8.3 / 9:50 A.M.: A 240-Character Vacuum Fluorescent Display and its Driving Ability

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INTRODUCTION

A flat panel 240 character Vacuum Fluorescent Display (VFD) has been developed which can display full ASCII character font.

A great number of flat panel numerical VFDs which display bright green figures under relatively low driving voltage and power consumption have been used in calculator, clock and ECR markets.(1)

As the next step, we developed single line character VFDs having 20 to 40 characters where anode substrates are formed with multi-layer of thick conductive and insulating films. They are used in personal computers, POS terminals, etc.

Now, the single line character VFDs have successfully extended to the multi-line, capable of displaying 240 characters, in which both thin and thick film technologies have been adopted for the anode substrate.

DESIGN

Structure of this VFD is illustrated in Fig. 1, where 240 characters are divided into 6 lines of 40 characters, and each character consists of 35 dots (5 x 7) and a cursor. There are 40 grids for time-sharing control of the emission flow from the cathode; a column of 6 characters is covered by one grid. A selection of forty grids enables one to operate the VFD with duty factor of approx. 1/40 which leads to a reasonably low voltage to produce high brightness as found in Table 1. In this case, total of 258 lead-outs (36 x 6 = 216 leads for the anode, 40 for the grid and 2 for the cathode) are necessary.

The character size is 5(H) x 3.5(W) mm and the dot 0.5 mm square. Spacing of lines and columns are equivalent to 3 dots and 2 dots respectively. Display overall is 250(L) x 100(W) x 14.5(T) mm.

FABRICATION

Preparation of Anode

It is an important factor to reduce the cross over points in the anode wiring in order to increase yield and reliability of the device through forming a simple insulating layer. The anode substrate is formed with only three layers and there are only two cross over points per dot. A simple three layer structure which consists of the first Al-thin film conductive layer for lead wiring, the glass thick film insulating layer for cross over and the second Al-thin film conductive layer for anode electrode is formed on a glass plate.

Approx. 1.5 um thickness Al-film is deposited on all over the surface of a normal soda-lime glass plate by DC magnetron sputtering. Then it is etched to the fine pattern as shown in Fig. 2 using photolithography, which is served as the first conductive layer.

The glass insulating layer having 20 to 30 μm in thickness is screen printed on the processed substrate so as to produce thru-holes only on the dots with the accuracy of the positioning within 75 μm.

The second conductive layer is deposited only on the thru-hole points of insulating layer by DC magnetron sputtering using a metal mask. Dot of the second conductive layer has a size of 0.5 mm square and contacts to the first conductive layer through thru-hole.

The cross section of the anode structure thus formed is illustrated in Fig. 3.

Assembling and Exhausting

This process is the same as our previous VFD: 1) phosphor is electrophoretically deposited on the anode electrodes, 2) mesh grids are fixed, 3) two filaments coated with cathode materials are stretched over a character line, 4) window glass is sealed with frit, 5) the bulb is exhausted and tipped off at approx. 1 x 10^{-6} Torr.

DRIVING

Driving diagram of this VFD is shown in Fig. 4.

A microcomputer and an external ROM/RAM have been adopted for this driving circuits.

CPU controls the whole driving circuits and I/O data to the host system.

ROM contains the full ASCII character patterns and the control program. RAM memorizes 240 character data which come from the host system.

Scanning of column from left to right is controlled by shift registers for the grid.

There are shift registers and latches for the anode. A series of 8 bit parallel signals from CPU is shifted 5 times to complete one character pattern. This process should be repeated 6 times to complete 6 characters in a column. And then, these patterns are latched. When grid scanning pulse selects the leftmost column position, the first latched 6 characters are pushed off to the display, and next 6 characters are input to the shift registers during this display timing.

The above cycle is repeated 40 times for one display cycle.

CONCLUSION

A new flat panel 240 character VFD having average brightness of 220 fL under standard operating condition (shown in Table 1) has been produced with a combination of thin and thick film technologies, which is proved to be effective for increasing of yield and reliability of this device.

Adopt of μP simplified the driving circuits, which opened the way for the wide applications, especially read-out of middle class of the intelligent terminals.

Reference:

1) K.Kiyozumi, et al. "Flat Panel Multi-Digit Fluorescent Display" SID 76 Int'l Symp. p130 & p131

Table 1

Electrical Characteristics

Item	Standard Operating Cond.		Note
Filament Volt.	8.8	Vac	r.m.s.
Filament Curr.	312	mAac	r.m.s.
Anode Volt.	50	Vp-p	du=1/45,p.w=100 μs.
Anode Curr.	4.5	mAp-p	per character
Grid Volt.	50	Vp-p	du=1/45,p.w=100 μs.
Grid Curr.	27	mAp-p	per column
Cut-off Volt.	-12	Vdc	against to cathode
Brightness	220	fL	average per dot

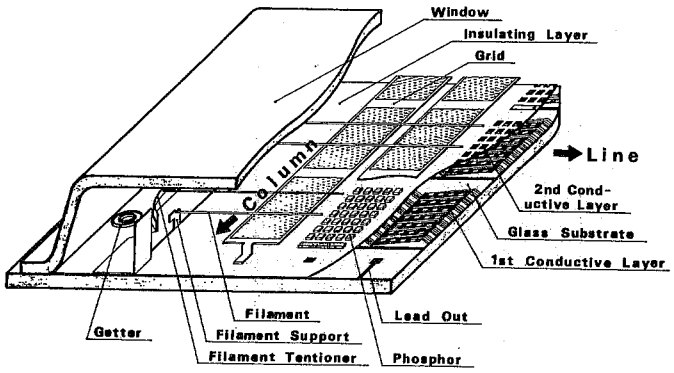

Fig. 1 Display perspective view

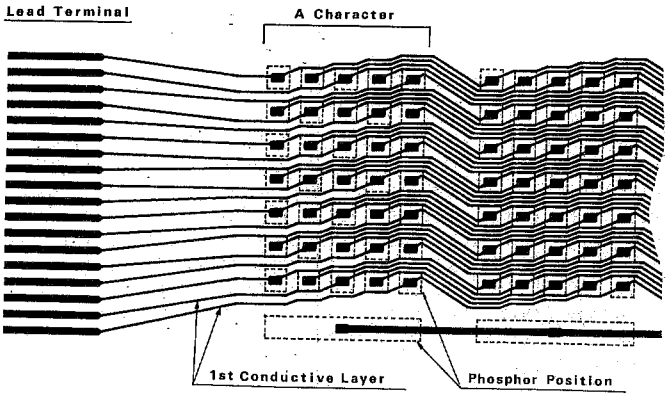

Fig. 2 Wiring Pattern of the Anode Dots

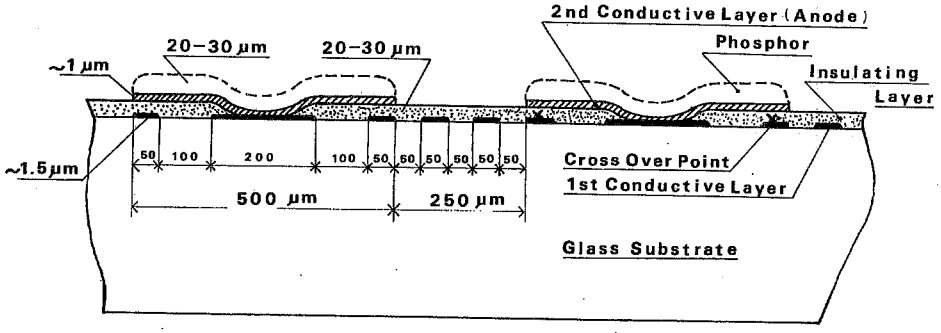

Fig. 3 Layer cross section: Detailed illustration of the anode structure

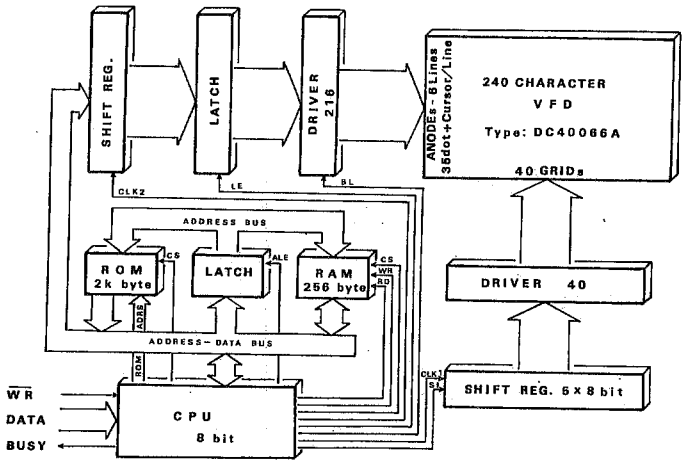

Fig. 4 An example of driving block diagram

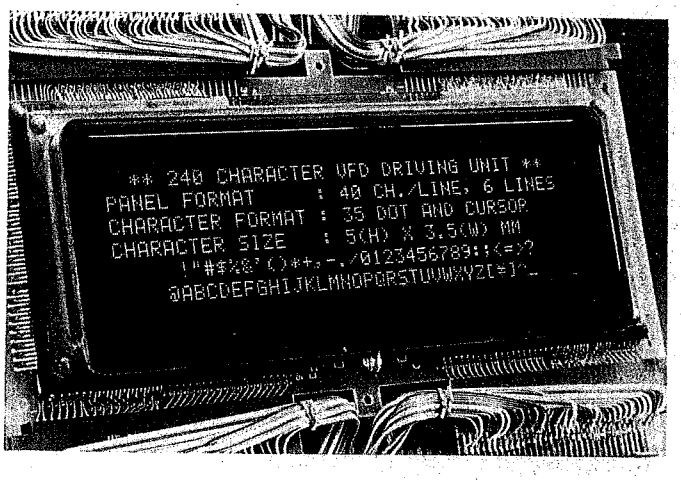

Fig. 5 An engineering model