13.3/9:50 A.M.: Vacuum Fluorescent Display for TV Video Images

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INTRODUCTION

A graphic VFD having 128 by 128 dot matrix was developed. Combination of thin and thick film technologies,[1][2] effective for high density anode pattern, was adopted in the VFD. Displays of TV images on VFDs became possible by increasing the number of pixels.

This paper describes the possibility of displaying TV images on the VFD. A 128 by 128 dot matrix VFD sample and Pulse Width Modulation circuits for gray scale display were used to study the picture quality.

DISPLAY DEVICE

Specifications

The VFD is illustrated in Fig. 1. Table 1 shows the dimensions, the electrical ratings and the electrical characteristics of the VFD. In this experiment 128(X) by 120(Y) dots were used, the display area resulting in 76.6(X) x 71.8(Y) mm^2.

Pin-out

Some examples of pin-out configurations of dot matrix VFDs are illustrated in Fig. 2. Fig. 2(a) shows a simple dot matrix VFD that requires a total of 256 pin-outs. Non-uniform illumination of the dots may take place with this VFD because negative potential on adjacent grids is liable to disturb the concentration of the electron flow to the dot which is to be lighted at reduced distances between dots.
However, this defect is solved by the 4 anode lines double-matrix method.[2] A number as many as 576 pin-outs, which is divided into 512 anode lines and 64 grid lines, are required in this method as shown in Fig. 2(b). This necessarily entails in complicated anode patterns and in cost-up.

Another solution is found in Fig. 2(c). Here, each row of dots is controlled by a single grid pin-out, while each column of dots is controlled by a pair of anode pin-outs. The dots along the columns are connected alternately into two groups of pin-outs. In order to have the right illumination on a given dot, the grid that runs over the dot as well as the two neighboring grids on both sides must be turned on at the same time. This scheme requires a total of 384 pins, 256 of which are anode lines and 128 are grid lines. The present experiment makes use of a VFD fabricated according to this scheme, the reason being in its expected better illumination than that of Fig. 2 (a) and in the reduced pin-out compared with Fig. 2(b).

Fabrication

Aluminum thin film anode wiring layer is deposited on the glass substrate. After the photolithography of the anode pattern, thick film insulating layer is screen printed on the aluminum layer except the area of dots and lead terminals. Several thick film printing procedures are repeated until sufficient thickness (ca. 100 μm) for the forming of the banks between dot columns is achieved. The purpose of the banks are; (1) electrical insulation, (2) spacer of the grid and anode and (3) the supports of the mesh grids placed over the anode dot rows. To achieve high resolution, the pitch and width of the mesh must be reduced accordingly at high processing precision. Here, consideration must be paid upon the tensile strength which naturally becomes weak as the grid is made finer. Thus, the fine mesh strips are placed at right angles upon ranges of insulator banks, for the purpose to secure accurate spacing between the anode and grid while assuring mechanical stability of the structure.

All other procedures are the same as the former VFD. (1)

DRIVING

Circuit Diagram

Fig. 3 shows the block diagram of the display system. Always three consecutive grids are supplied with positive voltage and are scanned by shift registers located at the grid side. Video signal is amplified and introduced to the 4 bit A/D converter. The converted digital signals are supplied to the line memories (serial-parallel converter) of the A and B groups of the anode lines. In other words, 4 bit gray scale signals are supplied to each anode line. These 4 bit digital signals are led to the multiplexer, into which 16 pulses of different pulse width are connected. Each pulse corresponds to each step of gray scale display. Pulses selected by the multiplexer is introduced into the drivers.

Timing

Fig. 4 shows the timing chart. A line-at-a-time scanning and one-field=one-frame at 60 Hz frame frequency are adopted here. The video signal is sampled 128 times in alternate scanning lines. A number of 128(X) by 120(Y) dots are used for display. The display is performed by line-at-a-time method, the signal of which being released from line memories. The line memories act as serial-parallel converters in both the A and B groups. These operations are done alternately. While A group goes on displaying, B group will be converting the next data to be displayed. Positive voltage should be applied to each grid during the 6H length. The 2H, located at the middle of the period, contributes to the illumination. The maximum anode pulse width, the high light of the images, corresponds to 2H in this case.

DISCUSSION

TV images were displayed on the VFD. Fig. 5 shows the displayed picture. The 16 gray scale control pulses correspond to brightness from non to peak luminance. Consequently, 16 gray scales must appear on the TV image display. However, a gray scale which was less than sixteen was actually observed. It is inferred that this came about because of the presence of abnormal and/or non-uniform luminance on the VFD. Also, alternate dim and bright stripes parallel to the filaments were observed. Hence, it is necessary to improve the VFD, by increasing the number of filaments, and to revise the circuit.
The displayed image, however, was better than expected. The response was similar to that of CRTs.
In concluding, it may be said that VFD is applicable for TV image display by improving VFD proper and the driving circuits for that purpose.

Reference

[1] K. Kasano, et al. "A 240-Character Vacuum Fluorescent Display and its Drive Circuitry", Proceedings of the SID 1980 Vol 21 p107-p111

[2] K. Kasano, et al. "A Ramdom Access Memory 26 x 258 Dot Flat Panel Vacuum Fluorescent Display, 1980 SID Int'l Symp. Digest p74-p75

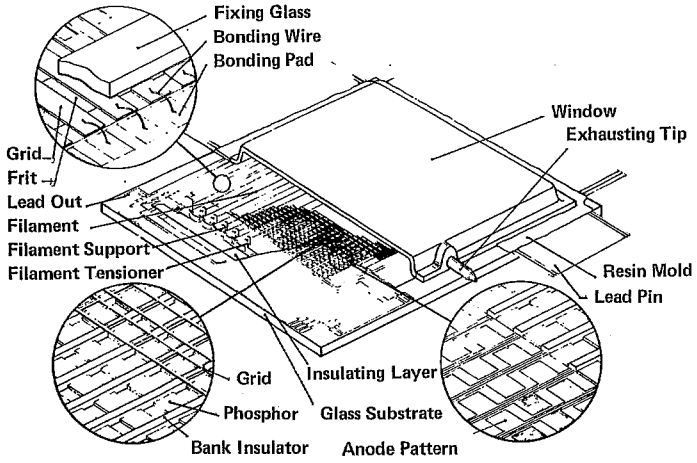

Fig. 1 Cut-Out View of the VFD

Physical Dimensions			
Number of Dots		128 X 128 = 16384	
Dot Size		0.4(X) X 0.35(Y) mm^2	
Dot Pitch		0.6 mm along X & Y	
Display Area		76.6 X 76.55 mm^2	
Display Size		17.7(T) X 130(X) x 150(Y) mm^3	
Electrical Ratings			
Filament Voltage	Ef	4.5	Vac
Anode Voltage	eb	70	Vp-p } D.F=1/150
Grid Voltage	ec	70	Vp-p } P.W=100μsec
Electrical Characteristics			
Filament Current	If	676	mAac
Anode Current/col.	ib	4.8	mAp-p
Grid Current/row	ic	3.7	mAp-p
Luminance	L	125	fl

Table 1 Specifications

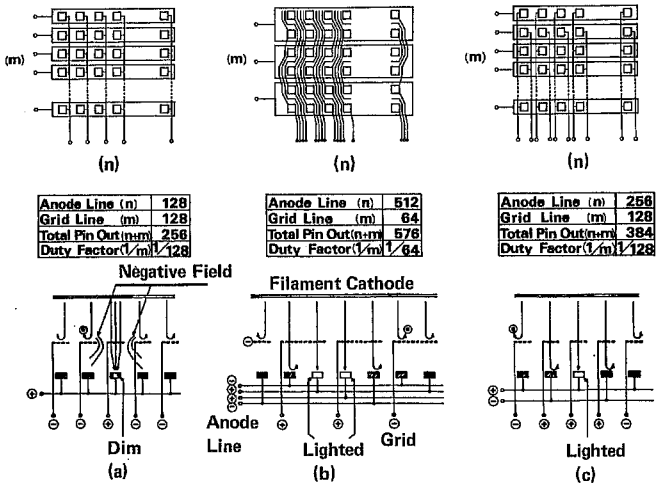

Fig. 2 Pin-Out Configuration

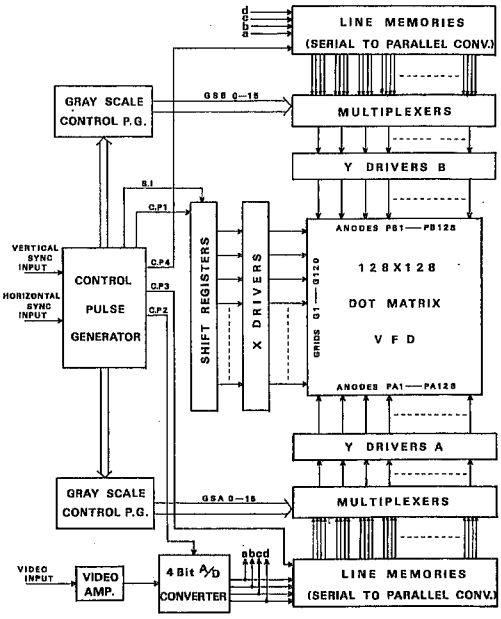

Fig. 3 Circuit Diagram

Fig. 4 Timing Chart

Fig. 5 Displayed Picture