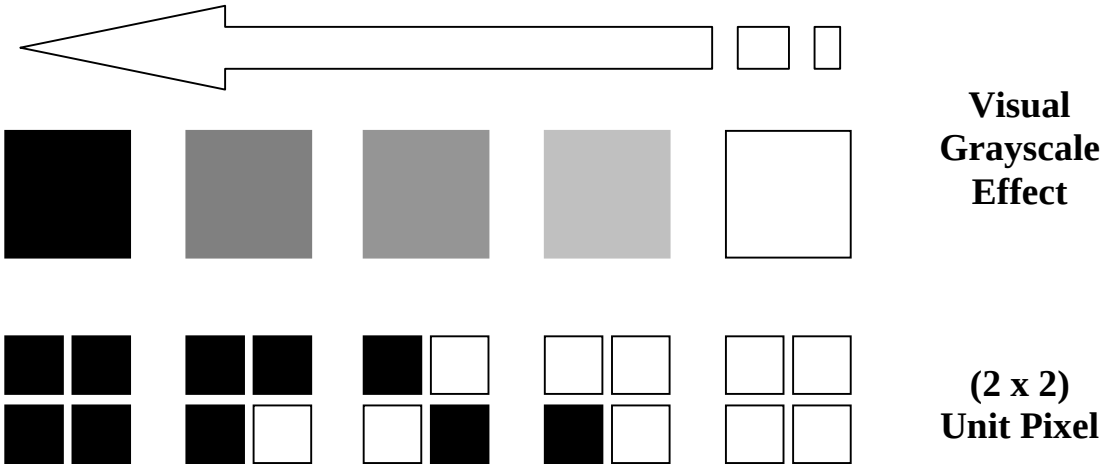
# *Grayscale and Color Generation with SLA/MLA products*

Basically, monochrome STN panel is only able to display black and white (On or Off). It is not inherently able to display gray shades or gray scales. Therefore, some driving methods have been developed in order to achieve grayscale and color display. Dithering and Frame Rate Control (FRC) are the two commons driving methods to generate grayscale in STN LCD Panel.

## ***Dithering***

Dithering is achieved by alternately driving some pixels black and some pixels white in a checkerboard type pattern. When using this method, the pattern should be produced in a random order to create the perception of a gray shade. Dithering is performed using a regular or repeating pattern, grayscale effect can then be detected by our human eyes.

Here is an example for dithering driving method of using a pattern with 4(2x2) pixels to generate 5 grayscale levels,



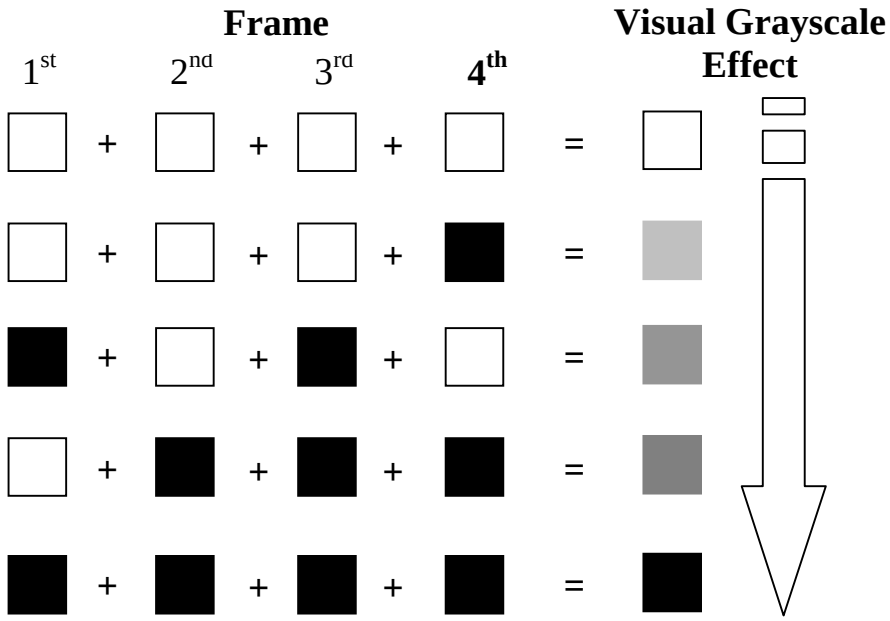

*Dithering Driving Method*

Commonly, more advance dithering methods will be adopted in order to generate a better grayscale display. For example, different checkerboard patterns and random “NO” pixel in a pattern may be used to avoid any visual side effects.

## ***Frame Rate Control (FRC)***

Frame Rate Control is achieved by tuning pixels on and off over several frame periods. With sufficient frame refreshing frequency, our human eyes will average out the darkness of a pixel so that the individual pixel will show as gray.

Here is an example of using 4 FRC to generate 5 grayscale levels,




*FRC Driving Method*

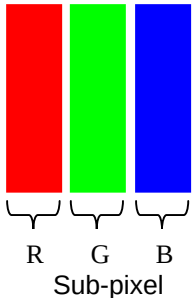
Commonly, FRC is an easier driving method for implementing grayscale. To avoid flickering on the display, the sequence of “ON” and “OFF” pattern should be randomized across each group of FRC pattern. Besides, sufficient high frequency is necessary in order to achieve a smooth display.

## ***Color STN Display***

If you know how to generate the grayscale, it is not a problem for generating color by dithering and FRC driving methods. Usually, there is a layer called color filter on color STN panels. The color filter will be divided into red, green and blue sub-pixel (RGB). Every sub-pixel can be treated as a pixel in the monochromic display. Three sub-pixels (RGB) will be used to display one point of the picture. By displaying different gray level of RGB sub-pixels individually, different colors

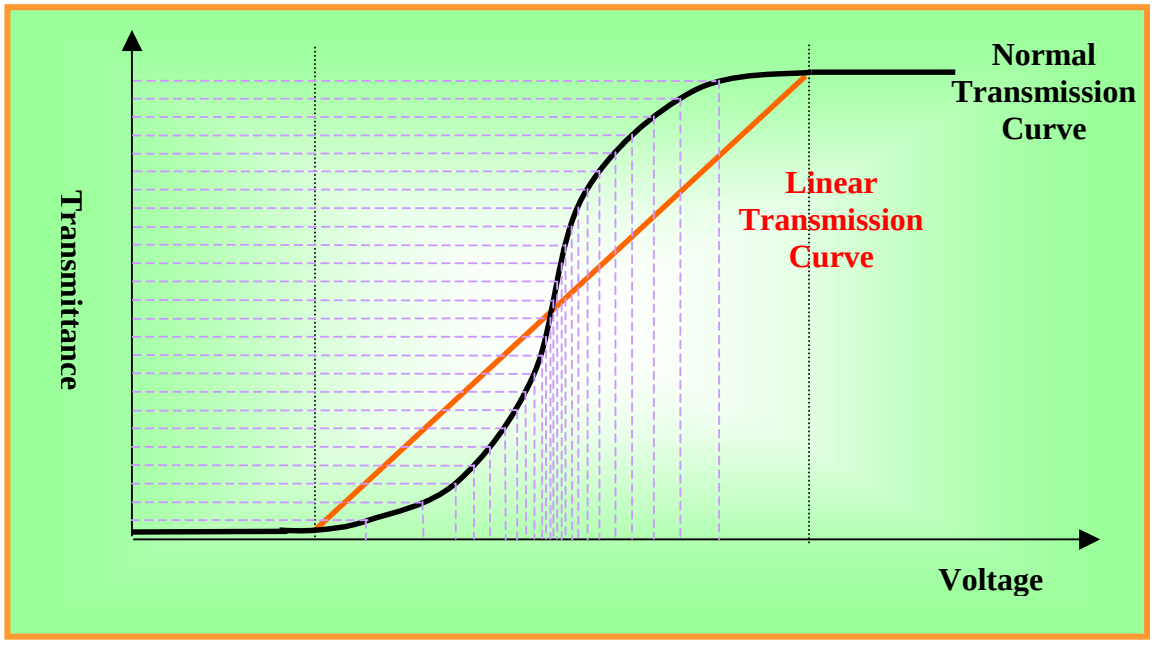
can be achieved. For example, if each R, G and B sub-pixels has 8 gray levels, the maximum display color will be $8^3$ (512 colors).

| Gray level in each sub-pixel | Maximum Color |
|---|---|
| 8 | 512 |
| 16 | 4096 |
| 64 | 262,144 |
| 256 | 16,777,216 |




*Color Generation Table*

Normally, gray levels in LCD are distributed as a non-linear line. The gray level located near the “ON” and “OFF” regions will be difficult to be distinguished. Some of the controllers in the market may provide a Look Up Table (LUT) technique to rematch the gray level to be more linear. This technique can fine adjust the color in LCD by passing through the color map that is preset by users.

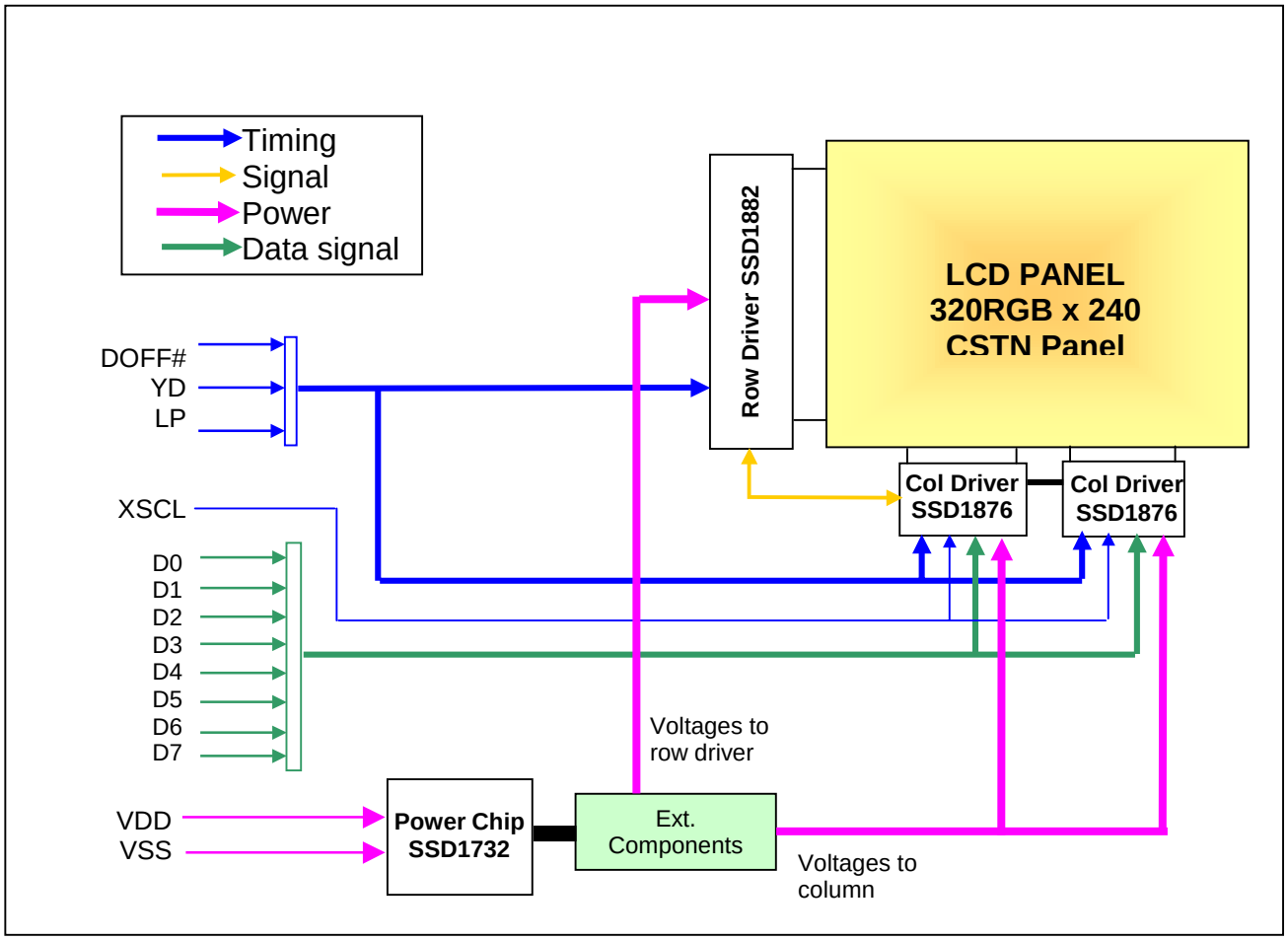



*Transmission Curve in LCD*

## ***Application of SLA and MLA products***

Single Line Addressing (SLA) and Multi-Line Addressing (MLA) are two commons driving schemes on STN LCD. Those driver products provide excellent solutions for PDA-size STN LCD Panel. By using above grayscale generation methods, STN panels can support not only monochromic display, but also the grayscale and color STN display. In fact, most of the LCD controllers in the market consist of such driving schemes and LUT to generate beautiful grayscale and color pictures.

Solomon Systech is one of the leaders in developing SLA and MLA chipset solutions with 480 outputs. A great variety of choices of chipset solutions are provided to the users in order to match with different resolutions and requirements. MLA chipset provides a low power consumption and high display quality solution. On the other hand, SLA chipset provides a cost effective and simple connection solution. The following diagram and table show a typical application circuit of using MLA chipset and suggested solutions with different resolutions.



*MLA Application Diagram*

| | MLA Chipset | | | | | | SLA Chipset | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Display Resolution | SSD1730/SSD1732 MLA Power Chip | SSD1871 160 Column Driver | SSD1873 320 Column Driver | SSD1876 480 Column Driver | SSD1881 160 Row Driver | SSD1882 240 Row Driver | SSD1701 160 Com/Seg Driver | SSD1702 240 Com/Seg Driver | SSD1703 320 Com/Seg Driver | SSD1706 480 Com/Seg Driver |
| **Mono/Gray Scale** | | | | | | | | | | |
| **160 x 160** | 1 | 1 | | | 1 | | 2 | | | |
| **320 x 240** | 1 | | 1 | | | 1 | | 1 | 1 | |
| **320 x 320** | | | | | | | | | 2 | |
| **Color** | | | | | | | | | | |
| **160 RGB x 160** | 1 | | | 1 | 1 | | 1 | | | 1 |
| **320 RGB x 240** | 1 | | | 2 | | 1 | | 1 | | 2 |
| **320 RGB x 320** | | | | | | | | | 1 | 2 |

*Suggested Solution Table*

*Chipset Solutions from Solomon Systech*

*A PDA Phone Application*

## ***Conclusion***

Obviously, monochromic display is no longer being a trend in phone or PDA applications. Color display should be the mainstream in portable devices. By using more advance color generation methods, SLA/MLA chipset can support better and better color display. Some of the products such as games, e-books, e-dictionaries, equipments, PDA phones and smart phones are requesting PDA-size STN display with beautiful color. Single chip solution is difficult to be applied on such applications due to relatively large panel size requirement. Therefore, SLA/MLA chipset should be the appropriate solutions for those markets. Besides, there is no doubt that high-resolution and high-color depth devices are definitely a trend. High pin count drivers that have 320 or 480 outputs will be most welcome in this market.