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Low-Temperature Poly-Si TFT-LCDs with Digital Interface

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1. Introduction

Interest in circuits designed using low-temperature polycrystalline silicon thin film transistors (poly-Si TFTs) has increased for their functional reasons [1]. If the performance and characteristics of poly-Si TFTs are thoroughly considered, it is possible to such driver circuits architecture used in conventional LCDs driver IC.

The data driver circuits perform serial-to-parallel conversion and supply the appropriate analog voltages to the data line. Analog video data are distributed along input lines, which are linked by transmission gates to the matrix data lines. On the other hand, serial digital data are fed into the shift register. Once the register is fully loaded, the data are transferred in parallel into digital to analog (D/A) converters, which generate the appropriate analog signals to drive the data lines. The digital interface with the functional performance is very attractive, but its circuit arrangement is more complex than a conventional analog circuit arrangement. It is still expected from the standpoint of signal shape and noise duration that the performance of LCD panel is greater with the digital interface. Recently a tentative experiment was carried out for the digital TFT circuits for a quarter VGA panel of 2.9 inches in diagonal [2].

In this paper, we describe the details of a full VGA TFT-LCD with integrated 4-bit digital data drivers. The digital drivers have D/A converters which select DC level. A D/A converter with each external standard voltage input is used in the data driver to obtain a digital input display.

2. Circuit Configurations

Figure 1 shows the block diagram of a TFT-LCD driving. The TFT-LCD has a scanning driver, two digital data drivers, and pixels. One digital data driver drives 960 data lines. The digital driver consists of 160 bit shift registers, 320 x RGB x 4 digital latches, 320 x RGB x 4 level shifters and 320 x RGB D/A converters.

We realized high mobility and low threshold voltage TFTs fabricated on a glass at low-temperature. Its each shift register can drive 3.12 MHz with the power supply of 10 V. Accordingly 6.25 MHz digital video data from a VGA controller can be operated by the digital driver. A 4-bit video data signal is stored on latch1 by output pulse of shift register, and, while blanking period of horizontal line video data, stored on latch2 from latch1 by latch signal. Digital video data of latch2 is decoded, driving one analog switch, which selects one DC level in 16 step DC levels. Selected DC level is written on data line. When a scan line is high level, the data is written onto pixels. Figure 2 shows the diagram of digital data driver.

3. D/A converters circuit performance

We confirmed the driving methods of the digital data driver before fabricating the TFT-LCD panel with digital interface.

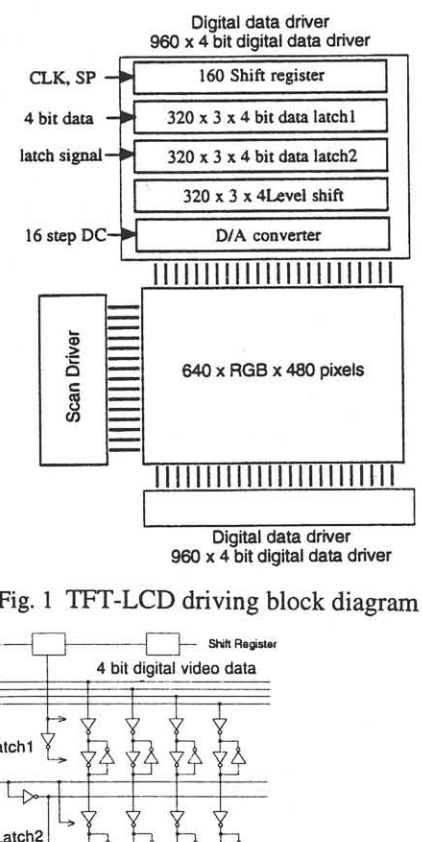

Fig. 1 TFT-LCD driving block diagram

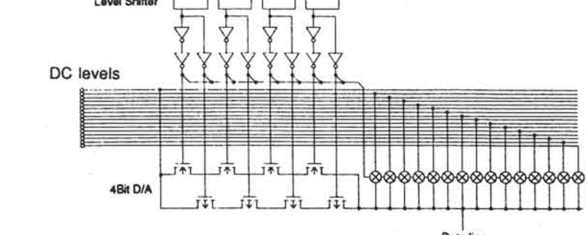

Fig.2 Circuit diagram of digital data driver

Figure 3 shows data of the output voltage of the D/A converter. The experimental 3 bit D/A converter is driven successfully.

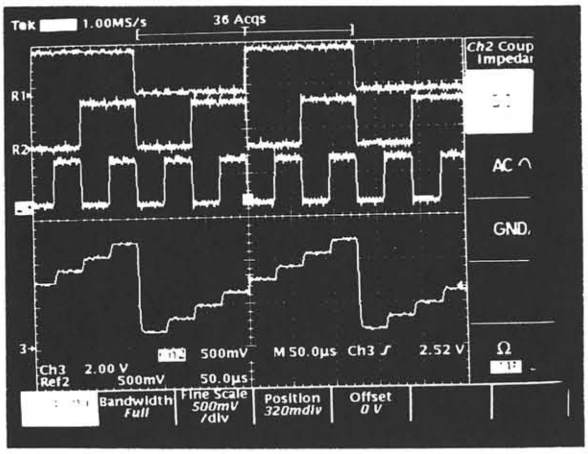

Fig. 3 Data of the output voltage of the D/A converter.

4. TFT-LCD panel performance

We applied the digital interface for a VGA panel which was 4.5 inches in diagonal and had 640 x RGB x 480 pixels. Table 1 summarizes the specifications and performance of the fabricated LCD panel.

Table 1 Specifications of the TFT-LCD

Display diagonal size	4.5 inches
Number of pixels	640 X RGB X 480 (VGA)
Pixel size	48 (H) x 144 (V) um
Aperture ratio	63%
Input data	3 x 4 bit digital
Power supply (Logic)	10 V
Frequency of data driver	6.25 MHz
Frequency of scan driver	15.7 kHz
Addressing mode	Column inversion
Contrast ratio	>100

5. Conclusions

We have newly developed a low-temperature poly-Si TFT-LCD with monolithic 4-bit digital data drivers. The digital data driver can write 6.25 MHz digital video data, and realizes 4096 colors. In this work we have successfully fabricated 4.5-inch full VGA panel.

References

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