixel when  $f$  consecutive frames are used to display  $(f+1)$  gray shades

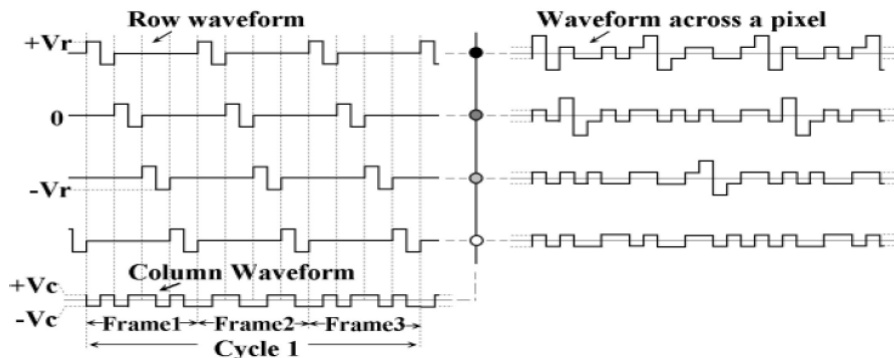


Figure 3. Frame modulation

Seen when the number of frames in a cycle is large. Hardware complexity of the drive electronics does not increase when frame modulation is used. In fact it is the same as that for displaying binary images without any gray shades, since each pixel is driven to just one of the two states in each frame as shown above figure 3. Under optimum conditions for multiplexing (when the selection ratio is maximum), row waveforms deliver one half of the energy to the pixel while the other half of energy is delivered through the column waveforms. In a line by line addressing technique the energy from the row waveform is delivered by a single pulse (which is larger than the threshold voltage). This results in turning even the OFF pixels partially ON resulting in poor contrast. Frame modulation has been popular with super twisted nematic (STN) LCDs. STN LCDs have response times in the range of 100–200 ms. Sixteen gray shades can easily be displayed without flicker in these displays with slow response times. Frame modulation is not suited for displays in television and other applications where in the image changes rapidly.

### III.IMPLEMENTATION

#### Pulse width modulation

The figure 4 consists clock generator, row driver, column driver used voltage level generator is generates row and column voltages in this technique two voltage levels. The row select time may be divided into four equal parts and the corresponding combinations of column voltages for displaying five gray shades are shown in the figure 6. Width of the pulses decrease as the number of gray shades increase. This results presence of high frequency components across the pixels.

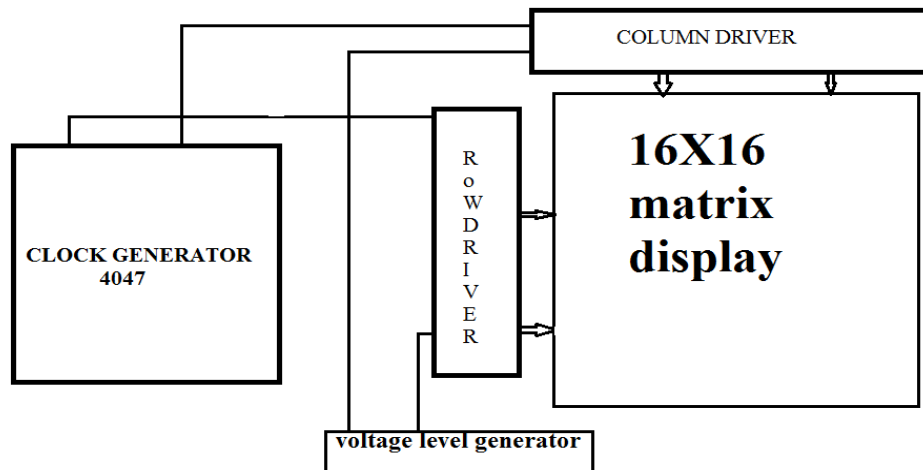


Figure.4 Block diagram of PWM

This will result in brightness non-uniformity of pixels in the display as the number of gray shades is increased .The rowdriver is design by using the ring counter and multiplexer as shown in figure5

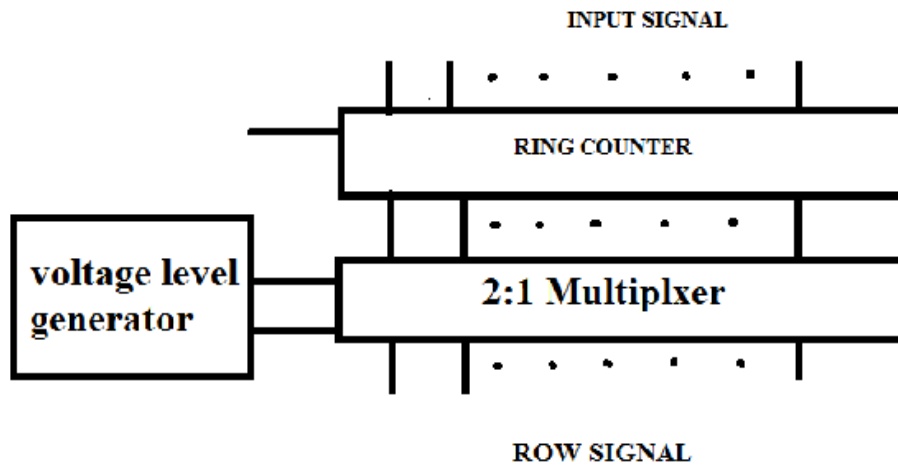


Figure 5. Block diagram of Row driver

Hence, use of pulse width modulation is usually restricted to display Width of the pulses decrease as the number of gray Shades increase..

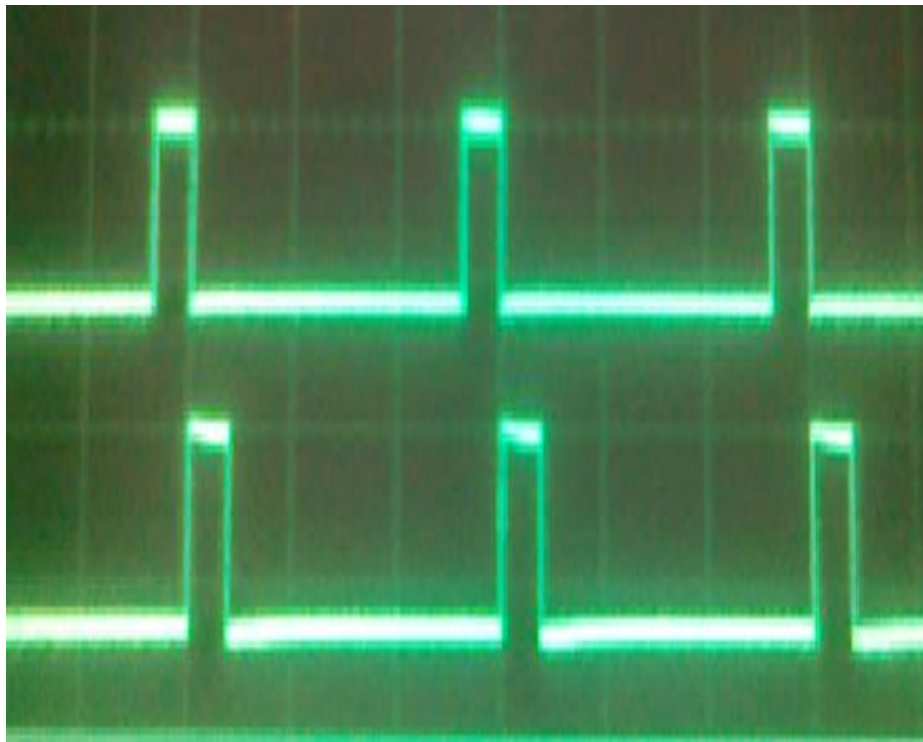


Figure 5(a) row signal from row driver

This results presence of high frequency components across the pixels this will result in brightness non-uniformity of pixels in the display as the number of gray shades is increased. Hence, use of pulse width modulation is usually restricted to display small number of gray shades

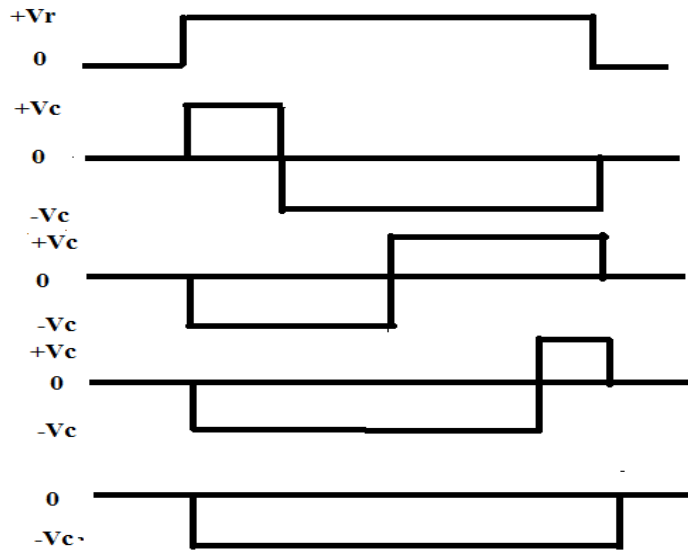


Figure 6 .Pulse width modulation

Column voltage of a pixel is switched between two voltages within a row select time of line-by-line addressing [6]as shown figure 7.

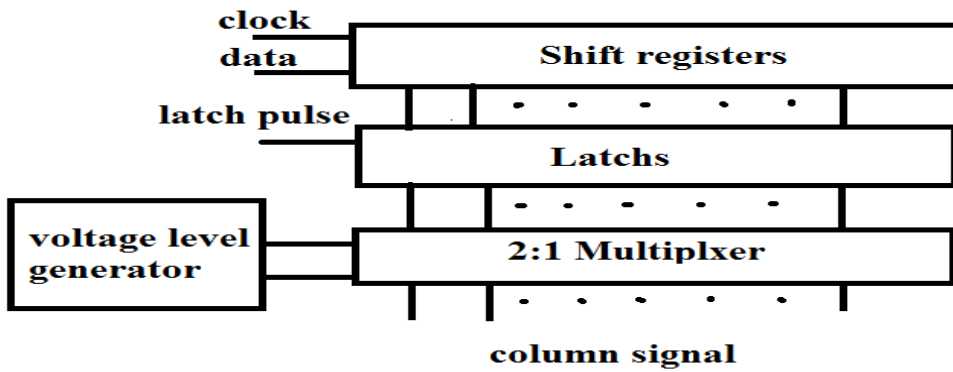


Figure 7.Block diagram of column driver

The two voltages are +Vc and -Vc corresponding to OFF and ON state in a display without gray shades. Here again (w+1) gray shades can be displayed using w time intervals in each row select time as shown figure 8.

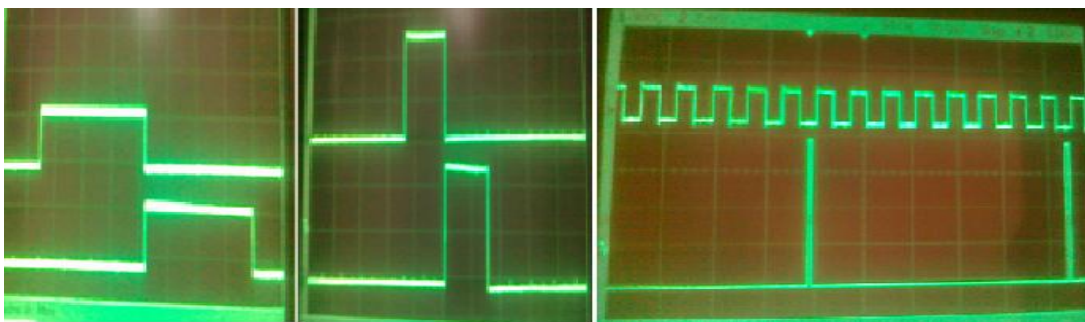


Figure 8. Column signal from column driver

The rms voltage across a pixel when the voltage corresponding to an ON state is applied to a column for time duration during a row select time and voltage corresponding to OFF state during rest of the time interval is:

$$V_{rms} = \sqrt{\frac{1}{NT} \int_0^T (V_r + V_c)^2 dt + \frac{1}{NT} \int_T^T (V_r - V_c)^2 dt + \frac{1}{NT} \int_T^{NT} V_c^2 dt}$$

$$= \sqrt{4 V_r V_c \left(\frac{T}{T}\right) + V_r^2 - 2 V_r V_c + V_c^2 N}$$

We know that  $\frac{V_r}{V_c} = \sqrt{N}$ . According to the APT relation selection ratio is maximum

$$V_{rms} = \sqrt{\frac{V_c^2}{N} (4\sqrt{N} \left(\frac{T}{T}\right) + 2N - 2\sqrt{N})}$$

#### IV.RESULT AND DISCUSSION

Experimental results are presented which verify the correct operation of a line by line addressing scheme based on pulse width modulation as shown figure 9.



Figure 9 Using PWM technique displaying gray shades

#### V. CONCLUSION

The principle underlying the development of pulse width modulation has been presented. The technique has been compared with other techniques for displaying gray shades. Pulse width modulation with g time interval is well-suited for displaying a (g+1) number of gray shades without flicker. Selection ratio as well as the supply voltage of this technique is the same as that of line-by-line addressing.

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